Formulation and standardization of millet-based protein-mineral enriched granola bar

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ABSTRACT

Malnutrition predominantly affects children and women, presenting itself in various forms such as undernutrition (characterized by wasting, stunting, and being underweight), insufficiency of vital vitamins or minerals, obesity, and leading the development of non-communicable diseases linked to dietary factors. Overcoming malnutrition can be achieved through the scientific preparation of traditional foods incorporating millets and pulses in appropriate quantities, considering the existing knowledge and preparation gap in traditional millet-based foods across generations. Recognizing this, NITI Aayog has recently unveiled a pilot program aimed at integrating millets into the Integrated Child Development Services (ICDS) and Mid-Day Meal (MDM) schemes nationwide.. The present study was undertaken to develop a protein and mineral-enriched granola bar based on millets mainly a combination of bajra, jawar, ragi crispy, amaranth puff, and moong dal. From a sweetness and health point of view, jaggery was used instead of refined sugar. The ingredients were mixed in different proportions based on response surface methodology (RSM) and the granola bars were prepared using a hot pressing technique. The optimized formulation was selected using RSM based on the protein content, overall acceptability, bowl life, and hardness. Further evaluation studies like nutrient composition and shelf life were carried out by standard analytical methods. The moisture content found to be 3.26%, while protein 10.85gm/100 gm, fat 11.80gm/100gm, carbohydrate 69.65gm/100gm, crude fibre 1.88mg/100gm.The total ash content of the bar was 2.65g/100g. The calcium and iron content on analysis was found to be 88.20mg and 5.03 mg/100gm respectively. The developed bar provided 428.20 kcal of energy per 100g, which qualified the product as a good energy-dense snack for children and women whom ed are o undernutrition. The microbial load of this bar was found to be below detectable limits during storage for 2 months. The unit cost of preparation of the granola bar was Rs.6.00/- per 25g. The developed millet-based granola bar is found to be a nutritious snack, easy to prepare, affordable, and more cost-effective than the commercial granola bar.

Keywords

Malnutrition, RSM, millets, overall acceptability

1. INTRODUCTION

A serious public health issue concerning malnutrition among children under five in India has been acknowledged. India has been identified to have one of the highest rates of underweight children globally, with a rate that is almost double that of Sub-Saharan Africa. This issue's concentration in India is evident through the observation that a significant burden is primarily borne by only five states and 50% of villages, equating to about 80% of the problem. The global impact of malnutrition is believed to result in approximately 2.3 million infant deaths annually, which accounts for 41% of all infant mortality in developing nations. (Swoop et al., 2017).

Finger millet, also known as ragi or manual (Eleusine coracana L.), is a widely cultivated crop in India and worldwide. India holds the title of being the largest producer, accounting for approximately 60% of the global output. Unlike other grains, finger millet is consumed without hulling. It has a growth period of 100 to 130 days and is well-suited for acidic soils and regions with higher rainfall (600 to 1,200 mm). In terms of nutritional composition, finger millet grain contains 81.5% carbohydrates, 9.8% protein, 4.3% crude fiber, and 2.7% minerals. Notably, its crude fiber and mineral content surpass those of rice, wheat, and other millets, while its protein content is also significant. (Amir et al., 2014)

Sorghum [*Sorghum bicolor (L.) Moench*], a staple crop originating from Africa, continues to play a

crucial role in the diets of rural populations. With an annual production of between 100,000 and 180,000 tonnes and grown primarily in arid regions with an average temperature of 25°C, sorghum serves as a source of food in areas with limited resources. The grain, with a protein content ranging from 8-12%, a starch content of 65-76%, and 2% fiber, is comparable in composition to maize except for its lower oil content. The germ of sorghum, however, stands out as a nutritious source of protein (19%), ash (10%), and oil (28% of the germ). (Abah et al., 2020).

Pearl millet (Pennisetum glaucum), commonly known as Bajra, Bajri, Sajje, Kambu, Kamban, and Sajjalu in various regions of India, belongs to the Poaceae family. This cereal crop plays a versatile role in providing sustenance, forage, and food. In comparison to other cereals like wheat, rice, maize, and sorghum, pearl millet exhibits exceptional nutritional value, attributed to its deep root system, which enables it to access nutrients from the soil. It is a rich source of vital minerals such as iron, zinc, magnesium, copper, manganese, potassium, and phosphorus. Consequently, pearl millet provides ample energy with a calorific value of 361 Kcal per 100g, and it possesses a high fiber content of 1.2g per 100g. These findings are highlighted in a study conducted by Monika et al. in 2020.

2. Material and methodology
2.1 Raw Materials
Formulations for the granola bar food composed of amaranth, jaggery, and moong dal procured from the local market of Loni kalbhor. Finger millet crispy, pearl millet crispy, and sorghum crispy were procured from Susy foods, Dadar West Mumbai. Amaranth and moong dal were procured in one lot and stored in closed containers for further use in the experiment.
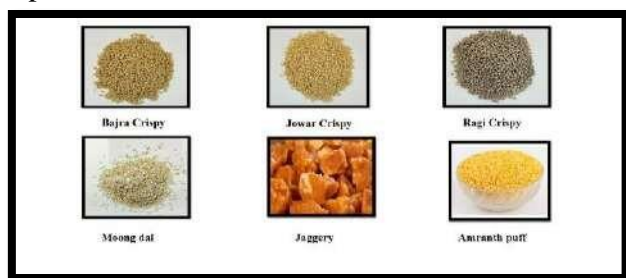

2.2 Preliminary trials

Table No-1

Raw material	S1	S2	S3
Ragi crispy	2.5	5	10
Amaranth puff	2.5	5	10
Jowar crispy	2.5	5	10
Bajra crispy	2.5	5	10
Moong dal	25	5	10
Jaggery	65	75	50

2.3 Procedure for developing granola bar
The granola bar development procedure reported by Fast and Caldwell (1990) was adopted for producing the granola bar. Various types of millets crispies are used (finger millet crispy, pearl millet crispy, and sorghum crispy) other ingredients namely amaranth puff, and fired moong dal. All these crispies are purchased from Susy food Pvt limited and checked for its purity before being used in the granola bar development. Following this method, twenty different formulations of granola bars in triplicate varying finger millet crispy, pearl millet crispy, and moong dal concentrations were developed.
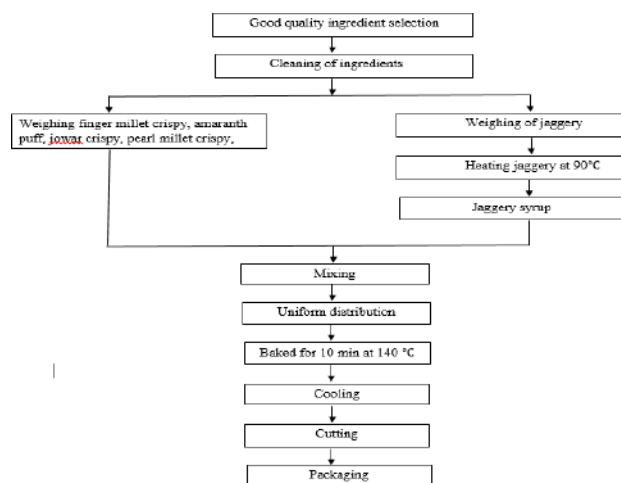
3. Results and discussion
3.1 Analysis of Raw Material

3.1.1 Proximate composition

A proximate composition such as moisture, ash, protein, crude fiber, carbohydrate, and fat analyzed for the selected raw material was discussed below.

Table 1 Proximate composition

Raw Materials	Moisture	Fat	Protein	Ash	Crude fiber	Carbohydrate
Bajra crispy	4.16 ± 0.76	1.64 ± 0.06	9.43 ± 0.60	1.78 ± 0.25	2.10 ± 0.36	80.89 ± 1.10
Jowar crispy	4.31 ± 0.65	1.35 ± 0.05	9.23 ± 0.92	2.38 ± 0.53	3.85 ± 0.78	78.88 ± 1.11
Ragi crispy	5.44 ± 0.60	2.36 ± 0.06	8.50 ± 1.32	1.95 ± 0.50	4.71 ± 0.25	77.04 ± 1.05
Amaranth puff	4.93 ± 0.25	3.59 ± 0.18	9.25 ± 0.66	1.70 ± 0.32	5.03 ± 0.45	75.50 ± 1.10
Jaggery	6.83 ± 0.76	1.25 ± 0.25	2.50 ± 0.50	4.50 ± 0.50	1.13 ± 0.12	83.79 ± 0.20
Moong dal	7.10 ± 0.36	1.45 ± 0.40	11.33 ± 1.52	3.50 ± 0.50	3.41 ± 0.38	73.21 ± 1.09

3.2. Physico-chemical and sensory evaluation of granola bar

3.2.1. Chemical analysis of granola bar

Table 2 Physicochemical analysis of granola

Parameter	Sample 17
Moisture %	3.26 ± 1.00
Protein %	10.85 ± 1.05
Fat %	11.8 ± 0.99
Carbohydrate %	69.56 ± 1.00
Energy Kcal/100g	428.2 ± 0.90
Total ash on a dry basis %	2.65 ± 1.01
Crude fibre %	1.88 ± 0.83

3.3. Effect of storage period on the moisture content of granola bar

3.3.1. Microbial quality of granola bar during storage period

The study measured the total plate count and yeast/mold count of the granola bars during a 60-day storage period. The results indicate that the use of high-density polyethylene (HDPE) and low-density. Polyethylene (LDPE) as packaging materials prevented microbial growth in the granola bars during the 60-day storage period.

Table 3 Microbial quality of granola bar during storage period

Storage period	HDPE	LDPE
0	3.26 ± 0.04	3.26 ± 0.04
10	3.30 ± 0.05	3.34 ± 0.04
20	3.35 ± 0.05	3.40 ± 0.06
30	3.42 ± 0.02	3.44 ± 0.04
40	3.51 ± 0.03	3.54 ± 0.06
50	3.57 ± 0.02	3.61 ± 0.03
60	3.67 ± 0.02	3.70 ± 0.08

4. Conclusion:

The formulation and standardization of a millet based protein-mineral enriched granola bar made from pearl millet, sorghum, ragi crispy, amaranth puff, jaggery, and moong dal can be an effective solution to address malnutrition. The addition of amaranth puff adds a crispy texture to the granola bar, which can provide a satisfying and enjoyable eating experience, encouraging individuals to

consume the supplement regularl. It is evident that the developed millet based granola bar is found to be nutridense snack, easy to prepare, affordable, and more cost effective than the commercial granola bar.

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Standardization and Value Addition for Development of Frozen *Kebab* using Germinated Brown Rice, Fenugreek Microgreens and Mustard Microgreens.

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ABSTRACT

The ingredients incorporated in frozen *kebab* is loaded with various nutritional properties. microgreens is 40% more nutritious than mature greens. The microgreens incorporated in frozen *kebab* prevents various health conditions.The addition of germinated brown rice, fenugreek microgreens and mustard microgreens was aimed for improving nutritional properties and to develop a convenience food product. The formulation of developed frozen *kebab* is standardized using germinated brown rice and two different types of microgreens (fenugreek microgreens, mustard microgreens), formulated with 20% GBR, 10% FM, and 10% MM was selected based on sensory characteristics. The selected product S3 has highest sensory score among all samples color (7.9), appearance (8.2), texture (8.3), flavor (7.8), taste (7.9), overall acceptability (8.02). The proximate analysis of S3 shows protein (12.66%), carbohydrates (26.64%), crude fiber (7.41%), dietary fiber (2.79%), ash (2.2%).

Keywords: *Germinated brown rice, fenugreek microgreens, mustard microgreens, kebab.*

1. INTRODUCTION

In response to changing lifestyles, there is an increase in demand for ready to fry convenient food items. A variety of frozen food products are continuously being launched to the market in order to meet the demand. The main drivers of increased use and variety of frozen meals are growing consumer preference for time saving convenience in food preparation and consumer openness to trying new food products (Torres and Canet, 2001).

Microgreens are young vegetable greens that have been collected after cotyledon leaves have formed and having intense aroma. Microgreens are excellent source of potent nutrients and can be used in various products to add a value to that product (Yanqi Zhang *et al*., 2021). Microgreens are having larger concentrations of phenolics, antioxidants, minerals, and vitamins than developed greens or seeds. These ae well recognize as good carrier of biologically active components (Mir *et al*., 2017). Microgreens are gaining increasing interest as a potential functional foods, due to their relevant contents of micronutrients and bioactive compounds (Sun j. *et al*., 2013). They are gaining popularity due to their attractive colors, textures, and flavors. (Renna *et al*., 2017).

In addition to being used as garnish, microgreens are increasingly being used as fundamental ingredients in the creation of new product with distinctive flavors (Renna *et al*., 2017).

Microgreens are loaded with nutrients despite the fact that their concentration may vary slightly, many varieties are rich in K, Fe, Zn, Mg, and Cu (Xiao *et al*., 2012). studies have shown that the percentage of nutrients in microgreens are up to nine times greater than the mature greens (Pinto *et al*., 2015). Presence of antioxidants can facilitate to lower risk of type 2 diabetes. In laboratory experiments, it is shown that fenugreek microgreens increases cellular sugar uptake by 25-44% (M.H., 1996; Wadhawan *et al*., 2018). Mustard (*Brassica juncea L.*) greens includes a variety of phytochemicals that are known to promote health, including carotenoids and phenolic compounds. These chemicals are frequently linked to their capacity to act as detoxifiers against oxidative stress. Mustard greens include a number of antioxidants such as phenolic compounds that may have health advantage against the onset of chronic diseases (Marissa D. Frazie *et al*., 2017).

The antioxidant activity of fenugreek microgreens is higher than fenugreek mature leaves, research clearly reveals that the antioxidant activity of fenugreek microgreens is 35% and fenugreek mature leaves is at 19.3% (M. D. Ghoora and N. Srividya, 2017).

Germinated brown rice having higher GABA content aids in the prevention of Alzheimer's disease. GBR dramatically enhanced spatial learning. Germinated brown rice have a powerful inhibitor of the protylendopetidase enzyme, which has been linked to Alzheimer disease (Kayahara and Tsukahara, 2000).

Germinated brown rice (GBR) was created to enhance the taste and flavor of brown rice. germination process produces beneficial bioactive compounds. Brown rice that has been germinated is also referred as sprouted brown rice, The germination process increses the bioavailability of nutrients (Swati B. Patil *et al*.,2011). It has been discovered that the germination of brown rice grains boosted the amount of numerous nutrients including total protein, vitamin B, reducing sugar (Trachoo *et al*.,2006).

The wholesomeness of germinated brown rice have drawn the attention of a growing number of researchers, and some of them have discovered a link between a diet high in germinated brown rice can treat the specific disease. germinated brown rice can be viewed as a functional food because it has been shown to have a variety of physiological effects such as antihyperlipidemia and antihypertension as well as it may decreased risk of cancer, diabetes, cardiovascular disease and alzheimers disease. functional foods have received special attention because they play a significant part in illness prevention or slowing the progression of chronic diseases by providing the critical nutrients through consistent ingestion at effective amounts as a part of a diet (Hasler, 2002) and (Viuda Martos *et al*., 2010).

During the analysis it is observed that acylated steryl glucoside (ASG) is major growth factor in brown rice after germination of brown rice the level of good enzymes are increased which is beneficial for preventing diabetes and helps to control the blood sugar level and reduces the risk of type 2 diabetes (Rasolt, 2008).

Germinated brown rice requires less cooking time and due to water absorption by kernels during germination resulted in size expansion of brown rice and has better sensory properties (Jiamyangyuen and Ooraikul, 2008).

Starch is main component found in rice grains, in endosperm polysaccharide is stored and hydrolyzed during the germination to produce soluble sugars. it is identified that during the germination the reducing sugar content of brown rice increases as germination process is initiated (Ayernor and ocloo, 2007).

The albumin and gluten protein contents of brown rice are increased during germination, while the globulin and gliadin concentrations are decreased. hence the bioavailability of the protein available in brown rice is improved much better (Zheng *et al*., 2007).

It is reported that during the germination process the level of protein is significantly increases time of the germination (Chen *et al*.,2003).

Initially the free amino acid content of brown rice is 1.96 mg/g but as germination process starts the free amino acid content is also increases to 3.69 mg/g (Veluppillai *et al*., 2009).

It has been reported that the germination of grains increases the antioxidant activity and also having a higher total phenolic acid contents (Xu *et al*., 2009).

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Raw Materials
Raw materials such as fenugreek microgreens, mustard microgreens are grown in laboratory on Grow mat, germinated brown rice were purchased from e-commerce website and soya chunks and other minor ingredients were purchased from the local market Loni kalbhor, Pune.

2.1.2 Chemicals
Chemicals of analytical grade were made available in the laboratories of MIT School of Food Technology.

2.1.3 Processing Equipments
The analytical equipment's like microwave oven for moisture content, kejaldhal for protein estimation, soxlet for fat estimation, fibrotron for total fiber estimation, muffle furnace for estimation of ash content were made available in the laboratories of MIT School of Food Technology.

2.2 Methods

2.2.1 Preparation of germinated brown rice and microgreens frozen *kebab*
The preparation starts with the production of microgreens, in product two varieties are used i.e. fenugreek

microgreens and mustard microgreens were grown on grow mat for 6-7 days and then procured for product preparation. then soya kheema is prepared from boiled soya chunks (80°C-4min) grind the boiled soya chunks and add ingredients required to make a soya kheema i.e. gram flour, corn flour, boiled potato, use this soya kheema mixture for further preparation of the product. the preparation of the frozen kebab starts with the blanching of microgreens at (60°C-3min) in next step germinated brown rice is coarsely ground and cooking is done at (70°C-6min) then add other minor ingredients (soya kheema, black pepper, chili powder, asafoetida, cumin seeds, black salt) mixing is carried out, after mixing of all ingredients shaping is done into a round shape(each kebab is weighed contains 25 gm of mixture) the prepared kebab is packed in metallized polyester and LDPE (low density polyethylene) and allowed to stored at (-18°C). The similar process was followed by (Maity T. *et al.,* 2012).

2.2.2 Formulation of brown rice and microgreens frozen *kebab*

Table 1 : Formulation of frozen *kebab*

Sample	Soya kheema	GBR	FM	MM
Control	100	0	0	0
S1	40	40	10	10
S2	40	30	20	10
S3	60	20	10	10
S4	60	10	10	20

GBR- germinated brown rice
FM- fenugreek microgreens
MM- mustard microgreens
for preparation of 40% soya kheema contains 24g boiled soya chunks, 4g bengal gram flour, 4g corn flour, 8g boiled potato. and 60% soya kheema contains 36g boiled soya chunks, 6g bengal gram flour, 6g corn flour, 12g boiled potato.

2.3 Sensory analysis
The sensory evaluation of frozen kebab sample was evaluated using a 9 point hedonic rating test (1-Extremely dislike to 9-Extremely like). The scorecard suggested by Ranganna,(1986) was used for judging the product frozen kebab during this study. A sensory judging panel was constituted with panelists among the faculty members of the MIT School of Food Technology. The experimental samples were served to the judges under ambient conditions. The panelists were instructed to rate each sample on 9 points hedonic scale which included a score for color appearance, taste, flavor, texture, mouthfeel, and overall acceptability of developed product. Also, judges were asked to comment on the characteristics of the samples. The final score for each attribute was obtained by averaging the score of all the panelists.

2.4 Proximate composition of frozen *kebab*
The developed product were analysed for moisture, fat, protein by AOAC, (2005), ash Ranganna, (1986), crude fiber AOAC, (2005), dietary fiber AOAC, (985.29), and carbohydrate content was calculated by difference method.

2. 5 Statistical analysis

The statistical analysis was performed by applying a one-way analysis of variance. The mean was calculated from triplicate readings. The level of significance was calculated CD (critical difference at 5%). The statistical design for analysis for analysis of data was used completely randomized design (CRD) as given by Panse and Shukhatme, (1967).

3. RESULT AND DISCUSSION

3.1 Sensory evaluation of frozen *kebab*

Kebab prepared with different formulations of Germinated brown rice, fenugreek microgreens and mustard microgreens were subjected for sensory evaluation to evaluate maximum acceptability of the product. The obtained results are presented in graph 1.
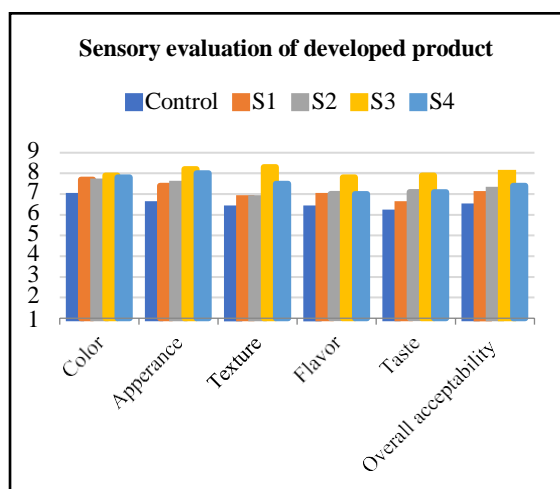
Graph 1: Sensory evaluation of developed product

The S3 incorporated with 20% germinated brown rice, 10% fenugreek microgreens, 10% mustard microgreens scored highest to sensory parameters color (7.9), appearance (8.2), texture (8.3), flavour (7.8), taste (7.9), overall acceptability (8.02) as compared to other samples.

3.2 Proximate composition of instant frozen *kebab* fortified with GBR, FM and MM

The prepared *kebab* were further analysed for proximate composition and obtained results are indices in Table 2.

Table 2: Proximate composition

The moisture content of formulated frozen kebab was found constant in all samples S1 to S4 (38.7%-38.6%) and slightly increased in control (39%). protein has immense importance as body building component. data from table 6 indicated the rise in protein S3 (12.66%). The control has highest protein because it contains 100% soya kheema so results are obvious regarding the protein content of control. The fat content was found slight difference (10%) for control, (9.8%) for S1 and S2, S3 has (10.24%) and S4 (10.2%). Fiber is made up of indigestive plant components or substances that pass through our stomach and intestines relatively undamaged, the primary function of fiber is to keep the digestive system healthy. due to inclusion of soya kheema and germinated brown rice the crude fiber content is increased from control (4.2%) to S3 (7.41%). The finished product has contain (7.41%) crude fiber highest among all the samples. The sensorially accepted frozen kebab incorporated with germinated brown rice, fenugreek microgreens and mustard microgreens (S3) contains (2.79%) dietary fiber. The ash content of food product is simply the result of organic content being burned away, leaving inorganic minerals. In frozen kebab ash content was found from control (2.2%) to S4 (2.1%). carbohydrates provide energy to perform daily tasks. carbohydrates was observed for finished product is (26.64%) for S3.

4. CONCLUSION

It can be concluded that new product is developed successfully by incorporating 60% soya kheema, 20% germinated brown rice, 10% fenugreek microgreens and 10% mustard microgreens. This could be improved the nutritional status of population. The developed product contains sufficient amount of nutrients such as protein (12.66%), carbohydrates (26.64%), crude fiber (7.41%), dietary fiber (2.79%). The product was gone through 12-semi trained panel members and it indicates that product was sensorially well accepted. The standardized product sensory score were found highest among all the samples color (7.9), appearance (8.2), texture (8.3), flavor (7.8), taste (7.9), overall acceptability (8.02).

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Samples	Moisture (%)	Protein (%)	Fat (%)	Carbohydrates (%)	Crude Fiber (%)	Dietary Fiber (%)	Ash (%)
Control	39	19.9	10	15.7	4.2	9	2.2
S1	38.7	8.1	9.8	33.3	6.4	1.7	2.2
S2	38.8	9.8	9.8	34	6.2	1.5	2.3
S3	38.45	12.66	10.24	26.64	7.41	2.79	2.2
S4	38.6	12.4	10.2	27	7.3	2.6	2.1
SE±	0.0522	0.0384	0.0180	0.0165	0.0285	0.0160	0.0253
CD@5%	0.1647	0.1210	0.0567	0.0522	0.0899	0.0506	0.0800

(The values were mean ± standard deviation of three independent readings)

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"IOT BASED POLLUTION MONITORING SYSTEM"

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Abstract: Internet of Things (IOT) is advanced technique for handling pollution levels in the atmosphere. It is the IoT-based Pollution Monitoring System. This procedure offers accurate, present data about the dissimilar pollutants present in the air, water, and earth by use the power of interacted devices and cutting-edge data analysis tools. The system is made up of sensors that identify and quantify contaminants, IoT devices that gather and send the data to a centralised server or cloud based platform, and a spontaneous interface for data visualisation and analysis. The devices placed in key areas constantly track the levels of contaminants like ozone, carbon monoxide, nitrogen dioxide, particulate matter, and other dangerous compounds. The Internet of Things (IoT) devices serve as data collection points, gathering sensor data and sending it over wired or wireless communication protocols to a centralised server. With the help of sophisticated algorithms and machine learning techniques, the central server or cloud platform processes and analyses the gathered data to produce insightful results. In conclusion, the IoT-based Pollution Monitoring System represents a significant advancement in environmental monitoring and management. By leveraging IoT technologies, data analysis, and visualization, this system offers a comprehensive solution for monitoring pollution levels, enabling informed decision-making, and fostering a healthier and sustainable environment.
Keywords: IOT (Internet of Things); Pollution levels; sensors.

1. Introduction

Publics are becoming worse and the climate is changing in such a way that it has made it difficult for publics to living, affording to the daily reporters and any other electronic or print media. Pollution is the primary cause of climate change and poor health in individuals. This technique was developed with the intention of conducting research on a severe issue and estimating the quality of pollution for humans and other living things.

Researchers are currently evaluating different air pollution monitoring methods. As automated systems are growing increasingly common every day, it is only natural that their primary design objective was to automatically collect environmental data and analyse it using cutting-edge technology. The plan's automatic data collecting and analysis was introduced by the system. We have discovered that this method frequently falls short of accurately detecting the contamination. Due to the prevalence of android operating systems and internet connection in modern society, a server and an android app have been created to keep track of the statistics.

Among the most basic and essential components for human existence is air. The path to

a healthy lives is to inhale clean, sound air. The United States' major and most impacting caring right now is air pollution. In general, reasonable pollution levels are unlikely to have any major short-term significances on someone who is young and in decent health. Higher pollution levels and long-term exposure, however, will result in more severe symptoms and bugs that are harmful to social health. This has an impact on more than just the inflammatory response and metabolic systems.

2. Review of Literature

The recommended mentioned system includes two main components: an Internet-Enabled Pollution inspecting Server and a Mobile Data Acquisition Unit (Mobile-DAQ). Let's explore each component in more detail:

2.1 Internet-Enabled Pollution Inspecting Server:

This server acts as the vital hub for assembling and handling smog-related data. It is intended to be unbreakable and capable of handling large amounts of data. The server is connected to the internet, allowing it to communicate with the Mobile-DAQ units and other devices in the system.

2.2 Mobile Data Acquisition Unit (Mobile-DAQ):

The Mobile-DAQ is a portable device that collects pollution data in real-time. It integrates several components to facilitate its functionality:

2.3 Global Positioning System Module (GPS-Module):

This module enables the Mobile-DAQ to determine its precise geographical location using signals from GPS satellites. It provides accurate location data, which can be used to correlate pollution measurements with specific locations.

2.4 General Packet Radio Service instrument (GPRS instrument):

The GPRS instrument allows the Mobile-DAQ to transmit data over the internet. It enables communication between the Mobile-DAQ and the Pollution Inspecting Server, facilitating the transfer of collected pollution data.

2.5 Pollution Sensor Array:

The Mobile-DAQ incorporates a sensor array specifically designed to measure and detect various types of pollutants in the environment. These sensors can detect parameters such as air quality, particulate matter, gases, and other relevant pollutants.

2.6 Single-Chip Microcontroller:

The single-chip microcontroller acts as the brain of the Mobile-DAQ, coordinating the operations of different components and facilitating data acquisition, processing, and transmission. It ensures efficient and reliable functioning of the device.

Overall, this recommended system allows for efficient and continuous monitoring of pollution levels in various locations. The Mobile-DAQ units collect real-time pollution data using the integrated sensor array, along with GPS information for accurate location tracking. The collected data is then transmitted to the Internet-Enabled Pollution Inspecting Server through the GPRS instrument, enabling centralized storage, analysis, and visualization of the pollution data.

The Smog-Server could be a high-end processer or computer application server with net property. The Mobile-DAQ element collects air pollutants levels (CO, NO2, and SO2), and packs them into a vary frame with the GPS physical location, time, and date. The arrangement is subsequently uploaded to the GPRS-Modem and conveyed to the Pollution-Server via the broad community mobile network. The Pollution-Server is linked to an information server which updates the pollution level for a broader spectrum of consumers, include insurance companies, automobile registration workplaces, and sustainability organisations. The Pollution-Server combines with Google Maps to show present levels of pollution and their precise locations in large urban areas. The technology has successfully undergone testing in the city. The system offers 24-hour/7-day reports on the location and level of period pollutants. [1]

The present research proposes the Pollution-Sense system for monitoring and decreasing air pollution. The system's primary goal is to provide people access to the pollution status so that they are able to deal to their specific issues. An enormous amount of pollutant information have to be offered by Pollution-Sense in time as well as space, at different granularities. Members of the government will be allowed to monitor and manage the Air Quality Index of a nation, state, or city. The most significant components of the structure are also described, including the sensing devices, first level integrator, graphical user interface, software architecture, individual client and server modules, and the data visualisation module. [2]

The theme of home automation that this paper presents would remotely live electrical parameters and manage household appliances. The united arrangement will let the residents avoid using different systems to track their home usage. The resident's preferred laptop or iPad device is frequently used to operate the systems. Installing Smart sensing modules and establishing a ZigBee-based WSN at a few homes allows the system's intended functionality to be tested. [3]

This paper aims to present the creation of an all-inclusive, low-cost technological solution capable of measuring CO, CO2, and dust density (i.e., the number of airborne particles per cubic metre), wirelessly transmitting the composed data in real-time, storing it in a relational database, and displaying this data in a Web application. This entails putting together hardware and software that can communicate with one another. [4]

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3. Methodology

The formation of a kit that will be located in the required position for checking is the focal goal. The kit will mainly contain of an Arduino, which will be used to arrange all the sensors, a Wi-Fi module for data transfer, and a GPS module for location finding. The Wi-Fi unit will send every analysis that the kit has taken to the server. Data from numerous positions are exposed utilising scientific and user-responsive methods, such as on a PC or smart mobile. When the pollution level betters the usual range threshold value, the appropriate specialists subject real-time warnings.
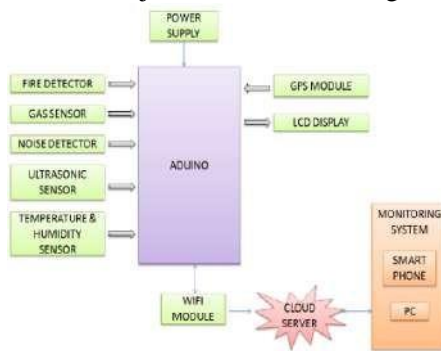
Fig.1. Block diagram of proposed system

3.1 Arduino Mega

The ATmega2560 microcontroller is backed by this board. It contains 64 unoriginal inputs, 4 UARTs (hardware serial ports), a crystal oscillator with a frequency of 16 MHz, 54 digital input/output pins (14 of which will be used as PWM outputs), an USB port, a power jack, a header for ICSP, and a reset switch. It includes anything desirable to support a microcontroller; for getting started, just connect it to a laptop with a USB cable, or power it with an AC-to-DC adapter or battery..

3.2. MQ2 gas device

The sensor in question has an identifying element composed primarily of ceramic with an aluminum-oxide base and a tin dioxide covering that is enclosed in a stainless steel mesh. Sensing element is held up by six connecting legs. The sensing element is warmed by two leads, while the other four are used to generate output signals. When a sensing material is heated to a high temperature in air, oxygen becomes adsorbed on the substance's surface. Donor electrons from the tin chemical complex then flow to this chemical element, stopping the flow of current.

3.3 Sound sensing element module

It offers an easy method for understanding sound and is usually used for sound intensity detection.

Applications involving security, changing, and observation will make use of this module. For ease of use, its accuracy will be simply altered. It makes use of a microphone to supply the input for related gadgets like a peak detector and buffer. When a sound is detected, the detector analyses the associated output voltage and sends it to a microcontroller, where the relevant operations are then carried out.

3.4 Ultrasonic Distance Sensing Element

The Flame Detector Sensor Modules is able to detecting either regular light or flames. Frequently employed as a flame alarm. It can detect a flame or a light source with a wavelength between 760 and 1100 nm. It is sensitive to the flame spectrum and has a detection range of within 60 degrees. Its sensitivity could have adjusted and works reliably.

3.5 IR Based Fire Detection Sensing Element Module

The Flame Detector Sensor Modules is able to detecting either regular light or flames. Frequently employed as a flame alarm. It can detect a flame or a light source with a wavelength between 760 and 1100 nm. It is sensitive to the flame spectrum and has a detection range of within 60 degrees. Its sensitivity could have adjusted and works reliably.

3.6 Temperature and Wetness sensing element

The DHT11 may be a simple, absurdly cheap digital humidity and temperature detectors. It detects the amount of moisture in the air surrounding it utilising an electrical phenomenon humidness detector and a thermister, then spit out an electronic signal on the information pin (no conventional input pins are needed). While it is reasonably simple to use, exact temporal preparation is needed for gathering information. The only significant drawback of this detector is that it is able to supply you with fresh information once per second. As a result, whereas utilising the library's resources, detector readings are sometimes up to two seconds out of date.

3.7 WI-FI module

A inexpensive Wi-Fi microprocessors with a full TCP/IP stack and microcontroller capabilities, the ESP8266 was created by Shanghai, China-based firm Espress ion Technology. With the ESP-01 module, manufactured by a third party supplier, the chip initially attracted the interest of Western companies in the month of August 2014. Using the aid of Hayes-style directions, this small module allows microcontrollers to connect to wireless internet networks and establish simple TCP/IP

connections. However, early on, there was very little English-language information available about the chip and the instructions it supported. Many hackers became attracted to the module, chip, and package on it in addition to transforming the Chinese documentation due to its extremely low price and the fact that it had so few external parts, which implied that it could ultimately be produced at a very low cost per unit. The ESP8285 is an ESP8266 with one MB of intrinsic flash, enabling single-chip Wi-Fi connectivity for devices.

3.8 GPS receivers

mobile devices, fleet management platforms, military use, etc. usually use GPS receivers to track or detect location. The Global Positioning System (GPS) is a satellite-based system that determines and measures its position on Planet utilising ground-based stations and satellites. Guidance Systems involving Time and Travel GPS is another name for GPS. For accuracy, a GPS receiver requires data from at least four satellites. The satellites receive no data from the GPS receiver. This GPS receiver is used in a variety of applications, include fleet management, cabs, and smartphones.A GPS receiver determines its precise location regardless of where it is through a constellation of satellites and ground stations. The receiver receives data signals from the GPS satellites at frequencies between 1.1 and 1.5 GHz.

3.9 Liquid Crystal Display 16×2
The liquid crystal display can not actually release light; rather, it makes advantage of liquid sunlight viewing abilities. A flat panel display or an electronic illustration display could both be liquid crystal displays. Low information LCD content is produced in the form of a fixed picture or an arbitrary image that is either apparent or undetectable, such as the existing words, numbers, or 7 segment display. Uninformed pictures have a lot of tiny pixels, and the element contains bigger pieces.

3.10 Software
Using the Arduino Integrated Development Environment (IDE), integrated C code is executed to turn on the Arduino controller. The no cost, integrated tools and atmosphere known as Arduino (IDE) may be used to programme the Arduino processor. The controller receives the programme instructions via a USB wire.

3.11 Blynk

Think of your cell phone as a test board where you can drag and drop buttons, sliders, screens, graphs, and other helpful widgets. And after a few minutes, these widgets will control Arduino and collect data from it. Using the Internet, Blynk operates. Thus, the only need is that your gear make use of the internet. Blynk libraries and sample sketches can get you online, connect to Blynk Server, and combine with your smartphone regardless of the type of connection you choose, whether it LAN, WI-FI, or even this new ESP8266 everyone seems to be talking about.

4. Advantages
- Toxic gas detection is relatively simple.
- Cost-effective.
- Circuit is less difficult.
- Because of its Internet of Things foundation, remote access is feasible.

5. Applications
- It may be utilised by government agencies or by any sector that regularly checks the level of pollution in the environment.
- Industry-related pollution can be frequently checked.

6. Result and Discussion
We carried out the study after connecting and programming each component to work with the others. We have created a prototype Internet of Things-driven pollution monitoring system that complies with the suggested method. The sensors, the GSM module, and the Arduino are all connected together.
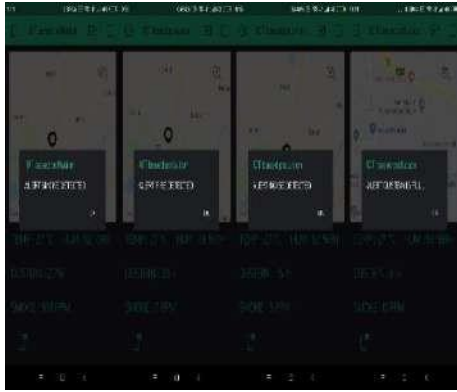

Fig.2. Top view of whole system.

Fig.3. Alert of smoke fire; noise detected and dustbin full

Information is collected via the Arduino from multiple sensors. The kit's surrounds are tracked for pollution with the sensors placed in different places. With the help of the Wi-Fi module, these sensor measurements are sent to the server. The data is displayed on a The Blynk programme. If the sensor values fall within the permissible range, they appear on the LCD display and the mobile device. In order to inform users to avoid highly polluted places, an alert message is presented on the Blynk application if the readings from the sensors surpass the threshold value.

To make it possible monitoring to take place at any time and from any place, we included a live pollution monitoring system in our project. Android phones are necessary for this. Using the Blynk app, which is available in the Google Play store, one can broadcast live. Another individual may then log into an account and see the live status.
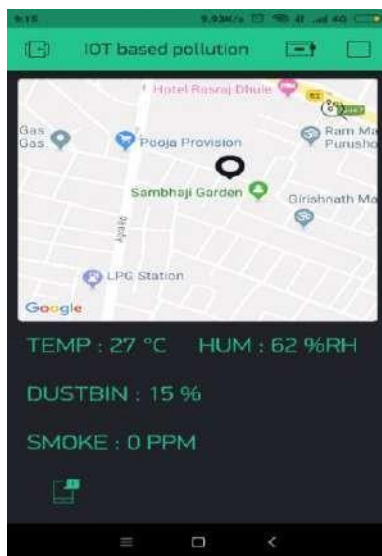

Fig.4. Map showing system location

7. Conclusion

Utilising the internet of things, a pollution monitoring system was created, put into reality, and tested. The setup is used to gather pollution from the environment. A central server collects environmental data from multiple sensors and sends it to authority. The objective was to develop an internet-based real-time tracking system for combating pollution. The model made up a computer system with an n-layer architecture, open-source hardware, and cheap software. In addition, a software part was created and programmed in the C/C++ language to enable data transmission. We needed to lower market prices and offer more affordable solutions with this software look at and the utilisation of Arduino-based hardware. In the years to come, our device might continue to be checked to see if the sensors are still working while offering real-time data. The hardware devices can have a light system added to it. The illumination system is going to function automatically. For instance, each of the four types of gases has its own light. When a specific sensor detects a gas, the corresponding light next to that gas will turn on, and when the sensor no longer detects that specific gas, the light will turn off automatically.

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Empirical study on investigation of applications of Artificial Intelligence in Food Safety

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ABSTRACT

The food industry currently place a strong emphasis on food safety. Food safety is important for public health. Looking at data from the World Health Organization (WHO), which predicts that 600 million people (nearly 1 in 10) get sick every year after consuming contaminated food, resulting in around 420,000 deaths, makes it very evident. Food safety is the practices of handling, preparing, and storing food in a way that minimizes the possibility that people would contract a food-borne illness.

In this study we reviewed many applications, comparing their benefits, limitations, and establishments as a guideline for selecting the suitable techniques for increasing AI and food safety-related advances. Additionally, the integration of this system with other devices such as an electronic nose, tongue, and computer vision system, 3D printing, and near-infrared spectroscopy (NIR) is stressed, all of which will benefit both industry participants and consumers.

It has been discovered that by developing and applying artificial intelligence approaches, one may enhance the quality and services of food while also lowering the risks to food safety in a variety of industries, including the dairy, bakery, beverage, fruit, and vegetable sectors.

In light of the Covid-19 outbreak, this study concludes studies on how food is handled from the farm to the workplace and how any neglect can devastate society. Strict regulation, an update to the food handling procedures, and measures to stop the spread of new infectious diseases related to food are all advised by this evaluation.

Keywords: AI, Food industry, Food sensors, Model development guidelines, Covid-19, Farm to fork

1. Introduction

Artificial intelligence (AI) is a branch of computer science (Schroer, 2023) that mimics human thinking processes, learning ability, and knowledge storage. Among the industries that have made use of AI methods are gaming, weather forecasting, heavy industry, process industry, food industry, medical industry, data mining, stem cells, and knowledge representation.AI algorithms include reinforcement learning, expert systems, fuzzy logic (FL), swarm intelligence, the Turing test, cognitive science, artificial neural networks (ANN), and logic programming. (Nidhi Rajesh Mavani, 2021) AI's enticing performance has made it the most appealing tool to use in industries

such as decision making and process estimation, with the objective of reducing overall costs, increasing efficiency, and increasing profitability. Food demand is expected to rise from 59 to 98% by 2050 as the world's population grows. Thus, to meet this food demand, AI has been used in areas such as supply chain management, food sorting, production development, food quality improvement, and proper industrial hygiene.

The AI method provides numerous benefits, and its use in the food industry has been increasing for decades. AI has been effectively used for applications such as sorting fresh produce, supply chain management, food safety monitoring procedures, optimal cleaning in place systems, predicting consumer desire, and new product development, with improved efficiency and cost savings (Isahit).Nonetheless, this paper will focus on the application of AI in food industries beginning in 2015, as there has been a tremendous increase in implementation and innovation recently.

2. Role of AI in Food Safety

AI or machine learning (ML) is a relatively new modeling system that has observed widespread application in real-world problems (What is Machine Learning? Defination, Types, Applications, and more, 2023). AI has been used in a variety of fields, including modelling, classification, and data analysis. In food science and processing, AI has been utilized for sorting, quality control of food samples, and wine analysis. CIP and COP systems help the food industry in maintaining hygiene and maintaining high product standards. Even these systems function with the assistance of AI. These are known as SOCIP (Self-Optimizing Clean In Place). (Mounika Addanki, 2022) AI in agribusiness generally requires data analysis, decision making, and good activity by applying machine power to a early diagnosis of yield sicknesses, and increasing farming inputs and profits.

As AI capabilities advance, food safety professionals will have an influence on the tools and algorithms used throughout the food industry, including the retail sector (Adam Friedlander, 2020). AI can improve food safety, but it will require strategic collaborations across the supply chain, including with technology providers, regulators, and academics, to be successful.

3. Different fields of artificial intelligence

Several artificial intelligence (AI) methods are being used in food safety to improve the efficiency and accuracy of food safety inspections, identify and prevent food contamination, and enable better traceability and recall management. Among these techniques are:

3.1 Machine learning(ML) -

Large volumes of food safety data are being analyzed using machine learning algorithms to identify patterns and trends that may indicate potential food contamination (Cangyu Jin 1 2, 2020). These algorithms can also be used to create predictive models that can help in the detection of potential food safety hazards before they occur.

3.2 Computer Vision (CV) -

Food safety inspections are being automated using computer vision technology, which analyses images and videos of food products to detect potential issues such as contamination, spoilage, or damage. This can aid in improving the precision and efficiency of food safety inspections. (Rijwan Khan, 2021)

3.3 Natural Language Processing (NLP) -

To identify potential food safety issues, NLP techniques are being used to analyze unstructured data such as customer complaints, social media posts, and online reviews. This can enable food safety agencies and businesses in identifying potential issues that traditional inspection methods may not detect. (Noor Sakinah Shaeeali, 2020)

3.4 Internet of Things (IoT) -

Sensors and RFID tags, for example, are being used to collect real-time data on food products throughout the supply chain. AI can be used to assess this data in order to improve traceability and recall management, as well as identify potential food safety risks before they occur. (Jinsong Zuo, 2022)

3.5 Robotics -

Robotics technology is being used to automate food production processes, allowing companies to reduce the risk of contamination while also improving the accuracy and efficiency of food safety inspections. (Damini, 2023)

Overall, these AI methods are assisting in the improvement of food safety by allowing for faster and more accurate inspections, detecting potential risks before they occur, and improving traceability and recall management.

4. Applications of artificial intelligence in food safety

4.1 Sorting Fresh Produce -

One of the most difficult challenges that food processing plants face is the inconsistency of feed-stock availability. (Adams, 2018) Manual sorting is used in food processing plants to sift and sort vegetables, resulting in inefficiency and increased costs. Food processing companies can achieve significant automation for food cataloging by combining cameras, lasers, and machine learning to enable more efficient food sorting. For example, by deploying Artificial Intelligence involving sensor-based optical sorting solutions, the time-consuming processes of sorting fresh produce can be eliminated, resulting in higher yields with better quality and less waste. AI is being used to better calibrate machines in order to manage multiple product sizes while reducing waste and costs.

4.2 Food Processing -

Many food processing plants are not fully automated. Artificial intelligence is helping the food processing industry with everything from sorting foods to maintaining health and safety

compliance's, developing new products, and improving the supply chain. Essentially, technology is assisting in the streamlining of work processes, making employees' jobs easier and operations more efficient (Agbai, 2020). By automating as many of their processes as possible, the food processing industry can ensure complete hygiene and high food quality.

4.3 Anticipating Consumer Preferences -

Food manufacturers use artificial intelligence-based solutions to clearly anticipate and model their target consumers' flavour preferences, as well as predict their response to such new tastes. Predictive analytic based on artificial intelligence will assist food manufacturers in developing new food products that are closely aligned with consumer tastes and preferences. AI 3D printing can be used to customize food products for specific consumers to improve food safety. Companies can reduce the risk of contamination or allergen exposure by creating products that cater to specific dietary needs or preferences.

In the COVID-19 era, 3D food printing becomes a significant turning point for non-face-to-face and personalized businesses. (Lee, 2021) 3D food printing is a technology that allows for the direct production of small quantities by means of 3D digital design and personalized nutrition data. However, due to the printing characteristics of various food groups, the current development stage of 3D food printing technology is only at the level of making a product with a simple form or only one material, and separate material processing is required to achieve an appropriate level of print quality.

4.4 Food Production -

AI is being used in advanced applications to improve the efficiency, safety, and profitability of food production. It has enormous potential for optimizing production and identifying the best operating points for manufacturing facilities.

The electronic nose, or E-nose, is a device designed to detect odors or flavors in the same way that the human nose does. (J.S. Kauer, 2009) It is composed of a network of electronic chemical sensors capable of detecting both simple and complex odors. Furthermore, controlling product quality is critical in the food industry. It has been used as an environmental protection tool as well as for explosives detection due to its ability to detect complex odors.

4.5 Food Packaging -

AI-powered robotic equipment can perform complex human tasks like packaging with precision. Near-infrared spectroscopy (NIRS) is a technology that uses AI algorithms to examine the near-infrared light wavelengths reflected or absorbed by food items. (Weixin Ye 1, 2022) By analyzing spectral data, AI NIRS can detect potential contaminants or quality issues in food products. Early detection of these issues enables businesses to take action to prevent contaminated goods from entering the food supply chain, thereby improving food safety. By analyzing the chemical composition of food products, AI NIRS can be used to authenticate their origin and quality. This can aid in the prevention of food fraud and ensure that consumers receive the products they expect.

4.6 Efficient Supply Chain Management -

With the increasing demand for transparency, supply chain management is a top priority for all food companies. To meet consumer demands, the food industry must supply markets with high-quality food products at reasonable prices. AI-powered supply chain management systems can be used to monitor and control the entire supply chain. AI can be used to reduce delays and increase profit margins by closely monitoring every supply chain operation. AI also aids in the efficient and transparent tracking of produce from farm to consumer, leading to increased consumer confidence. (Bonanni, 2019)

4.7 Robotics -

Robots are widely used in the food industry, but they are only available to large corporations and are still out of reach for small and medium-sized businesses. Robots are used for everything from seeding, water spraying, and harvesting to cutting, processing, and packaging food products. (Anas Mathath, 2017)

5. The Challenges to AI Adoption in the Food Industry -

AI implementation in the food and beverage industry enables fewer human errors, less waste of abundant products, cost savings, happier customers, process optimization and automation, and more personalized orders. While there are numerous advantages to using AI in the food industry, there are some drawbacks. AI has yet to become widespread due to cost constraints and a scarcity of skilled experts. The high cost of large-scale deployment in the sector limits the market's ability to grow. It is never easy to integrate new technologies, such as AI into food companies. While AI technology is still in its infancy, there is a growing demand for specialized skill sets in data collection and analysis. The technology can essentially work alongside humans to improve operational efficiency. (Spd.group, 2021)

6. Conclusion -

In conclusion, AI has played a significant role in the food industry for a variety of purposes such as modeling, prediction, control tool, food drying, sensory evaluation, quality control, and solving complex problems in food processing. Aside from that, AI can improve business strategies by predicting sales and increasing yield. The applications of AI, their benefits and limitations, as well as the integration of the algorithms with various sensors such as E-nose, NIRS, and 3D printing in the food industry, are critically summarized. While AI holds great promise, the future depends on collaborative efforts among the food industry, policymakers, and technologists. (Roy, 2018)

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"Study On Consumer Acceptance Towards Millet Based Gluten Free Products with Special Reference to Pune City"

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ABSTRACT

People's need for quick food in urban and semi-urban regions is increasing as a result of the growth of QSRs (Quick Service Restaurants) and Cloud Kitchens. Due to millennials and Generation Z's demand for satisfying rapid meals, pizza and hamburger sales have increased to account for approximately 25% of the food and beverage sector. Yet, the gluten content of the pizza base and burger buns, which ranges from 9 to 15%, is harmful to human health since it promotes the development of gluten sensitivity and damages the small intestine in a significant portion of the population. Several people aware of this situation are more likely to choose to eat items with lower gluten content or gluten-free options. Millets don't contain gluten and are a healthy source of protein. They include a lot of insoluble fibre, which aids with weight loss and lowers blood sugar and cholesterol levels. According to research, urban residents' reliance on millet-based quick breakfast blends and other food products has dramatically increased. The working middle class group is steadily becoming interested in products like millets atta, millet dosa mix, millet pancake mix, and millet noodles. To satisfy the needs of its health-conscious clientele, well-known companies like "Aashirwaad" and "MTR" have added millet-based goods to their product lines. (Bansal, 2021)

With the use of primary data, the percentage of respondence in this study who would accept gluten-free items derived from millets as replacements for gluten-based dough, particularly in their pizzas and burgers, is noted.

It was discovered through critical research that the majority of fast food consumers were under the age of 30. As the alternative product includes health advantages, which is a big worry for most of them, they are quite happy about the philosophy of altering the main element from their regularly eaten food products.

Keywords: Millets, Gluten, Health, Food

INTRODUCTION

Due to its primary objective and the fact that every human being depends on food intake, agriculture has been shown to be the most sustainable industry in the world. Food companies and delivery services made more money during the Covid virus epidemic when the secondary and tertiary sectors were about to collapse because individuals were persuaded to purchase meals online in order to rapidly satisfy their hunger. In the past ten years, fast food consumption has also grown significantly, which has led to an increase in dietary and health

problems. The presence of gluten in products that are often consumed by urban consumers is the main factor contributing to this issue.

Pizza and hamburgers are the most often requested items from various restaurants and cafes, according to statistics from popular meal delivery apps like Zomato, Swiggy, Uber Eats, and Eatsure from past years. These goods contribute 25% to the food and beverage business. The wheat used to make pizza crust and hamburger buns contains 9–15% of gluten. Consuming gluten frequently damages the bowel and interferes with metabolism. According to research, the population's gluten intolerance is growing. This can be the case as superfoods like millets aren't part of the typical diet.

Yet, 2023 is reportedly the year of millets. The highest millet grower in the world is most likely India. All 11 types of millet have great nutritional value for everyone. As a result, the Indian government is pushing farmers to produce millet crops on their farms.

OBJECTIVES

1. To draw attention to benefits of millets' for human diet.
2. To understand why millets aren't consumed by urban residents.
3. To understand how consumers behave when buying millets with additional value that are gluten-free.

SIGNIFICANCE OF MILLETS

Improves mood:

- Due to its high concentration of the amino acid tryptophan, millet might elevate one's mood. A diet high in tryptophan, according to research Trusted Source from 2014, may help lessen the signs and symptoms of anxiety and despair.
- The tryptophan in millet increases the body's serotonin level, which aids in lowering stress. A cup of millet porridge each night can promote restful sleep.

Digestion & Weight loss:

- Millet is a fibre-rich meal that promotes intestinal motility and, by increasing the density of stools, promotes waste ejection. Insoluble and soluble fibres are both present in millet.
- The fibre content improves the efflux of food or solid waste, which benefits a person's intestinal health. Because they are high in fibre, grains are beneficial for gut health.
- Probiotic bacteria, which are insoluble fibres, are present in millet. It promotes the growth of helpful bacteria in the intestines. Among many other symptoms, insoluble fibre eases bloating, gas, cramps, and incontinence.
- It has a low Glycemic index, making it help control blood sugar levels and aid in weight loss. It contains few simple carbohydrates and more complex carbohydrates than other foods.

Aid for reproductive system:

- It aids in conquering ovarian, sperm, PCOD, and infertility issues. Both males and females can benefit from their assistance in treating illnesses of the reproductive system.
- This is beneficial to women who are experiencing period issues, to those who have STDs, and to males who want to increase their sperm count.
- It is high in iron, protein, antioxidants, dietary fibre, calcium, magnesium, potassium, and folate, all of which are elements that pregnant women need more of, millet is one of the nutrient-rich grains for them. Haemoglobin levels are raised by its high iron content.

Anti-ageing properties-

- L-lysine and L-proline, two amino acids, are abundant in millet. Collagen, a material that provides the tissue of the skin structure, is produced in the body with the aid of millet. Consuming millet boosts collagen levels, improving skin's suppleness and reducing wrinkle risk.

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(: Basavaraj G, 2010) Pearl millet production is concentrated in the developing countries which account for over 95% of the production and acreage. Exports and imports of pearl millet grain are negligible suggesting low demand, and/or unreliable availability of marketable surpluses for this commodity in world markets.

(Mallesh, 2021) In India and other Asian and African countries, millets commonly include sorghum, pearl millet, and a range of small millets (Vetriventhan et al., 2020). The term "millets" in this paper refers to all of these crops. India is the leading producer and consumer of different types of millets, such as finger millet, pearl millet, kudo millet, foxtail millet, barnyard millet, pros millet, and little millet (www.smartfood.org[1],[2]). India is the sixth largest producer of sorghum globally

(Mohan, 2023) Although genetic factors are obviously important, it is clear that the genetics did not change during the 50-y period when diabetes rates increased by almost 10-fold in India [9]. This clearly points to the role of environmental factors having a greater role in the causation of the diabetes epidemic [10]. Indeed, the rapid socioeconomic changes in the region has led to changes in both the quantity and quality of diets consumed along with markedly reduced physical activity leading to obesity, one of the main contributors to T2D.

(Nitya Sharma a, 2023) . Considering their climate resilience and potential role in nutritional and health security, the year 2023 has been declared as 'International Year of Millets' by the United Nations. Cereals being the major nutrient vehicle for a majority population, and proteins being the second most abundant nutrient in millets, these grains can be a suitable alternative for plant-based proteins

(Vali, 2019) Food items made with maida are converted within 10 minutes into glucose and join the bloodstream and the chemicals used to make maida are harmful to the pancreas. Normally there are only 6 to 7 grams of glucose in our blood (4-5 litres).

(FSSAI, 2023) Tribal Co-operative Marketing Development Federation of India (TRIFED), the 'Nutri hub' India is honoured to be at the forefront of popularising millets, whose consumption furthers nutrition, food security and welfare of farmers. - Shri Narendra Modi Hon'ble Prime Minister of India the technology business incubator hosted by ICAR-IIMR and TRIFED is collaborating for the marketing of millets and mainstreaming tribal through livelihood opportunities. Promotion of millet value chain activities in the Van Dhan Vikas Kendra's in the tribal belt and scaling up for the national security of the tribal population, these examples vouch for the active efforts of the Indian government in the advocacy of millets in diet especially through the tribal route.

(APEDA, 2023) "The millets market is set to grow from its current market value of more than \$9 billion to over \$12 billion by 2025. Favourable government initiatives to proliferate the global millets market size over 2019-2025".

METHODOLOGY

A combination of primary and secondary sources are used to get the necessary information. Using a custom created questionnaire with open-ended and closed-ended questions, the data on millets intake was gathered from 120 respondents with the help of online survey method. The responses were all primarily from Pune city. Secondary materials, such as newspaper articles, research papers, and magazines, were also used to analyse how consumer attitudes regarding millets have changed over time. Table below portrays the data collected.

Table 1: Primary data recorded of participants from Pune city and converted into figures for study.

|	
Pizza and Burger consumption	**71.7%** people are fond of pizza and burger. **28.3%** dislike pizzas and burgers.
Awareness about "gluten" and its effects	**83.3%** respondents were aware. **16.7%** respondents weren't aware.
Want to have nutritious gluten free cuisine	**95.8%** desire healthy food. **4.2%** are fine with the normal.
Believe millets make a wonderful all-purpose flour alternative for preparing pizza and burger dough.	**89.2%** Agree **10.8%** Disagree
Parameters considered while accepting gluten free products	**Nutrition** - Highly **Taste** - Highly **Price** - Likely **Appearance** – Neutrally
Age of respondents	**84.2%** Between 20-30 years **6 %** Between 10-20 years **6%** Above 40 years **3.2%** Between 30-40 years
Gender of respondents	**62.5%** Male **37.5%** Female

RESULTS AND DISCUSSION

Gender: It's been seen that males consume fast food more frequently than women; this might be due to the greater proportion of men who work in the workforce. Men are more socially active than women, and since fast food is simple to prepare and enjoyable to eat with friends, most men choose to do so while they are spending time with loved ones.

Age: Those younger than them tend to like fast food the least, followed by those between the ages of 10 and 30. Fast food is far more affordable, accessible, flavourful, and fully fills hunger than fruits or other healthful choices. In other instances, marketing tactics, peer pressure, and fads also cause people to gravitate towards junk food. Our hormone of motivation, dopamine, drives the brain to repeat pleasurable behaviours. Large dopamine spikes in the brain are caused by the ideal ratio of sugar, salt, fat, artificial flavours, and sweeteners in ultra-processed food, which makes people want to keep eating it.

Awareness: Several individuals are aware of gluten's detrimental impact on human health. Yet, the explosive rise of QSRs (quick service restaurants) over the last few decades has pushed people to select food products that are simple to get in order to state their hunger. Millets are nutritious cereal crops, but older generations who once devoured them failed to carry on their eating habits. Because of this, relatively few people in the younger age group know about and consume millets on a daily basis. Currently, consumers choose packaged foods or quick mixes over cooking since they save time while still providing nutritional advantages. Few people are aware that millet powder, which is used to make baby food, is also healthful for adults.

Availability: Very few millets-based value-added goods are readily accessible on the market. While they are rather expensive, those with lower incomes do not really favour them. Health-conscious people make sure to regularly consume millets while keeping in mind the advantages they provide for the body; yet, other people avoid them owing to their expensive cost, unappealing colour and texture, or unpleasant taste. The fig1.1 shows the major reasons behind less consumption of millets.

Fig 1.1 Reasons given by participants for not consuming millets
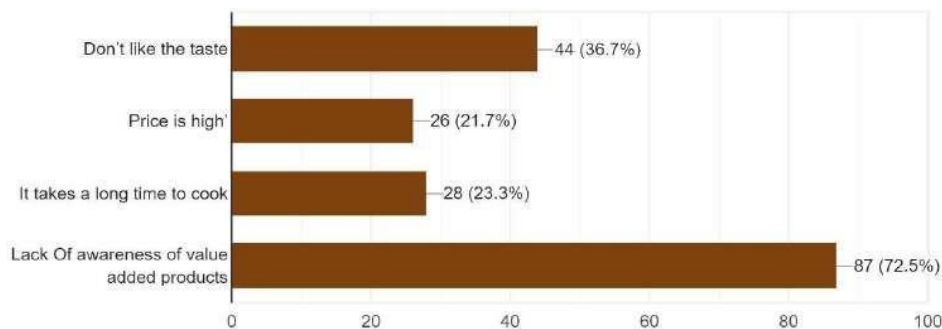
The statistics shows that the main cause of the poor purchase and consumption of millets is a lack of knowledge about value-added goods. The processing sector makes insufficient expenditures in NPD (new product development), as well as in marketing and promoting the already-available products. One of the explanations might potentially be the low social standing of tiny millet meals. (thehindu.com, 2021)

Fig 1.2 Ratio of respondents seeking healthy gluten free products

Fig 1.3 Ratio of respondents thinking millets are good for changing consumption habits of future generations.

The abovementioned pie charts i.e. fig 1.2 and 1.3 show that individuals have a highly good attitude regarding embracing the value-added millets products. In the upcoming years, it will be necessary to satiate customer demand with a greater emphasis on necessities for health. It is obvious that the majority of urban residents do not consider price to be a problem when nutrition is their top priority. Appropriate steps should be implemented to improve Pune city inhabitants' consumption and shopping habits, with a concentration on millets.

RECOMMENDATION AND CONCLUSION

Greater attention should be made on production and consumption of millets. People will be quite concerned about their health in the years to come, especially those who live in metropolitan areas. According to Prime Minister Narendra Modi, 2023 will be the year of

millets in India. Farmers should be encouraged to plant millets since they can be utilised as both a food source and a raw material by the processing sector to create new goods with value additions. Brands should invest the proper amount in promoting and advertising their already-released goods. Some considerable recommendations by the respondents collected through primary data are stated below.

➢ The government ought to make millet or items made from millet a component of meal plans like midday meals for public schools.
➢ Together with rice, wheat, pulses, cooking oil, and kerosene, millet products ought to be distributed to the general people as rations through the Public Distribution System.
➢ Make millets readily available to individuals who truly wish to incorporate nutritious food products in their diet, and raise knowledge of millets and its advantages.
➢ If millet goods are made more pleasant and savoury, people are more inclined to consume it more.

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"STUDY OF CONSUMER ACCEPTANCE FOR WINE COCKTAIL WITH SPECIAL REFERENCE TO PUNE CITY"

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ABSTRACT:

By 2025, it is anticipated that India will consume 52.2 million litres of traditional wine. Parallel to this, the market has seen the emergence of new wine substitutes made by combining wines with fruit juices or by flavouring wines with synthetic or natural tastes. A bottled cocktail is an alcoholic beverage made from a spirit or spirits combined with additional ingredients that has at least 5% alcohol by volume and not more than 15%. Cocktails in a Bottle or Can are the newest popular items that will change the way people consume alcohol. Because only restaurants and bars provide wine cocktails, RTS cocktails have a tremendous opportunity. An in-person survey of a consumer group of young adults was undertaken to determine the possible customer acceptance and expectations for this new product (21-25). In this study, we primarily concentrate on RTS wine cocktail customer acceptability and availability in Pune City. Just those sample members who drink wine were targeted, and more questioning were conducted. We conducted an analysis of the data gathered using the JASP technique. As a result, we determined that wine cocktails were preferred to wine.

Keywords: Consumer acceptance, Consumer Perception, New product acceptability, Wine Cocktail.

OBJECTIVES:

1. To study the consumer acceptance for wine cocktail in Pune city
2. To investigate the effects on Pune city's wine and cocktail customers.
3. To examine crucial factors from the viewpoint of the consumer to aid in the creation and adoption of the wine cocktail.

INTRODUCTION:

The term "development that fulfils the demands of the present without compromising the ability of future generations to meet their own requirements" refers to sustainable development; it addresses economic, social, and political actions that may have an influence on the environment. (Valentina Maria Merlino 1, 2021) As producing food requires a significant amount of resources and inputs, agriculture is important in this perspective. These elements have the potential to negatively impact both the environment and the items' own food safety, with potentially disastrous results for the environment (i.e. accumulation of pesticides, soil erosion, gas emissions). So, in order to address the worsening of these issues, new strategies and solutions are required.

Grape post-harvest losses: Due to their perishable nature, fruits and vegetables frequently experience both pre- and post-harvest losses. Due to inadequate post-harvest procedures and infrastructure, the Indian horticulture sector is predicted to lose more than 2 trillion rupees ($32.7 billion) yearly. According to a survey by Assocham, 30% of India's fresh food gets spoiled after harvesting and is therefore unsuitable for eating (Anonymous, 2013). Grape postharvest losses have been estimated by several employees to range from 8.23% to 16% nationwide. According to the current estimate of 8.23%, India is losing over 223 thousand tonnes of grapes every year. The loss is far more than anticipated if it is measured as an economic loss, rather than just a visual loss. The losses incurred during the preparation, gathering, packaging, storing, shipping, and distribution of table grapes can also be quite considerable due to the fragility and great perishability of grapes. (Sharma, 2018)

Among the 75 wineries in Maharashtra, 50 are in danger of closing down due to an estimated 50 lakh litres of unsold wine piling up in barrels and wineyard owners struggling to repay interest-bearing bank loans. Some farmers have abandoned the production of wine grapes in favour of the more sombre table grape industry.

Wine can be further processed into cocktails in order to offset these losses and strengthen the winemakers' financial position. Most individuals who don't enjoy the flavour of alcoholic beverages can still consume it and it will increase the worth of the wine. The process of making wine cocktails involves crushing and fermenting entire, dark-colored grapes with addition of flavours and spices, which might vary in taste and colour. The following are some wine cocktails' health benefits. Contains several antioxidants, Reduces harmful cholesterol, Maintains cardiac health, Regulates blood sugar, Reduces the risk of cancer, Helps treat

common cold, Keeps memory sharp, Keeps you slim, Reduces the risk of depression, Has positive effects on the digestive system.

We can examine crucial factors from the viewpoint of the consumer to aid in the creation and adoption of the wine cocktail. Taste, appearance, aftertaste, and consistency make up these criteria. We performed a poll to learn this crucial factor and customer acceptability of wine cocktails in order to understand the consumer's point of view. We have concentrated on young adults (21-25) who drink any alcoholic beverages. On their judgement, we further filtered the data. We examined the data and obtained the necessary conclusions with the aid of the JASP software, taking into account a specific age group and their interest in the acceptance and consumption of wine cocktails. It was simple to obtain accurate replies from customers by taking into account the characteristics of our content.

METHODOLOGY:

The data was collected by a personal interview using a targeted questionnaire in the Pune City area and released in 2023. The survey was carried out in line with moral principles. All respondents gave their free and informed consent to participate in the survey. We majorly focused on young adults (21-25 years). The completion of the surveys did not result in any rewards. The questionnaire was divided into several sections, as shown in Figure 1.

SECTION A	SECTION B	SECTION C	SECTION D
Socio Demographics Variables 1. Age 2. Gender	1. Consumption of alcoholic beverages 2. Frequency of consumption of alcoholic beverage	1. Awareness about wine cocktails. 2. Preference over traditional wine.	1. Parameters while considering wine cocktails. i. Appearance ii. Taste iii. After taste

Figure 1. Questionnaire theoretical framework.

Only closed-ended questions were included in the survey's created questionnaire, which helped gather accurate data. Section D's questions were designed to help participants identify the

attributes of a wine cocktail that could be the most crucial in order to develop a product prototype that meets customers' expectations. Three parameters were specified for this purpose, and the respondents had to rate the characteristics they would like in the product based on their preferences for each of them. The responses to the questionnaires were analysed to determine what people expected and thought about wine cocktails. The Likert scale method was used to examine the variations in consumer expectations for the sensory characteristics of wine cocktails. The analysis was performed using JASP software (JASP 0.17.1.0) package for windows. In order to distinguish various consumption orientations based on consumer experience, anticipation, and perception of a new product, Section C and D answers were chosen separately. Section C was examined using a distribution plot.

RESULTS AND DISCUSSION:

In the present study 231 participants were interviewed, of whom 145 were alcohol consumers who were also knowledgeable about wine cocktails. On the basis of these 145 samples, the data was further processed. The remaining sample was not considered. Males made up the majority of the sample (76%) compared to females (24%). This resulted from the candidates' engagement with the questionnaire. Frequency of buying alcohol can be monitored using figure 2.
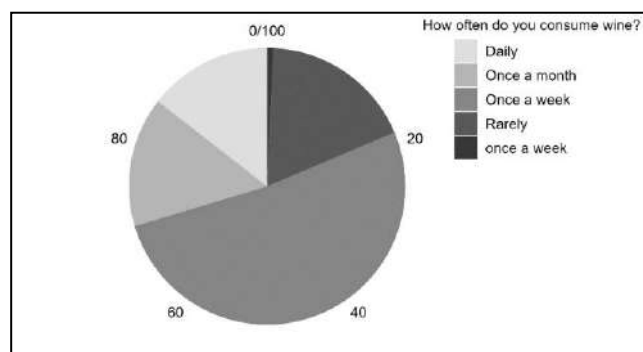
Figure 2: Consumption of alcoholic beverage

Concentrating on the whole sample who consume alcoholic beverage, we have identified that 68% of individuals were aware about wine cocktails, 23% were not at all aware about the same and 8% were not sure about their opinion. The next question was whether people would prefer wine cocktails to wine, and based on the data, we can conclude that 70% of respondents planned to try wine cocktails, 25% had zero interest in the product, and 6% weren't sure what they thought.
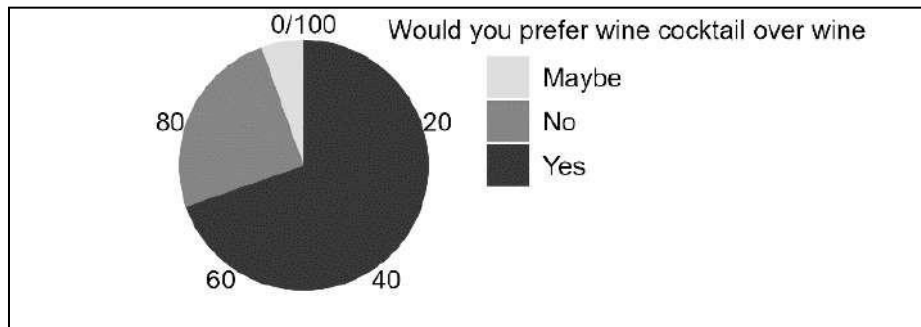
Figure 3: Preference of wine cocktail over wine

Regarding the latter consumers, the percentages of replies gathered about the reasons why they do not intend to approach this new product are displayed in Figure 3. As shown in the graph, people (25%) also responded. Instead, personal preferences for traditional beverages (such as wine, beer, and spirits) were the main driving force, followed by a lack of interest in and appeal for product innovation.

When alcoholic beverage consumption patterns were analysed, significant differences were found, particularly when beer and spirit consumption was taken into account. In particular, the new entry category was more targeted towards spirit consumption. New entries statistically varied from existing ones when the most frequent level of consumption was considered, indicating a higher tendency of consumption in the new entries. In terms of consumption frequency of alcoholic beverages, new entries statistically differed considering the most frequent consumption level, highlighting a higher propensity of consumption in the new entries.

Ultimately, the factors were taken into consideration to know the customer acceptability about new product i.e., wine cocktails. Figure 4.1,4.2,4.3 presents a brief insight regarding the characteristics especially taste, appearance and after taste.
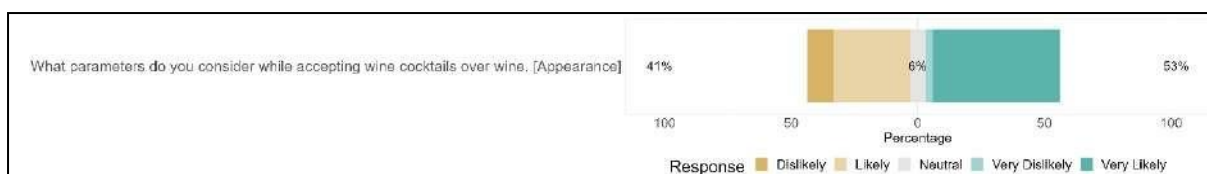

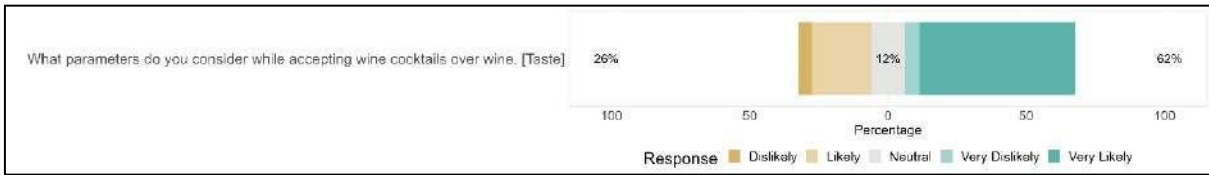**Figure 4.1: Parameters while accepting wine cocktails(appearance)**

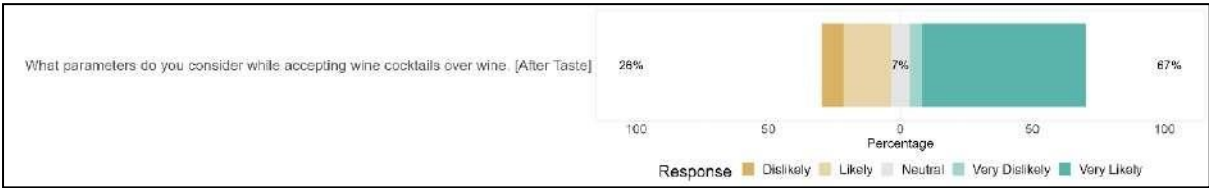**Figure 4.2: Parameters while accepting wine cocktails(taste)**

Figure 4.3: Parameters while accepting wine cocktails (after taste)

Figure 4.1 allows us to examine the product's appearance. It shows that 41% of people are unable to accept the product's appearance, while 53% are inclined to do so. As we questioned the individuals more about their unwillingness to accept the appearance, we learned that they firmly think that only the traditional wine colour belongs there.

Through figure 4.2 we can analyse the taste of the product where we can see that 62% individuals are likely to accept the product taste and 26% people don't like the taste of wine cocktails that they have tasted. We investigated it further and came to the conclusion that the wine cocktails that are currently available lack flavour. the taste of wine and other flavours is impaired.

Using figure 4.3 we can study the after taste of the product where we can see that 67% individuals are likely to accept the product after taste and 26% people do not like the after taste of wine cocktails that they have tried. We investigated it further and came to the conclusion that the wine cocktails that are now available has less after taste and is not identical to conventional wine. Instead, those who are likely to enjoy the appearance, flavour, and aftertaste of a wine cocktail choose bottled cocktails due to their convenience.

CONCLUSION

This survey helps us comprehend the views of customers regarding wine cocktails. With reference to Figure 3, we can conclude that 70% of people are eager to try wine cocktails over wine, with the bitter taste and smell of conventional wine being the key factors in their choice. The people were interested in bottled cocktails that may make consumption easier after trying

wine cocktails in bars and restaurants. Figures 4.1, 4.2, and 4.3 help us to draw the conclusion that several factors influence how the wine cocktails taste. Further, by taking into account each person's previous experience, the variations in customer perception could be a marketing tool to be taken into account in the product communication strategies. Our research will assist the beverage sector in developing an effective communication strategy relating to drink attributes in order to meet and exceed customer expectations. This final point assumes additional significance in the case of new entrants who stated sensory expectations for the new product in this research that could not change in a number of wine cocktails. So, in this research, this outcome enables us to effectively emphasise the descriptors influencing the acceptance of the new entries. A successful strategy for a product's market entry might involve capillary communication of its features as well as their effects on society and the environment. By showcasing the benefits of wine cocktails, this promotional strategy could also get the attention of individuals. We are aware of the research's limitations with regard to sample size and composition. However, by extending the research into more regions and sectors to examine various consumer profiles, especially taking into account more age groups of people, this limitation may be solved. Nevertheless, based on our findings, the commercialization of wine cocktails could have a bright future and might be a useful tool for reducing food waste and loss while also enhancing the sustainability of wine chains.

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A study of consumer preferences towards ready to eat food in Pune

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Abstract

Most of the people in modern time are adopting instant cultures and behaviors. the food habits are not immune to these transitions. People are increasingly buying and using instant food products. The reasons may be listed out related to work pressures and busy life styles, most people are now choosing quick and simple methods enabling them to cook quickly. Subsequently they are preferring instant foods. The cup noodles, ready mix dal and curries, instant upma, instant idly mix, ready to cook curry powders, etc. are the examples of the ready to cook and eat products increasingly demanded by the people.

The purpose of this study is to learn about the preferences of people from Pune City for instant food products, including the variables that impact their decision to buy such products and the difficulties they encounter when consuming them.

A number of consumers from Pune city had participate in the study. The studies are undertaken on the stalls of the ready to eat food products in the consumer exhibition.

This descriptive study uses a simple random sampling technique to find consumers among Pune residents.

Secondary data is captured using books and websites. Primary data is collected from questionnaires. Statistical tools like ANOVA, frequency analysis, and independent sample t-tests are used to describe the nature of variables under study, to predict relationships among the variables and inferential analysis is used to infer the confidence the researchers have on the results. Finally, the researcher offers suggestions to the marketers of ready to cook food products.

KEYWORDS: Instant food products, Ready to cook products, Consumer Preferences, Consumer Behavior

Introduction

Food is the most sought after product which enjoys major share of consumer spending. A study by Kalidas, K., & Mahendran (Kalidas, 2017) claims that a typical Indian consumer's spent on food is more than half of the income. The consumers of world on an average are spending one third of their income on food. The ready to eat food products had occupied a considerable shelf space in stores and super markets and Malls in India. The instant mix market in India was estimated to be

worth approximately Rs.350 crores during the year 2003 and at the end of 2004, it was estimated to be around Rs.700 crores.

The Indian kitchens occupying the instant meal products began to spread since 1980s. Today Every kitchen shelf in the world is having one or another instant food product.

So the study is undertaken to find out the Consumer behavior especially answering the questions, how individuals choose ready to eat products, and what are their preferences.

Review of Literature

The research undertaken by R. Keerthanan and Dr. R. Amsaveni (Amsaveni, 2022) is an attempt to determine which are the most popular instant food items and to know the reasons behind the selection of instant food products by consumers. The study is undertaken in the city of Tirupur in which 150 consumers were had participated. Judgmental sampling was used. The report findings state that, majority of the respondents prefer vegetarian food products. They check the expiry date before purchasing. Most of the respondents are from salaried class, and they have nuclear family. They spend a monthly budget of Rs. 301 to Rs. 500 on instant food products. The new clients are drawn by Advertisements giving a message that these products are reducing the cooking time considerably and they also able to prepare dishes like a famous restaurant. The study recommends that if the marketer provides complete information of the product including nutrients, quality, recipe, and required time, the sales are improved. Sample packs and discounted packs are to be used pull the new customers.

The study undertaken by J Saujanya and Yadigiri Nikitha (Nikitha, 2022)states that the life pressures of indian people are forcing them to adopt to the ready to cook products. The researchers analyzed consumer perception and satisfaction towards ready-to-eat food goods and discussed the factors those motivate consumers to consume the ready to cook products. A questionnaire is used to collect primary data, and books and magazines are utilized to collect the secondary data. Most of the respondent order food from restaurants when food is required. They look for flavor and nutrition while buying ready to cook food products, they look for TV advertisements and learn about the products. Maximum of the respondents have reported their satisfaction level towards these products as neutral. The research recommended that ready to cook products to be made easily available in retail stores, to enable point of purchase their prices should be decreased, and the taste must be improved to resemble home-cooked food.

The study undertaken by Nitya Khurana and Prachi Goyal (Goyal, 2021) claims that the Food is a vital component of all living things as it provides nutrition and support. The Consumer Behavior has experienced a significant change in the current environment. The growth in Urban population, transition towards nuclear families, changes in the employments and organizations, lack of time, quest for convenience, and changed lifestyles have forced the consumers to ready to cook food. Consumers like to save their time for cooking. Especially the young people, who are working. In most urban areas both the husband and wife are working hence they are forced to consume the ready to cook products.

The study undertaken by Bhavya Saxena (Saxena, 2021) focuses on Consumer behavior of instant food products related to usage of media and the other variables making impact on instant food products. A survey of adults and millennial from Bhopal is undertaken for this study. The study focuses on popularity of the brands of instant food and the regularity of their purchases. The study claims that urbanization and nuclear family structures, lack of time, easy access, and changed life styles are the factors influencing the increase in sale of ready to cook products. The study has targeted women in the household. The study claims that women play a major role in purchase of the ready to eat products. The study also reveals that Consumer perceive that the instant foods are expensive than homemade food products and the quality and flavors of instant foods need to be improved to earn consumer trust. The suggestion to use media to promote sales is given in this study.

The study undertaken by E, M. A., & A, S. I. A. in 2018 (E, M. A., & A, S. I. A., 2018) stated that the Indian Instant Food production is one of large production in the World. The total food production in India will likely to double over the next 10 years and the demand for Instant Food products will also increase because of the urbanization, changes in food habits, and changes in traditions.

Statement of the problem

The eating preferences of people are changing. Most of the urban people frequently buy food in addition to the home made food. Most of the people are working and get little time to prepare food at home. Most literature claim that the nuclear households more frequently buy ready to eat food. There is significant change in the attitude of house wives also towards cooking and serving homemade food. In this context, the researchers intend to study the preferences towards ready-to-eat food products by the citizens of Pune.

Scope of The Study

The Global Ready to eat food products is expected to expand significantly. Most companies are eyeing this market strategically. The aim of the current study is to identify the variables influencing ready to eat food products and customer issues among Pune city.

Objectives of the study

- To identify the awareness level of ready-to-eat food products
- To Measure satisfaction level of the people towards ready to eat products.

Research Methodology

The researchers have undertaken exploratory research by studying available literature and descriptive study in which survey of people visiting the stall of ready to cook product in consumer exhibitions in Pune City is undertaken.

Questionnaire was administered to 100 respondents who visited stall of ready to eat foods with samples and packets of different gravies in May 2022

Respondents responded to the questions of the questionnaire after tasting sample of the product items

Data Presentation, and Analysis

1. Demography of the respondents who are aware of the ready to eat products

    ▪ 45 percent of respondents are aware of Ready to cook masala gravies

    ▪ Most of them are aware of Suhaana brand followed by Mother's Recipe

    ▪ Out of those who are aware about ready to cook masalas, 52 percent are from nuclear families and 48 percent from joint families.

    ▪ Out of those who are aware,49 percent are self-employed and 30 percent are from service background.

2. Level of satisfaction to the taste of Ready to Eat Products

Level of Satisfaction * Characteristics Rating Tasty

Level of Satisfaction

Characteristics Rating Tasty	Mean	N	Std. Deviation
0	3.18	17	1.131
1	5.00	1	.
2	3.50	2	.707
3	3.83	6	1.169
4	3.73	30	1.143
5	4.02	44	1.045
Total	3.78	100	1.115

44 percent of Respondents for whom tasty is a very important characteristic are somewhat satisfied with the current ready to cook masalas with mean satisfaction of 4.02. This is an area of improvement.

3. Level of Satisfaction: Taste like Home food

Level of Satisfaction * Characteristics Rating Taste like home food

Level of Satisfaction

Characteristics Rating Taste like home food	Mean	N	Std. Deviation
0	3.19	16	1.167
1	5.00	1	.
2	3.75	4	1.258
3	3.80	5	.837
4	3.62	34	1.181
5	4.13	40	.966
Total	3.78	100	1.115

40 percent of the respondents for whom taste like home food is very important have reported a mean satisfaction rating of 4.13 on the attribute of taste like home food. This is an area of improvement.

4. Level of Satisfaction: Healthy

Level of Satisfaction * Characteristics Rating Healthy

Level of Satisfaction

Characteristics Rating Healthy	Mean	N	Std. Deviation
0	3.19	16	1.167
1	5.00	1	.
2	4.20	5	.837
3	3.60	10	1.350
4	3.76	25	1.052
5	4.00	42	1.059
65	3.00	1	.
Total	3.78	100	1.115

42 percent of the respondents for whom *healthy* as an attribute is very important have reported a mean satisfaction rating of 4.00 on the attribute indicating only somewhat satisfied. This is an area of improvement.

5. Level of satisfaction: Artificial food colors

Level of Satisfaction   * Characteristics Rating No Artificial colour

Level of Satisfaction

Characteristics Rating No Artificial colour	Mean	N	Std. Deviation
0	3.19	16	1.167
1	5.00	1	.
2	4.00	3	1.000
3	3.60	10	1.506
4	3.79	24	.977
5	3.98	46	1.043
Total	3.78	100	1.115

Lesser levels of satisfaction reported on the attribute of no artificial color. This is an area of improvement.

6. Satisfaction Level: No Preservatives

Level of Satisfaction   * Characteristics Rating No preservatives

Level of Satisfaction

Characteristics Rating No preservatives	Mean	N	Std. Deviation
0	3.19	16	1.167
1	4.33	3	1.155
2	4.33	3	.577
3	3.67	3	.577
4	3.77	26	1.210
5	3.92	49	1.057
Total	3.78	100	1.115

Lesser levels of satisfaction reported on the attribute of no preservatives. This is an area of improvement.

Findings:

Pune citizens are well aware of ready to eat products. The ready to eat products are used by both nuclear as well as joint families. The awareness is present among self-employed as well as employed citizens.

The preferred attributes in ready to eat products are Taste, Taste like home food, healthy, no artificial colors and no preservatives.

The respondents are found to be somewhat satisfied about their preferred choices. Hence it is to be taken into notice that the ready to eat food producers have to improve in the preferred attributes of the ready to eat products to have patronage from Pune Citizens.

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The Study On Services Offered by Forensic Accounting Sector

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Abstract: The objective of this study is to analyse the existing literature on the services offered by forensic accounting sector to Indian corporate, banks, insurance etc. and identifying the gaps in literature. This study provides an overview of the existing study on services offered under forensic accounting done by researchers from all over the world plus with specific reference to India. This study is helpful for researchers who wants to do further research in this domain. This is also helpful to academician, consultants, professionals, forensic accounting practitioners, corporate risk managers and regulators. **Methodology:** This study analysed 27 research articles which have been conducted in the forensic accounting domain. The sample has been selected from different online database like Google Scholar, UGC Care & Scopus Indexed Journals etc. from the period 2011 to 2021. This paper will explore services under forensic accounting domain which are unexplored. The overview of these services will give new perspective to Indian corporate world for prevention of fraud in early stage through forensic accounting. **The result of the study** is showed that, if organization will use forensic accounting services as one of the internal control measure, it may reduce the fraud at some extent.

Keywords: Forensic Accounting, Corporate Governance, Fraud, Internal Control Measure, Fraud Risk Assessment.

I. INTRODUCTION

The typical work of accountant is to do closing monthly balance sheet, P&L, reconciliation and process few payment cheques. Whereas forensic accountant looks beyond the ledger and tries to find out corporate wrong doings. A forensic accountant should have investigative & analytical skills, knowledge of accounting & law, as they are frequently called as an expert witness during trials, good communication skill and he should be techno savvy, as technology plays a major role while investigating fraud. Forensic accountant need to look beyond the numbers. Many cases of financial statement misrepresentation have been reported, from big corporates like Enron, WorldCom, Adelphia, Xerox, Qwest, and many more.

In Indian context we can name few like frauds at Satyam Computers, Karvy Stock Broking Ltd., Punjab & Maharashtra Co-Op Bank (PMC), PNB (Kala Ghoda Branch) and recent IL&FS, ABG Shipyard scam which shook Indian Economy recently. These corporate frauds bought forensic accounting profession into limelight.

Due to increase in new techniques of fraud, organization started to realise, they need to hire an expert who will do inspection or audit in unbiased and independent way and one of that independent expert is forensic accountant. Forensic accountant's services are required by all sectors like bank, corporates, regulators like SEBI, RBI and even law officials while filing fraud cases in court.

Frauds could be categorized as below:

1) **Bank frauds**: In India, there is a large number of bank frauds. It is increasing over time in all of the major operational areas of banking. There are various areas in banking such as deposits, loans, inter-branch transactions, accounting, and so on. (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

2) **Corporate frauds**: Corporate fraud by leading Indian businesses is shaking the Indian economy on a regular basis. Satyam Computers shocked the national financial world in 2009, when Satyam's Founder B. Ramalingan Raju declared he had exaggerated profit and inflated the company's Balance Sheet by more than one billion dollars, to the PNB Fraud in 2017 and the recent 23K-Cr fraud at ABG Shipyard in 2022. Corporate fraud by leading Indian businesses is shaking the Indian economy on a regular basis. Satyam Computers shocked the national financial world in 2009, when Satyam's Founder B. Ramalingan Raju declared he had exaggerated profit and inflated the company's Balance Sheet by more than one billion dollars, to the PNB Fraud in 2017 and the recent 23K-Cr fraud at BharatPe & ABG Shipyard in 2022. Fraud is evident in corporates. This must be strictly monitored in order to guarantee economic stability and the growth of the emerging economy. (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

3) **Insurance frauds**: In the insurance industry, there are various types of fraud. For example, health insurance, claim fraud, bogus claims, insurance speculation, application fraud, and so on. (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

4) **Cyber frauds**: Cyber frauds are internet-based scams that target the illicit use of digital instruments such as credit cards, ATM cards, and home-based cyber equipment, among other things. (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

5) **Securities frauds**: Frauds in the securities market, in addition to corporate fraud, harm a large number of people. When it comes to securities fraud, the investor community cannot forget the under truncate Rs.4000 crore Harshad Metha scandal and the above Rs.1000 crore Ketan Parekh scams, both of which defrauded investors by causing them to lose their money in the main markets. Furthermore, insider trading is often regarded as securities fraud. (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

If we explore further in corporate fraud then, there are a number of ways in which a companies can commit fraud – (*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

- A authorised person can approve his personal purchases. Recent example is BharatPe's fraud.

- Can create a record of dummy or Ghost employee. Means who is on payroll but not doing any work or

after the death of employee, data is not removed purposely.

- Embezzling Money or stealing of cash before it is being recorded.

- Companies avoid to pay taxes or pay less tax by using a legal method.

- There may be theft of asset. Even using organization's asset for personal use is also a asset theft.

- Prepare a false Financial statement by -
- Delaying depreciation acknowledgement by prolonging the depreciation period.

- Transferring debt to specific companies.

- Speeding up the recognition of revenues.
- Capitalize the expenditure.

II.   OBJECTIVE OF STUDY

- To explore services offered under forensic accounting domain.
- To find out whether inclusion of forensic accounting services as an internal control will prevent the fraud at early stage and strength the corporate governance.

III.   METHODOLOGY

For this research data collection is through secondary sources available through research journals. books, magazine, newspaper articles from India Today, Business Times, Economics Times etc., Past Survey and Case studies of previous frauds.

IV.   LITERATURE REVIEW

Forensic accounting is not a new concept for the developed countries like USA but in the current situation it is just gaining popularity in India as frauds are increasing day by day. It started gaining momentum from around 2013-14. Especially after the Satyam Fraud shook the entire country in 2009. Still Small & Medium Enterprise (SME) sector which is very prone to fraud aren't aware of the forensic accounting services available. So indeed it is very much essential to explore services offered by forensic accounting. Also to study the effect if it will use as one of the internal control measure.

1. **Areas where Forensic Accountant give services:**

Fraud   Risk   Assessment
Forensic Accountant are a FRAUD STOPPERS and have a dedicated Fraud Risk Assessment Team, who are unique in the sense that they come from both the field of Auditing and Forensic Accounting. The professionals who work on fraud risk assessments have been a part of implementation of many forensic accounting standards, like United States' Public Company Accounting Overseas Board (PCAOB) standards. FRAUD STOPPERS are now a trusted name when it comes to Fraud Risk Assessment and Forensic Accounting. Fraud Risk Assessment is an ongoing process which helps to identify the inherent risks and helps to mitigate those threats. These services, which fall under the forensic accounting umbrella, are required by the corporate kings of our county.(INDIAFORENSIC.COM)(*STUDY MATERIAL   PROFESSIONAL   PROGRAMME FORENSIC AUDIT*, n.d.)

- **Due Diligence**
  Due diligence is a comprehensive investigation of a company or individual in order to determine the risks associated with providing resources and capital.
  Forensic accountants can help companies to assess opportunities and threats in foreign markets. They will carry out research into relevant factors such as: foreign market entry strategies for companies, types of joint-venture partner, financial guidelines for investing overseas, country-specific business customs, accounting requirements for foreign currency transactions. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

- **Information Security Risk Assessment**
  With the emergence of cyber-crimes, Information Security assessments have emerged as an essential aspect of forensics practice and services. An information security assessment is a critical requirement of risk management in any organization to assess the organization's current level of risk, threats and vulnerabilities. Even being a new service area, it has seen a lot of traction due to the introduction of Sarbanes – Oxley act in America and the impending regulations under the same act in Europe with general data protection legislation. The information security assessments are largely conducted by technology forensic accountants. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

- **Asset Tracing**
  The Stamp Paper Scam involving Abdul Karim Telgi was the greatest scandal, involving over 30,000 crores of rupees. Abdul Karim Telgi had a

couple billions of rupees in assets before he was jailed. The largest scam going on in India is the generation of assets through bank transactions. If we look into the records of bank transactions pertaining to the years after 2014 we can find a huge number of suspicious transactions, which do not match with actual asset purchased and made under Benami accounts. These are just few examples and if someone starts looking into records, he would be amazed to find out the magnitude of scam and get convinced about its existence. Forensic accountant's job is to trace & identify client's assets which are illegally in possession of third parties. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

Vendor Monitoring

It is very much essential to check authenticity and reliability of vendor or borrower in all types of industries from manufacturing to Information Technology. Banking officials should verify this before the process of credit approval. As there are lots of cases where companies duped bank in working capital loan. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

Money laundering compliance programme

Money laundering is a serious crime which is directly related to criminal activities. Illegal arms sales, smuggling, drug trafficking, prostitution gangs, extortion, market manipulation, bribing, and computer fraud schemes are just a few examples of criminal activity. Profits from such unlawful operations provide an incentive to "rationalise" the ill-gotten gains by laundering the money. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

- **Litigation Support**
  Forensic accountant also proves litigation support. He provides technical questions of accounting & audit, taxation, law. In case of fraud he also calculates quantification of losses, business valuation, insurance claims and many other situations. (INDIAFORENSIC.COM)(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

2. **Preventive Role of Forensic Accounting**

Forensic accounting is an innovative branch of accounting which involves the investigation of financial crimes. Forensic accountants handle subject matters like valuing companies, discovering frauds, criminal acts and any other illegal activities for the organization and related parties.(*STUDY MATERIAL PROFESSIONAL PROGRAMME FORENSIC AUDIT*, n.d.)

Till date in Indian Context Forensic Accounting is used as a detective method after fraud took place. But Forensic Accounting should be look like as a tool or activity for prevention of fraud. Major reasons for fraud occurrence is immaturity of corporate governance and not using Forensic Accounting as a preventive tool within the organisation (Ali Rehman, Fathyah Hashim,2020; Singleton, T. W. & Singleton, A.J.2010). Control activities should be undertaken within the company such as planning, regular assessment of all types of transactions so red flags will raised in their early stage, close monitoring of loans /advances. Corporate governance should be nurtured and complimented internally within the organisation. Similarly, Forensic Accounting should be included as an in-house activity and included in the organizations management policy. It is well known fact proved through many researches that frauds are majorly conducted by the persons who are working or a part of the internal organisation and they can have carried out frauds because of weak internal control system and it means immature corporate governance. If the Control mechanisms will have enhanced, it will reduce the risk of fraud and will increase the Corporate Governance maturity. To achieve this Forensic Accounting should be included as an in-house activity by the organisation to eliminate the risk of fraud which may be the obstacle for the growth and sustainability.

Because of continuous increase in frauds, there is constant pressure on accounting and auditing profession to identify the alternative ways to detect and mitigate frauds. This alternative way can be defined as Forensic Accounting (Bhasin,2013; Malusare (2013) (Bhasin, 2013b)(Bhasin, 2013a). Forensic Accounting can be seen as a cost saving measures when compared with the amount of the fraud and amount spent for legal & litigations in addition of Preventive measure (F Vinluan,2015). Forensic Accounting's existence is necessitated because of the increasing organizational frauds which are not detected through conventional audit. Frauds are still occurring even with the availability of policies, code of corporate governance and bodies (Bhasin,2013). Forensic Accounting as a preventive tool can be represented as identification of fraud before its occurrence. In comparison with

the preventive role of Forensic Accounting, detective role is only limited to the detection of fraud (Singleton, T. W. & Singleton, A.J.2010). Detection of fraud can only happen when fraud actually happened (Rehman, A., & Hashim, F. (2018). In current business environment, role of Forensic Accounting is normally perceived as detective role only (MJ Nigrini, 2012; Adrian, Lawrence & Cristal, 2009).

In 2013 & 2016, Madan Lal Bhasin has a theoretically contributed on Forensic Accounting & Corporate Governance. He portrayed 'Global Regulatory Action for Corporate Frauds, Corporate Governance and Accounting Reforms Scenario' in which he researched various accounting reforms undertaken by regulatory bodies to improve the corporate governance and to prevent the corporate frauds. In the Indian context, he also investigated whether the abilities required of FCAs in developed nations differ greatly from the expectations of clients and accountants in India.

In 2017, To strengthen the Corporate Governance system, Madan Lal Bhasin studied the requisite skills, education, and training requirements for CFAs.

Another major contributor to the Forensic Accounting & Corporate Governance study is Ali Rehman , Fathyah Hashim.

In 2018, His research adds to the body of knowledge and contributes to the previous literature collection, laying the foundation for future research and gaining new knowledge on issues connected to forensic accounting and corporate governance.

In 2018 Indonesian researcher Imang Dapit Pamungkas, the goal of this study was to look at the risk factor of the fraud diamond model in relation to accounting fraud, as well as corporate governance as a moderating component. Using the fraud diamond theory, this study will look at how excellent corporate governance can avoid accounting fraud. They used 12 fraud companies and 32 non-fraud companies that were listed on the Indonesia stock exchange for this study.

In Dec 2020, Ali Rehman , Fathyah Hashim published an article on how to integrate related literature and empirical research in order to enhance the claimed capabilities of forensic accounting on corporate governance maturity, particularly for publicly traded businesses. They used data from the

KPMG study from 2014 and the Observer from 2017. "'Fraud Risk Assessment' (FRA) is a control," they conclude, "and due to its non-implementation, many parts of fraud and related activities go un-checked, increasing the likelihood of cheating and severe mismanagement, which can have a detrimental impact on the accomplishment of Corporate Governance Maturity."

In 2020, Ali Rehman , Fathyah Hashim researched on another topic that, There is a link between fraud risk assessment and excellent corporate governance among companies registered on the Muscat Stock Exchange in Oman.

In 2020, Ali Rehman , Fathyah Hashim also researched measuring the impact of forensic accounting's (FA) on Omani public listed businesses' sustainable corporate governance (SCG).

Deloitte India's 'India Corporate Fraud Perception survey, IV-2020, (Figure – 1,2 & 3)

As per Deloitte survey 80.3% says, fraud would rise in the future, especially in the cybercrime due to large-scale remote working arrangement and business change model. Whereas, 37.80% says, fraud will rise due to large-scale remote working arrangement.

These frauds will rise due to 2 main reasons –

1. Inability to understand vulnerabilities and
2. Dependency on static data for fraud risk assessment.

Procurement (19.35%) and Information Technology (16.94%) are most vulnerable to fraud risk. 48.5% believed techniques of fraud prevention is the key for success of fraud risk management. Approximately 35% that future frauds would get detected by using data analytics tools. In addition to this around 50% people believe that 'Employee Behavioural Analysis Tool', Artificial Intelligence (AI) and Machine Learning (ML) tools will prevent frauds partially or completely.

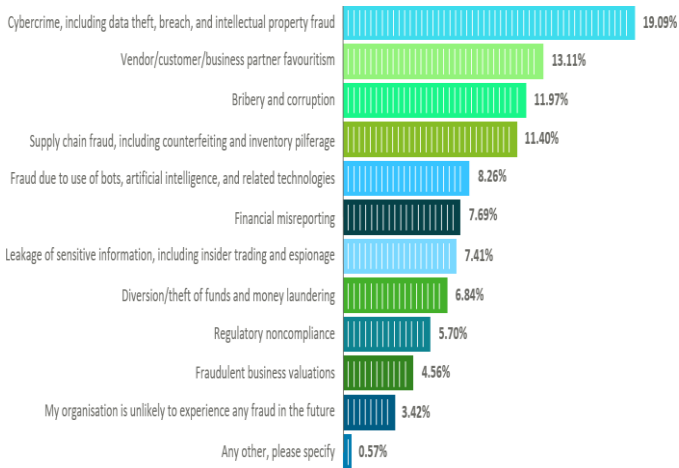Figure 1- Source: ©2020 Deloitte ToucheTohmatsu India LLP

Figure 2- Source: ©2020 Deloitte ToucheTohmatsu India LLP

Is organisation's existing fraud risk management framework is adequate?

Figure 3- Source: ©2020 Deloitte ToucheTohmatsu India LLP

V. CONCLUSION

A branch of Forensic Accounting in India is still in the beginning stage which displays sign of future potential and growing area of need in all types of corporate structure of India.

In 2002, the Sarbanes-Oxley Act (SOX) was enacted as a result of the Enron scandal and collapse of the Satyam Computers amended the Company Act in 2013. Similarly, Frauds at security market especially Harshad Mehta, Ketan Parekh and Karvy Stock Broking Ltd gave birth to National Stock Exchange (NSE) in 1992, SEBI Act,1992 was amended in 1995. Amended act gave SEBI more authority to access the records of any bank and inspect the books of Public Listed Companies. Harshad Mehta scam became an eye-opening event for Indian financial sector and the beginning for better Corporate Governance policies in India.

After timely amendments in laws still frauds are increasing day by day especially after the pandemic situation research in this domain is very much essential. India is marching towards the fraud free corporates & Financial institutions but, still companies are not ready for extra expenditure on forensic accounting services.

So it is very necessary to do research on how inclusion of Forensic Accounting in a system can improve Corporate Governance of the organization as well as will decrease the cases of frauds.

If organization will consider Forensic Accounting as a part of governance management system, just like internal & external audit, frauds can be avoided before the occurrence.
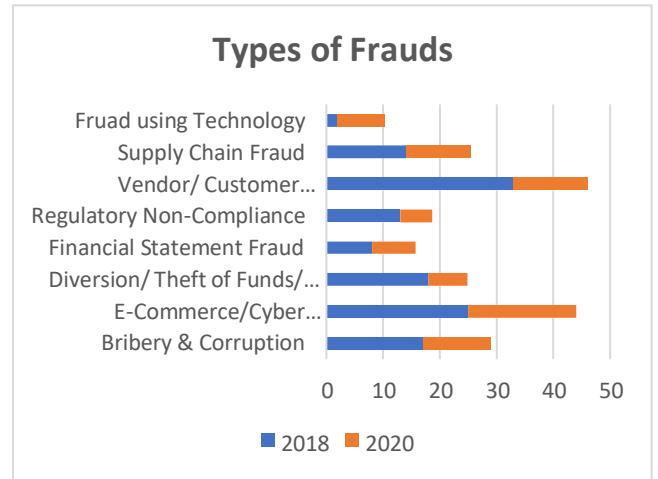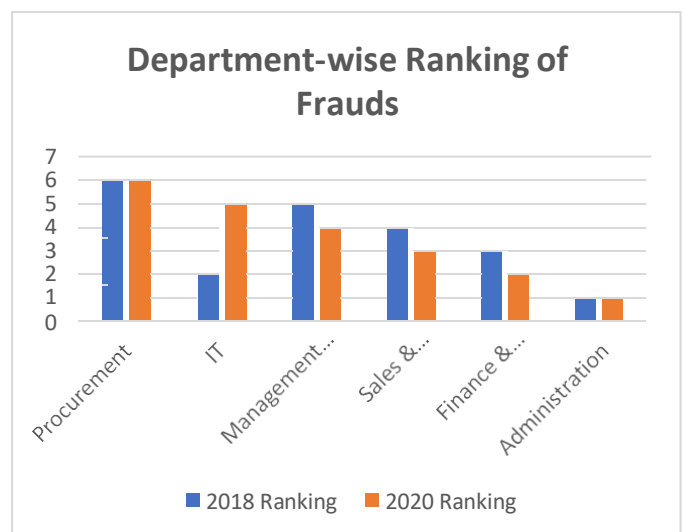

Figure 4 – Source: Compiled by Researcher

From figure-4 it is evident that fraud using technology are increased tremendously.

As per figure 5 chart, Procurement department remains at the top where maximum frauds happen. Whereas, frauds in IT department increased more than double.

Figure 5 – Source: Compiled by Researcher

As we are marching in 2022, so the skill set required almost after 8 to 10 years' time gap are different. There were introduction of new techniques and software like AI & ML technology. Especially after pandemic it is predicted by different sources that frauds will be increased

majority in the cybercrime. For this forensic accountant must be aware with current technology. So there is a need to do fresh research on this topic in the current time period as from 2011 to 2022 there are lot of amendments in rules & regulation in Indian law. The major which is related to Forensic Accounting is 'The Company Act, 2013' which amended after India's first major corporate fraud i.e. Satyam Computers.

Right Fit uses its expertise in the area of forensic accounting & investigations, to develop a fraud risk assessment report. Through discussion with the client and analysis of the client's working environment and industry, they are able to understand what are the possible areas where fraud is likely to happen. The purpose of this exercise is to identify risks related to management override, gross misstatement, collusion between employees and outsiders for illegal personal gain, as well as operational weaknesses that may be susceptible to fraud. Based on the risk assessments carried out by Right Fit; suitable strategies are formulated that help minimize frauds so that liability pertaining to fraudulent accounts is contained and affirmed in timely manner.

As per 'IndiaForensic', Software businesses have created software for internal auditors that complies with SOX requirements. On a same line, in future they may develop a software using a set of pre-defined standards for spotting fraud's red flag and to design such software, software companies will prefer the functional consultants with Forensic Accounting Background.

This study proves, the Corporate Governance maturity is the internal system of the organization to fulfil their goals & objectives. Forensic accounting's proactive role improves corporate governance maturity. which gives satisfaction to shareholders and increases their faith in the organization. It also protects the rights of the shareholders. Forensic Accounting as a preventive tool within the organisation is a control activity within the company such as planning, regular assessment of all types of transactions so red flags will raised in their early stage of fraud.

It is now proved that frauds are majorly conducted by the persons who are working or a part of the internal organisation and they can have carried out frauds because of weak internal control system, which means immature corporate governance. If the Control mechanisms will have enhanced, it will reduce the risk of fraud and will strengthen the

Corporate Governance maturity. To achieve this Forensic Accounting should be included as an in-house activity by the organisation to eliminate the risk of fraud which may be the obstacle for the growth and sustainability.

If organization will follow measures like appointment of independent directors, regular scrutiny of high value transactions, consideration of whistle blower's complaints, appointment of credible expert like forensic auditor etc. which are shown in the Figure 4, will reduce the chances of fraud.

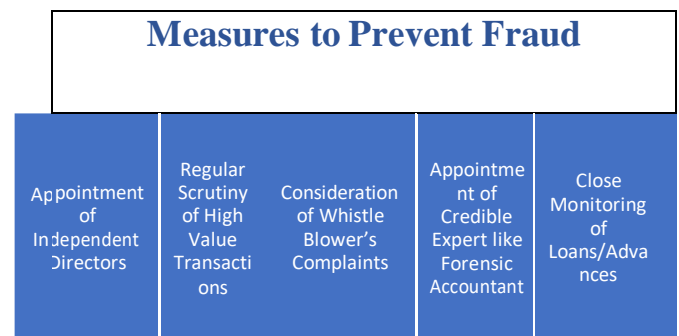| Measures to Prevent Fraud				
Appointment of Independent Directors	Regular Scrutiny of High Value Transactions	Consideration of Whistle Blower's Complaints	Appointment of Credible Expert like Forensic Accountant	Close Monitoring of Loans/Advances

Figure 6 – Chart by Researcher

If organization will consider Forensic Accounting as a part of governance management system, just like internal & external audit, frauds can be avoided before the occurrence.

This study highlights the fact that Forensic Accounting can be used as a preventive tool and also as governance management control. Currently Forensic Accounting is used only as a detective tool after the fraud happened. This research supplements the available literature in India. This research paves the way for future research in the fields of Forensic Accounting, Fraud Risk Assessment and Corporate Governance.

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A Study of the digital payment adoption in India, current potential and the future ahead

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Abstract:

Digital payments have become an integral part of our lives, providing convenience and speed in transactions. The Government of India has prioritized rapid digitization as a key objective with initiatives like Digital India. This initiative playing a significant role in propelling the country towards a digital economy. This trend is not limited to individuals but also extends to small and medium business communities as well. The demonetization resulted in tremendous growth in digital payments. With the government initiative such as Digital India and increased use of mobile and internet are means to exponential growth in use of digital payment. The primary objective of this study is to investigate the factors responsible for the widespread adoption of digital payments among people, to study potential size, and drivers of India's digital economy of the future; and to determine what needs to be done to ensure progress toward realizing the vision.

Keywords: UPI, Digital Payment, Digitalization, e-payment, Online payment

1. Introduction:

India is one of the fastest growing economies worldwide, and acceptance of Digital Payments in India has been one of the major reasons behind this phenomenal growth. The digital payments ecosystem has witnessed growth spanning over three significant areas. Firstly, there is growth in payment infrastructure. India has strong position in global benchmark for availability of alternate payment systems [2] As all eyes are set on India; the government is leaving no stone unturned to transform the country into a complete digital economy. With the rapid advancement of technology and the increasing prevalence of mobile devices, modern payment methods have become increasingly prevalent. With the widespread availability of smartphones and internet access, technology has become much more convenient for people, leading to a greater emphasis on digitalization. The demonetization that occurred in recent times has further fueled the demand for digital payments, leading to the entry and success of numerous digital wallet companies in India. This progress has not only revolutionized trade and commerce, but also made payment transactions quicker and more efficient

than ever before. The present report comprises a compilation of literature reviews by various articles, blogs and authors delving into the various modes of digital payments, their rate of adoption, frequency of usage, growth and their potential for the future. Additionally, it highlights how the Digital India initiative launched by the government has the potential to make our nation a cashless economy, with the help of digital payment methods.

2. Literature Review

Digital payment systems have revolutionized the way people conduct financial transactions, and research on this topic has been growing rapidly in recent years.

A systematic review of digital payment research by Huang and Benyoucef (2020) highlighted the key themes and trends in the literature, including the adoption and usage of digital payments, security and privacy concerns, and the impact of digital payments on businesses and society.

According to Shri Narendra Modi Hon'ble Prime Minister of India, Over 40 percent of the world's real-time payments took place through UPI in 2021.

Kshetri (2018) examined the potential of blockchain technology to enhance supply chain management, which could facilitate more efficient and secure digital payment systems.

Liébana-Cabanillas (2014) investigated the antecedents of consumer acceptance of mobile payments, while Zhang and Mao (2018) examined the role of trust in the adoption of digital payment systems.

Research by Lee and Kozar (2012) explored the factors influencing the adoption of online payment systems. Together, these studies provide a comprehensive understanding of the challenges and opportunities in the digital payment landscape and can inform future research and practice in this field.

As per view expressed by Shri Ashwini Vaishnaw Minister of Electronics & Information Technology, Railways and Communications, India's digital payments last year were more than the combined digital payments of four big economies- US, UK, Germany, France.

Rakesh H M & Ramya T J (2014) in their research paper titled "A Study on Factors Influencing Consumer Adoption of Internet Banking in India" tried to examine the factors that influence internet banking adoption. It is found that Internet banking services are impacted by the perceived reliability, ease of use, and usefulness of the system. To promote the adoption of these services, experts should focus on highlighting the benefits they offer and increasing awareness among consumers. By doing so, attention and interest in internet banking can be generated.

Kartikeya Bolar (2014) In his research paper "End-user Acceptance of Technology Interface In Transaction Based Environment "stated that to make informed strategic decisions in improving technology interfaces and competing on different quality dimensions, technology creators and investors require knowledge of customers' evaluations of the interface's features and various quality dimensions. This

information enables them to enhance the technology interface and remain competitive in the market.

Sanghita Roy, Dr. Indrajit Sinha (2014) . stated that Although the E-payment system in India has exhibited significant growth, its adoption rate remains low, with 90% of transactions still being conducted in cash. To address this issue, a study utilizing the Technology Acceptance Model identified four key factors that can enhance the system: innovation, incentives, customer convenience, and a strong legal framework. Further efforts are needed to promote E-payment usage in India.

E-payment systems serve as both a secure and convenient method for individuals and organizations to make payments online, while also providing a gateway to technological progress in the global economy. (Slozko & Pello, 2015).

Shri Rajeev Chandrasekhar Minister of State for Electronics and Information Technology and Skill Development and Entrepreneurship stated that Promotion of digital payments ecosystem is aimed at digitalising the financial sector and economy with consequent benefits of efficiency, transparency and quality. -

As per opinion stated by Shri Alkesh Kumar Sharma Secretary, Ministry of Electronics and Information Technology, Digital India has truly empowered the Indian society and contributed to making knowledge economy. -

As per Neeraj M in his article Digital Payments in India: Mobile Will Be Instrumental in 26.2% CAGR During 2016 – 2020 in India, only one-third of mobile phone users have smartphones, albeit the penetration (population) of a mobile phone has already crossed 80%. With just 450 million smartphone users, India is entering into a smartphone revolution era.

3. Objectives of the Paper:

This research paper initiative has three objectives:

1. To recognise the progress made by India on digital adoption.

2. To articulate the vision, potential size, and drivers of India's digital economy of the future; and

3. To determine what needs to be done to ensure progress toward realising the vision.

4. History of Digital payment

The Digital India programme, launched in July 2015, is a flagship programme of the Government of India with a vision of transforming India into a digitally empowered society and knowledge economy. In line with the Honourable PM Shri Narendra Modi's vision of ensuring that technology is "accessible, affordable, and adds value", the Digital India initiative was aimed at improving the life of the common person. The programme centres on three key vision areas: a) digital infrastructure as a utility to every citizen, b) governance and services on demand, and c) digital empowerment of citizens.

Having built a strong foundation of digital infrastructure and expanded internet access through some 836 million subscriptions, India is poised for the next phase of growth — the creation of tremendous economic value and the empowerment of millions of Indians as new digital applications permeate and transform a multitude of activities and types of work at a national scale. Over the last few years, the government has taken up initiatives across many spheres, including e-governance, skills, and digital infrastructure, that have shown significant impact on the way that the nation lives and works.

The adoption of digital payments in India began even before the internet was born. Back in the 80s, we did not have any internet infrastructure in the country. Yet, there were two products that were being used in place of physical cash by many people. We are talking about credit and debit cards, of course.

Andhra Bank introduced the first credit cards in 1981. This was 30 years after the first bank credit card was introduced in New York. Soon, many other banks in India followed suit and issued their own credit cards. In 1987, HSBC Bank set up the first ATM.

Soon, people started to carry around these little plastic cards instead of a big wad of cash. Cash was still a staple part of the payments industry though - until the internet came knocking. If you really want to put a pin on when the digital payment system in India began, you can trace it back to the mid 90s and early 2000s. In the 90s, the internet started to become wildly popular in India. VSNL Limited was one of the first internet providers, offering internet connections at the speed of 9.6 Kbit per second.

People then began to sell stuff online. In other words, the e-commerce industry was born, although it was in its nascent stages. But selling things online gave way to the need for an online payment system.

BillDesk was founded in 2000, on the cusp of the new decade. It was the first payment aggregator in the country, and it made digital payments easier for e-commerce customers. In 2005, digital transactions like fund transfers got easier, thanks to the introduction of National Electronic Funds Transfer (NEFT).

 Simultaneously, the popularity of debit cards also soared in the 2000s, leading to easier digital payments both online and in-store. The gamut of choices available in the digital payment systems in India was clearly on the rise. The National Payments Corporation of India (NPCI) was established in 2008-09. This umbrella organization oversees the retail payment systems in India and has been leading many developments in this area over the past decade.

And by the time 2010 came around, we had several online payment channels such as credit and debit cards, Magnetic ink character recognition (MICR) clearing channels, Electronic Clearing Service (ECS), NEFT and Real Time Gross Settlement (RTGS).

 In the years that followed, the NPCI rolled out several other digital payment options to strengthen the payments system in India. Here is a preview of some of these solutions.

RuPay- RuPay is one of the flagship products of the NPCI. It is a global card payment network that is widely accepted at various nodes like ATMs, e-commerce portals, POS machines and more. Over 1,000 banks in India issue RuPay cards today, and this selection includes credit, debit, prepaid and government cards. This innovative system played a tremendous role in the penetration of digital solutions in the tier 2 and tier 3 cities in India.

Aadhaar Payment Bridge System (APBS)- The Aadhaar Payment Bridge System helps the government and governmental agencies make direct transfers to the beneficiaries of the many schemes sponsored by the central and state governments. It uses the beneficiary's Aadhaar number as the primary key.

The Bharat Bill Payment System (BBPS)

The Bharat Bill Payment System (BBPS) is a one-stop solution for all your regular payments. You can pay your electricity, gas, DTH, insurance, telecom, water and even your FASTag dues online via the BBPS route. There are over 200 billers in the system in various categories.

With demonetization being announced in 2016, the digital payment system in India was further strengthened as more people began to turn to these channels for their everyday transactions. Furthermore, the outbreak of the COVID-19 pandemic made it increasingly necessary to initiate contactless payments.

The use of NFC technology in POS terminals made it easier for retail consumers to pay for their purchases in a contactless manner. But in view of the lockdowns enforced over the past years, the need for more robust contactless solutions made Unified Payments Interface (UPI) increasingly popular.

5. **Government Initiative:**

The Digital India programme is a flagship programme of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy. Promotion of digital payments has been accorded the highest priority by theGovernment of India to extend digital payment services to every segment in the country.

The vision is to provide digital payments facilities to all citizens in a convenient, easy, affordable, quick and secured manner

Ministry of Electronics & Information Technology (MeitY), Digital Economy & Digital Payment Division has been entrusted with the responsibility of leading this initiative on "Promotion of Digital Transactions including Digital Payments". MeitY is coordinating with multiple stakeholders including Banks, Payment Service Providers, Central Ministries/Departments and States/UTs, for promotion of digital payments across the country.

Coordinated efforts of the Government with all stakeholders have led to a significant growth in digital payments, as given below:

Financial Year	2017-18	2018-19	2019-20	2020-21	2021-22
Digital Transaction Volume (in crore)	2,071	3,134	4,572	5,554	8840
Digital Transaction Value (in lakh crore)	1,962	2,482	2,953	3,000	3,021

(Source:RBI, DigiDhan Dashboard)

6. The current situation:

India is among the top three global economies in number of digital consumers. With 634.9 million internet subscriptions in 2022 India is the second-largest internet subscriptions market in the world. Likewise, India has the second-largest number of instant messaging service users worldwide, behind China.
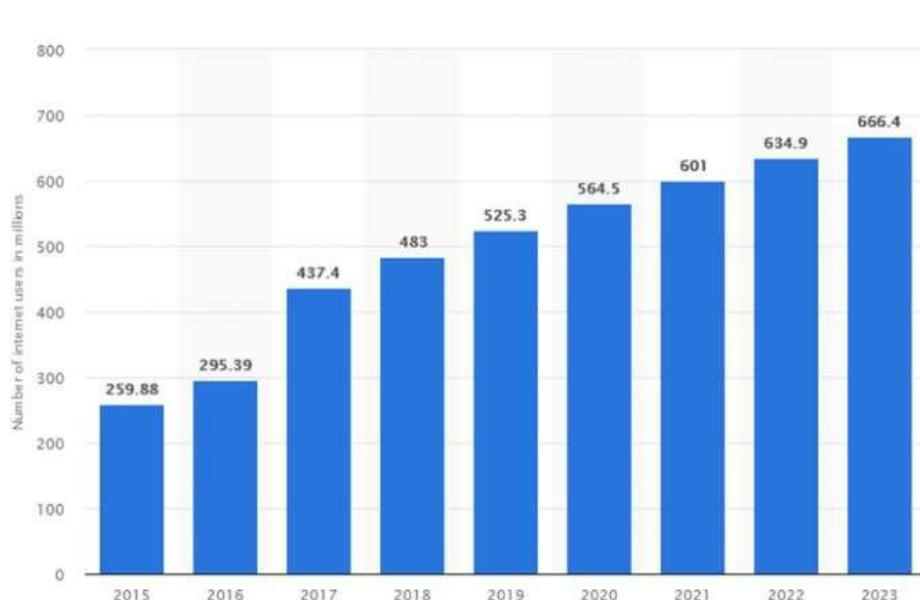
Figure 1 : Number of internet subscribers in India as of June 2022

Source: https://www.researchgate.net/

As mentioned by Shri Rajeev Chandrasekhar, Minister of State for Electronics and Information in his address to the upper house- India achieved a total number 8,193 crore digital payment transactions till March 20 2022, across payment modes like Bharat Interface for Money- Unified Payments Interface (BHIM-UPI), Immediate Payment Service (IMPS), National Automated Clearing House (NACH) set up by the National Payments Corporation of India (NPCI), debit cards, credit cards, NEFT, RTGS, PPI and others.

"Over the year, digital payments transactions have grown multifold from 2,071 crore in FY2017-18 to 5,554 crore in FY2020-21. During current financial year i.e. FY2021-22, the total number of 8,193 crore digital payment transactions have been reported till 20th March 2022," Chandrasekhar also mentioned that BHIM-UPI emerged as a preferred mode of payment among citizens, with record 452.75 crore digital payment transactions with a value of Rs 8.27 lakh crore till February 28. Total value of UPI-based digital transactions in India is Rs 81 lakh crore (FY2021-22); Rs 41 lakh crore (FY2020-21); Rs 21 lakh crore (2019-20); and Rs 9 lakh crore (FY2018-19), as per the NPCI data cited by the minister.

He also apprised the parliamentarians of the measures taken by the Ministry of Electronics and Information Technology (MeitY) to promote digital payments across the country. These include incentive scheme for promoting RuPay debit cards and low-value BHIM-UPI transactions (P2M). This incentive scheme facilitates banks to build robust digital payment ecosystem, promote RuPay debit cards and BHIM-UPI digital transactions across sectors and segments.

7. India's Digital Payments Landscape:

India has witnessed a tremendous growth in the digital payments sector in recent years. According to reports, there has been a staggering 44% compound annual growth rate (CAGR) increase in digital payments by volume from 2017-18 to 2021-22.

Unified Payments Interface (UPI)- With over 60 billion digital transactions till date, the Unified Payments Interface (UPI) has emerged as a popular platform for inter-bank transactions, with a transaction volume of 7829.49 million as of December 2022.

RuPay card - The indigenously-developed RuPay card, launched in March 2012, has also been a success, with over 714 million total RuPay cards in circulation as of December 2022. In December 2022, the platform recorded a total of 78.80 million point of sale (PoS) transactions, worth INR 12,82,005.01 crore in transaction value.

The National Electronic Toll Collection (NETC)- (Fast Tag) launched in December 2016, has also seen tremendous growth, with a total of 53,54,312.76 million transactions, worth INR 4,939.75 crore in December 2022 alone.

Bharat Bill Payment System (BBPS)- Another significant addition to the digital payments sector is the Bharat Bill Payment System (BBPS), which was launched in 2014. As of December 2022, BBPS has over 20,600 billers live on its platform, and recorded a total transaction value of INR 1,39,022 crores from April - December 2022. BBPS aims to provide a seamless and accessible platform for customers to pay recurring bills.

Aadhar Enabled Payment System (AePS) - It was launched in November 2010. AePS is a bank-led model that uses Aadhaar-based authentication to enable online interoperable transactions. The system has gained significant popularity, with INR 1,88,421 crores worth of transactions done through AePS from April-December 2022, and 69.7 crore transactions done between April-December 2022.

e-RUPI- Another payment system, e-RUPI, was launched in August 2021. e-RUPI is a person and purpose-specific cashless e-voucher designed to ensure that the stored money value reaches its intended beneficiary. In December 2022, 27,652 vouchers were created through the system.

UPI Lite- It is a new payment solution that can be used to process low-value transactions below ₹200, was launched on 20th September 2022. The system has already recorded 6.62 lakh transactions until 12th December 2022.

IMPS, an instant payment inter-bank electronic funds transfer system, was launched in November 2010 and is the second-largest payment method in India after BHIM-UPI. The system has witnessed a 47% CAGR growth in the volume of transactions through the last five years, with INR 40,93,673 crores worth of IMPS transactions between April-December 2022, and 423 crore transactions done between April-December 2022.

The National Automated Clearing House (NACH) service, launched in 2016 by the NPCI, facilitates electronic automation of inter-bank high volume, low-value debit and credit transactions. The system has recorded a 13% CAGR growth in the volume of transactions since 2018, with 384 crores of transactions in FY 2021-22, and a 22% CAGR growth in the value of transactions from 2017-18.

The National Electronic Funds Transfer (NEFT) was launched in November 2005 by the Reserve Bank of India (RBI) and is a nationwide centralised payment system. NEFT has recorded a 30.6% CAGR growth in volume since 2018, with 404 crores of transactions in FY 2021-22 and a 14.3% CAGR growth in value from FY 2017-18 to FY 2021-22.

The Real-Time Gross Settlement (RTGS) system has witnessed 20.8 crores transactions in FY 2021-22, with INR 1092 lakh crores worth of transactions between April-December 2022

8. The way forward:

Making India a world leader in the digital economy will require a multifaceted approach that involves a combination of government policies, private sector initiatives, and individual efforts. Here are some steps that could be taken:

Expand digital infrastructure: India needs to invest in the expansion of digital infrastructure, such as high-speed internet connectivity, data centers, and cloud services. This will require significant investment in both urban and rural areas to ensure that everyone has access to digital services.

Encourage entrepreneurship: The Indian government should create policies that encourage entrepreneurship in the digital space, such as tax incentives and easier access to funding. This will help create a vibrant startup ecosystem that can develop innovative digital solutions and products.

Embrace emerging technologies: India should focus on embracing emerging technologies such as artificial intelligence, blockchain, and the Internet of Things. This

will help to create new industries and drive economic growth.

Increase digital literacy: India should invest in increasing digital literacy among its population, especially in rural areas. This will help to ensure that everyone can participate in the digital economy.

Develop digital talent: India should invest in developing digital talent by improving the quality of education in science, technology, engineering, and math (STEM) fields. This will help create a pool of skilled workers who can drive innovation in the digital economy.

Foster international partnerships: India should foster international partnerships to exchange knowledge, resources, and ideas with other countries. This will help to create a more robust and global digital ecosystem that can drive innovation and economic growth.

The 360-degree Approach: There is need for a 360 degree robust approach

Digital Foundation

The foundation of a strong digital infrastructure for a should rest on four key pillars.

The first pillar is universal coverage of digital identity, authentication, and consent framework. This ensures that every citizen has a unique digital identity, which they can use to authenticate themselves across various digital platforms.

The second pillar is a world-class environment for cybersecurity and data protection, which safeguards against cyber threats and protects sensitive data.

The third pillar is digitised data assimilated from an open API framework with utilities developed using deep analytics and real-time visualisation. This will enable the government to leverage data insights to make informed decisions and deliver efficient public services.

Finally, the fourth pillar is requirement of skilled workforce in new digital and emerging technologies, which is crucial for driving innovation and economic growth. With these four pillars in place, a nation can build a strong national digital foundation that can propel it towards digital transformation and success in the digital economy.

Digital Reach

In today's digital age, it is crucial to connect unserved and underserved people with affordable, high-speed internet. This can be achieved by providing fibre and 5G connections to every household, enabling two-way data speeds of up to 20 Mbps. With more than 1 billion internet users globally, it is imperative that we also provide strong local-language content and universal digital literacy to ensure everyone can take advantage of the benefits of the internet.

To maximize the potential of the internet, new digital platforms and delivery models are emerging in areas such as agriculture, education, transportation, and other services. By embracing these technologies, we can create a more inclusive society where everyone has access to the same opportunities and services.

Digital Value

The goal of creating a $1 trillion digital economy is achievable by leveraging digital and data-backed innovation to boost productivity in key sectors such as manufacturing, agriculture, and services. This can be achieved by nurturing vibrant IT-BPM, telecom, e-commerce, and electronics sectors, which will encourage an explosion of new digital startups. Additionally, more workers will be absorbed into the formalised, digitised sector through tech platforms and value chains, driving further growth. To support this growth, our nation aims to become a global leader in digital identity and public digital platforms, as well as data utilities. We also strive to become a hub of innovation in fintech, edutech, healthtech, agritech, and other areas of technology innovation. To support these efforts, we will build a powerful data analytics engine that will enable us to offer valuable insights and services to the world.

The Indian government has taken several measures to support and promote the growth of digital businesses in the country. One of their main goals is to significantly improve the ease and reduce the cost of operations for digital businesses. The government has set a target to make India one of the 50 easiest countries to do business in, and their efforts are beginning to bear fruit.

Another key initiative is to unlock the flow of domestic capital into digital businesses. While India has attracted large amounts of foreign investment in its technology sector, the government recognises the importance of domestic savings as a strong complement. Encouraging the flow of domestic capital into digital businesses will help retain the assets and wealth created by these businesses in the country, contributing to the growth of the digital economy.

To ensure that India's workforce is equipped with the necessary skills for the digital economy of the future, the government should put more efforts to unshackle centres of higher education and innovation. They must recognise that competitive advantage will lie in developing skills in design, creativity, and innovation. Finally, the government should have supportive policies and regulations that will enable the growth of the digital economy. By implementing these policies and initiatives, the Indian government hopes to create a thriving digital economy that benefits all citizens.

9. Conclusion:

In conclusion, digital payments have become an integral part of our lives, and the Government of India has prioritized rapid digitization through initiatives such as Digital India. This focus on digitization has played a significant role in propelling India towards a digital economy, with benefits that extend to individuals as well as small and medium-sized businesses. The demonetization in recent times has further fueled the demand for digital payments, leading to the entry and success of numerous digital wallet companies in India.

India's digital payments ecosystem has witnessed growth in payment infrastructure, the introduction of various payment systems, and a significant increase in the digital payments sector. With the widespread availability of smartphones and internet access,

technology has become much more convenient for people, leading to a greater emphasis on digitalization.

To ensure progress towards realizing the vision of a complete digital economy in India, a multifaceted approach is required that involves a combination of government policies, private sector initiatives, and individual efforts. This approach should focus on increasing digital literacy, extending digital reach to the people, improving infrastructure, and data protection.

India has the potential to become a world leader in the digital economy, and the government is leaving no stone unturned to make this vision a reality. With the rapid advancement of technology, the increasing prevalence of mobile devices, and the growing acceptance of digital payments, India is poised to lead the way in the digital revolution.

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Development of Mapping and Surveying Drone

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Abstract— **Traditional surveying and mapping methods for obtaining ground data are often inefficient, inaccurate, expensive, and risk damaging or losing equipment. Enter drones, and unmanned aerial vehicles (UAVs), which address these issues by providing innovative mapping capabilities. GIS professionals can use drones to perform topographic surveys with accuracy, matching traditional methods, but with reduced efficiency and cost. The use of drones reduces the workload of on-site experts and improves the efficiency of on-site investigations. The project aims to develop a mapping and surveying drone capable of capturing terrestrial images that can be converted into a 3D representation, collecting important parameters such as distance, area, and volume. Essentially, traditional surveying and mapping methods have limitations such as inaccuracy, high cost, and high risk, while drones used for surveying and mapping have multiple advantages including faster surveys and more efficiency, reduced costs, and relief of the experts' workload. The main objective of the project is to design a drone capable of capturing terrain images and converting them into a 3D representation, making surveying more efficient and precise, potentially revolutionizing surveying methods.**

Keywords—Drone, Prototype, Mapping, Photogrammetry, 3D Model

I. INTRODUCTION

Land mapping in India has suffered from a variety of issues, with a primary cause being inefficiency, inaccuracy, and high costs. The traditional method of land mapping is a lengthy and tiresome process, requiring extensive human effort to manually measure distances and collect data. As a result, this method is prone to human error and inaccuracies, which often results in disputes over land ownership and boundaries. Furthermore, traditional mapping techniques often rely on outdated equipment and technology, rendering them less reliable and less precise. This obsoleteness can lead to further complications and disputes, as the data gathered, may not be reflective of the current state of the land. The financial burden of traditional mapping techniques is also a significant issue, making them inaccessible to rural communities and small-scale farmers. The inaccessibility to accurate land mapping data poses a considerable obstacle to economic development, leading to social inequality.

In summary, traditional land mapping techniques in India have faced numerous challenges, limiting their effectiveness and accuracy. The solution to these challenges may be in the adoption of modern technologies such as drone mapping, which can provide a more precise, faster, and cost-effective method of mapping land, benefitting individuals and society as a whole. [1,2]

II. BASIC CONCEPTS

A. Drone Mapping

Drones are flying robots, ranging from unmanned aerial vehicles (UAVs) that fly for miles to small drones that fly in confined spaces. They are aerial vehicles without a human operator, which can fly remotely or autonomously, carry lethal or non-lethal payloads, and are considered drones.

Drone mapping is an aerial survey which is conducted by the means of a drone and specialized cameras, which can include RGB (for photogrammetry purposes), multispectral, thermal, or LiDAR sensors. Drone mapping is a process that involves surveying an area of land using an unmanned aerial vehicle (UAV). This method is used by many industries that require surveyors to provide maps of areas of land. The process involves flying the drone over an area of land and taking hundreds of pictures. These images are then stitched together using computer software to create a model of the site. The drone mapping process allows surveyors to collect highly-accurate data quickly and safely. In fact, drone mapping collects data over 90% faster than manual methods. The collected data can be processed through several available drone mapping software to create 3D models, 2D maps, and digital elevation models. These assets are used to extract information that is required by the user such as highly-accurate measurements and volumetric calculations.

Drone mapping has several advantages over traditional mapping methods. It is faster, cheaper, and safer. Drones can scan large swathes of terrain in a fraction of the time it takes to manually measure on the ground, especially in areas with difficult terrain. This reduces operational costs and risks, as investigators do not necessarily need to be onsite or in hazardous areas to obtain data. Combined with traditional surveying methods, drone mapping can also produce extremely detailed and highly accurate point files down to millimeters. In summary, drone mapping is a highly efficient and effective way to survey and map areas of land, providing valuable data for a range of industries. [3]

B. Photogrammetry

Photogrammetry is a method that permits the creation of 3D models from 2D photographs. It is utilized in a broad range of applications, including architecture, archaeology, and geology. The method comprises capturing a series of photographs from different

viewpoints and then employing specialized software to generate a 3D model from the images.

The process of photogrammetry can be quite intricate, involving multiple diverse steps and calculations. The first step is to capture a series of photographs of the object or scene to be modeled. These photographs must be taken from varying angles and distances to capture all the necessary details. Once the photographs have been captured, they must be processed using specialized software. This software employs algorithms to match up the diverse images and calculate the positions and orientations of the cameras that captured the photos. This information is employed to create a 3D point cloud, which represents the surface of the object or scene. The point cloud can then be employed to create a 3D model using further processing steps. These steps may include smoothing the surface, filling in any gaps or holes in the data, and adding textures or colors to the model. The resulting 3D model can be used for a diverse range of purposes, such as visualization, measurement, and analysis. [4-5]

For example, an architect may use a photogrammetric model to plan a building renovation, while a geologist may utilize a model to examine the topography of a landscape.

Photogrammetry is a powerful tool for creating detailed 3D models from photographs. Nevertheless, it can be a complex and time-consuming process, requiring specialized equipment and software. Additionally, the accuracy of photogrammetric models depends on many factors, including the quality of the photographs, the precision of the camera positions, and the processing algorithms employed. Despite these challenges, photogrammetry is a valuable method that has transformed the way we create and study 3D models.

III. DRONE PHYSICAL PARAMETERS

Drones are all the rage nowadays, being widely used across various industries such as photography, agriculture, and surveillance. Nevertheless, operating a drone without considering its physical parameters like weight, thrust, and power consumption can prove to be very dangerous. These are just a few of the physical parameters that affect a drone's flight characteristics, like speed, agility, and endurance. Grasping these parameters allows drone operators to pinpoint the perfect battery size, propeller type, and motor power required to attain their desired flight objectives.

According to the required needs for the functioning of the drone, the values were calculated to be as follows: -

Sr. No.	Parameter	Value
1	Minimum Thrust per Motor	0.3 kg
2	Average Current Drawn	18 A
3	Average Flight Time	16.7 min

Table 1. Calculated values for the drone

IV. CONVERSION OF 2D PHOTOGRAPHS INTO 3D MODELS

Photogrammetry is the process of creating 3D models from 2D images. It consists of the following steps: -

1) Collect a series of photographs of the object or scene from different angles and positions.

2) Prepare the images by formatting, aligning, cropping or resizing, adjusting brightness and contrast, and removing distortions.

3) Import the images into photogrammetry software and identify common points in the images manually or through automated software.

4) Generate a point cloud, which is a collection of 3D points representing the object or scene.

5) Use the point cloud to create a mesh, a 3D surface approximating the shape of the object or scene.

6) Apply texture mapping to the mesh by projecting the images onto its surface to create a realistic 3D model.

A. Capturing Images

The key to successfully creating great 3D models through photogrammetry is to capture high-quality images that provide good coverage of the object or scene from multiple angles, with consistent camera settings and lighting conditions. For this we must note these points before capturing images:

1) Use a high-resolution camera: A high-resolution camera is essential for capturing sharp and detailed images that can be used to create an accurate 3D model.

2) Ensure good lighting: Good lighting is important for capturing clear images with proper contrast and color.

3) Capture the scene from multiple angles: Capturing the scene from multiple angles will help ensure that you have good coverage of the object or scene, and will provide more data points for the photogrammetry software to work with.

4) Use a stable camera platform: Using a stable camera platform, such as a tripod or steady surface, will help ensure that your images are sharp and in focus.

5) Use a consistent camera setup: Consistency is important when taking photographs for photogrammetry. Use the same camera settings, including aperture, shutter speed, and ISO, for all of your images.

6) Overlap each image: Overlapping each image by about 60-80% will help the software to identify common points in the images more accurately and create a more detailed 3D model.

7) Avoid blurry images: Blurry images can cause problems for the photogrammetry software and result in a less accurate 3D model. Make sure your images are sharp and in focus.

Fig.1 Reference Photograph of the area

B. Generation of Point Cloud Data

Point cloud data is a 3D representation of an object or scene, consisting of a collection of points that describe its surface. Generating point cloud data in photogrammetry involves identifying common points in multiple images and using these points to triangulate the object or scene's position in space. [6-7]

Point clouds are collections of XYZ coordinates that precisely locate every point within a 3D model. They act as the base for creating more intricate models such as mesh or surface models and have a broad range of applications such as analysis, measurement, and more. Because of the vastness and complexity of point clouds,

specialized software is necessary to manage and process them. With the help of this software, users can accurately manipulate and utilize the data contained within point clouds. In summary, point clouds provide a detailed representation of 3D models, and by using specialized software, they can be leveraged for a wide range of purposes. The generation of point cloud data in photogrammetry is based on triangulation.

Triangulation is a mathematical process that photogrammetry uses to generate point cloud data. This process determines the 3D position of a point in space by analysing its relationship with other known points. In photogrammetry, triangulation is used to calculate the position of common points in multiple images. By triangulating these common points, photogrammetry can create accurate and detailed 3D models of real-world objects. Therefore, triangulation is a critical component of photogrammetry that enables the creation of precise and reliable 3D models.

The software (In this case software used is 3DF Zephyr) identifies these common points by either manual identification or through automated feature detection algorithms. Once the common points have been identified, the software uses the geometry of the camera lenses and the relative positions of the cameras to triangulate the position of each point in 3D space. By using appearance data from multiple images, the software generates a dense point cloud that accurately represents the surface of the object or scene. [8-10]
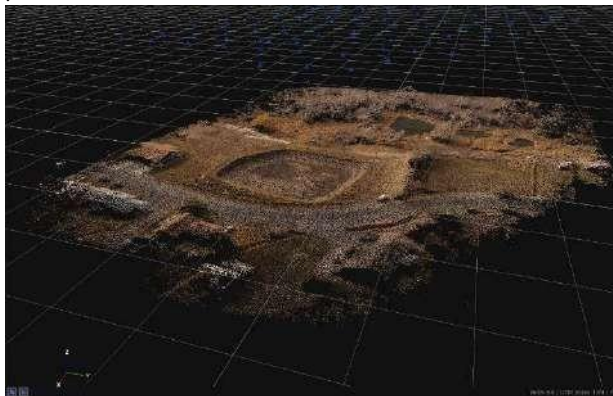
Fig.2 Point cloud data

C. Mesh Creation

In photogrammetry, a mesh refers to a 3D surface model of an object or scene that is created by connecting the points in a point cloud to form a continuous surface.

Mesh creation is an essential aspect of photogrammetry that involves creating a 3D surface model of an object or scene. In the process, a mesh is formed by connecting the points in a point cloud to create a seamless surface. The mesh is made up of a network of triangles that define the surface geometry of the object or scene being scanned. The mesh creation process comprises several steps, including cleaning and processing the point cloud data to eliminate any noise or outliers. The next step involves connecting the points to form a triangular mesh that is then refined and smoothed to create a more accurate representation of the object's surface. While mesh creation can be done manually, specialized software often automates the process. The software provides users with various parameters to adjust the quality and density of the mesh to their desired output. In summary, mesh creation plays a vital role in photogrammetry, converting raw point cloud data into a more usable and visually pleasing 3D model.

Fig.3 Mesh Creation

D. Texture Mapping

Texture mapping is the process of adding color and texture to a 3D mesh created from photogrammetry.

Texture mapping in photogrammetry involves projecting 2D images onto a 3D mesh model to create a texture map. The process starts by aligning the 2D images with the 3D model through camera calibration, which determines the camera parameters like focal length, lens distortion, and relative position. Then, texture projection is applied to project the images onto the 3D model by determining the position and orientation of the cameras at the time of image capture. After texture projection, a seamless texture map is generated by blending the 2D images together and removing any seams or artifacts.

This results in a single texture map that can be applied to the 3D model to create a realistic and visually appealing representation of the object or scene. Texture mapping is a vital step in photogrammetry as it enhances the visual quality and realism of the 3D model. Specialized software is often used to automate the texture mapping process and enable the user to adjust parameters to control the texture map's quality and resolution. [11-13]

Fig.4 Texture Mapping

V. CREATION OF A PROTOTYPE

Prototyping is an essential step in the product development process that enables designers and engineers to test their ideas before committing to costly and time-consuming production processes. By creating a physical model of a proposed product, they can identify areas where the design needs refinement and improvement. Creating a prototype allows designers to observe and interact with the product in a way that is not possible through mere digital simulations or descriptions. This hands-on experience provides valuable insights into the strengths and weaknesses of the design, which can then be used to refine the product further. For

example, a prototype can reveal issues related to ergonomics, aesthetics, or functionality, which can be addressed in subsequent iterations. Moreover, the prototyping process can also help designers to communicate their ideas more effectively to stakeholders and investors. By providing a tangible representation of the proposed product, it becomes easier to demonstrate its potential value and appeal. [14-15]

A. Materials required

When it comes to the performance and durability of drones, material selection is a critical factor. There are a multitude of reasons why this is the case. Firstly, drones are not bound to a specific environment, which means that they have to be able to handle a broad range of weather conditions and other environmental factors. Secondly, lightweight materials are crucial to maximize flight range and duration, making it necessary for the materials used to have specific characteristics. Lastly, drones are employed for a vast array of purposes, such as agriculture, surveying, and aerial photography, and the quality of the data they gather is reliant on the material properties of their components.

When selecting materials for drones, various factors must be considered. These include weight, strength, stiffness, durability, and corrosion resistance, among others. Carbon fiber, aluminum, titanium, and various types of plastics and composites are some of the commonly used materials in drone construction. [19,20]

Carbon fiber is a top choice for drone frames and components due to its strength, stiffness, and lightweight properties, which make it ideal for flying. Aluminum and titanium are also preferred materials because of their high strength-to-weight ratios and corrosion resistance. Plastics and composites are often utilized due to their ease of manufacturing, affordability, and their ability to be molded into complex shapes, which makes them a great choice for components that require intricate designs.

The materials selected for the creation of the prototype:
1. Drone Frame: - Carbon Fibre
2. Propeller Arm: - Carbon Fibre
3. Propellers: - ABS Plastic

B. Electronic Components

Drones rely heavily on electronic components to function properly. These components are responsible for controlling the flight, capturing data, and communicating with the operator. Without them, drones would be rendered useless. The most crucial electronic components include the flight controller, GPS module, motors, and camera. The flight controller acts as the brain, receiving commands from the operator and transmitting them to the motors. The GPS module provides location data, while the motors control movement. Finally, the camera captures high-quality imagery and video, enabling a broad range of applications, such as aerial photography, surveying, and inspections. [16-18]

The electronic components used are: -

1. Flight Controller: - Flight Controller is a circuit board with a set of sensors that detect the movement of the drone as well as user commands. Using this data, he can control the speed of the motors to make the craft move as directed. It supports 8 RC channels and 4 serial ports. Therefore, this prototype uses a PIXHAWK PX4 2.4.8 Flight Controller which is a high-performance autopilot on-board module for fixed-wing, multi-rotor, helicopter, or any other robotic platform that can move.

2. Electronic Speed Control (ESC): - The electronic speed controller (ESC) is an important part of the drone flight control system. They regulate the speed of the motors for stable flight, precise motion control and efficient power management. As mentioned earlier, the prototype draws an average of 18 A, so a higher ESC is required and the next available standard was a 30 A ESC.

3. Geo Positioning System (GPS): - Drone GPS modules provide position data for accurate and reliable navigation, precise positioning, and autonomous flight capabilities. Therefore, the prototype uses a new generation of Ublox NEO-M8N GPS, which has low power consumption and high accuracy. The final accuracy reaches 0.6 meters, which is actually close to 0.9 meters, which is larger than the previous generation NEO-7N 1.4 -1.6 American precision.

4. Motors: - Motors provide the necessary lift and propulsion for a drone to fly, enabling it to move and maintain stable flight in the air. The prototype has a 1000kv motor at its disposal.

5. Camera: - For photogrammetric purposes, cameras are an essential element. For the current application, the GoPro camera was chosen because of its light weight of around 150-200 grams, pits ability to record and capture in 4K, and its excellent image stabilization allowing for sharp images even when the prototype moved and wobbled.

Fig.5 Prototype Image

VI. CONCLUSION

The paper provides a compelling argument for using drones instead of traditional methods for land mapping. The traditional method of land mapping is time-consuming, labor-intensive, and inefficient, as it requires extensive human effort to manually measure distances and collect data. In contrast, drones are faster, cheaper, and safer, and can scan large patches of land in a very short amount of time, making them ideal for mapping large areas quickly and efficiently. This is especially useful in areas with difficult terrains, such as mountainous regions, where it can be challenging for humans to measure distances manually.

The paper also discusses how drones can be used for land mapping through the means of photogrammetry which is a technique that uses photographs to create 3D models of an area. The process involves taking a series of overlapping photographs of the area and using specialized software to create a 3D model from these images some of the steps involved in creating the 3D model, being; capturing images, creation of point cloud data, mesh generation, etc.

The paper also describes the creation of a prototype drone for land mapping purposes. The physical parameters and electronic components of the prototype are also discussed, providing a blueprint for the construction of similar drones.

Overall, the paper highlights the advantages of using drones for land mapping purposes, including increased efficiency, cost-effectiveness, and safety. It also explains the process of using photogrammetry to create 3D models and provides a detailed description of the prototype drone.

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Control of Bipod Robot and its stability

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Abstract—**The ideology of biped robotics has a very wide range of application making it a very crucial one. In order to achieve this, the most important factor to take into consideration is its stability. The stability affects the aesthetic structure as well as the systematic functioning of it. The sophisticated robot can also be programmed the alter the speed of motion, direction change and obstacle detection and motion for inclination. Issues can be resolved by the utilizing the concept of Zero Moment Point (ZMP). It is defined as the point at which all of the system's moment and inertia cancel out, or when there is no net moment. Also, the influence of center of mass (CoM) trajectory on biped robot stability was studied in this research. The biped walking robot that receives ankle rotation assistance may have an additional non-performing degree of freedom situated between the toe of the foot and the surface of contact. The biped models under consideration are the revolute and the prismatic one and using the knowledge of kinematics, an inference is drawn in which the superior model will be considered.**

Keywords— crucial, stability, aesthetic, trajectory, revolute, kinematics, moment, inertia.

I. INTRODUCTION

The invention and development of legged motion resulted in a technological revolution in transportation; the most important concept of this motion was bipedalism, which was inspired by humans. Modern bipedal robots are developing to the area of interest in which it could be applicable to substitute mankind in a vast range of jobs performed in surroundings composed only for mankind (such as the usual commercial and factory workplace). Leg movement is distinguished by the availability of numerous collection of surface touch points that result in similar postures. This feature is extremely effective in unusual landscapes because the humanoid body position is less restrained by obstructions (if one collection of surface contact areas is not possible due to an obstacle, after which alternate solution sets are generally possible), as contrasted to wheeled locomotion, which has fixed points of contact that cannot overcome the hindrances. Bipedal robot integrate the adaptability of human movement with a minimal amount of surface touch area (which simplifies the designing of propulsion algorithms) at the price of increased motion stability challenges.

Biped robots are often investigated with the goal of imitating human-like movement skills while also taking animal biped locomotion [1-3] into account. Human movement is divided into two instances: such as the swing instance as well as double foot supporting instance. Throughout the swinging stage, one foot, known as the balance assistance foot, remains grounded on the surface. Meanwhile, the other leg, known as the balancing leg, swings forward at a speed that is sufficient to keep the user from toppling over. Movement on two feet has a number of challenges, prominent among them being stability.

Static stability necessitates such the bipedal robot must be steady in any static arrangement, and its measurement is solely dependent of the information of position. The related idea is dynamic stability, that demands that the bipedal robot not collapse on the walking surface when displacing without regard for stability at any point of the trajectory. [4,5] Velocity data is also used to calculate dynamic stability.

II. 3-D LIPM AND ZMP

The Linear Inverted Pendulum Model (LIPM) is used to potray the estimated displacement of the bipedal walking robot while stably assisting its structure on its one foot. A 3-D linear inverted pendulum is such a system in which the inverted pendulum that travels in one plane alone. The physics model may be expressed as follows if the restricted plane is considred as a landscape plane.[6]
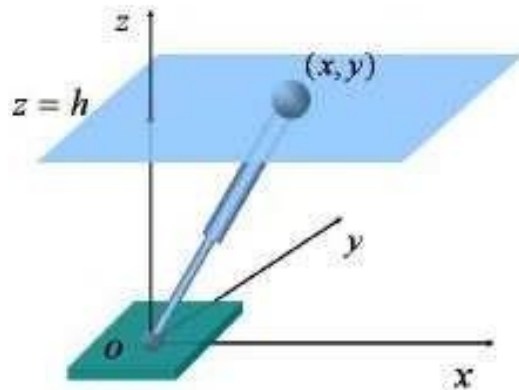

Fig. 1 3-D LIPM

$$\ddot{x} = \frac{g}{h}x + \frac{1}{mh}T_y \qquad (1)$$

$$\ddot{y} = \frac{g}{h}y - \frac{1}{mh}T_x \qquad (2)$$

Here the gravitational acceleration is considered to be g , the provided vertical height is h, the inverted pendulum has a mass of m, (x, y) as well as (ẍ, ÿ) are considered as the location as well as the pendulum's acceleration within the restricted plane, also the _x, _y are x-axis and the y-axis torque respectively.

Another key notion in biped walking is the ZMP. It is designated as the place lying on surface of the earth in which the moments cumulation (which can be considered as the inertia as well as the gravitational force) is a net zero [7].

Bipedal robot may walk in a steady way during which the ZMP lies in the limitation of the elliptic curve of the touchdown area within the leg and the surface of contact; the biped's feet will thoroughly contact the ground. It is especially important for humanoid bipod robots that have touch sensors positioned beneath their feet to be able to adjust their balance by using the input received from such sensor.

Calculating the ZMP in a three-dimensional LIP can be done by,

$$p_x = -\frac{1}{mg}\Gamma_y \qquad (3)$$

$$p_y = \frac{1}{mg}\Gamma_x \qquad (4)$$

where (px, py) are considered as the point of the ZMP. We can rewrite (1) and (2) as,

$$\ddot{x} = \frac{g}{h}(x - p_x) \qquad (5)$$

$$\ddot{y} = \frac{g}{h}(y - p_y) \qquad (6)$$

To accomplish full walking, the double-support phase might be scheduled in a lower-level planning based on ZMP decisions. Our simple bipedal walking model is as follows:

1) Consider the biped to be a linear inverted pendulum stably assisted with its anyone foot. The robot's combined mass is spread over the Center of Mass, and travels horizontally at a static and fixed height. Inertia's effects are disregarded.

2) The walking process is exclusively made up of single-support periods. Each of the robot's legs serves the stably assisting foot in each motion turn. In theory, one single-assisted moment might quickly move to the adjacent.

3) During the single-assistance moment, we employ a singular ZMP result rather than a ZMP trajectory.

III. CENTER OF MASS (COM)

The information included in the center of mass states plays a crucial part with the management and steadiness of biped robots. The interference, expressed as the modelling fault as well as the acceleration fault, might have a negative impact on the optimization mechanisms. CoM conditions are employed in the standard of steadiness, either directly or indirectly through inertial and gravitational forces.[8-11]

Managing the biped CoM dynamics necessitates knowledge of the CoM states as well as the ZMP trajectory. The ZMP may be determined by utilizing constraint optimization to estimate the reaction forces and their placement.[12] The restrictions are caused by the leg coming into contact, friction, and the support polygon.[13] Process and measurement models are used to estimate CoM states. The perturbation might have a substantial impact on the

system.[14] It may be approximated by representing it in the system model as an enhanced step disturbance state.

The position and the displacement speed states of the CoM are estimated.

To estimate the disturbance, the enhanced state approach is applied. Position and force measurements are included in the measuring model. Using accelerometer sensor and feet accelerometer sensor, the interference observation recored is utilized to measure the exterior factors. The ZMP interference observation divides the ZMP fault into the location as well as the acceleration fault focused on band of frequency, but it ignores the CoM states. [15]

The process dynamics of the prediction are formed using the LIPM dynamics as building blocks.

$$\ddot{c}_x = \frac{g}{z_c}(c_x - p_y) \qquad (7)$$

$$\ddot{c}_y = \frac{g}{z_c}(c_y - p_x) \qquad (8)$$

where c Z is the CoM's constant height. For the sake of simplicity, the subscripts x and y shall be ignored from now on. The following analysis applies to both the x and y dimension.

In an ideal setting, the force "p f" calculates the same p as the force "p".

$$p - c - \frac{z_c}{g}\ddot{c} \qquad (9)$$

IV. BIPED MODELS

Both of the kinematic structures under consideration feature two feet also a rigid associating waist. Considering that the disposition of the biped examined within the study is limited to the sagittal surface, the feet that require that they displace within this surface, and therefore each of these have a smooth surface structure.

The initial structure's kinematics, in which each and every linkages are of the revolving type. Each leg contains three joints (all of which are systematically functioned) that correspond to the humanoid foot: the hip joint, the knee joint, and the ankle joint. A prismatic joint replaces the knee joint in the second construction. [16-18]

The modelling of each structure takes use of a significant notion that they are both sequential chain of kinematic, and therefore typical approaches for the kinematics as well as dynamical structuring of the sequential operators (6-dof sequential operators for each and every structure) may be applied. This process associates the manipulator's base with the assisting foot as well as the manipulator's end-effector with the balancing foot.

The influence as well as the surface response forces are represented as the exterior factors affecting on the manipulator's tip, i.e., the stability assisting foot.

The three joints of the 6R structure have and application to locate and organize the feet, but within the RPRRPR

arrangement, the joint of the knee is solely utilized to place the legs, along with the joint of the ankle primarily employed for leg organization.

As a result, describing an associative disposition for the arrangement of the RPRRPR is less complicated than for structure 6R. [19-21].
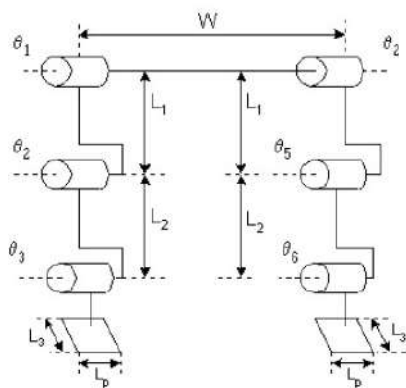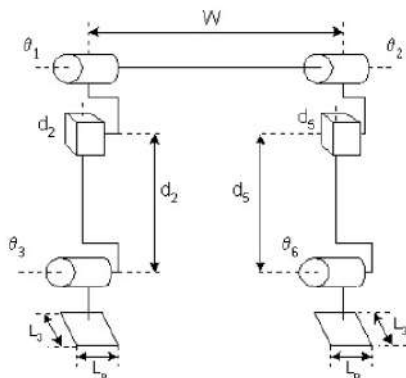

Fig. 1 Revolute Structure (6R)

Fig. 2 Prismatic Structure (RRPRRP)

V. CONCLUSION

In this paper, we describe a novel approach for biped walking planning. We discussed the LIP model, the ZMP notion, and a simpler walking method. The control approach of managing the CoM trajectory to achieve a stable walking pattern was explored. Walking pattern generating system based on the notion of changing CoG ahead of time to respond to changes in road conditions as humans walk. Both of the structures that are shown cannot stand on their own because they are statically unstable, despite the fact that they are mechanically straightforward. In order to prevent the robot from toppling over, any maneuvers that are performed when it has just one foot grounded on the surface need to be performed quickly. Because of the rapid pace at which the robot moves, the actuators need to be powerful enough to provide significant torques and forces despite the rapid pace at which they operate. Also, the mobility description for the RPRRPR design is less restricted, with smaller amplitudes of hip and ankle joint motions than the 6R structure. As a result, the prismatic structure is selected for implementation.

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Study on Application of AI controllers for speed control of motors

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Abstract—**Building high-performance motor drives is vital for industrial uses. A high-performance motor drive system must be quick in terms of dynamic speed order monitoring and load regulating. The motor controllers can provide system protection by regulating or limiting torque, protecting against overloads, and safeguarding against mistakes. Many motor controllers include logic for managing applications as well as additional features like data recording and data collecting. The purpose is to study various tuning techniques for motor speed controllers using Artificial intelligence. The controllers such as proportional integral (PI) controller and proportional integral derivative (PID) controller have been considered here. Most frequently used Artificial intelligence (AI) methods such as Artificial Neural Networks (ANN), Fuzzy logic controller (FLC), Genetic Algorithm (GA), Bat Algorithm, Adaptive Tabu Search (ATS), Ant Colony Optimization (ACO), Ziegler and Nichols (ZN) Algorithm are considered by their decision-making capability. In the proposed work the rigorous literature review is done for analyzing the performance of AI based controllers. This will help other researchers to understand various aspects of the said controllers, particularly technology involved. In depth review and application of AI controllers are highlighted using various charts and graphs for easy understanding.**

Keywords—AI motor controllers, Fuzzy Logic, PID controller, PI controller, Genetic algorithm, PSO algorithm, Ziegler and Nichols algorithm, Bat algorithm, Adaptive Tabu search algorithm.

I. INTRODUCTION

In our day today activities, we use electrical motor in the various machines, appliances, electric vehicles, large scale industries, medical sector, electric traction, robotics, air-crafts, military equipment, hard disk drive, etc. To get the efficient output from the motor shaft, the speed regulation of the motor must be reliable and robust at various conditions. For speed control of the motors Lately, numerous contemporary management methods have been put forth to regulate the motor's speed. The traditional PID controller, has a straightforward algorithm, that is simple to modify, operates steadily, and is more reliable. The majority of time, conventional PI and PID controllers are used to regulate motor speed. [1,2]. However, the majority of commercial processes use nonlinearities, parameter variations, and unsettled parameters. Due to the difficulty of tuning traditional controllers values under these circumstances, the total system's robustness is reduced.[3]. The effectiveness of the motor is diminishing in the case of the traditional PI controller as a result of rollover. Due to the saturation effect, rollover is an issue that occurs in traditional PI controllers. Saturation occurs when the processor receives steady input or when there is a significant amount of erroneous input.[4]. Therefore, for the entire system to operate reliably, an advanced control

algorithm is required to regulate the motors' speed. These intelligent techniques, however, are more complicated and challenging to execute. [5].

To identify the most applied AI technique for speed control of the motor 40 research papers are studied related to application of AI controllers. Due to straightforward structure, conventional motor controllers or deterministic motor control techniques like PID (Proportional Integral Derivative) controllers are still extensively used. However, in order to use the previously stated controller to its full potential, the system's controller parameters must be precise and accurate (such as tuned Proportional, Integral, Derivative values, back electromotive force constant, armature and field coil impedance and inductance etc.) [6]. Additionally, the reason why traditional controllers, like the PI controller, have limited capability is because their overshoot from the set point is too high. Additionally, sudden changes in load torque and their sensitivity to controller gains Ki and Kp can cause delays in obtaining constant and weak responses. [7]. For the majority of complicated nonlinear systems with indeterminate mathematical analysis, appropriate control strategies can be developed by applying artificial intelligence methods. Smart controllers are preferred because they can be created for any mechanism without the need for a quantitative model, increasing the controller's effectiveness and dependability [8]. Controlling the speed of the motor as per the load requirements is quite a difficult task, but with the use of the right motor controller, getting desired speed requirements becomes easy.

The paper is ordered as following; types of conventional motor controllers in section II. The artificial intelligent controllers are described in section III. The observation and discussion of the study are presented in section IV. Finally, the summary is given in section V.

II. TYPES OF CONTROLLERS

A. Proportional Integral Controller:

The PI controller is currently widely used in commercial applications due to its simple setup, straightforward presentation, and affordable price. The block layout for a proportional-integral (PI) control system is shown in Fig. 1.
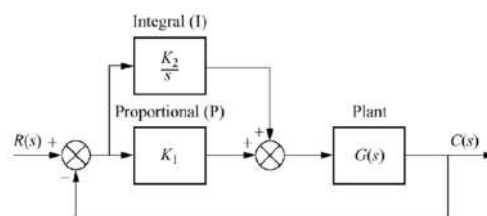

Fig. 1. Block diagram of Proportional Integral controller[7]

The PI controller receives the speed error EN between the motor's real speed N and the standard speed NR, and its proportionate end integral gains are K1 and K2 [9].

$$T = Kp\ e(t) + Ki\ \int e(t)\ dt \qquad (1)$$

By using the gain Kp, the Proportional controller generates an output that is proportionate to the present error value. When the regulated system is highly complex and unpredictable, the PI controller fails. Integral action must be done in order to maintain the system's functioning. By using proportional action and delayed reaction, this integral mode is used to build steady state defect [9-10]. Almost any operation that could imagine has been controlled by PI-controllers, from aircraft to mobility management, from sluggish to rapid systems [10-11].

B. Proportional Integral Derivative Controller:

PID controllers are employed in a variety of commercial environments. PID controllers are used in closed loop functions in about 95% of the field. Proportional- Integral-Derivative, or PID, is a term. The combination of these three functions results in the production of a control signal [12]. To prevent overshoot and oscillations in the system's output response, the derivative gain component is additionally added to the PI controller within the PID controller. The result is formed by adding three terms—proportional, integral, and derivative terms. The controller provides high stability, no oscillations, quick response times, and 0% steady errors [13,14]. The following equation indicates the basic structure of a PID Control system:

$$y(t) = k_p\ e(t) + k_i \int e(t) + k_d \frac{de(t)}{dt} \qquad (2)$$

In which u(t) is the control variable, Kp is the proportionate gain, Ki is the integral gain, and Kd is the derivative gain, e(t) is the program error (change in between standard input and the process output) [14]. Although k_p, or the proportional constant, accounts for the error's current value, k_d or the derivative constant, accounts for the error's future value by taking into account its present rate of change. As an integral constant, k_i accounts for the error's past value [15-16]. Fig 2 shows the block diagram of the proportional integral derivative controller.

1) **Proportional part**: If a deviation is generated, the supervisor will attempt to decrease it using a proportionality link that reflects the deviation signal.

2) **Integral component**: primarily used to reduce static mistake and increase system reliability.

3) **Differential part**: can show the deviance signal's change tendency (change rate) and initiate a better preventive adjustment signal before the value of the deviation signal becomes excessive, accelerating system operation and cutting down on modifying time [17].
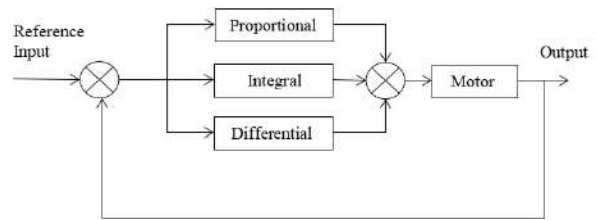

Fig. 2. Block diagram of PID controller [15]

III. ARTIFICIAL INTELLIGENT CONTROL TECHNIQUES

A. Artificial Neural Network:

In a traditional system, an ANN replaces a PI or PID control system. This can be used to export the motor's power, flux, or flux inclination at any moment in the past time or present time [18,19]. Here, the benefits of AI are quickly addressed. Examples include ANNs and fuzzy neural networks. An observed multi-stacked stream forward ANN can be trained using back-propagation (BPA) instruction to estimate the rotor location and rotor inclination. The square of the variance between the expected and real ANN output is reduced by using the back propogation. The real-time programs can make use of the trained ANN [20,21]. An ANN of this type includes concealed levels, an input, and an output. Though it should be noted as a rule that in electronic real apps, the depiction of concealed levels to be used is not recorded in preparation; this must be settled by experimentation. Additionally, the number of concealed elements in the hidden levels is also unknown beforehand and must once again be determined through experimentation and trial and error. The maestro levels for neural networks are shown in Figure 2 [22].

B. Genetic Algorithm:

GA is a technique of random worldwide responsive search algorithm. that is based on the workings of natural selection. In comparison to other optimization approaches, GA has recently come to be acknowledged as an effective and efficient tool for solving optimization issues [23]. Each chromosome in the initial population of the GA represents a different solution to the issue, and a optimization algorithm evaluates its effectiveness. GA's three main stages are evolution, crossing, and classification. These three basic techniques allow for the growth of new individuals who may surpass their forebears. After many iterations, the programme stops when it encounters the characters who best reflect the solution to the issue [24,25]. These more recent characters fare better than their forebears. Each chromosome in the initial population of the GA represents a different solution to the issue. It's employed to enhance the general efficiency of the system as well as other parameters like overshoot, rise time, and settling time. The choice of the goal feature (fitness) constitutes the most important stage [26,27]. Figure 3 displays the Genetic Algorithm Architecture.
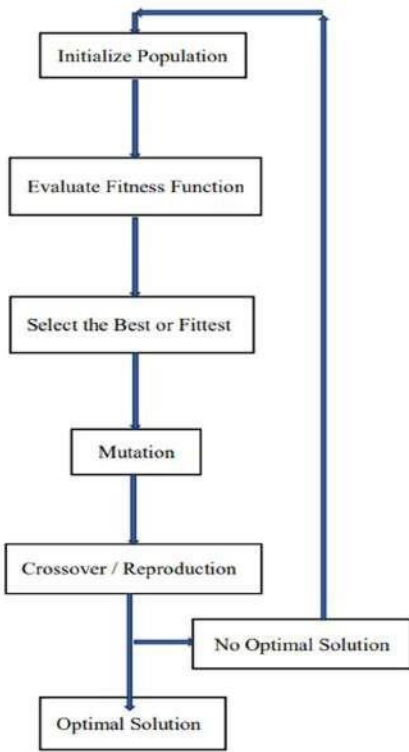
Fig. 3. Genetic Algorithm Flowchart[27]

C. Fuzzy Logic Controller:

The block diagram of the dc motor control system with a basic FLC is shown in Fig. 4. The basic FLC consists of the following four blocks:

- This fuzzy logic generator transforms the incoming data (error and error rate) into appropriate language values.

- The rationale employed in decision-making to choose the best course of action for control.

- The rationale employed in decision-making to choose the best course of action for control.

- Defuzzifier that generates an inferred fuzzy control action's membership function as a non-fuzzy control action [28,29].

Using the Center-of-gravity approach, defuzzification is carried out, and the inferred (numerical) value of the

$$u = \frac{\sum mi\, Ti}{\sum Ti}$$

where Ti is the corresponding degree of fulfilment and mi are the singletons.The regulated voltage supply, which transforms the incoming signal into an equal voltage to control the motor speed, is fed its output from the Fuzzy controller as its input [30,31]. The action of the flexible system frequency reaction is first studied to make it easier to incorporate knowledge and expertise into fuzzy control algorithms [32].
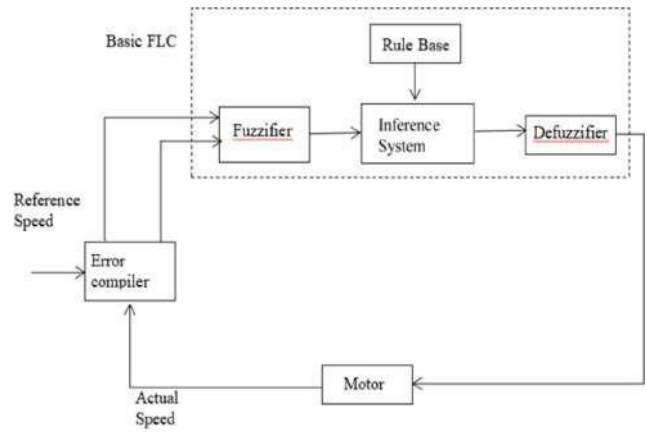
Fig. 4. Basic Function of Fuzzy Logic Controller [32]

D. Ziegler Nichols Method:

There are many approaches to adjust a PID and PI cycle. The most efficient techniques typically involve the creation of some type of system design, then P, I, and D are chosen according to the features of the dynamical system. especially if the circuits' response times are several minutes or greater, manual tuning techniques may not be adequate [33]. Ziegler and Nichols provided the finest PID controller tuning approach, which is now regarded as industry standard procedure in the field of control systems. Both methods make previous assertions about the system model, but they don't demand that these models be known in particular. Plant step reactions serve as the foundation for the Ziegler-Nichols equations used to define the controllers [34]. Tuning a controller means adjusting the gain setting to the correct amount. Any system's efficiency can be increased with the correct controller setting. If the gain settings of a controller are set at an incorrect number, the control signal deteriorates and becomes unreliable. As a result, appropriate controller tuning is required to obtain the intended result [34].

E. Adaptive Tabu Search:

The updated form of the Tabu Search is called the adaptive tabu search, or ATS. The ATS was introduced in 2004 and is based on an iterative neighbourhood search strategy. The ATS search process starts with a few early answers that are randomly selected and fall into a neighbourhood search space. Every answer in the local search area will be assessed using the objective function [35]. The answer providing the lowest goal cost is retained in the tabu list and set as the new starting point of the following search round (TL). The process flow of ATS is shown in Fig. 5.

The basis of ATS is a live neighbourhood search methodology for nonlinear and complex issues. The adjustable radius (AR) and backtracking are ATS methods (BT). AR technique is heavily used in the ATS search process to hasten it. The BT device can also be used to get out from under nearby obstacles [36,37]. One crucial component of this technique is the Tabu collection, which is used to keep track of resolution behavior and take a different course that can avoid a minimum error hazard. The ATS technique also includes two extra methods to improve convergence: retracing and responsive search range.
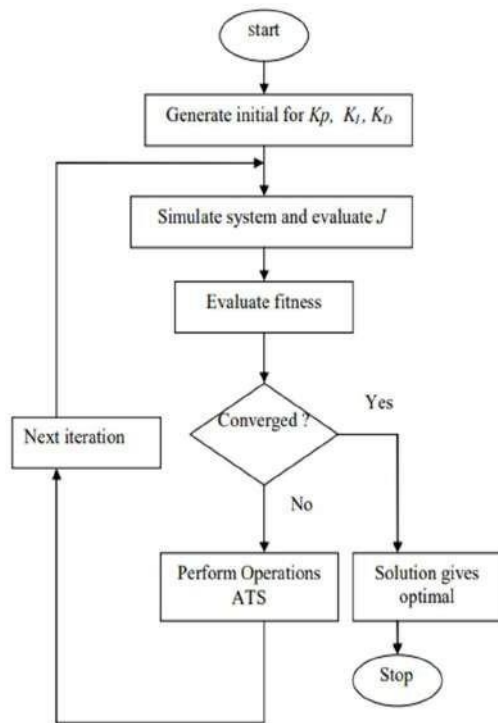
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Fig. 5. Flowchart of Adaptive Tabu Search [37]

F. Bat Algorithm :

The echolocation technique used by bats is known as the bat algorithm. These bats use echolocation to produce a very high sound pulse and pay attention to the echo that is reflected back from nearby items. Species differences affect the transmission band-width of these organisms. Frequency, volume, and pulse release rate are all components of each sound pulse [38]. While the remainder use fixed-frequency signals, the majority of bats use signals with adjusting frequencies. These animals operate in the 25 kHz to 150 kHz frequency band. The following factors form the basis of the bat algorithm: echolocation, which all bats use, and the ability to tell a target from an obstacle. Bats travel at arbitrary speeds, in random places, and with varying frequencies, decibel levels, and pulse emission rates [39-44].

G. Ant Colony Optimization :

The theory behind Ant Colony Optimization is that ants can locate the quickest route from their home to a food location. In 1992, Marco Dorigo created the very first Ant Colony Optimization device. Both the cubic distribution issue and the roaming marketer challenge were addressed using ACO. Due to their innovative idea, ant strategies have received extensive study over the recent few years, and their uses have been expanded to include inflation issues, network invasion, information extraction, etc [40]. ACO has several benefits over other optimization methods, including appropriated computation, a positive responses mechanism, optimistic scanning, and improved extensibility. Its drawbacks include a bottleneck and a lengthy scanning duration. However, the symmetry can somewhat compensate for these drawbacks [45-49].

IV. DISCUSSION

From the study of the mentioned AI controllers it is observed that all the Artificial controllers are robust and perform with high accuracy for the speed control of the motors. The AI control techniques and their hybridization with conventional controllers and the application for different motors are mentioned in the TABLE I.

TABLE I. APPLICATION OF AI CONTROLLERS FOR SPEED CONTROL

Sr. No.	Name of the Technique	PID	PI	AC motor	DC motor
1	Genetic Algorithm	4	2	2	5
2	Particle swarm optimization	3	0	0	3
3	Adaptive Tabu Search	2	0	0	3
4	Ziegler and Nichols	3	2	0	4
5	Bat Algorithm	1	1	0	2
6	Ant Colony Algorithm	2	0	0	3
7	Artificial Neural Network	2	1	4	3
8	Fuzzy Logic	5	8	7	10

A. AI Application on PID Controller:

The application of AI techniques for controlling speed of the motors have shown in the pie charts and bar graph below. From the pie chart Fig 6, it is observed that, most of the research has been done on the Fuzzy Logic PID Controller and Artificial neural network controller. Implementation on these AI techniques is much easier than the rest of the mentioned AI techniques.
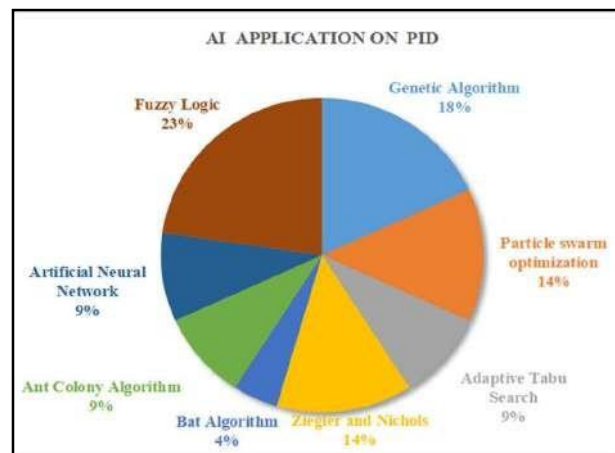

Fig. 6. AI applications on PID controller

Due to which more research is done on the Fuzzy logic PID controller and Artificial neural network PID controller.

The new hybrid AI methodologies are compared with conventional Ziegler & Nichols tuning method. And by

the comparison table it is shown that new hybrid AI techniques are much efficient and widely used in speed control of motor application.

B. AI Application on PI Controller:

By studying research on various AI techniques, it is observed that, most of the research has been done on the Fuzzy Logic PI Controller and genetic algorithm based controller. Implementation of these AI techniques is much easier than the rest of the mentioned AI techniques. Due to which more research is done on the Fuzzy logic and Artificial neural network techniques. The new hybrid AI methodologies are compared with conventional PI controller. And by the comparison, it is shown that new hybrid AI techniques are much efficient and results zero steady state error. The AI techniques like Firefly Algorithm, Bat Algorithm, Ant colony Algorithm are used less because of their complex structure as well as complication in implementation. Tuning of PI controller by these AI techniques is not as simple as PID controller because of the output parameters. Therefore there are less papers available on Bat algorithm, Firefly and Ant colony algorithm. The application of AI techniques and research papers availability is shown by the pie chart diagram in Fig. 7.
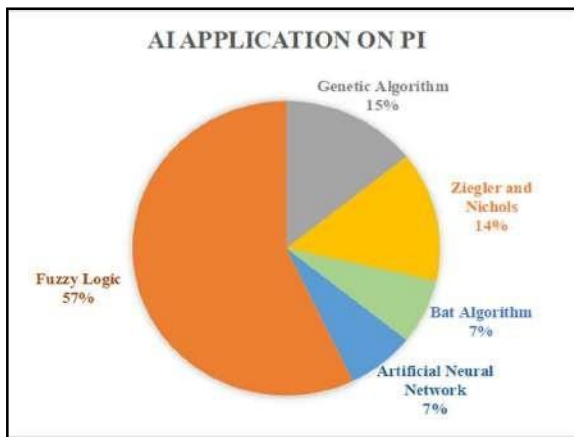
Fig. 7. AI applications on PI controller

All the AI methodologies are applicable on different motors as shown in Fig. 8. The bar chart shows that mainly most of the research of AI speed control techniques are done on the DC motors because of its robustness and ease of implementation. The AI methodologies discussed are mostly applied on the DC motors. The use of DC motors is much wider in various small day today applications. The use of AC motors is mainly applicable for industries and heavy duty operations. Therefore, the speed control methodologies are mostly experimented on DC motors.
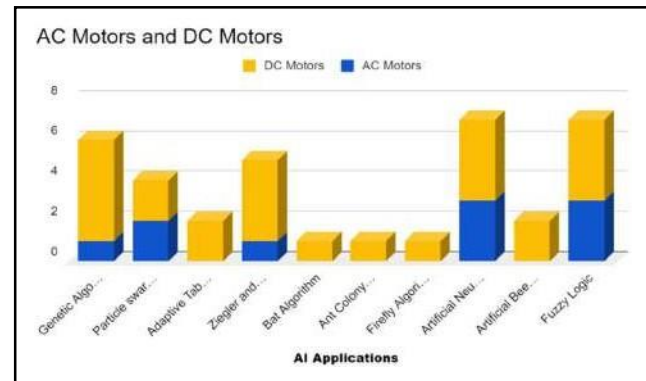

Fig. 8. AI applications on AC Motors and DC Motors

In TABLE II. letter 'Y' indicates consideration of that particular methodology.

On the basis of study of the research papers available on AI techniques for speed control of motors. The research done is classified by the year of research published with the author's name and on which specific AI technique the experiment is done with particular motor used for experiment is mentioned. As per the information gathered in the table, it is observed that the research done on Fuzzy logic and genetic algorithm on DC motor is more than the research done on rest of the AI techniques and on AC motors. In case of the research on tuning method for PID controllers, the most conventional Ziegler & Nichols technique is utilized for the comparison purpose. All other AI techniques results significant rather than the conventional control technique. In some of the researches AI tuning techniques are directly applied on the motor input parameters.

TABLE II.   APPLICATION OF AI TECHNIQUES ON MOTOR CONTROLLERS FOR SPEED CONTROL

Publication year	Author	AI Control Techniques								Controllers		Motors	
		GA	PSO	ATS	ZN	Bat Algorithm	ACA	ANN	Fuzzy Logic	PID	PI	AC motor	DC motor
2009	Yang. Yi							Y				Y	
2009	K. Ang, G. Chong									Y			Y
2010	Changliang Xia						Y		Y				Y
2010	Atef Saleh Othman									Y			Y
2010	Adel A. A. El-Gammal	Y								Y			Y
2011	Hassan. M. Kamel								Y		Y	Y	
2011	Mohanasundaram K.								Y		Y	Y	
2012	E. Daryabeigi									Y			Y
2012	J. L. F. Daya								Y		Y	Y	
2012	Tan Chee Siong								Y		Y		Y
2013	Rohit G. Kanojiya				Y					Y	Y		Y
2013	H. Aloui								Y			Y	
2013	Walaa M. Elsrogy						Y	Y	Y	Y			Y

Year	Author												
2013	Yogesh Mohan								Y		Y		Y
2014	Dhivya.N.M							Y				Y	
2014	S. Mishra							Y			Y	Y	
2014	Amir Ahmed	Y							Y				Y
2014	Ch. Bhanu Prakash	Y								Y			Y
2015	Pranoti K. Khanke								Y		Y		Y
2015	Olivier Munyaneza								Y	Y			
2015	K. Premkumar		Y			Y			Y	Y			Y
2016	Sajid Ali Bhatti				Y						Y		Y
2016	Essamudin A. Ebrahim						Y			Y			Y
2017	Sushma J Patil								Y		Y	Y	
2017	Ansar Rizal							Y					Y
2017	Meena D. K.	Y			Y					Y			Y
2017	Yasser Ali Almatheel								Y	Y			Y
2017	P. Suganthi								Y	Y			Y
2017	Thanet Ketthong			Y						Y			Y
2018	Abasin Ulasyar									Y			Y
2018	S.Sakunthala							Y	Y			Y	
2018	Gamze Demir	Y									Y	Y	
2019	Archana Mamadapur							Y		Y			Y
2019	Vishal Verma									Y	Y		Y
2019	Era Purwanto	Y										Y	
2019	Amer Mohammad Jarjees			Y					Y				Y
2019	Manoon Boonpramuk1	Y		Y		Y				Y			Y
2020	S. Balamurugan									Y			Y
2020	Kiran Gadekar									Y	Y		Y
2020	Paliwal D.					Y					Y		Y
2022	Sandeep Yadav	Y	Y				Y			Y			Y

CONCLUSION

In this study, research papers on 'AI techniques for speed control of the motors' are considered for the identification of robust and easily applicable methodology for speed control of the motors. On the basis of the study we can say that, most applied AI techniques for the speed control of the motors are fuzzy logic and Genetic Algorithm. From the all studied research papers, for PID controller there are 23 percent papers available on fuzzy logic and 18 percent on genetic algorithm. Which are major among all the AI techniques. For PI controller, 57 and 15 percent papers are available on fuzzy logic and genetic algorithm respectively. The aforementioned AI techniques are mostly applied on the PID controller than the PI controller. As well as the implementation is mainly done on the DC motors rather than the AC motors. In future, more combinations of these AI techniques can be used to control speed of the motors in much efficient way.

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A Review on Involvement of AI, RPA and IoT in Human Resource Management

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Abstract— **By definition, Human Resource Management (HRM) is the strategic approach to effectively and efficiently managing people in a company or organization. HRM involves tasks like recruitment, training, and development, managing company culture, managing employee benefits, salary processes, attendance records, data maintenance, exit formalities, etc. From the start of HRM, the work was mainly paperwork, which is being digitized in this digital era. In this paper, technologies like AI (Artificial Intelligence), RPA (Robot Process Automation), and IoT(Internet of Things) are reviewed. These technologies help HRM departments and HR (Human Resources) individuals in several ways to improve the services involved in it. The primary purpose of the present research is to investigate the ways in which HR practices are being influenced by technological advancements. Taking into account earlier study investigations and evaluating both the prospective benefits and drawbacks of utilizing these systems, one arrives at the conclusion that this technology is very recent.**

Keywords— Human Resource Management, Artificial Intelligence, Automation, Robotic Process Automation, Internet of Things.

I. INTRODUCTION

The oversight of the human resources department is a role in organisations that strives to maximise the performance of employees in helping to achieve the corporate objectives of the company they work for. This role is frequently referred to as human resource management (HRM) or just HR for short. Human resources is largely concerned with the management of people inside organisations, with a particular emphasis on policies and procedures. In most businesses, the Human Resources (HR) department or unit is responsible for a variety of tasks, some of the most common of which include employee recruiting, training and development, performance evaluation, and awards. Industrial relations also fall within the purview of HR. l [1].

Human resource management (HRM) maximises employee performance to meet the company's strategic goals. HRM in changing organizations, 2009. HR is primarily focused on policies and mechanisms that govern how people are handled within firms. HR departments and units are often in charge of a variety of tasks, such as hiring new employees, providing them with training and development, evaluating their performance, and providing awards. Industrial relations or the balance of organizational practices with rules resulting from collective bargaining and governmental laws is another area of HR that is of interest. The goal of human resource management, also known as HR or just HR, is to maximize employee performance in support of the strategic goals of the company. 2009 study on HRM in evolving organizational situations. HR is primarily focused on policies and mechanisms that govern how people are handled within firms [2]. HR departments and units are often in charge of a variety of tasks, such as hiring new employees, providing them with training and development, evaluating their performance, and providing awards. [3].

However, there has been relatively little research done on its effectiveness, and the majority of the research that has been done thus far has not examined the degree to which these new platforms assist businesses in achieving their HR goals of attracting, motivating, and retaining workers. The fact that current systems have a variety of problems, such as the fact that they primarily rely on one-way communication, are impersonal and passive, rarely permit an interpersonal connection, and usually create an unnatural barrier between people and organizations, is one reason for this. Another reason for this is that technological advancements have made it possible for individuals to communicate with each other in multiple ways. [4].

II. ROLE OF HR

Documentation, hiring, screening, training, relations with employees, and remuneration are all topics included in normal HR programs. Despite the fact that each of these programs comprises a variety of HR-related activities, these activities can be categorized into three basic categories: transnational, conventional, and revolutionary. HR personnel makes sure that the company employee is having high productivity so they can help companies to achieve their goals. And in this process employees get the benefits that companies have set aside for them. HR personnel deals with onboarding when more workforce is needed while doing so, they have to evaluate and assess the right candidate for the vacant position. In a bad time of a company where management decides to lay off some workforce for cost-cutting or whatever the reason might be HR personnel has to deal with the procedure of letting go of employees [5].

Large-scale management of organizational leadership and culture falls under the purview of HR. HR frequently oversees health, safety, and security in addition to making sure that local labour and employment laws are followed. When workers seek and are able to legally hold a collective bargaining agreement, HR frequently serves as the company's main point of contact with the employee representatives. In order to advance its objectives, HR thus participates in lobbying actions with governmental organizations, usually through representatives. The field may also deal with mobility, especially in relation to expatriates, and it frequently takes part in merger and

acquisition activity. HR is typically viewed as a business support role that reduces risks and expenses [6].

III. AI IN HUMAN RESOURCE MANAGEMENT

In order to successfully transition HR operations into the digital age, AI is absolutely necessary. Certain activities, such as training, development, and organisation, will be increasingly vital to adapt to these changes that have occurred internally with certain activities and workers, particularly owners' simple skills and regular work. This is because certain activities and employees may be dispensed with, such as certain activities and employees. There is no question that the rising usage of technology and information within the organisation has dramatically altered the kinds of business you need to be successful in as well as the abilities you need to have. The application of artificial intelligence (AI) in the field of human resources can be helpful in a number of areas, including the recruitment and retention of employees, the reduction of the workload of shared service centres and help desks by addressing typical enquiries, and the reduction of the amount of time that HR specialists spend on administrative tasks. [7-10].
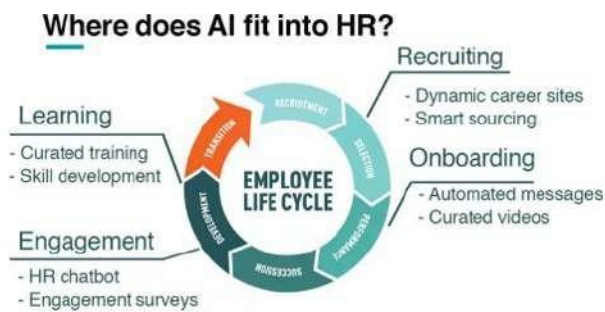
Fig:- 1 [7]

Between 2000 and 2018 on numerous HR subjects using AI, they discovered that until roughly 2006 or 2007, very little research had been done in HRM. These themes included management, team estimation, training, turnover, employability, etc. The use of AI in management proceeded around the first half of 2010, and from then on, the research centered on its use in hiring [11].

An AI system can help with administrative tasks including providing IDs, granting access requests, and organizing first meetings for new hires. It can also verify documentation, manage orientation programs, manage orientation sessions, and manage orientation meetings. Training and development is another area where AI will have a profound effect on HR. In all industries, improving one's skills is a key strategy for remaining competitive. Enhancing your employees' skill sets through training and development is a terrific idea. AI tools can be used to construct training and development plans that are unique to each individual. Consider providing different employees with varying levels of training modules based on their skill levels, employment status, and requirements. Additionally, these AI systems can make it easier to discover resources internally by connecting new projects with employees who have enhanced their abilities or completed a required course. The degree of engagement that a person has

in their work can be significantly improved through the use of recognition and incentives. A motivated employee is one that is not only more productive but also more self-reliant in their work. When it involves incentives and honour, there are a few factors that are necessary, and they include the following: the benefits need to be promptly, they need to be comprehensive, and they need to be consistently.

Zomato is a meal delivery business that works with other delivery companies to offer them with an artificial intelligence system that encourages them to make more deliveries. The system rewards delivery partners with financial incentives after they have completed a predetermined threshold of deliveries. A sizeable portion of each workday is devoted by HR staff members to fielding inquiries. When performance reviews are carried out, a great number of additional questions pertaining to the completion of assessment forms, the submission of work, and the filing of complaints are posed. [12]

These fundamental questions can be answered by AI tools, which may result in a reduction in the volume of messages sent via chat and email that a person must process each day. In addition, AI may assist with the administrative chores of a corporation. Some examples of these are the handling of employee paperwork, the generation and updating of organisational terms and conditions, the updating of employee information in the internal database, and the verification of legal compliance. Depending on the kinds of adaptations that are required, AI may be able to take over some, most, or all of these jobs. AI tools have the potential to assist in decision-making, but not entirely, through the use of methods such as conducting surveys, gathering feedback, and a variety of business-related statistics, such as performance, engagement, and potential areas for improvement. Individuals working in HR are able to base their decisions on the information offered by AI tools. [13-14].

There are many different applications for AI in HRM, some of which include recruitment, personnel acquisition, performance evaluation, and compensation. There are several establishments that use artificial intelligence to screen the thousands of applications they receive, which makes the hiring process far easier and more cost-effective for enterprises. Additionally, it is especially beneficial when picking the most qualified individual to fill a post. An advantage over the competition can be achieved by a business in a service-based economy, in which people are the most valuable resource a company possesses, by using decision assistance to select the best employees. Artificial intelligence (AI) systems are able to "predict" and "learn" statistically by drawing curves that indicate prospective outcomes and then make decisions that are optimized for a range of parameters. As a result, it is possible that AI will eventually develop a system that "predicts" a candidate's performance on the job based on all pertinent demographic data, employment history, and interview questions. When looking for new personnel, it is no longer essential to spend countless man-hours searching through tens of thousands of applications and online job profiles. [15-16]

A firm that offers services related to AI recruiting has stated that the amount of time required for the hiring process may be

cut down to nine days using the AI candidate sourcing algorithm that it has developed. Previously, the procedure required 34 days. The efficiency of candidate sourcing and onboarding have both seen considerable improvements as a result of the implementation of a non-biased strategy that removes the need for assumptions throughout the sourcing process and discovers individuals who are technically qualified for the post. The application of AI also enables the automation of the candidate screening process. This advanced method makes it possible to collect significantly more data from online sources, such as social media accounts, online career records from the past, and school credentials, which in turn improves the ranking system of prospects from which recruiters can choose. [17].

Companies that want to save money on hiring expenses, improve access to talent, shorten response times, and enhance candidates' impressions of the organisation may choose to implement an electronic recruiting platform. Proponents of this strategy assert that automatic matching between job offers and suitable candidate profiles offers a number of benefits, including reduced effort (in terms of cost and time) and the elimination of the requirement that HR professionals have knowledge pertaining to However, despite the fact that the shift towards the use of information technology for electronic recruitment has altered the process of employee hiring and retention, there are a number of obstacles that prevent it from being fully effective. [18].

Over the years due to the digitalization of job information, including information from candidates to employer and employer to candidates is easily available it has resulted in a reduction of cost and inconvenience of matching jobs. With this applications from interested candidates have increased exponentially. To be able to deal with the assessment of a lot of data could be expensive and inefficient for humans but, AI has been proven more efficient over past decades than humans. fairness can become a determinant of AI adaption. this paper consists of 21 interviews from different backgrounds and ages. It demonstrates that the pre-selection of promising talents is where the use of AI in recruiting is most widely acknowledged.

There are some factors that contribute to fairness that are The level of perceived fairness increases with the degree of diversity, ethical aspects considered, the degree to which people think AI makes fair decisions and reduces discrimination, and the degree to which decisions made using AI are understandable increases or decreases the degree of fairness of AI in hiring. HR leaders and practitioners need to have a comprehensive understanding of how decisions are made. Making sure that employees trust the new technology will depend on this openness For instance, according to a Deloitte survey of senior executives, 72% of them believe that AI in hiring is essential, but just 31% believe that their companies are set up to take advantage of the potential [19].

The term "artificial intelligence" refers to a technology that, in some contexts, can perform as well as or even better than the brain of a human being. When the efficiency of automation the process for hiring was compared to that of conventional recruiting processes, businesses took note of the former and took steps to implement it. Now that growth is being pursued, the recruiting sector is integrating intelligent techniques to recruit, specifically through the use of artificial intelligence. Because it enables the recruiter to align all unstructured candidate biodata, develop profiles into uniformity, and discover and match skill sets required for the sector, artificial intelligence technology is of significant assistance in the recruitment process. [20].

Specialised artificial intelligence (AI) systems are evolving at an impressive pace in a variety of industries, including health care, automobile manufacturing, online communities, advertising, and sales. While overall-purpose AI continues to be some way off in every field of human endeavour, AI as a whole is nevertheless in its infancy. Concerns relating to the administration of the workforce have led to a lot fewer headway. We offer the following causes for this phenomenon: the complexities of HR, the limited data available from the HR department, equitable and legal constraints, and the responses of employees to AI administration. [21].

Candidates who participate in AI-enabled recruiting may be influenced in their decision-making by a variety of factors, including online communities, intrinsic perks, equal opportunity, and trendy on the side of potential employment. 89% of people who are looking for work say that their mobile devices are the most important resource they have while doing so, and 45% of those people indicate that they use their mobile devices to look for work at least once each day. However, just 16% of applications are submitted via mobile devices.

Push notifications will encourage candidates to engage and complete AI-enabled job application processes on their mobile devices in order to increase that number and AI-enabled advertising. Job seekers could easily anticipate the intrinsic advantages of participating in a social media job application process using artificial intelligence (AI) without regard to any practical consequences, such as landing a job through an AI-enabled hiring procedure. Candidates will be more engaged and more likely to finish a digital, AI-enabled job application process if they perceive it as intrinsically satisfying. The issue is that HR sees AI-enabled recruiters as a threat to their jobs, yet instead of being a threat, AI-enabled recruiters will allow HR to pivot into their higher-value activities. When enterprises carry out recruiting AI was used for evaluating applications. The enhanced efficiency brought about by AI in recruiting was clear, however, opinions on the accuracy of applicant evaluations were divided. More than 50% of those surveyed who had not yet used technology or who planned to do so in future either disagreed with an evaluation of the application or had no opinion on it, there was a lack of trust shown in AI's capabilities for evaluation [22].

IV. RPA IN HUMAN RESOURCE MANAGEMENT

Transactional activities are daily activities that largely concern record keeping. Examples include entering payroll data, monitoring changes to an employee's status, and overseeing benefits administration. Traditional HR programs including planning, hiring, selecting, training, compensating, and managing performance. These activities may have strategic value for the organization if the results or outputs align with the organization's strategic objectives. Organizational or cultural change, structural realignment,

strategic reorientation, and increased creativity are examples of transformational actions that offer value to the organization. [15].

Robotic process automation is being used to transform HR procedures in small and medium-sized businesses (SMEs) enhancing competitiveness in the digital era. An evaluation of the HRM department's present manual, paper-based processes are required to assess whether or not RPA can be used to improve them. Adding automation to operations is a significant barrier for many SMEs. The order in which RPA could be used to automate various processes and sub-processes, as well as which ones to automate first, can prove to be a significant problem for HR departments of SMEs. RPA deployment is dependent on the RPA platform being utilized; therefore it might be challenging to select the best RPA platform for the HR department. The type of papers being analyzed whether they are scanned or created, with or without graphics, etc. must be taken into account while establishing an RPA-based solution for documentation. Processing data that has been wrongly extracted might frequently take a long time. RPA can be regarded as a feasible option for streamlining HR procedures, which can quickly increase a business's overall value even though some HR processes still need human intervention to fix extraction problems [15].

A pilot implementation of RPA in an enterprise is carried out to gather information about how RPA can be implemented in an enterprise and how it affects employee productivity although it remained in the initial phase and could not be implemented in live operations. But this study has presented some benefits like when human resources are overused or when the HR department is unable to manage onboarding or training on time, the organization may leverage this robotic capability. The very repetitive jobs, which are still carried out by humans and may lead to burnout and other workplace problems, provide another enormous area of opportunity. This might be done by robots, and since work-life balance is popular right now, it might be advertised as a perk for employees [16].
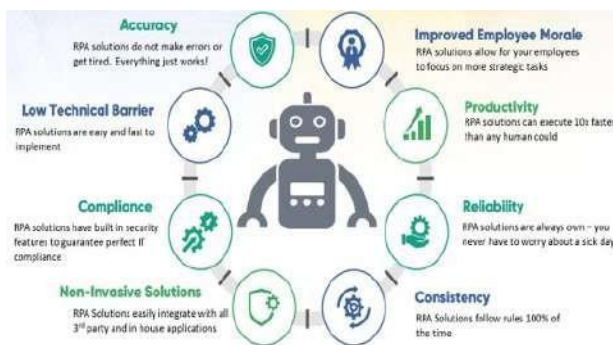
Fig:2 RPA benefits [14].

The use of RPA in HR procedures has enormous potential. It can facilitate the automation of numerous common HR operations, including the onboarding and offboarding of employees, updating employee information, the procedure for timesheet submission, and many other similar duties. this study gives a structured approach in implementing RPA which involves 6 stages. Stage 1 involves assessing the RPA product, identifying processes that should be automated, and creating a business case for RPA implementation. The second stage involves resource allocation and approval. The third step entails creating the RPA structure and putting together the team to implement it, with an emphasis on developing internal capabilities and self-sufficiency as soon as is practical. It also involves team training for all participants. The fourth stage involves testing the four automated processes, communicating the test results to management, emphasizing the advantages of RPA, and addressing concerns about job loss. In stage 5, six more processes are automated, offering all employees advanced training. Stage 6 is concerned with ongoing development [17]. Chronologically growth from year 1998 to th recent year is shown in Table-1.

V. IoT in Human Resource Management

In recent years, IoT is revolutionizing the industry by connecting everything to the internet and the HR department is no exception to it. IoT wearable devices are helping enterprises to gather data about their employees about their physical health, mental health, and productivity, IoT sensors also help in the training and evaluation of an employee.

The application of IoT in HRM necessitates changes to HR technology (hardware, software, and data), HR activities including flexible work schedules, performance improvement, and customised work environments, as well as HR actors (tasks and qualifications) With the aid of employee self-service (ESS) technology, staff members can manage their own data without the assistance of HR specialists and register for training with the goal of increasing productivity. Electronic performance monitoring may change a number of HR processes, including evaluation, recruitment, and training. There are currently electronic records of prescription administration, call and internet monitoring, and other typical EPM forms in use. However, it is becoming more and more common to state that technology like body heat sensor desk hardware and microchip wrist implants may be the future of job monitoring [23].

The usage of wearable IoT in the workplace; these devices collect information on employees' food, sleep, pulse location, and other habits. This information helps companies and people increase productivity at work. It also helps companies keep track of employees' health in real-time .With the use of IoT wearables, there are some concerns present, even though wearables are useful for tracking attendance. It also calls into question the privacy of the workforce. HR should have a company policy about IoT, or there should be laws.

Learning management systems can deliver training in real time if sensors identify employee qualification gaps. Real-time delivery of the relevant training measures is required. Delays and interruptions are reduced if a device can measure typing speed of an employee and that employee is better at typing than receiving calls for example then [19]. This study tries to systematize the academic contributions made thus far and to make clear the uniqueness of Big Data, its implications and difficulties for HRM practice, and the primary contributors within HR practice systems. Big Data will contribute to a more diverse talent pool from which to recruit potential future employees [24]. No matter where an employee is located, IoT devices like smartphones can be utilized to solicit their innovative thoughts and proposals. Employers are using fitness trackers to monitor employee

health, which might provide a company with important employee data that could be utilized to create customized policies. For the objective of increasing efficiency, location trackers monitor the employees' movements and locations. The Microsoft HoloLens and other virtual reality and augmented reality tools aid in the evaluation of applicants by placing interviewees in a simulated setting to gauge how they would behave there.

VI. CASE STUDY

There were two different case studies in the articles that were examined. The first case study focuses on the application of RPA to a business process. This particular case study was carried out on a business process outsourcing (BPO) provider company in Bogotá, Colombia. As a result of the fact that RPA was identified by a number of analysts as one of the new technologies that not only threatens conventional process outsourcing but also presents an opportunity for this sector, this BPO company initially began by testing and prototyping this automation technology on a number of its customer's business procedures. The use case was tested on a procedure involving the creation of a payment receipt. Participants in this operation were split into two groups: those with RPA and those without RPA. One group was responsible for carrying out the operation. In the group that did not utilise robotic process automation (RPA), there were both front- and back-office agents; in the group that did use RPA, however, there were only front-office agents because the robot took care of the back-office tasks. The length of time spent on each case and an agent's overall productivity were the metrics that were utilised in the process of analysing the results. These metrics were calculated for each agent by tallying the number of cases they worked on throughout the time period being evaluated. The conclusion

reached after conducting the test for a week.

When productivity was determined by the number of cases that were worked on by each agent, the group that utilised RPA was able to work on 21% more cases than the group that utilised traditional methods. On the other hand, it was discovered that the RPA group experienced a mean case duration that was just 9 seconds less than the control group experienced. The fundamental reason for this is that some people with a lot of expertise might finish mundane back-office tasks very rapidly, even more swiftly than software robots that simulate human behaviour. [25-28]

The second case study is an interview-based investigation of the application of AI in the field of human resources (HR). The research consisted of a series of surveys that included both open-ended and closed-ended questions. The research addresses ten different questions. According to the findings of the research, interviewees would rather speak with real people than a computer throughout the interviewing process. When questioned about the influence that AI will have on their job, 32% of respondents said it will have a significant impact, 37% said it will have some impact, 20% said it will have little impact, and 10.8% said it will have no impact at all. A total of 72 percent of respondents believe that AI will make recruiting cheaper in the future, while the remaining respondents do not believe it will make any impact. When asked whether they believe AI will totally replace HR positions, 33.8 percent of respondents responded that it will, while 53.8 percent of respondents felt that it will not completely replace HR jobs. 12.4 percent of people were unsure. About 55.4% of respondents indicated that they had trust difficulties regarding the application of AI, whereas 40% of respondents stated that they do not have any trust issues.

TABLE I. CHART FOR YERARWISE TECHNOLOGY USED AND WORK DISTRIBUTION

Ref. No.	Year	Technologies used				Work contribution
		AI	RPA	IoT	HRM	
[1]	1998				√	This paper presents a definition and work of HR individuals.
[2]	2009				√	Discussion on the role of HR individuals.
[3]	2021		√			This study collected data on how robotic process automation (RPA) is being utilised to improve human resource (HR) procedures in medium-sized organisations (SMEs) and increase technological competitive.
[4]	2019				√	Discussion about various technology and their impact on HRM.
[5]	2019				√	The authors have described HR activities.
[6]	2019	√				AI technology helps recruiters align unorganised applicant biodata, generate standardised the profiles, and find and connect industrial competencies, which greatly impacts the recruitment procedure.
[7]	2020	√				The use of AI in human resource activities can aid in a number of areas, including recruiting and retention, lowering the workload of shared service centres and help desks by handling common inquiries, and reducing time spent on administrative chores by HR experts.
[8]	2019				√	Papers show research done from 2000 to 2018. It shows in which area of HRM have research taken place over the year.

[9]		√			Gives a brief description of Ai's involvement in every aspect of HRM.
[10]	2018				This study presents problems that the implementation of AI can face one of them being that employees trust on the new technology.
[11]	2019	√			It is a study of 21 interviews where AI is used to increase the degree of fairness.
[12]	2015	√			AI technology enables recruiters align unorganized applicant bio-data, create standard the profiles, and find and match industry-specific skill sets.
[13]	2019	√			HR procedures, ethics and legal constraints on advertising, and staff responses to AI management might slow growth.
[14]	2020	√			Although it was obvious that AI had increased productivity, there were differing views on how accurate application evaluations were among more than 50 per cent of surveyed individuals who planned to use or not used the technology.
[15]	2021		√		This article outlines early findings from a university-SME partnership on RPA use in HR activities. Many SMEs struggle to automate.
[16]	2019		√		This study provides a pilot implementation of RPA although it remained in initial phase it has produced some benefits.
[17]	2020		√		The study gives a structured approach to implementing RPA. It is 6 stage approach that identifies the process, resource allocation, training and maintenance.
[18]	2017		√		This study presents a study on the implementation of RPA in BPO service provider.
[19]	2018			√	This paper discusses the usage of IoT wearables and their benefits.
[20]	2020			√	Papers present a framework for IoT usage and issues with the usage of IoT wearables.
[21]	2022			√	IoT devices and how they help in the learning management system by providing real-time data.

VII. CONCLUSION

In conclusion, there need to be more quantitative research needs to be presented for further advancement of technologies in HRM. It will help to measure the benefits of mentioned technologies. AI helps in recruiting, data Maintenance, and benefits distribution. In recruiting it helps sort candidates according to job role also in interviews it could eliminate bias giving a candidate a fair chance. AI has difficulty in implementation as there are trust issues for humans as it is a very new technology. RPA helps employees to reduce their repetitive and time-consuming tasks. But RPA increases the productivity of enterprises. RPA is considered a job-snatching technology by employees. Employees will need training before getting used to the RPA.

IoT devices keep track of real-time data which helps enterprises to track their employees' data. This data will help in the policy-making of enterprises. IoT devices collect data all time and the privacy of employees.

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HESS with Control Algorithms in Dual-Chemistry Battery Pack for Light Electric Vehicles

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Abstract— **Electric vehicles with excellent sources of energy will proliferate in the near future. An overview of hybrid electric vehicles (HEVs) is covered in this review article, with a focus on battery cell technologies, topological HESS configurations, and control algorithms. The main objective is to improve the effectiveness and efficiency of the battery system under safe working conditions. A study found that some researchers have improved driving cycles, range, and vehicle efficiency using battery-UC HESS. The use of a second storage system has been found to increase the main storage system's lifespan (battery). Ultra-capacitors' quick charging and discharging capabilities made it feasible to store the regenerative braking capacity in the right way. The development of superior optimization techniques will lead to improved energy management within the HESS. Using a variety of modular hybrid battery managers, the HESS design links the different battery chemistries (HBMs). Power-mix algorithm for dual-chemistry HESS is one of this work's most important advances. These goals can be accomplished through a variety of means, some of which include the hybrid predictive power optimisation (PPO) control approach, the adaptable FLC plan of action, the grey wolf optimisation methodology, and the pontryagin's minimal principle.**

Keywords — *HEV, HESS, Predictive Power Optimization (PPO), FLC, Energy storage, HBM, Grey Wolf Optimization, Pontryagin's Minimum Principle.*

I. INTRODUCTION

The problems associated with the energy crisis and environmental contamination have become much more severe in the twenty-first century [1]. Climate change and global warming are what pose the biggest danger to the environment. The use of fossil fuels as a source of energy has led to a rapid rise in greenhouse gases (GHG) and a rapid depletion of natural resources. The excessive use of fossil fuels has irrevocably harmed the ecosystem. The energy sector is one of the main drivers of the rise in greenhouse emissions. Due to greater environmental awareness and stricter emission laws, environmentally friendly electricity generation has become more essentialIt is absolutely necessary to make the switch to energy sources that are greener and more sustainable. [2].

The basis for electrifying cars is the development of energy storage technologies. The lithium-ion battery is significant energy storage devices right now [3]. An apparatus that transforms molecular energy into electrical energy is a battery. The creation of Lithium ion batteries, each with a distinct chemical composition, was motivated by

various factors. LFP, NMC,LTO and others are a few of numerous Li-ion battery varieties used in the evs [4].

II. TYPES OF CONTROL ALGORITHMS

A. Basic of hybrid energy storage system:

While control procedures are being developed, a depiction of two distinct battery packs in the form of a schematic showing how they will be connected in parallel by way of a DC-DC converter. For example, if we examine any two distinct battery packs to be Li iron Phosphate and Li nickel manganese cobalt oxide, we can see that there are significant differences between the two., and In order to hybridise, it's necessary to find an acceptable compromise between all of the characteristics; for example, "LFP" and "NMC." [5].
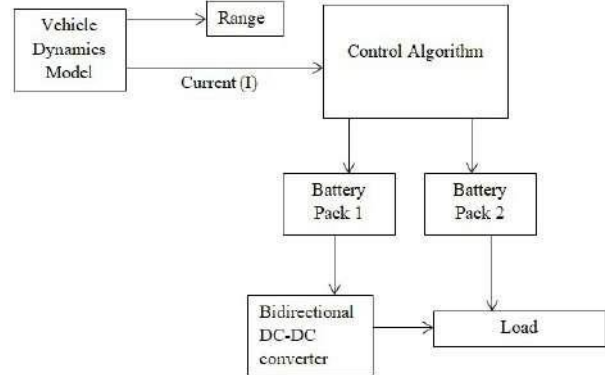

Fig 1.1 Schematic diagram of HESS

B. Control strategies :

Currently, strategies based on optimization have been researched to handle complex management objectives, such as lifetime and cost-effectiveness. These techniques are built on improving performance and reducing cost function [6].

III. ENERGY MANAGEMENT STRATEGIES

In the papers [7], numerous EMSs for FC-based hybrid energy systems have been described. These techniques can be broken down into four distinct categories: rule-based, control-based, filter-based, and optimization-based strategies respectively. [8].

A. Pontryagin's minimum principle

This regulating technique is the utmost fit for handling a vehicle's energy because of the EMS-base Pontryagin's minimal principle capabilities. It also gives the finest

circumstances for promptly addressing issues, which makes it the best choice overall. This strategy aims to maximise the number of battery cycles while simultaneously minimising the amount of energy used. Control Utilising Adaptive and Fuzzy Logic.

Adaptive fuzzy energy management algorithms have been put into action in order to analyse the power separation that occurs between the Supercapacitor, the Fuel Cell, and the battery unit. As a result of the complexities of the hands-on controller issues, a fuzzy controller is required. [9-10].
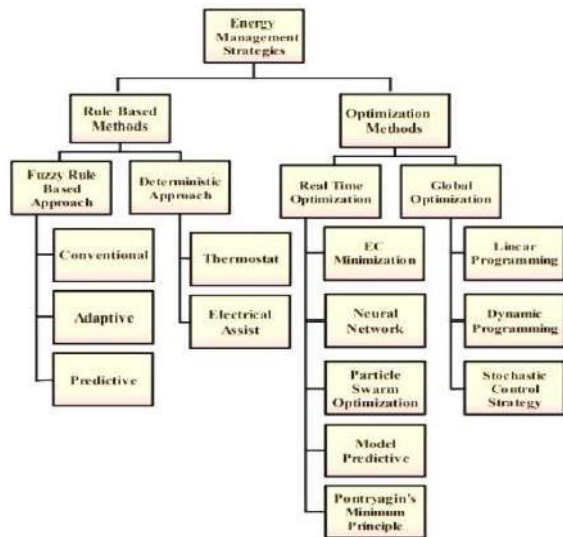
Fig. 2 Classification of EMS [9]

The evolution of the EMS is based on the consideration of these three factors.

(1) Operating cycle's energy requirement should always being met. Although its propulsion system and the operating environment may vary, electric vehicles must be prepared to function like conventional vehicles. As a consequence, it will always be crucial to show a pattern of operating circumstances in simulations and the real experiment.

(2) Operating conditions have a considerable impact Th on the battery in terms of how long it will last, how efficiently it will perform, how healthy it will be overall,

(3) It is important to keep in mind that the primary source of power for the EV must come from the batteries. Because of the nature of batteries, the whole amount of power essential to energising the entirety of the drive cycle must originate from batteries; any more power must originate from either super-capacitors, fuel cells, or both. Batteries are the only acceptable source of power. [11-13].

B. *Grey Wolf Optimization Technique*

Based on Gray Wolf Optimizer, an energy management approach is created for a fuel cell and super-capacitor hybrid energy storage system. The algorithm resembles qualities that are similar to the behavior of the grey wolf, from which it derives its name.
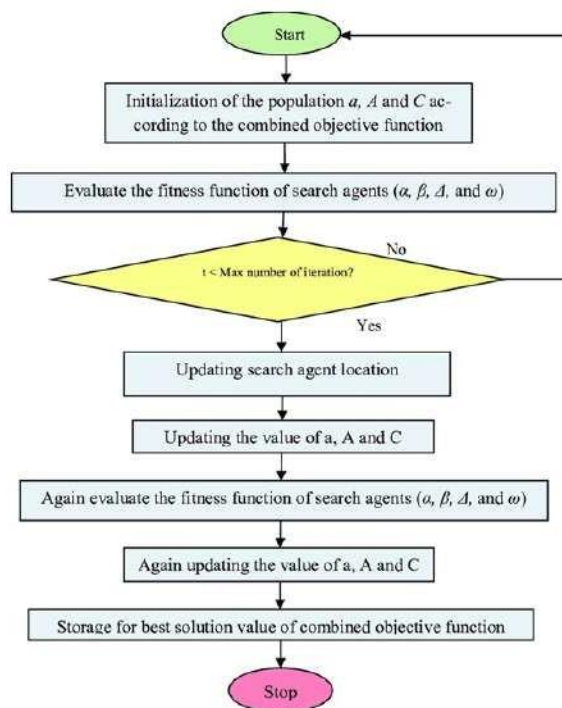
Fig. 3 Grey Wolf Optimization algorithm [12]

In this investigation, the Grey Wolf Optimizer algorithm was put through its paces by utilising a multi-sources, single-area power network that included hydro power plants, gas turbine power plants, and reheat thermal power plants, all of which were outfitted with mechanical hydraulic regulators. This network was used to test the algorithm's ability to optimise power distribution across the network. The research was carried out by utilising a power network that served only a single area. [14-17]

C. *EMS based Particle Swarm Optimisation (PSO)*

A stretegy using meta-heuristic population-based approach was chosen to tackle the problem. PSO, a well-known population-based optimization technique, was first presented by Kennedy and Eberhart. The steps are given below as:

Step 1: Initialization of variables like velocity, search region boundaries, acceleration coefficients, iterations, and swarm size. The placements of the particles are first established inside the searching region in a completely randomized fashion..

Step 2: The objective function's value has been determined at that particular time.

Step 3: The best position of the particle, referred to as pbest, and the best position in the world, referred to as gbest, are both determined in the third step.

Step 4: The speed and location of the swarm particle are reformed in the fourth step of the process.

Step 5: The algorithm is complete once Step 5 has been completed, when OF is minimal.

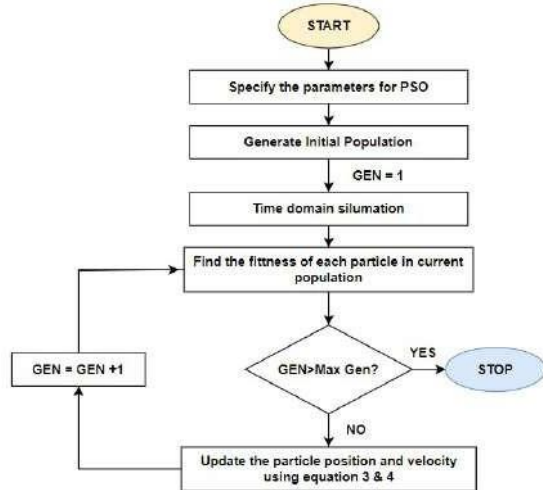Step 6: It is decided what desirable characteristics the components should have.

Fig.4. Flowchart of PSO Algorithm [13]

IV. THE ARCHITECTURE OF HESS

The reaction time of the slow unit, which is longer than one minute, needs to be synchronised with the reaction time of the fast energy storage unit, which has a response time of less than one minute to increase income (or decrease total price) from HESS. (reaction time less than one minute). An optimal control approach has been developed for this purpose.[18-22]
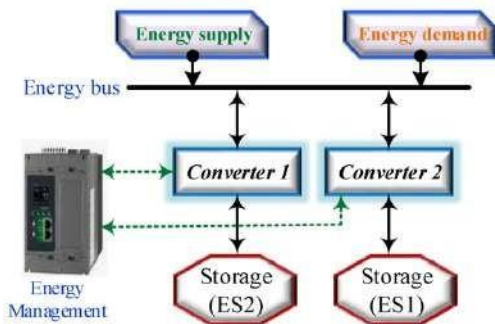
Fig. 5. The architecture of HESS [13].

A. Control strategy for battery UC HESS

To enable precise control of power flow in both battery and the super-capacitors, this architecture was selected. If the motor is only being powered by the batteries, losses can be minimized by connecting the batteries straight to the motor inverter.

Considering the low voltage at which supercapacitors discharge, they are not immediately connected in the arrangement. [23-22].
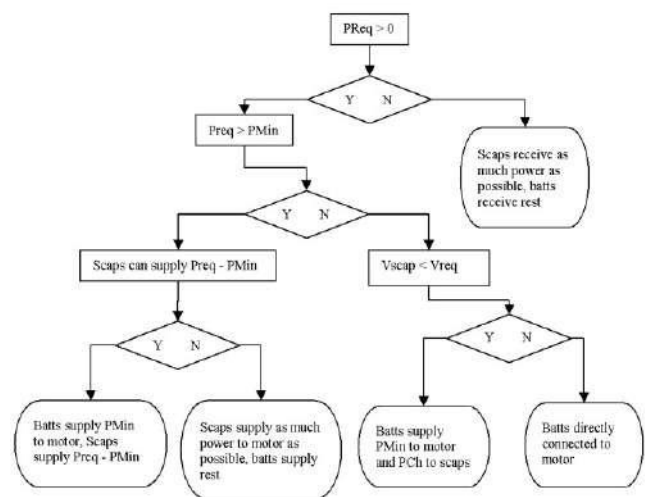
Fig.6. Flowchart of control strategy for a requested power PReq from the energy storage system [14]

B. dynamic programming in hybrid energy storage system
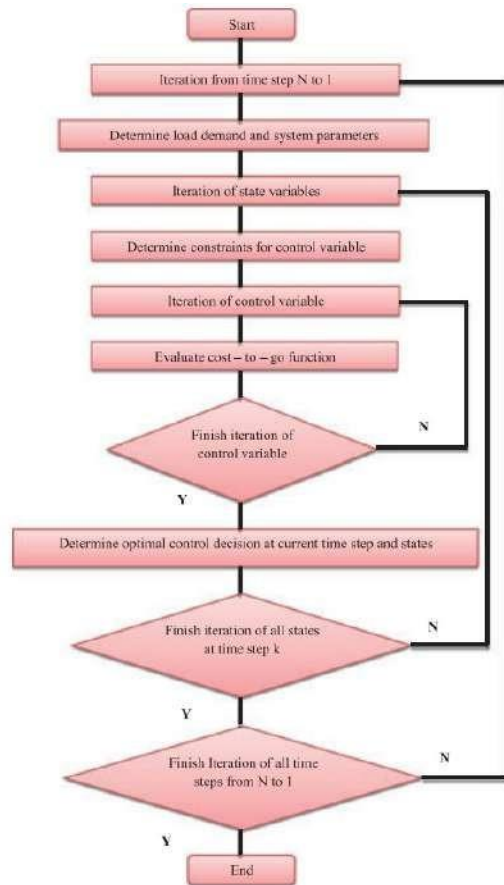
Fig. 7. Flowchart of dynamic programming [14].

TABLE I.   EVALUATION OF DIFFERENT EMS METHODS

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Methods	CoS	CT	ToS	RoPK
FL	×	Small	Global	Yes
PSO	×	Medium	Global	×
PMP	×	Small	Local	Yes
GWO	×	Medium	Global	×
DP	Yes	Medium	Global	Yes
MPC	×	Small	Global	×
NN	Yes	Small	Global	Yes

Here terms are described as follows:

CoS	Complexity of Structure
CT	Computation Time
ToS	Type of Solution
RoPK	Requirement of the Prior Knowledge PSO Particle Swarm Optimization

V. SUMMARY

This study educates us on a wide range of control strategies applicable to a variety of models, as well as their significance and possible future directions for research into control strategy. When common and well-known driving patterns are considered, an optimization technique has the potential to considerably increase the lifespan of the hybrid's power storage device. They aren't making any attempt to correct the sporadic working habits that they have been observing. Although fuzzy-based methods that are very effective for various drive cycles are available, optimal control approaches typically have a significant impact on better battery life. This is the case despite the fact that these alternatives are available. In addition to this, the GWO in the ESS that is integrated with the fuel cell helps to minimize the fluctuations in current and provides protection against the unstable state of charge that the battery may occasionally assume. Both of these benefits come about as a result of the combination of these two components.

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Autonomous Indoor Mapping Robot using ROS

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Abstract—**The concept of mobile robots has always been the prime topic of interest among the community of the roboticist However, the idea of engineering a mobile robots robot that can display indoor mapping and navigation, The current robots that we find are made for only a particular task orientation and are not user friendly as well as they also lack the ability of flexibility in the development of the robot, The purpose of this research thus involves developing and fabrication of the highly user-friendly and open source flexible interface of ROS(Robotic Operating System) which can integrate a wide range of sensors and can perform various operation as well as functions very efficiently and it takes the shortest time to cover (i.e.) Path planning, In the indoor environment, It also is the combination of A* algorithm into the robot automation firmware using obstacle avoidance, and thus every decision is unique and optimized. The experimental and simulation results are validated here to show the effectiveness of the A* algorithm.**

Keywords—UGVs, ROS (Robotic Operating System), Path planning, mobile robot navigation, obstacle avoidance, indoor mapping, A* algorithm

I. INTRODUCTION

Robotics constitutes a significant subfield within the discipline of mechatronics engineering. Robotics encompasses various aspects, including the strategic formulation, conceptualization, physical realisation, functional execution, and practical use of robotic systems. A robot is a machine, specifically one that can be programmed by a computer to execute a set of intricate activities autonomously. In the manufacturing sector, robots are commonly employed for various tasks such as the creation, finishing, transfer, and assembly of components. Various forms of robots exist, including drones. The six most prevalent categories of robots are autonomous mobile robots (AMRs) [1], automated guided vehicles (AGVs) [2], articulated robots, humanoids, industrial robots, and hybrids. Robotics is an engineering discipline concerned with the development, design, and operation of robots for the purpose of automation.

It is also associated with the study and implementation of robotics, encompassing the construction of robots through the integration of diverse technologies and their utilisation in our daily activities. The field of robotics presents significant prospects for future advancements. Robotic systems find extensive utilisation across diverse domains, serving a multitude of objectives. Presently, their deployment is particularly prominent in hazardous settings, encompassing tasks such as inspecting radioactive substances, detecting and neutralising explosive devices, as well as facilitating manufacturing operations. Additionally, robots are employed in environments that are inhospitable to human presence, such as outer space, underwater realms, extreme heat conditions, and the management and confinement of perilous materials and radiation. Robots possess the capacity to assume various physical manifestations, with certain models specifically designed to closely resemble the human form. This facilitates the integration of robots in specific tasks that typically involve human-like replication. These robots endeavour to imitate many human activities [2].

A. Challenges and Motivation

With the due research done, we came to know there is not much evidence of using the A* algorithm in the robot with ROS and implementing that in the mobile robot navigation the main objective is to optimize path length and navigational time and find the shortest distance, This was a challenging task to implement (Robotic operating system) with the A* algorithm because the method was unknown and we had to find many different innovative ways to accomplish the task and we are successful in making that, There are various parameter for the A* algorithm to inculcate in our research.

The 1st section contains information on robotics, its uses, and its application, the 2nd section contains and information about the navigation and mapping of the mobile robot including the self-localization and mapping. The 3rd section of the research paper consists of the path planning of the robot using the A* algorithm and integrated with the ROS (Robotic Operating System) and the detailed information on the robot construction with the software used in the simulation it also consists which path planning algorithm (A* algorithm) used in the indoor environment. 4th section consists of the simulation and analysis of the robot in the different indoor environments in using A* path planning and ROS architecture with different parameters are taken into consideration having graphical and statistical data. 5th section consists of the simulation results during the simulation of the robot in the indoor environment using ROS and the A* algorithm. 6th section consists of all the research papers that we have gone through and had some useful insights during our research.

II. MOBILE ROBOT NAVIGATION

The field of autonomous mobile robotics places significant emphasis on control systems and navigation as primary areas of concern. The system has components for hardware circuit design, control software, and upper computer software. The velocity and current control of DC motors have been observed in lesser computer systems. The navigation pack holds significant importance and possesses considerable power inside the framework of the ROS (Robotic Operating architecture) architecture. The navigation system employed in the autonomous car [3]. As depicted in Figure 1, the comprehensive structure of the navigation and Path planning involves determining the most efficient route considering the surrounding environment and the presence of obstacles that the robot must navigate. There are two primary categories of obstacles: static obstacles, which remain stationary, and dynamic obstacles, which are subject to movement. Upper computer interaction primarily facilitates human interaction, machine interaction, remote control, and data communication. The navigation stack operates at a basic conceptual level by receiving input from the odometry and sensor streams.

In order to ensure accurate navigation, several prerequisites must be met for the mobile base to receive appropriate velocity commands. Firstly, the robot must be utilising the ROS software framework. Additionally, the tf transform tree must be properly established. Furthermore, the publisher data should be transmitting the correct messages. Lastly, the ROS configuration should be tailored to accommodate the shape and dynamics of the robot, enabling it to operate at an optimal level. The hardware requirements of the navigation stack are specifically designed for wheeled robots with differential drives. It implies that the mobile base may be controlled by transmitting velocity signals. Additionally, the navigation stack necessitates the presence of a planar laser, which should be positioned on the mobile base. The laser in question is utilised for the purposes of map construction and localization. The navigation stack was originally devised for implementation on a square robot, therefore yielding optimal performance on robots of all shapes and sizes. However, while employing this navigation stack on larger rectangular robots within confined areas such as entrances, certain limitations may arise [3].
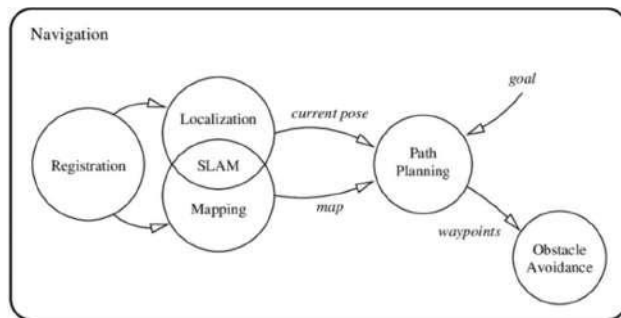
Fig 1 Navigation Stack

A. Self-localization

The expeditious execution of a comprehensive methodology for a robotic system to achieve self-localization within an indoor setting that may be represented as a basic polygon. As depicted in Figure 2, the robot's sole source of information consists of a polygon map and sensor data obtained from a range detecting device. It is assumed that in this manner, the robot possesses access to its localised visibility polygon. The iterative approach we employ involves consistently moving towards the nearest point where the robot can ascertain the elimination of at least one potential location in which it may be situated [4].
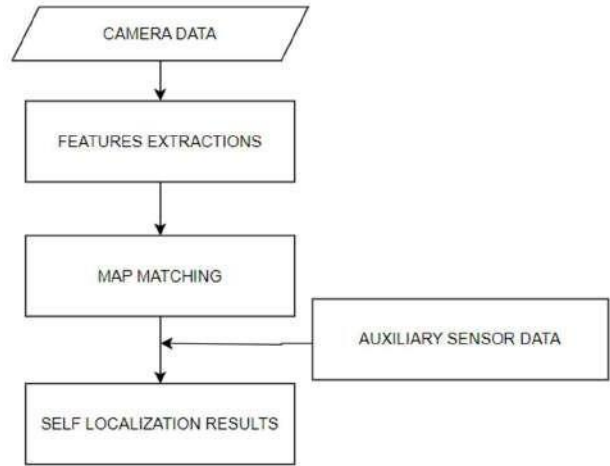

Fig 2 Self Localization

B. Map Building and Map Interpretation

The process of mapping the mobile robot is a fundamental aspect of achieving effective navigation in the field of mobile platform technology. Figure 3 illustrates that localization is a fundamental and crucial undertaking for attaining a high degree of autonomy in robot navigation and ensuring resilience in vehicle positioning. The field of robotic mapping and map interpretation is closely associated with cartography, employing techniques and computational methods to construct trajectory maps that accurately represent reality and effectively convey spatial information. [4].
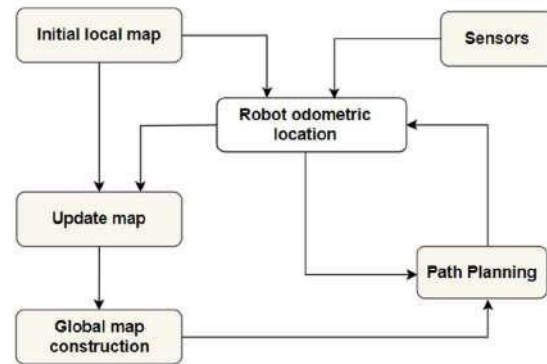

Fig 3 Robot Mapping

III. PATH PLANNING OF MOBILE ROBOTS USING A* AND ROS

Path planning, also called motion planning, is a computational problem that involves determining a set of feasible configurations to move an object between two locations. The objective of a path-planning algorithm is to determine a geometric trajectory that links the robot's present position to the desired destination, utilising a given map. Moreover, mobile robots working in unorganised settings or service and companion machines often lack comprehensive or complete prior understanding of the setting. Additionally, the context in which these robots operate is not static, meaning that while in motion, the robot may come across other robots, human beings, or companion animals.

Consequently, its performance of tasks is frequently influenced by unpredictability. Local obstacle handling, which includes obstacle detection and avoidance, is also required to achieve collision-free path planning. Robots may now detour around barriers utilizing modern approaches by quantitative measurement of the dimensions of obstacles [5]. In order to simulate the robot, the proposed algorithms were implemented in the Robot Operation System (ROS) as shown in the (Fig.4) the An free to use, meta-operating system designed for robotic platforms. The operating system, or OS, offers a range of services that are typically anticipated, such as hardware conceptualization, control over low-level devices, implementation of frequently utilised functionalities, inter-process communication through message-passing, and managing packages. More importantly, ROS (Robotic Operating System) has plenty of open-source packages including sensor drivers, navigation tools, environment mapping tools, path planning tools, communication and visualization tools, and many others that ultimately rigidifies the robot software network. The robot has a 360 Lidar module which can sense and give proper instructions to the micro-controller of that of the obstacle within the alarming range of the robot it also has a Bluetooth module for the communication of the instructions that the robot needs to accomplish and it has the encoder. The unmanned vehicle autopilot software suite in the Gazebo environment [5], the robot receives its position from the LiDAR module that connects to ROS(robotic operating system) for continuous movement along its x, y axes. In a SITL simulation, the desired path runs on the computer (either on the same computer or another computer on the same network). Sensor data is observed on the computer from the vehicle dynamics model in the simulator during SITL operations [6].
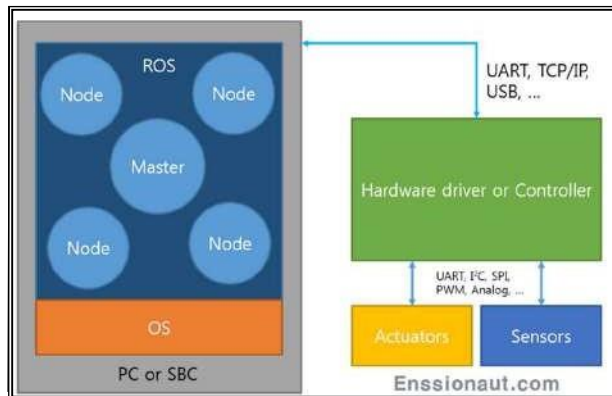
Fig 4 ROS-Robot Framework

A. Robot Construction

Mobile robots are required to know their locations within the environment as well as their surroundings so that they can perform assigned tasks. These issues are investigated within the context of localization and mapping, a phenomenon in robotics that analyses the world around a mobile robot. As shown in (Fig.5) The method is implemented in software that runs on the(robotic operating system) ROS platform. by using the stereo depth sensor on the robot, a point cloud about the obstacles is obtained for simulation and its applications the robot is equipped with various sensors for obstacle identification. the robot is equipped with 360 LiDAR shown in (Fig.6). This method involves the utilisation of remote sensing techniques, wherein the surrounding environment is subjected to scanning through the emission of a pulsed laser beam. Subsequently, the time taken for the reflected signal

from the object to reach the detector is measured. Lidar sensors possess the ability to identify obstacles throughout a broad range of visual perception, rendering them highly suitable for integration into a comprehensive sense and avoid framework. Additionally, ultrasonic sonic sensors and a depth camera are also used to determine the presence of obstacles and its data will be used to plan the optimal path. A number of filter operations are used to convert this data. The robot receives the user's intended destination information, which is used in conjunction with the drone's position and map information to construct the intended flight path [6].
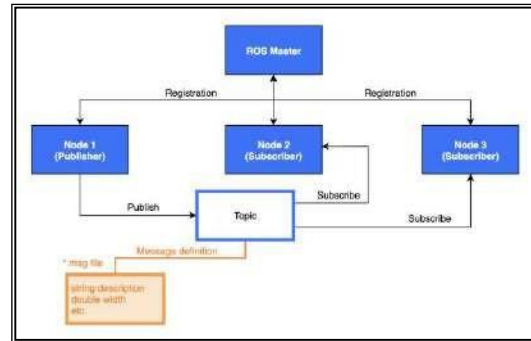

Fig. 5 Robot Sensors Publish and Subscribe pattern

Fig 6 Robot Design

B. ROS (robotic operating system)

The Robot Operating System (ROS) comprises a collection of software libraries and tools that facilitate the development of robot applications. ROS is an open-source, meta-operating system designed for robots, encompassing a wide range of components like as drivers, state-of-the-art algorithms, and a robust development community. The operating system offers a range of services and resources, which encompass hardware abstraction as illustrated in the block diagram (Figure 7), implementation of frequently utilised functionalities, inter-process communication through message-passing, and package management. Additionally, it provides a diverse array of tools and libraries for the acquisition, construction, composition, and execution of code across many computational devices. The Robot Operating System (ROS) incorporates various modes of communication, encompassing

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synchronous Remote Procedure Call (RPC)-style communication through its service offerings, asynchronous streaming of data via topics, and data storage on a Parameter Server. The major objective of the Robot Operating System (ROS) is to facilitate the reuse of code in the field of robotics research and development. The Robot Operating System (ROS) is a distributed framework consisting of a collection of processes referred to as Nodes. These Nodes allow for the creation of executables that can be created independently and have loose coupling during runtime. The aforementioned processes can be categorised into Packages and Stacks, facilitating their seamless sharing and distribution. Currently, the ROS framework is exclusively accessible on operating systems that are Unix-based. The software designed for the Robot Operating System (ROS) is consistently subjected to testing on Ubuntu and Mac OS X operating systems. However, it is worth noting that the ROS community has actively contributed to extending support for more Linux platforms like as Fedora, Gentoo, Arch Linux, and others. [6].
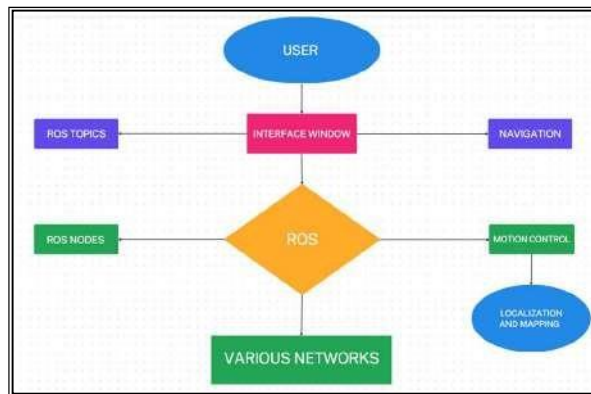
Fig 7 ROS Interface and Architecture

1) *Packages:* Packages play a crucial role in the organisation and structuring of software within the Robot Operating System (ROS). A package encompasses ROS runtime processes (referred to as nodes), a library that is dependent on ROS, datasets, configuration files, or any other components that are effectively organised in conjunction. Packages are the most desirable build item and release item present in ROS framework.

2) *Nodes*: ROS nodes are essentially just processes that are communicating with the robot through the use of ROS application programming interfaces (APIs). It's possible for a robot to have a lot of nodes to help it with its computations. ROS client libraries, such as roscpp and raspy, which will be covered in the next sections, allow us to establish ROS nodes. In the following parts, we will discuss:.

3) *Topics:* ROS topics are one of the ways in which two ROS Department of Mechanical Engineering nodes can communicate with one another and exchange ROS messages with one another. ROS messages are used to communicate between participants on designated buses known as topics.

In the search for the optimal course, the academic literature presents a great deal of different approaches. Every obstacle in the planning process requires a series of decisions that must be carried out in sequence throughout the course of time. In addition, it is absolutely necessary to specify in the planning formulation how the state shifts as activities are carried out. Each step of the path-planning procedure takes into account both the initial state and the destination state [7]. In many cases, there are two distinct categories of planning issues. The first factor to consider is whether or not the goal can actually be accomplished. To do this, you must devise a plan that, regardless of how effectively it works, will bring the robot to the desired destination. The second objective is to devise a plan that is both practicable and effective in enhancing performance in a particular manner. On the other hand, the effectiveness of these algorithms was evaluated according to the following ideal criteria: time required for computation and distance travelled [8].

In this work, we have used A* algorithm below is the general working and the basics of the A* algorithm and this is one of the best path planning algorithms that produced very satisfactory results.

a) *A* Search Algorithm:* There is a well-known and fundamental heuristic method called a star search (A*, A-star, or A* search [8]. Methodically, (Fig.8) the algorithm that the A* uses for its optimization. It is attempted to minimize the function, formalized as $f(n) = g(n) + h(n)$ taking into account the links between nodes and edges. In mathematical terms, $g(n)$ is the cost of the beginning point or node, while $h(n)$ is the cost of the remaining journey. $h(n)$ hereby constitutes the heuristic base of the algorithm [8].
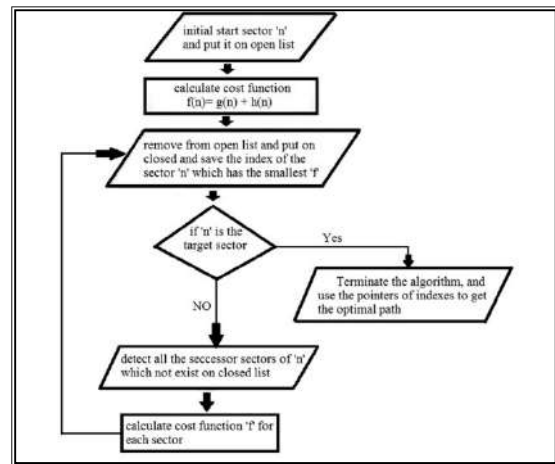

Fig. 8 The A* Algorithm flow chart

TABLE I. A* ALGORITHM PARAMETERS IN SIMULATION

Sr No	ALGORITHM PARAMETERS	
1	α - Safety Distance	0.8m
2	β - Safety Distance	0.7m
3	Velocity safety Distance	1.2m
4	Critical Safety Distance	0.07m
5	Max velocity	0.4m/s
6	Octomap resolution	0.1m
7	Spherical matrix resolution	6 degrees

The simulation that is performed in the indoor environment parameter used for the A* parameter is shown in (Table No 1). The UGV parameters of the performed simulation are shown in (Table No 2), The results of the simulation of the Special Case 1 are shown in (Table No 3), The results of the simulation of the Special Case 2 are shown in (table No 4).

TABLE 2 UGV PARAMETERS FOR THE SIMULATION

Sr No	UGV PARAMETERS	
1	Mass	2kg
2	Radius	35 cm
3	Inertia, ixx	0.0348
5	Inertia, iyy	0.0459

IV. SIMULATION AND ANALYSIS

After getting a broad grasp of how these algorithms function theoretically, it's crucial to put them to the test on a real robot to determine their effectiveness and usefulness. As shown in (Fig.9) the top view of the navigation and mapping sensors ROS (robotic operating system) includes a real-time physics simulator environment called Gazebo[9], allowing a robot model to be thoroughly evaluated before a prototype is built. In addition, the robot model is integrated into the Gazebo using a technique known as 'Software in the Loop,' or SITL[10], which feeds real-life robot data to the physical environment for simulation.
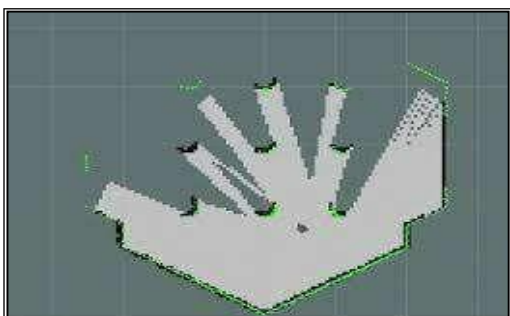
Fig 9 Robot sensors Navigation and Mapping
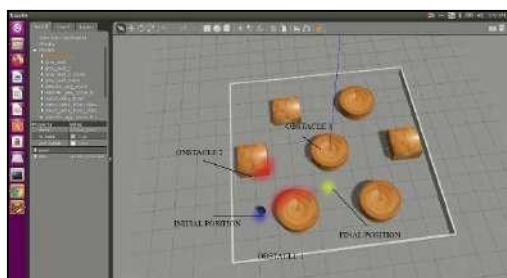
(a)

Special Case 1: The robot in the room with the Gazebo closed environment and with some static obstacles and the robot is situated in a particular position here the robot navigates through the obstacles and intelligent path planning is used to navigate the robot to find the most efficient path which has less cost in covering the distance, The (Fig.10) depicts the navigation mapping and the path taken by the robot. Here we give the robot a particular target position and the robot first determines the initial position of the robot in the room and analyses the target position given to the robot through which

it navigates and reaches its given destination in the most efficient way possible to reach the point of target. (Table.3) gives the coordinates of the initial position and goal position of the robot with its navigational time taken by the robot and the path length achieved by the robot. The graphical representation of the statical data of particular case 1 is shown in (Graph.1) performed in the indoor test environment.
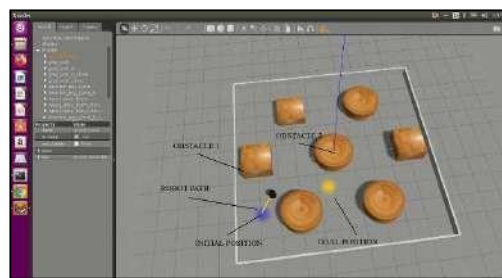

(b)
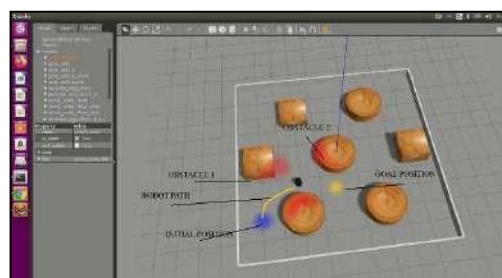
(c)
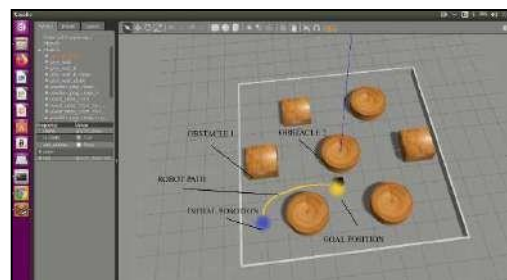
(d)

Fig 10 Test scenarios created in Gazebo simulator

Fig (a) The robot initiates the action by analyzing the initial position of the robot. Fig.(b) The robot starts the path planning and acts according to the set path planned by the software. Fig.(c) The robot is in the given path and detects the object and avoids the object and moves around. Fig. (d) The robot reaches the final destination.

TABLE NO 3-PATH LENGTH AND NAVIGATIONAL TIME USING A*ALGORITHM

| Sn No :	Initial position (x, y)	goal position (x, y)	Navigational time (s)	Average path Length (m)
1	-10; -10	-2.1; -1.35	1.72	8.5950
2	-10; -10	-2.3; -1.96	1.70	9.5950
3	-10; -10	-2.2; -1.21	1.69	8.1056
4	-10; -10	-2.2; -1.36	1.66	8.2369
5	-10; -10	-2.0; -1.54	1.74	9.1256
		Σ	1.702	8.73162
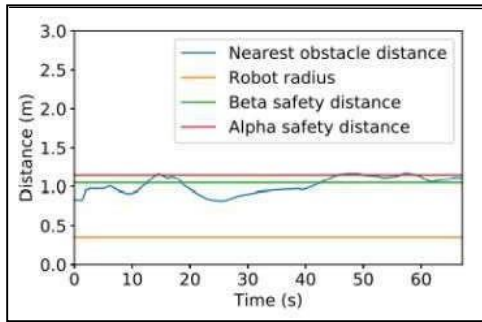
Graph 1 of Path Planning using A* algorithm in case1

TABLE NO 4 PATH LENGTH AND NAVIGATIONAL TIME USING
A* ALGORITHM

Sr No:	Initial Position (x, y)	Goal Position (x, y)	Navigational time (s)	Average path Length (m)
1	-5, 10	-3; -2.5	2.73	15.5873
2	-5, 10	-2.9; -2.5	2.78	15.6669
3	-5, 10	-3; -2.72	2.69	15.6988
4	-5, 10	-3; -2.61	1.88	15.6524
5	-5, 10	-3; -2.65	2.88	15.2546
		Σ	2.592	15.5720
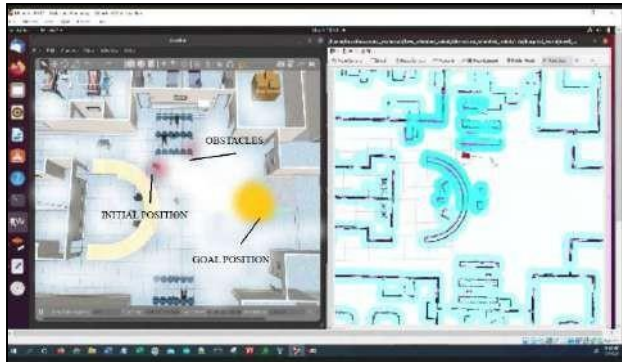
(a)
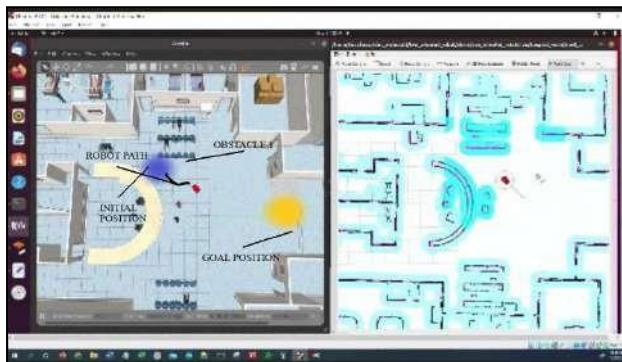
(b)

Special Case 2: As shown below (Fig.11) that the robot performs path planning with many obstacles as well as obstacle avoidance, In this simulation environment the robot is placed between many obstacles that are stationary as well as some of them are dynamic obstacles the robots need to analyze the data from the sensors and make the necessary decision and decide the most efficient path through the obstacles it helps the robot to reach its target decision in the best possible way. (Graph.2) below depicts the statistical information of case 2 of the indoor mapping environment performed by the robot. (Table.4) shows the results of the simulation performed by the robot in case 2.

(c)

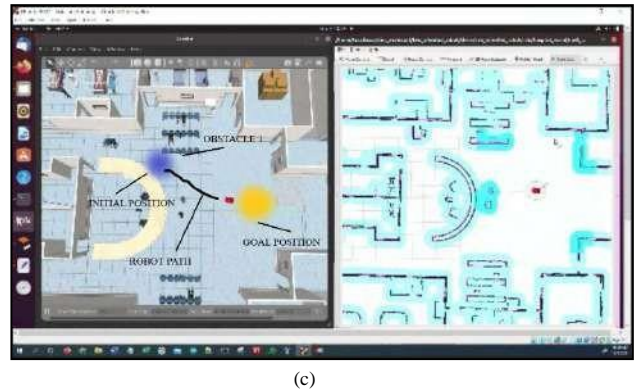Fig 11 Test scenario 2 created in Gazebo simulator
Fig (a) The robot initiates the action by analyzing the initial position of the robot. Fig (b) The robot starts the path planning and acts according to the set path planned by the software. Fig (c) The robot is in the given path and detects the object and avoids the object and moves around. These are some of the navigation codes used in the ROS environment to plan the path to be executed to reach from given position of the robot to the target destination. These codes include various parameters that the robot has to behave accordingly.
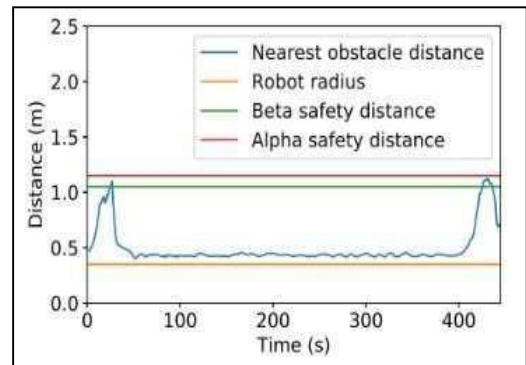

Fig. 12 Path planning using A* algorithm in Case-2

CONCLUSION

The experiments reveal that the A* algorithm takes the shortest path, however, it uses significantly more computing power than the other algorithms. The proposed research was in the view to develop a autonomous mobile robot system that is capable enough to smartly navigate to the given goal position, and efficiently follow the path provided by an optimized path planning algorithm. This study included that the A* algorithm is more efficient and better in performance with the robot in the Gazebo Simulator using the ROS (robotic operating system) framework, and it was discovered that the A* algorithm produced better results and computes the path more quickly in the particular environment in which the robot was situated in the Gazebo environment.

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Exploring benefits of 3d printing technology in Industry 4.0

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Abstract— **This paper reviews the advancement which has taken place due to the adaptation of 3d printing technology in Industry 4.0. Chuck Hill originally popularized 3D printing technology at the beginning of the 1980s. The key improvements brought by 3D printing technology are energy efficiency, ease of manufacturing, and little to no human participation. This paper discusses the benefits that came along with the adoption of 3D printing technology in modern manufacturing technology or Industry 4.0. The fourth Industrial Revolution, or Industry 4.0, is the term of the current trend in intelligent automation technologies. Utilizing contemporary manufacturing technology while incorporating cutting-edge information technologies is crucial in the present day. When manufacturing any component, manufacturers constantly focus on three key factors: Efficiency, Reliability, and Quality. The 3D printing technology is the cutting edge that provides in all three of these critically important areas. This article provides an overview of the advantages of 3D printing technologies, the applications of these technologies, and finally, the role that these technologies play in the fourth industrial revolution.**

Keywords— 3D Printing, Industry 4.0, Automation, Energy Efficiency, Reliability.

I.   INTRODUCTION

The additive manufacturing technique that is utilised in the 3D printing technology results in the formation of 3D models in a format that is based on layering. With the advancement of this technology, different processes with the key major application have been developed. These technologies include powder bed fusion, inkjet printing, fused deposition modelling (FDM), and contour crafting (CC). The first 3D printer that was used commercially relied on a process called stereolithography (SLA) as the method of manufacturing. The process of 3D printing, which has evolved over time and now employs a wide variety of methods, materials, and tools, has the potential to alter the procedures for manufacturing and logistics. One example of an industry that has made substantial use of additive manufacturing is the construction industry. Prototyping and the biomechanical professions are two more examples. Despite the many advantages of 3D printing in the construction industry, such as less waste, greater design freedom, and increased automation, the technology has only lately begun to gain popularity. [1].

The motivation for writing this paper was obtained by reviewing existing trends in industrial manufacturing, although research in the field of 3D printing technology is studied on a wide scale, the key advantages which Industry 4.0 thrives on i.e. environmental effect caused by the use of this technology, ease of production, smart manufacturing and integration with IoT were not majorly highlighted from the existing research work, we aim to cover all this key areas.

A new industrial stage has been designated as Industry 4.0. This stage is characterised by the construction of Cyber Physical Systems (CPS) through the integration of information and communication technologies (ICT), most notably the Internet of Things (IoT), with manufacturing operations systems. [2] The fourth iteration of the industrial revolution is commonly referred to as Industry 4.0. Both the beginning of the fourth industrial revolution, also known as Industry 4.0, and the beginning of the digital transformation of business both began at the beginning of the 21st century [3]. The beginning of the 21st century also coincided with the beginning of the digital transformation of business. The promise that was held for the so-called "fourth industrial revolution" has been more than fulfilled, and the revolution itself has been a huge success. Since the term "Industry 4.0" was first introduced to the public in 2011, global corporate leaders and governments have been paying attention to the digital transformation that is required by Industry 4.0 [4]. The interaction of networked computers, intelligent machines, and smart materials with one another as well as their surroundings in order for them to communicate with one another and, ultimately, make decisions with the assistance of very few humans is a defining characteristic of Industry 4.0. [5].
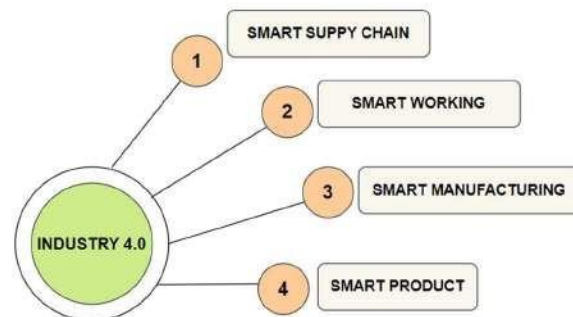

Fig 1-IOT Framework

The four key elements of Industry 4.0 are contained in the first layer (front-end technologies) and each one stands for a different subset of technologies: Smart Manufacturing [6], Smart Products [7], Smart Supply Chain [8], and Smart Working [9]. The connection and intelligence of the frontend technologies are believed to be part of the second layer (base technologies) (e.g. IoT and analytics). We next determine trends in the uptake of these two layers of technology in the examined organizations and unravel the relationships between them using a cluster analysis [10]. We identify a hierarchy of

Industry 4.0 technology layers as an important finding, show the levels of adoption of various technologies, and discuss how these adoption levels affect how the Industry 4.0 concept will be put into practice. These findings are assembled in a framework that provides a conclusive illustration of the maturity of Industry 4.0 implementation in the sample under investigation [11].

II. RESEARCH METHODOLOGY & METHODS

3D Printing Process There are four key processes in the 3D printing process: creating a three-dimensional model, pre-processing, prototyping, and post-processing [12]. Three-dimensional model: The additive manufacturing technology is directly driven by the 3D CAD data model. Designing the product's 3D CAD data model should thus be the initial step in the additive manufacturing process. Currently, STL is the data file format that many software programs accept. To replicate the original solid model and the original 3D data model, several small triangular planes should be employed [13].
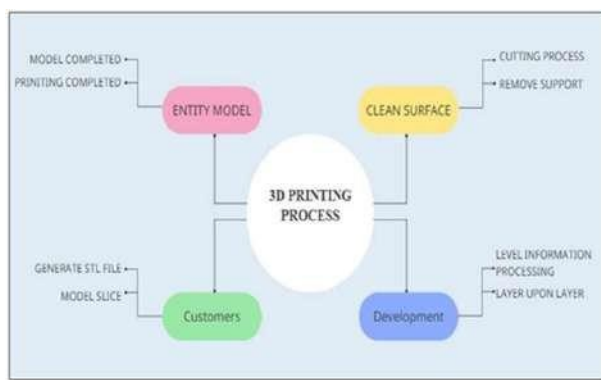

Fig 2 - Flow chart 3D printing process

Pre-processing: choose the proper moulding direction and cut the 3D model in the direction of the moulding height with a series of planes spaced equally apart to collect the 2D contour data of the cutting layer. The better the moulding precision, the longer the moulding process takes, and the less efficient the moulding is, the shorter the spacing height [14]. Prototyping: A forming head is used, controlled by a computer, to execute a two-dimensional scanning movement according to the cross-sectional contour information of each layer. The materials from each layer are then layered and bonded to create the final three-dimensional solid. A nozzle or a laser head might be the forming head [15]. Posttreatment: The goal of post-treatment is to enhance product strength and lowering product surface roughness. Repair, grinding, posturing, peeling, polishing, and coating are all steps in the procedure [16].

2.2. Types of 3D printer Different 3D printing methods have been created, each with a specific purpose. The different types of the major 3D printing process are binding jetting, Stereolithography (SLA), Fused Deposition Modeling (FDM), Electron Beam Melting (EBM), and PolyJet. There are no arguments about whether machines or technologies work better since each one has a specific use. Modern 3D printing technologies are being employed to create a wide range of items rather than just prototypes. Binder jet 3D printing: Binder jet additive manufacturing (AM) technique, also known as binder jet 3D printing or binder jetting, has several benefits over conventional metal additive methods. Large-scale constructions are easily constructed, and build

timeframes are frequently quick. To prevent the accumulation of residual stress in the completed component, powder layers are bound together during processing rather than thermally fusing them. The variety of certified metal powder feedstocks for binder jetting has to be expanded as the demand for this efficient technique rises [17].

Advantages- The fact that the binder jetting process takes place at room temperature means that thermal variables, which might lead to component deformation, are not an issue. This is the primary advantage of using binder jetting. As a direct consequence of this, the build volumes of bindery jetting machines are among the highest of any 3D printing method. Sand casting moulds are often fabricated using the largest equipment available, which measures 2200 millimetres by 1200 millimetres by 600 millimetres. Using metal binder jetting systems, it is possible to create multiple components at the same time. These systems are larger than DMSL and SLM systems, despite the fact that they are smaller (they can measure up to 800 x 500 x 400 mm).
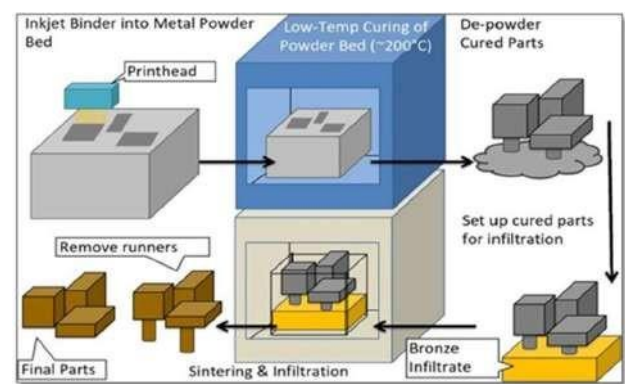

Fig 3- Binder Jet 3D Printer [18]

Disadvantages- Due Accuracy and tolerance are the primary concerns with binder jetting, and it can be difficult to make accurate projections because of component shrinkage that occurs throughout the postprocessing steps. For instance, as a result of infiltration, the metal components of smaller objects may shrink by up to 2%, while the metal components of larger things may shrink by more than 3%. The friction that occurs between the furnace plate and the bottom surface of the object during the sintering process might cause the object to deform. Additionally, the object will shrink by an average of 20%. The component can become softer as a result of the sintering heat, and portions of the component that are not supported may bend as a result of the weight of the remainder of the part. Although these concerns may be handled in the design, taking into account nonuniform shrinkage may prove to be more difficult. Casting patterns, aerospace components, prototypes, full-color decorative objects, cores and moulds, jewellery, and other applications are all possible with this material.

Stereolithography (SLA): One of the most well-known and widely implemented techniques for additive manufacturing is known as stereolithography, which is also referred to as SLA 3D printing on occasion. It accomplishes this by focusing a powerful laser beam on a reservoir of liquid resin, which causes the resin to solidify and construct the required three-dimensional shape. Simply explained, this technology uses a low-power laser and photopolymerization to convert photosensitive liquid into layer-by-layer 3D solid polymers. [19].
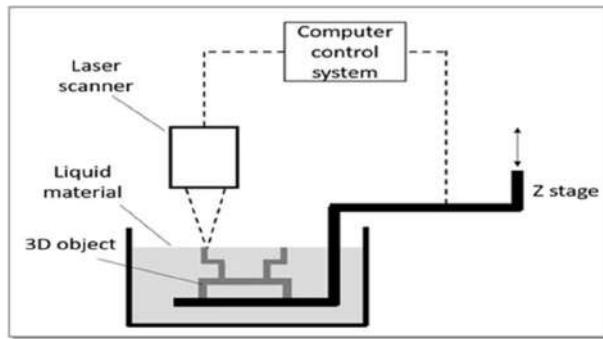
Fig 4- Stereolithography [20]

Advantages- One of the most accurate methods of 3D printing currently available is called SLA. It is possible to make prototypes with intricate geometrical patterns and features that are exceedingly complex (such as thin walls, sharp angles, etc.). These prototypes can be as detailed as desired. It is possible to have layers as thin as 25 μm, while theminimum feature sizes range from 50 to 250 μm. SLA offers the tightest dimensional tolerances of any fast prototyping or additive manufacturing method, with tolerances of +/- 0.005″ (0.127 mm) for the first inch and an additional 0.002″ for each additional inch. The prints have smooth surfaces [21].

Disadvantages- Printing typically requires a significant amount of time. During the construction process, support structures are necessary for slopes that are excessively steep and overhangs. These components run the risk of falling apart whenever printing or curing processes are being performed on them. Because of their brittle nature, resins are not suitable for use in mechanical testing or in the creation of functioning prototypes. The majority of the time, SLA only provides hues and materials in the range of black, white, grey, and translucent. Because resins are typically protected by intellectual property rights, it can be difficult for printers made by various manufacturers to swap them out. Uses include: Rapid Tooling, Jigs, and Fixtures. • Casting patterns as well as moulds. • Snap-fit assemblies and designer models for customization. • Optics, as well as covers that are see-through. • Models to scale and for presentation.

Modelling via Fused Deposition Thermoplastic material that has reached its melting point is employed, and then the molten material is pushed out in order to layer by layer construct a three-dimensional model. As the design progresses, each layer can be interpreted as a horizontal cross section of the overall structure. Following the completion of one layer, the nozzle of the printer is lowered in order to add the subsequent layer of plastic to the design. Once something has been made, the components that supported its creation can be removed. [22].

Advantages: Increased production speed is one of the key advantages that comes with using FDM for 3D printing. It is possible to construct an entire object using 3D printing in a matter of minutes or hours, which reduces the amount of time needed for lead times and speeds up the process of prototyping. FDM makes it possible to print larger objects than ever before, and because the architecture of the printers is so easily scalable, the cost-to-size ratio of the objects that can be printed is surprisingly low [23]. Disadvantages The use of fused deposition modelling for 3D printing comes with a number of important limitations, one of the most significant being the lowest achievable resolution. Because FDM has a

layer height that is relatively high compared to other 3D printing methods, it is not recommended for use in the manufacturing of components that contain minute details.
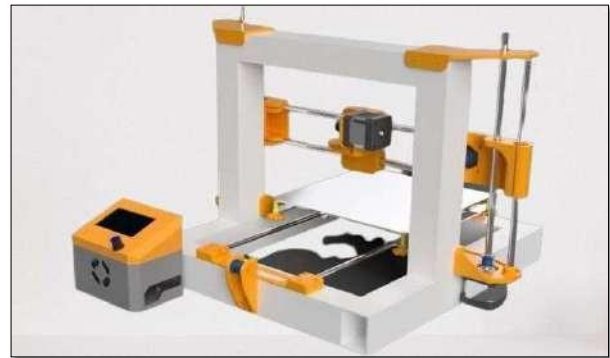

Fig-5 FDM type 3d printer

Additionally, the end items are likely to have rough surfaces and will need post-processing in order to have a smoother finish. This is something that must be taken into consideration. Epoxy adhesion, gap filling, and vapour smoothing are all processes that can improve the appearance of a part; however, each of these processes also adds time to the production process. Epoxy adhesion is one of the processes that can improve the appearance of a part. Because of this, FDM printers are not the best option for the manufacturing of products that require smooth finishes or a high resolution because they cannot produce these qualities. Some of the applications are Functional Testing Engineering and Concept Models. Rapid Manufacturing; Low-volume Production of Complex Parts; Rapid Manufacturing; Tools, Jigs, and Fittings; Rapid Manufacturing; Rapid Manufacturing.

Electron Beam Melting (EBM): In the process of electron beam melting, sometimes known as EBM for short, a powdered metal is melted by a strong electron beam. This method is commonly referred to by its acronym alone. The process of printing in three dimensions is also referred to as electron beam melting in some circles. When layers of powdered metal are melted by an electron beam, a stream of electrons is formed. These electrons are guided by a magnetic field as they are produced. This causes an electron stream to be produced, which can then be used for a variety of applications after it has been produced. The application of this technique will, in the end, result in the manufacture of a product that satisfies all of the requirements outlined in a CAD model to an exceptional degree. The manufacturing process is carried out within a vacuum chamber to eliminate the possibility of any oxidation taking place, which would put highly reactive components in jeopardy if it did take place. [24].

Advantages of EBM- • Reduced tooling and setup costs; • Minimal material waste • Reduced residual stress owing to increased process temperature • Reduced oxidation due to vacuum environment • Geometric flexibility for engineers designing engineered products [26]. Disadvantages of EBM- • There are few commercially available materials. • Has a surface smoothness similar to that of sand casting • Requires complete comprehension to reap the full rewards of the technique [27]. Application- • Aerospace • Automotive • Défense • Medical Applications • Petrochemical.
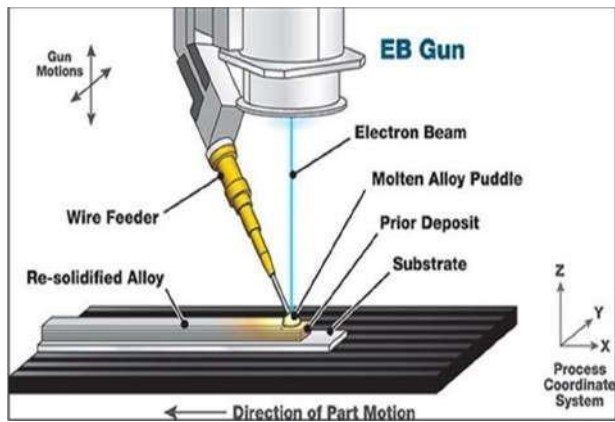
Fig-6 Electron Beam Melting [25]

Polyjet:The robust form of 3D printing known as PolyJet is able to produce smooth and accurate tools, prototypes, and components that can be used in manufacturing. Because of its extraordinarily fine layer resolution and accuracy, which may go down to 0.014 mm, it is able to make thin walls and challenging forms out of the widest spectrum of materials that is now imaginable using any technique. This ability allows it to compete with 3D printing in terms of both versatility and production capacity. When compared to more conventional manufacturing methods, this is a huge advantage. [28].
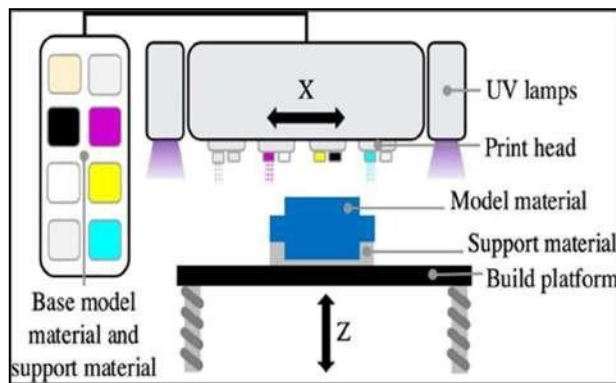

Fig-7 Polyjet [29]

Advantages- • Design slick, minute prototypes that reflect the aesthetics of the finished product. • Create precise moulds, fixtures, jigs, and other production equipment. • Achieve detailed details, complicated forms, and delicate characteristics. • For unequalled efficiency, combine the greatest selection of hues and materials into a single design [30]. Disadvantages- • Surface quality changes due to the support material (surfaces without support are shiny and smooth; those with support are drab and rougher) • Cost is rather costly in comparison to other 3D printing methods. • Sharp edges are frequently somewhat rounded in Polyjet [31]. Application- • Product presentation and form-fit testing. • The prototyping of intricate pieces. • Overmolding. • Rubber-like, flexible models. • slippery or supple surfaces.

2.3. Environmental Effect Numerous factors, including idea evaluation, equipment upkeep, and environmental considerations, must be taken into account while developing manufacturing processes [32]. Although industrial methods have an impact on the environment, clean manufacturing of Green products and products with minimal environmental effects are crucial themes in the development of industrial processes [33]. However, all manufacturing procedures use

resources, require energy, and discharge toxins. The same holds with AM technology [34]. Energy consumption-The and effective use of energy are regarded as major aspect in the examination of the environmental effects of the manufacturing process. The most significant environmental impact of AM methods seems to be electrical energy. While this does not hold for the manufacturing of samples, AM in mass production uses more electrical energy than injection molding [35]. Interestingly, several factors affect energy usage. Material: At the moment, many materials may be used in AM techniques. Different energies are needed in manufacturing using AM methods because varied materials have different densities and heat capabilities. As a result, using low-temperature materials requires less energy [36].

Table no. 1 [37]

Process	Material	Machine	Energy (KWh/kg)	Ref.
PBF	Metallic powder	EOSINT M250	710	[38]
	Polyamide	Vanguard HiQ	15	[39]
		EOSINT P760	40	[40]
VP	Epoxy resin	SLA 250	33	[41]
		SLA 3000	41	
		SLA 5000	21	
FDM	ABS plastic	FDM 1650	346	[42]
		FDM 2000	116	
		FDM 8000	23	

Build volume: By utilising this feature, users have the ability to determine the maximum number of discrete components that can be manufactured simultaneously by a certain 3D printer. According to previous research [43], printers that possess the ability to engage in parallel manufacturing and simultaneously print many components are regarded as having higher energy efficiency. The phenomenon of increasing the thickness of the layers. Achieving a reduced layer thickness is considered a fundamental requirement in the pursuit of producing surfaces of superior quality. One potential approach to attaining this objective is to employ a slower printing speed, which necessitates a greater amount of energy. Additionally, a low layer thickness leads to printed components having more layers overall, which raises energy usage [44]. Process speed: Different process speeds are possible with AM methods. In addition, other factors like material and thickness have an impact on printing speed. In all AM techniques, the lengthier process uses more energy, whereas quick printing uses less energy [45,46].

Waste materials- The usage of diverse waste materials through recycling methods facilitates the development of innovative components. In order to integrate recycled materials into additive manufacturing (AM) processes, one viable approach involves the recycling and utilisation of polymeric waste. A diverse range of polymers demonstrates the ability to undergo recycling procedures and afterwards be reintegrated into practical applications. Examples of such polymers are high density polyethylene (HDPE) and low density polyethylene (LDPE). In addition to low-density polyethylene (LDPE) and high-density polyethylene (HDPE), high stiffness polymers such as polypropylene (PP), polylactic acid (PLA), and acrylonitrile butadiene styrene (ABS) are also undergoing recycling processes. The efficacy of recycling these resources for filament production has been established [47,48]. The implementation of recycling practises holds promise in significantly reducing annual expenses amounting to millions of US dollars. This is achievable through the repurposing of filaments for 3D printing, which may be efficiently utilised in the production of polymeric structures.

TABLE 2. NO OF RESEARCH PAPER STUDIED

Sr. No	Field of research	No. of papers
1	Industry 4.0	9
2	3D printing introduction	8
3	3D printing Process	4
4	Binder jet 3D printing	3
5	Stereolithography (SLA)	3
6	Fused Deposition Modeling (FDM)	2
7	Electron Beam Melting (EBM)	3
8	Polyjet	3
9	Environmental effect introduction	2
10	Energy consumption	9
11	Waste material	2
12	Air pollution	3
	Total	51

The identification number for resin is used to classify the various types of waste plastic. In light of the numerous applications for AM processes and the growing demand for 3D printing technology, a recycling code for goods that were manufactured using 3D printing should be provided. In point of fact, if detailed printing is done, there may be concerns if the volume of plastic waste made by other MA processes rises. This is because other MA activities produce waste in the form of waste plastic. The process of recycling that is suggested for use with AM technology is illustrated in Figure 8. Before being chopped into flakes, the recycled material in this instance is first sorted according to the resin code. In some filament extruders, the flakes can serve as a potential source of raw material. In order to ensure the filaments' quality, it is necessary to evaluate them according to certain technical criteria. [49-55].
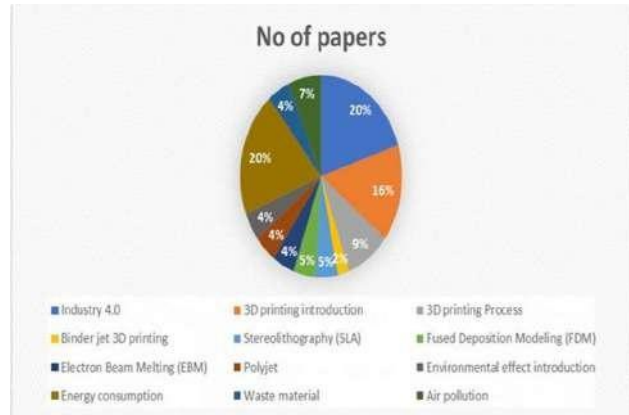

Fig 8. Pie chart presentation of Research Paper studied

Air pollution- Over the course of the past few decades, there has been a discernible rise in the significance of the problem of air pollution on a global scale. The impact of additive manufacturing (AM) on air pollution can be broken down into two broad subdomains: (a) the air pollution that is produced by AM processes, and (b) the use of AM in manufacturing to reduce air pollution. The creation of components from raw materials is one of the major contributors to pollution caused by industrial processes [51,52]. The activities involved in manufacturing are directly responsible for 19% of the world's total emissions of greenhouse gases [53,54]. As a result, it is necessary to make use of the most advanced and applicable technology available in order to reduce the amount of air pollution that is caused by these operations. The different industrial operations contribute different levels of air pollution. Because of this, there is a growing concern regarding the impact that AM technologies have on the quality of the air. [56-62].

III. RESULT AND DISCUSSION

With increasing popularity of 3D printing in industry 4.0, it has become crucial to choose correct method for manufacturing, we have presented various process in this paper which manufacturer can choose from, we have also covered crucial aspect of environmental effect due to the processFor the purpose of this study on 3D printing and its place in Industry 4.0, a literature review of around fifty technical articles, which included research papers and review papers, was carried out. The papers came from a variety of journals, conferences, and publications. This work fills a gap in the existing literature that we discovered after evaluating more than 50 other papers. The gap concerns the effects of the environment on a variety of processes, materials, and after effects. Additional research might be conducted on the subject of the integration of different 3D printing processes with the internet of things, the difficulties associated with automation, and the search for eco-friendly alternatives to the polymers that are now in use.

CONCLUSION

This article covers the breakthrough that the 3D printing technology has brought to industry 4.0. It focuses mostly on

the following topics: an introduction to 3D printing; an introduction to Industry 4.0; the 3D printing process; different types of 3D printers; and the environmental effect. We have covered all of these topics in the context of 3D Printing technology along with classification of the effects produced by each type of 3D printer, advantages, disadvantages, and application. Since industry 4.0 primarily focuses on less waste, smart production, and environmental effects, we have covered all of these topics in the context of 3D Printing technology. This is because industry 4.0 is primarily focused on reducing waste. The environmental effects are categorised according to the types of materials used in production, the requirements for post-processing, and the effects of air.

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Design and development of 5-dof robotic arm with a mechanical gripper

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Abstract— **The objective of this study is to conceive and construct a robotic arm possessing five degrees of freedom (DOF). This endeavor may be divided into three distinct phases: the design phase, which entails conceptualizing the arm's structure; the control logic phase, which involves formulating the algorithms necessary for governing the arm's movements; and the hardware mechanism phase, which encompasses the selection and implementation of the components responsible for controlling the motion of the arm's links and joints. In order to regulate the movement, a mobile application has been created, utilizing the Bluetooth module HC-05 for transmission, which provides a range of roughly 10 meters. The code has been implemented in the C++ programming language, allowing for either automated or manual control of the motion through the mobile application. The Arduino Mega microcontroller is employed for the purpose of establishing a connection between the wireless controller and the robotic arm. The utilization of 3D printing technology is employed in the advancement of a robotic arm. The prototype that has been built is anticipated to address the issue of manual object choosing and positioning.**

Keywords— Bluetooth, Microcontroller, 3D printing, Wireless Controller

I. INTRODUCTION

The industrial sector is expanding quickly. As a result, industrial automation is crucial in today's environment. Pick and place mechanisms are necessary for all automated operations to transfer and rotate goods on production tables or conveyors. Robotic arms, however, are fixed at one point and are unable to travel to other areas, unlike a human worker who may pick up a product or material, carry it to a separate workstation for a different operation, and then deposit it on another. [1] The robotic arm is a sophisticated mechanical device that replicates the motions and uses of the human arm. It is frequently utilized in manufacturing and other fields where the accurate and precise performance of repetitive tasks is required. In comparison to human employees, the robotic arm offers several benefits, such as the capacity to operate constantly, a decrease in human mistake rates, and an increase in productivity. The use for which a robotic arm is intended determines its design. The end-effector, the arm, and the base are the three basic parts that make up the majority of robotic arms. The arm's end-effector is the portion that engages with the outside world

and carries out the necessary function. The end-movement effectors and location are controlled by the arm, while the arm is supported by and stabilized by the base. A robotic arm is built using a variety of materials, including steel, titanium, and aluminum. Electric motors, pneumatic actuators, hydraulic actuators, or a mix of these are frequently used to power the arm's joints. The robotic arm's control system is made up of sensors, actuators, and a CPU that interprets input signals from the user or the environment into the proper actions. [2]

Functionality-The end-effector and control system programming are what determine how well a robotic arm works. Many applications, including welding, painting, and pick-and-place tasks, can be accommodated by the end design. effector's Programming methods like teach-pendant programming and off-line programming can be used to operate the robotic arm. The robotic arm's movements, such as moving, grabbing, and releasing things, are conducted in a certain order according to programming. [3] Types and Applications: Based on their construction, motion range, and payload capacity, robotic arms may be divided into many varieties. Robotic arms of the articulated, Cartesian, cylindrical, polar, and scara varieties are the most prevalent. Each kind is ideal for particular uses and has benefits and disadvantages of its own. [4] Articulated robotic: Since they feature a jointed construction and a high degree of freedom, articulated robotic arms are ideal for applications that call for flexibility and mobility. They are frequently employed in material handling, painting, and welding.

-Cartesian robotic arms can be used for tasks that call for accurate, repeated motions and have a rectangular workspace. They are regularly utilized in packing, assembly, and pick-and-place processes.

Robotic arms with circular workspaces are appropriate for uses that call for a large payload capacity. They are frequently employed in demanding material handling and assembly tasks. Polar robotic arms are appropriate for applications requiring a high level of accuracy and precision because they use a polar coordinate system. They are frequently employed in medical procedures including imaging and surgery. Scara robotic- While they have a smaller range of motion, scara robotic arms have a similar construction to articulated robotic arms. They are appropriate for tasks like pick-and-place operations and assembly that need great speed and accuracy. [5]

However there are challenges: The high cost of development, the complexity of the programming, and the safety issues surrounding the interaction of the robotic arm with people have all been difficulties for the development of

robotic arms. Recent technological developments, such as the creation of collaborative robots that can operate securely with people, have nonetheless solved some of these issues. Future advancements in the field of robotic arms include the development of self-learning robotic arms that can adapt to different environments and tasks without the need for programming. [6] An embedded system is a collection of computer hardware, software, and maybe other mechanical or non-computer pieces that are used to carry out a particular task. An embedded system is a microcontroller-based, software-driven, dependable, real-time control system that is marketed into a competitive and price-conscious market, autonomous, or human or network interactive, working on a variety of physical variables and in a variety of situations.[7] A standard commercial or scientific application, a PC or UNIX software system, or a computer. the system used largely for processing are not examples of embedded systems. Systems that are both high-end and low-end embedded [8].
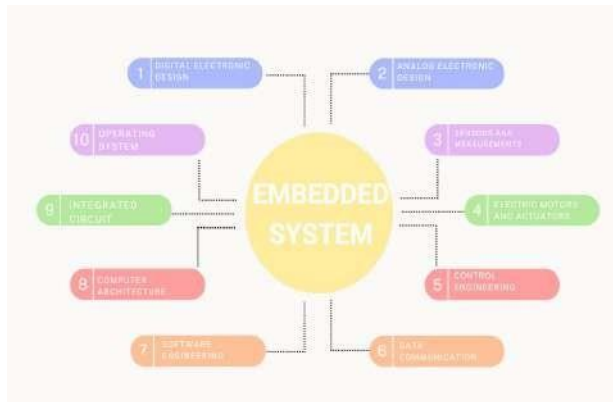

Fig-1 Embedded System Framework

II. DESIGN

For designing the robotic arm we will use AutoCAD Fusion 360

Fig 2- 3D CAD model of the robotic arm

Fig 3- Exploded 3D view of the robotic arm

Calculation- One of the six actuators on the arm opens and closes the gripper in the kinematic model, which does not count as a degree of freedom. The total degree of freedom for the entire system is five, with one degree of freedom for each of the five spinning actuators. The relation: represents the Gruebler-Kutzbach equation, which mathematically expresses the DOF of the arm. [9,10]

$$A = 3 * (b - 1) - 2 * M1 - M2 \qquad (1)$$

where M1 is the number of joints with one DOF and M2 is the number of joints with more than one DOF, A is the
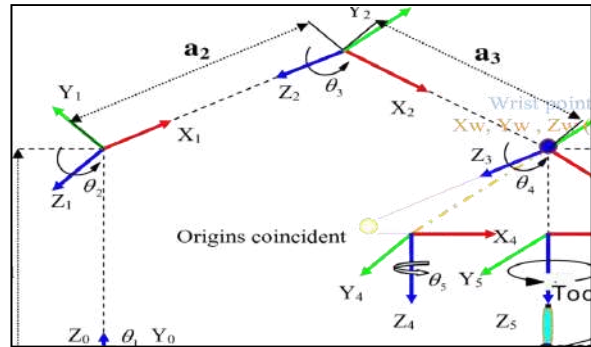

Fig 3- Axis and joint movement representation [10]

system's DOF, n is the number of links (including the base frame), and b is the number of links.

The joints (1, 2, 3, 4, and 5) and links (Z1, Z2, Z3, Z4, Z5, and Z6) of the arm are visible. As there are no joints with two DOF in the system, the M2 value is 0.

Therefore:

$$A = 3 * (b - 1) - 2 * M1 - M2 = 3 * 5 - 10 \Rightarrow (6) \ A = 5$$
$$DOF \ [11] \qquad (2)$$

III. METHODOLOGY

Figure 4A and figure 4B represent the actual robotic arm model created with the help of 3D printing. For a clear understanding of the links, both lateral and font view is represented.

Fig 4A - Robotic arm model lateral view

Fig 5- Robotic arm model front view

A. Hardware Connection

Circuit board- A customized circuit board was designed to fulfill our design requirement consideration, it provides the connection to the servomotor, steeper motor, and drivers
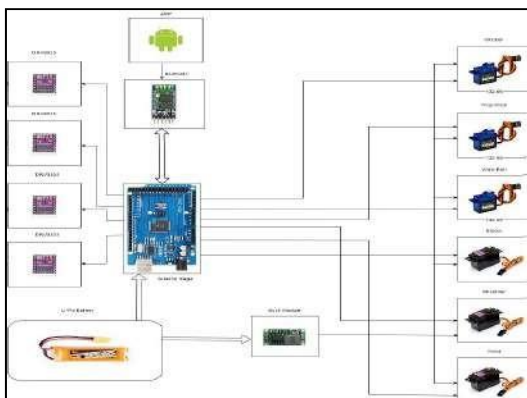The circuit connection is shown in the following pattern[11,12]

Fig 6- Electric circuit diagram connection

B. CODE

This section covers the programming for the robotic arm. The application used is called the Arduino IDE (Integrated Development Environment). The programming languages C and C + + are supported by the software. Programmers have access to a variety of input and output methods using the software libraries provided by the Arduino IDE. One way to include a library that is used to identify mathematical equations while programming is by adding # includes math. h> to the command line of the Arduino IDE,[13-16] for example. We created four programmers that show how the arm sensor works with various contemporary industrial forms of production by looking back at prior research.[17]


```
servo02.attach(3);
servo03.attach(4);
servo04.attach(5);
servo05.attach(6);
servo06.attach(7);


// Define baud rate of the Serial3 module
Serial3.begin(9600);
Serial3.setTimeout(5);
delay(20);
```

Fig 7- Sample Code for Arduino in C

Arduino Mega – Arduino—The open-source Arduino board, a microcontroller board, is built on an Atmega 2560 CPU. The expanding environment of this board executes the processing or wiring language. These boards have revived the automation industry because of their user-friendly platforms, which enable anybody with little to no technical experience to start by learning the skills required to operate and program the Arduino board. These boards may be used to expand many interactive things or connected to computer applications like Max MSP, Processing, and Flash.
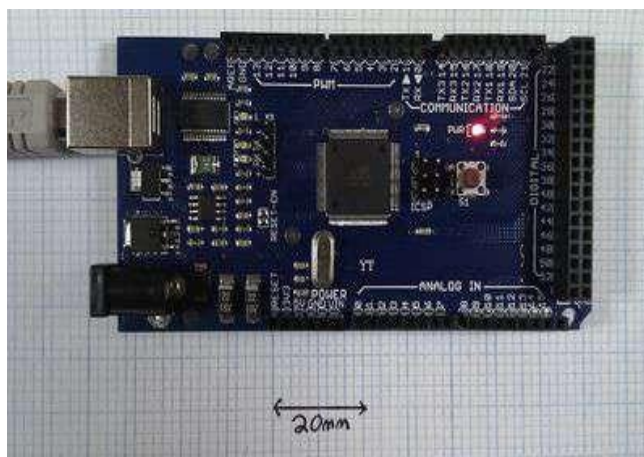

Fig 8- Arduino Microcontroller [15]

Mobile Application- For the mobile application we have used the MIT APP inventor, coding with the backend using the interface is quite convenient with the coding block, the coding for the app is done in C++. [18-22]

The application allows the movement of the robotic arm the mobile application is connected via Bluetooth connection and has a range of 10m. After coding the interface we convert our files into downloadable apk which can be downloaded and shared with multiple mobile phones.
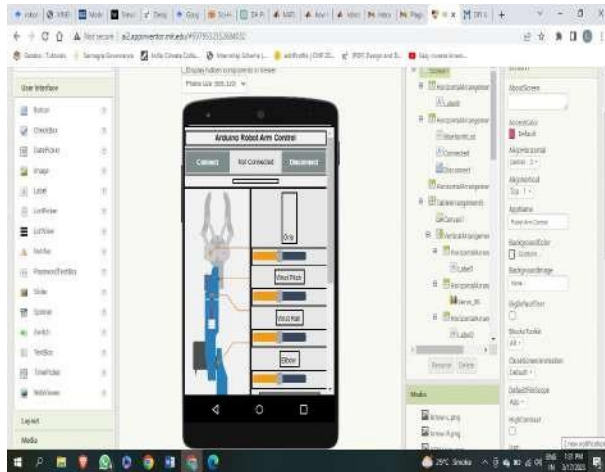
Fig 9A- Mobile Application Frontend

Fig 9B- Mobile Application Backend code with blocks

CONCLUSION

The investigators have successfully designed and built a robotic arm that possesses five degrees of freedom (DOF). The robotic arm's ability to manipulate and relocate objects is made possible by the presence of a mechanical gripper on the end of the arm. Utilizing an Arduino microcontroller makes it easier to manage motors and motor drivers in a system. This is because of the versatility of the Arduino platform. According to the results of the tests that were carried out, our robotic arm has proved that it is capable of moving in five different degrees of freedom (DOF). It is possible to save the coordinates of the robotic arm and then use them later for the purpose of automating processes. By utilising a mobile application, the management of position control may be made available on any mobile device that is equipped with Bluetooth capabilities. This accessibility can be achieved by using any mobile device.

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Development of dual purpose treadmill bicycle model

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Abstract— **The work for this project involves modifying a treadmill such that it better meets the needs of users. The human beings who enjoy running outside are the target audience for the treadmill bicycle. The combination of a treadmill with a bicycle frame result in a significant innovation that has been dubbed the "TREADMILL BICYCLE." This bicycle features electronic components and operates flawlessly when propelled forward by human momentum. The rider walks on a treadmill, which causes the belt to rub against the bike's rear wheel, which in turn causes the bike to go ahead. Running and cycling are two of the best forms of exercise, and the treadmill bicycle combines the two for a low-impact, high-performance work out that can be done outside. This equipment is created specifically for runners as the ultimate treadmill device. In our opinion, it is the most suitable piece of equipment for fit runners. It provides an experience that is more analogous to running than any other form of exercise that is currently on the market.**

Keywords— Treadmill, Walking Belt, Wheels, Rollers, Bearing, Flywheel, Sprocket

I. INTRODUCTION

The treadmill bicycle is a completely novel kind of exercise that was developed especially for people who go for runs. Running, hiking, or walking on a treadmill is practically the same thing as doing it on a treadmill. Think back to the last time you rode a bicycle across challenging terrain, whether it was through train tracks, potholes, or speed bumps. It's possible that when negotiating the challenge, you stepped on the pedals to give yourself a little more stability. [1]

The user is responsible for maintaining a balanced stance at all times while riding the treadmill bicycle.[1] Because of the cooperation of a DC motor and a great many additional components, you are now able to walk considerably more quickly. Because it does not require the use of any fuel, it has become a popular method for people who have a lot on their plates to take care of their health. Even people who have a lot of things going on in their lives can maintain their physical and mental health. A typical treadmill, on the other hand, can only be used inside of enclosed spaces, while a treadmill bicycle can be ridden on public highways. This makes the treadmill bicycle more versatile than a traditional treadmill. This innovation addresses a common criticism levelled against conventional treadmills, namely that they are fixed in place and deny users the opportunity to simulate running in natural environments. The proposed method offers a comprehensive solution by completing the task in its entirety through the addition of wheels to the treadmill bicycle and the subsequent transformation into a walking cycle. [2]

A. The Treadmill

The frames of treadmills that are marketed in their normal configuration are often constructed of steel, although the frames of newer, more expensive models are typically made of aluminium. These are the two most common sorts of materials that are utilised in the building of frames. If you plan to maintain your treadmill for a very long period of time or if your weight is extremely close to the machine's maximum capacity, you should consider purchasing one with a frame made of aluminium because it is more durable than other varieties. When beginning and stopping the treadmill, you should make use of the treadmill rails, which are also referred to as bars or grips.[2] Handles are another name for the rails that go along the top of a treadmill. Because the handrails are not meant to be held throughout the entirety of your workout on the treadmill, you will need to position them in a location that is not only convenient but also out of the way to avoid getting in the way of your workout. When you do find yourself in a position where you require the grips, you want them to be not only comfortable but also simple to get access. [3-5]

B. Walking Belt

The walking surface of a treadmill is composed of a narrow belt that is continuously moving and a rigid plate that is maintained in place between the two surfaces of that belt. As can be seen in Figure 1 When the transverse load of footfalls is applied to the walking surface of the treadmill, this plate will provide support so that the treadmill may continue to function properly. Before commencing your workout, it is imperative that you take into mind the belt size of your treadmill if you intend to run or jog on it. If you plan to spend the most of your time walking, the size of the belt you wear won't matter as much as it would otherwise. The conventional width for belts is 19 inches, and their length is typically 50 inches. Despite the fact that this appears to be a suitable width and length, you need to bear in mind that the belt fits onto a deck, which integrates a section of the frame in addition to your console. This is something that you need to keep in mind at all times.

Therefore, even though the measurements of your belt are 19 inches by 50 inches, the dimensions of the place in which you will be running may be 16 inches by 45 inches. To restate, if the only activity that you want to perform on your treadmill is walking, then the size that you have should be fine. If you want to give running a try, however, you will require a belt that is both wider and longer than what is typically worn since when we run, our bodies have a propensity to sway slightly from side to side. [6,7]

The augmented width will enable individuals to sway without encountering any obstructions from the frame, while the augmented length will allow for jogging with a normal stride without the potential hazards of tripping or falling off the treadmill.

FIGURE 1 TRAEDMIL BELT

C. Wheels

A wheel is a component that has a circular shape and may rotate freely. It is held in place by an axle bearing and has a graphical representation that can be found in Figure 2. The wheel is a crucial component of one of the six basic machines, which is known as the wheel and axle, and it is also the machine's namesake.[5] Axles and wheels are essential parts of the machinery that enables the transportation or movement of huge objects while simultaneously supporting a load or carrying out mechanical labour. The usage of wheels involves a wide variety of applications, some of which include, but are not limited to, the steering wheel of a ship, the potter's wheel, and the flywheel. The use of axles and the ability of wheels to allow motion through rolling both contribute to a significant reduction in friction.

The requirement that the wheel must have a moment applied about its axis in order for it to circle can be met by gravity or by the application of some other external force or torque, but only one of these possibilities can meet the need.[6] In a single statement, the outline can be summed up as follows: "the outside edge of a wheel will be retaining the tyre." When applied to vehicles such as automobiles, it will produce the outer circular design of the wheel on which the inner edge of the tyre is fixed. This design may be seen from the outside of the vehicle. Because of this, the vehicle will be able to travel with less resistance. A large hoop, for instance, is the component of a bicycle wheel that is exposed to the outside and is attached to the extremities of the spokes. The bicycle's tube and tyre are both housed within this section of the wheel of the bicycle. [8-10]

FIGURE 2 WHEEL

D. Rollers

Even if the bicycle does not go forward when being ridden on bicycle rollers, which are a specialist sort of bicycle trainer, it is nevertheless feasible to ride a bicycle indoors using these devices. As may be seen in Figure 3, Because rollers, unlike other forms of bicycle trainers, are not attached to the frame of the bicycle in the same manner that other types of bicycle trainers are, the rider needs to be able to keep their balance while exercising on the rollers.[7] The rider of the bicycle moves forward and backward on top of the bicycle rollers, which normally come in sets of three for the front wheel. Because one of the back rollers is connected to the front roller of the bicycle through a belt, the movement of the pedals on a bicycle will cause the front wheel to spin when the bicycle is being ridden by a human. In most cases, the spacing between the rollers of a bicycle can be adjusted to correlate with the length of the wheelbase of the bicycle. The front roller will typically be adjusted in such a way that it is positioned some distance in front of the hub of the front wheel. This is the case in the majority of cases. [11-13]

Figure 3. Rollers

E. Bearing

One moving machine portion that acts as support for another moving machine element is referred to as a bearing. The moving machine has a component known as the journal.[8] Bearings allow for relative movement between the contact surfaces of the various sections while still effectively transferring the load. The process of reducing or removing frictional resistance results in a loss of power. It is possible to utilise a lubricant to decrease the amount of frictional resistance, the amount of wear, and the amount of heat that is produced. Lubricant use is a common application for mineral oil that has been processed further from crude petroleum.

The bearings are held in place by a bearing block that is a part of it. Cast iron is the material that is used to produce it. Every bearing that is made use the machine frame in some way. [14,15]

FIGURE 4. BEARINGS

A lubricant may be used to reduce frictional resistance, wear, and to dissipate the heat produced. Mineral oil that has been refined from petroleum is frequently used as lubricant. It has a bearing block to hold the bearings. Cast iron is used to make it. The machine frame is used to produce every bearing.

F. Flywheel

The term "flywheel" refers to a rotating mechanical device that is employed for the purpose of storing the energy that is generated by rotation. Flywheels have something called the moment of inertia, which gives them the ability to withstand changes in the speed at which they are turning.[9] The amount of potential energy that may be collected from a flywheel is proportional to the cube of its spinning speed. When a torque is applied to a flywheel, the flywheel's rotational speed increases, and the quantity of energy that the flywheel stores as a result of this increase is increased. On the other hand, a flywheel makes use of speed in order to release energy that has been accumulated. [16,17]

FIGURE 5 FLYWHEEL

G. Sprocket

A sprocket refers to a wheel that has been specifically shaped and furnished with tooth structure, cogs, or additional sprockets, intended to engage with a chain, track, or any other perforated or indented material. This wheel can also be referred to as a sprocket wheel. Sprockets and the wheels that they spin on are both capable of being referred to as gears in certain contexts. As can be seen in Figure 6, A "sprocket" is generally understood to refer to any wheel that has radial projections and is designed to support a chain that runs over it. This particular application of the word "sprocket" occurs quite frequently. In contrast to a gear, a sprocket is never directly coupled to another sprocket, and whereas a pulley does not have any teeth, a sprocket does. A sprocket also has teeth, whereas a pulley does not. Even though they rotate in the same direction, sprockets and gears are never actually connected to one another in any way. The illustration can be found in figure 6.
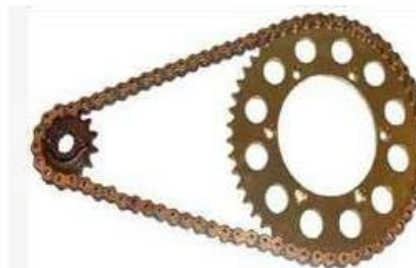

FIGURE 6 SPROCKET

II.   WORKING PRINCIPLE

When a bicycle is converted into a treadmill, the rider moves forward by walking or running on a surface designed for walking. This causes the bicycle's rear wheel to turn, which in turn moves the bike forward. The moving belt that serves as the walking surface on a treadmill has a rigid plate sandwiched in between its two surfaces in order to provide additional support. When the walking surface of the treadmill is subjected to a transverse load from footfalls, this plate acts as a backup to support it. The original treadmill had a support plate that was an unaltered sheet of pressed particle board that was 0.75 inches thick. This support plate was not modified in any way.[12] This was fastened to the frame of the treadmill in four different locations using wood screws that were positioned in close proximity to the sheet's four corners. The plate was supported vertically when it was lying on the rails in a depressed position by two rubber pads that were positioned so that they were centered under the longest edge of the surface and halfway between the two places of rigid installation.

According to the paperwork that was included with the treadmill, the flexible multi-point mounting system was developed with the intention of lessening the plate's overall rigidity by providing more support than would be feasible with a direct attachment to two solid rails. This was done in an effort to make the treadmill more user-friendly. This support was intended to serve as an alternative to the support that would be provided by a direct attachment. Both the thickness and the stiffness of the surface of the particle board were significantly higher than what was required to entirely eliminate any and all perceptible deflection in the system. In order to mitigate the compliant impact of the rubber supports, additional aluminium reinforcements were introduced intermediate the sheet and the rails, users were unable to identify the change in stiffness that happened as a result of the modification. This was because the change

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occurred so quickly after the adjustment was made. We came to the conclusion that in order to develop the optimum impact-absorbing walking surface that is also capable of lowering the impact forces that are associated with running and walking, there will need to be certain adjustments made.

In addition to that, the bottom face of the sheet of particle board featured two metal brackets that were oriented outward in a direction away from the sheet. When the system was operational, they were arranged in such a way that the conveyor belt would pass over them in the order listed above, one after the other. In the event that the belt moved away from the centred position of its rollers, this had the effect of automatically maintaining the belt's alignment by generating a restoring force.[18-21]

If the belt was shifting away from its centre while it was resting on its rollers, this resulted. As soon as we start using the treadmill, the back wheel will begin to move, which will cause the flywheel to build up momentum. Once the flywheel has gained initial momentum, the bicycle will continue to go forward due to the momentum that is created by the flywheel. In addition to that, we used a gear system to attach a dynamo to the rear wheel of the vehicle. As a consequence of this, the dynamo spins and generates electricity each time you use the treadmill. This power can then be stored in a battery and used at a later time. The design model can be seen in Fig.7.

FIGURE 7 3D DESIGN OF BICYCLE

CONCLUSION

It performs its duties admirably both on the inside and the outside of the house. This makes use of technology that decreases the amount of petrol that is consumed, which is an absolute requirement in the modern world. It is viable to utilise it as an infrastructure for an indoor locomotive device in retail malls, warehouses, open marketplaces, vast offices, and other conditions that are analogous to these kinds of locales. The employment of a device such as this one helps to ensure that pedestrian law enforcement officials do not become exhausted during the course of their shifts. Pedestrians moving through expansive campuses may also find that the use of this product is to their advantage. In future we can able to develop a fuel-saving car for people who do not ride bicycles.

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Survey on Techniques Available for Sugarcane Maturity Testing

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Abstract— **In this paper, the most recent techniques for sugarcane maturity testing are reviewed. The best time to harvest sugarcane is determined by sugarcane maturity testing, which has a major impact on both sugarcane quality and yield. Traditionally, labor-intensive and time-consuming methods like refractometry and polarimetry have been used to determine the sucrose content in sugarcane. In contrast, new developments in non-destructive techniques like near-infrared spectroscopy (NIRS) and spectroscopy imaging have shown encouraging results in the provision of quick and precise sugarcane maturity testing. The principles and instrumentation of these cutting-edge methodologies, the data analysis methods employed, the difficulties and potential future paths for sugarcane maturity testing are all covered in this review article. It is possible to significantly increase the efficiency and accuracy of sugarcane maturity testing through the integration of cutting-edge technologies, giving farmers crucial knowledge to maximize the yield and quality of their sugarcane crops.**

Keywords— *sugarcane maturity, advanced technology, Test sensor, AI, ML*

I. INTRODUCTION

A vital cash crop grown for the production of sugar and bioenergy sugarcane is grown all over the globe. A crucial element that profoundly influences sugarcane production and quality is the best time to harvest. Thus, determining the ideal harvesting period requires gauging the sugarcane's maturity level. Refractometry and polarimetry are time- and labor-intensive traditional techniques for determining the amount of sucrose in sugarcane. However, new developments in cutting-edge technologies, including near-infrared spectroscopy (NIRS) and spectroscopy imaging, have demonstrated encouraging results in the provision of quick and precise sugarcane maturity testing. The goal of this review paper is to give a summary of the most recent technological developments in sugarcane maturity testing [1].

The world's second-largest producer of sugar after Brazil, India contributes significantly to the global sugar market by producing roughly 15% and 25% of the world's sugar and sugarcane, respectively [2]. It contributes to an important boost to the growth of the nation's social and economic structures, respectively. There are currently 597 functioning sugar factories, 309 distillations, 213 power generation plants, and multiple pulp, paper, and chemical-based establishing units that are all a part of the sugar processing sector. The sugar sector is assisted by four that lead the sugarcane plant research organisations, 22 state sugarcane research points, and world-class sugar machines producers,

vendors, and technical specialists. [3]. In order to satisfy domestic sweetener demand, the industry produces about 300-350 MT of cane, 23-25 MT of white sugar, 6-8 MT of jaggery, and khandsari on an average of 5 million ha, or about 3% of the gross cultivable area in the nation. In addition, about 2.9 billion liters of alcohol, 2,330 MW of electricity, and numerous chemicals are produced [4].

Fig 1 Largest sugarcane-producing states in India

The most common commercial methods for evaluating the Brix content of sugarcane are the refractometer,, Brix hydrometer, spectroscope, and chemical analysis commonly performed in the electronic saccharimeter of Brix. Amongst them, a spectroscope is a one-of-a-kind non-invasive instrument that enables continuous tracking in addition to rapid tests that can be carried out with a high degree of accuracy. On the other hand, monitoring in real time is not practicable because of the tremendous cost of doing so [5]. A wide array of non-destructive technical devices, such as electromagnetic sensors, image processing, ultrasound, magnetic resonance, and laser excitation, can be used to observe the physicochemical features of food. These instruments are generally utilised for the detection of physicochemical parameters such as Brix and TSS. (Total solids that are soluble). Instruments that rely on food scent, capacitive sensors, and spectroscopy (NIR, which stands for near-infrared spectroscopy, and MIR, which stands for medium-infrared spectroscopy) can be used to calculate the amount of sugar that is present in sugarcane. [6]. Sugarcanes are deemed mature and prepared for harvesting when they reach a certain minimum Brix value. Mukhtar's maturity study included additional criteria for when sugar cane is considered ripe, such as when all but the bud of the cane are visibly dried up leaves. Or we could say that the most leaves fall off of the sugarcane when it reaches maturity [7].

The equal percentage of %brix of sugar cane in the bottom and upper parts of the plant is a chemical sign that the plant is mature. We must conduct a measurement in order to learn the sugar concentration of the sugarcane in the field. Cutting some samples of sugar cane plants and squeezing them into the milling, then transferring the liquid solution to the laboratory for identification, is the most current technique for determining sugar content. This approach is regarded as a challenging, costly, and time-consuming approach. There is a chance of using an alternative technique to determine the sugar content. As a light source, they used a photometric detector emitter (LED), and the sensors they used were LDR and photodiode array. Yeh and Tseng (2006) also made an effort to create a low-cost spectrometer using LED and LDR. However, all of the instruments mentioned above should be used with sugar cane watery solution. It denotes the destruction of the tested substance. Additionally, using LEDs as a light source has a range drawback. Naderi-Boldaji provided a description of a non-destructive technique. They used a parallel plate capacitor to explain the technique for calculating sugar content based on the characteristics of the dielectric constant. They suggest the non-destructive Brix meter, which is founded on the optical characteristics of sugar content, as a result of the concept of non-destructive measurement. This method of measuring using a photometer and spectroscopy methods employs the Brix scale. Our device uses a photodiode array as a detector and LEDs as its light source [8].

This research used the portable, inexpensive, and non-destructive Vis/SWNIR method to forecast sugarcane Brix based on stalk scanning. The PLS systems provided a good level of constraint for both the baseline ranges and the estimated amounts of the reflectance and absorbance spectra, with R2 values of 0.91 and 0.89, respectively. With an overall accuracy of 83.1%, the ANN that was used to divide Brix into various quality classes had produced acceptable classification performance ranging from 50 to 100% accuracy. Overall, this research has shown that the combination of ANN and Vis/SWNIR spectroscopy possesses the ability to be utilised for real-time quality monitoring in order to fulfil PA criteria. This review article provides a detailed overview of the techniques used to determine sugarcane maturity.

II. REVIEW AND TESTING METHODS

A. Advanced methods of sugarcane maturity testing

Two primary techniques are available in advanced methods: a destructive method and a non-destructive method.

B. Destructive method

destructive methods of sugarcane maturity testing provide accurate and detailed information about the composition of sugarcane samples, but they require specialized equipment and expertise, and they destroy the sample in the process.

C. Lipid polymer membrane method (sweetness sensor)

Sugarcane maturity testing frequently makes use of sweetness test instruments. These sensors are made to measure a sample's sweetness or sugar content, which is a crucial indicator of how mature it is [9]. There are many different types of technology, but sugarcane skin scanning is the most prevalent. That strategy also functions well in the field of agriculture. markers of fruit and vegetable maturity. The two groups into which maturity has been divided are

physiological maturity and horticultural maturity [10]. The maturity index serves as a sign that a commodity is available for harvest. The timing of harvest is determined using this as a guide. A. Physiological development: When a fruit or vegetable reaches this stage of development, it has experienced its greatest growth and maturation The various formulation types offered on the pharmaceutical market come in a variety of forms, but tablets and capsules are the most widely used [11].
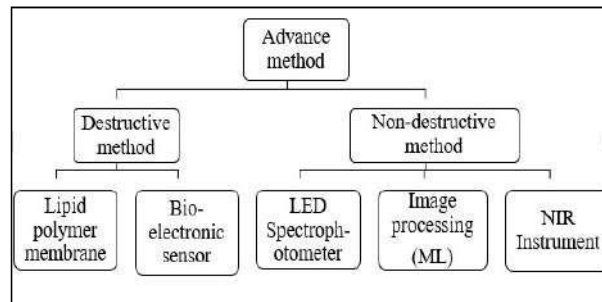

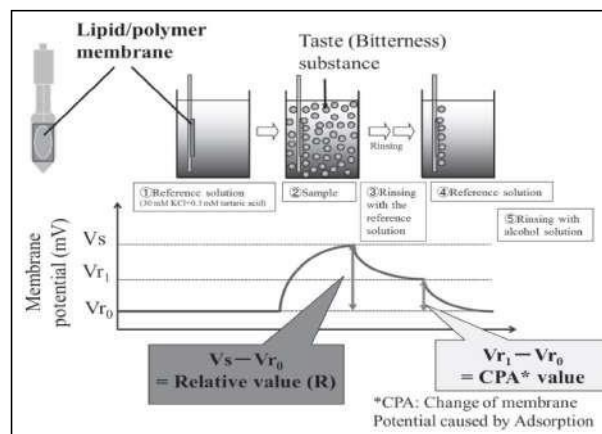Fig 2 Advance methods of sugarcane maturity testing

Fig 3 Lipid polymer membrane [11]

These formulations provide numerous advantages, such as dosage accuracy and relatively high stability, as well as the ability to alter the medication release profile in order to delay or keep a therapeutic effect. However, their palatability is crucial for patient adherence and effective medication, especially if they have a bitter flavor [12]. have investigated the variations between the Insent taste-sensing device for pharmaceutical formulations and the ASTREE electronic tongue. Both systems have benefits and drawbacks, according to those writers. Because each taste sensor membrane reacts to a particular flavor, the Insert taste sensing system excels at quantifying taste attributes like bitterness strength. However, this approach cannot identify all substances [13].

D. Bio-electronic sensor method

An appropriate pattern recognition tool and a sensor array with limited individual discrimination were described as the electronic tongue. established the terminology for liquid potentiometric analysis used globally [14]. In this context, the term "electronic tongue" refers to a multisensory system that makes use of a wide range of low-selective instruments and advanced mathematical signal processing methods based on pattern recognition and/or multivariate analysis. This device is employed to classify data. Its operation is founded

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on measuring a large number of samples and using principal component analysis to monitor their variability. (PCA) [15].
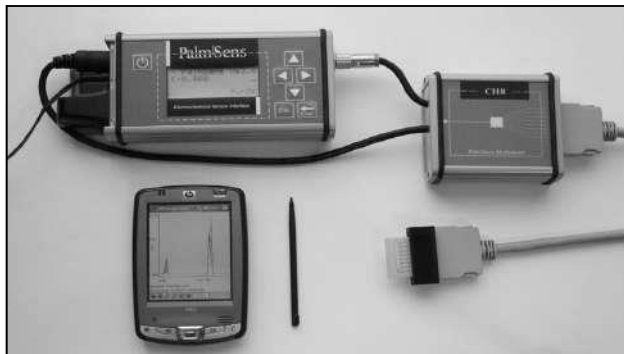

Fig 4 Bio electronic sensor

As a consequence, the data are divided into distinct groups according to various sample characteristics. The created artificial tongues make use of the electrochemical properties of samples. Potentiometry and voltammetry, which employ a variety of modified working electrodes, are used to provide appropriate responses and are adequate detecting systems. Electrochemistry was replaced with systems based on visual and piezoelectric principles (Surface Acoustic Wave, Quartz Crystal Microbalance) [16].

E. Non-Destructive method - LED Spectrophotometer method

Non-destructive methods of sugarcane maturity testing involve analyzing the sugarcane without damaging or destroying the sample. These methods are becoming increasingly popular in the industry because they are faster, more convenient, and do not require the destruction of the sample.

Modern tools like LED spectrophotometers are used to check the sugarcane's ripeness. They are based on the spectrophotometric principle, which entails determining how much light is absorbed or transmitted by a sample at various wavelengths [17]. illumination-emitting diodes (LEDs), as opposed to conventional lamps or lasers, are used as the illumination source in LED spectrophotometers. LED spectrophotometers are used to gauge the sugar concentration of the juice during sugarcane maturity testing. The LED spectrophotometer produces light with a particular wavelength and gauges how much of it reaches the sample [18].
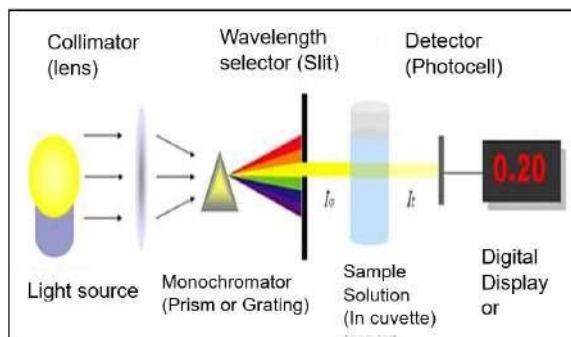

Fig 5 LED Spectrophotometer [18]

The sample's ability to absorb light is proportionate to how much sugar is present. Due to their advantages over conventional spectrophotometers, such as low power consumption, high sensitivity, cheap cost, and a long lifespan of the LED light source, LED spectrophotometers are preferred. They are ideal for field applications due to their portability and compactness [19]. In the sugarcane business, a variety of LED spectrophotometers, including benchtop and handheld models, are employed. Handheld spectrophotometers are appropriate for use in the field, whereas benchtop spectrophotometers are best used in laboratories. The DS2500 UV-Vis Spectrophotometer, the Jenway Genova Nano UV/Vis Spectrophotometer, and the spectrophotometer are a few of the well-known LED spectrophotometer models used in the sugarcane business.

F. Non-Destructive method - Image processing (ML) method:

Methods of image analysis are frequently employed to gauge sugarcane maturity. These techniques involve examining digital pictures of samples of sugarcane and extracting characteristics that indicate maturity. Utilizing color-based techniques, the maturity of sugarcane samples is determined by examining their hue [20]. These techniques extract color characteristics from the images, such as hue, saturation, and intensity, using image processing algorithms. The maturity level of the sample is then determined by comparing the color characteristics to a reference color chart. Utilizing texture-based techniques, the maturity of sugarcane samples is determined by examining their structure. These techniques derive texture characteristics from the images, such as entropy, contrast, and homogeneity. The samples are then categorized into various maturity levels using the texture characteristics. A model is trained using a dataset of images of sugarcane and the associated maturity levels in machine learning-based methods [21]. The model learns to categorize the pictures based on their maturity level by extracting features from them using image processing algorithms. Then, the learned model can be used to forecast the maturity level of fresh samples of sugarcane. Images of sugarcane samples are taken using multispectral imaging at various light frequencies. After that, spectral characteristics that are suggestive of maturity are extracted from the images using image processing algorithms. Compared to color-based and texture-based approaches, these techniques can offer more comprehensive information about the sugarcane samples [22].
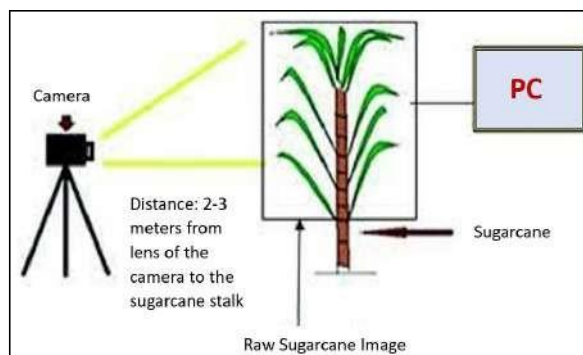

Fig 6 Image processing method for sugarcane maturity testing

Orbital images are frequently used in agriculture to identify large-scale spectral fluctuations brought on by soil and crop features. This aids farmers in making better management decisions by giving diagnostics for agronomical crop factors. For instance, the definition of management zones for annual harvests through the use of orbital. [23].

G. Non-Destructive method -NIR Instrument method

Sugarcane ripeness can be assessed quickly and non-destructively using a technique called near-infrared spectroscopy (NIRS). By measuring the sugarcane samples' near-infrared reflectance or transmittance, NIRS generates a spectrum that can be used to identify the molecular makeup of the sample [24]. By measuring the sucrose concentration of the juice obtained from the sugarcane stalks, one can ascertain the sugarcane's maturity. By examining the near-infrared spectrum of the sugarcane samples, NIRS can be utilized to forecast the sucrose concentration. The sugarcane samples' near-infrared spectra reveal details about their molecular make-up, including the amount of sucrose present [25,26].

A spectrometer, a light source, and a sample holder are the usual components of the NIRS device used to assess sugarcane maturity. Depending on the measurement method, the sample holder may be a reflectance or a transmission cell. In the reflectance setting, the sample is mounted on the sample holder and exposed to the near-infrared light [26]. The sample is positioned between two clear windows in transmission mode, allowing the near-infrared radiation to pass through the sample. The near-infrared reflectance and transmittance of the sugarcane samples over a variety of wavelengths are measured by the NIRS instrument. The acquired near-infrared spectrum is then processed using chemometric methods like principal component regression (PCR) or partial least squares regression (PLSR). These methods make it possible to predict the correlation between the near-infrared spectrum and the sucrose content. The maturity of sugarcane can be ascertained by examining the near-infrared spectrum of the sugarcane samples after the connection between the near-infrared spectrum and the sucrose content has been established.
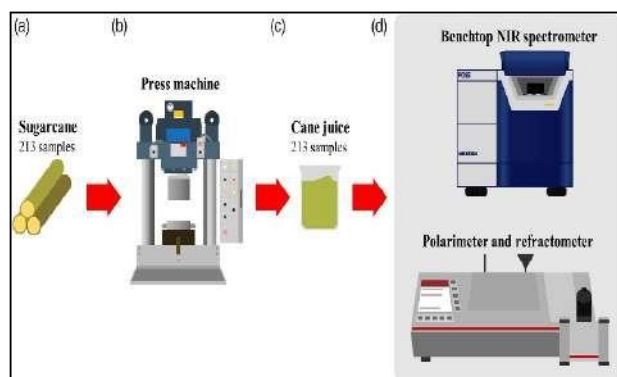

Fig 7 NIR Spectroscopy method [26]

The near-infrared spectrum can then be used to forecast the sucrose content and identify the sugarcane's maturity [27,28]. The data is obtained from the various literature and content is highlighted in the Table-1. The dataset mentors about the year, methods used and corresponding findings obtained by the various researchers has been listed. Next to

that, further discussion is carried out and pointed out in the results and discussion section.

III. RESULT AND DISCUSSION

In the current review paper, there is a debate regarding advanced methods of sugarcane maturity assessment. This paper examines 27 works to determine whether or not those papers are relevant to this subject. There are a total of 15 papers that can be accessed, with 8 of them referring to destructive techniques of sugarcane maturity testing and 11 of them pertaining to non-destructive methods of sugarcane maturity testing. The scope of the other studies is extremely vast.

The process of determining the maturity of the sugarcane is an essential step for the sugar industry since it has a substantial impact on the amount of sugar in the final product, as well as the yield and quality of the product overall. Brix and Pol readings, which are often used to determine the maturity of sugarcane, can be labour- and time-intensive to measure, in addition to occasionally producing inaccurate results. However, as a result of developments in technology, a number of sophisticated methods have been developed. These methods provide precise, non-destructive, and speedy evaluations of the sugarcane crop's development stage.

Fig 8 Total papers available for sugarcane maturity testing

The Near-Infrared Spectroscopy (NIRS) technique is one of the more sophisticated ways to gauge sugarcane ripeness. NIRS is a quick, non-destructive technique that measures how well sugarcane samples transmit or reflect near-infrared light. The method produces a spectrum that can be used to identify the chemical makeup of the sample, including its sucrose content. The sugar business has widely adopted the NIRS method because it has been demonstrated to be an accurate and trustworthy method for determining sugarcane maturity. [29-31]

An further cutting-edge strategy for figuring out when sugarcane is ready to be harvested is to use various sensors and imaging techniques. These methods involve the utilization of several pieces of equipment such as thermal imaging, laser-induced fluorescence, and hyperspectral cameras in order to monitor the evolution of the sugarcane's physical and chemical properties over time. It has been demonstrated that these sensors are accurate and dependable ways for evaluating the maturity of sugarcane, and the data that they collect may be utilized to construct models that can predict when sugarcane will attain maturity.

TABLE I. FINDINGS FOR THE EXPECTED SURVEY YEARWISE MENTIONED THE INFORMATION FROM LAST DECADES

REF. NO.	YEAR	METHODS USED	FINDINGS
[1]	2014	-	This paper gives about general introduction about sugarcane production in India.
[2]	2021	Ultra brix device	Utilizing Brix monitoring from planting to harvest, Ultra Brix can also be used as a support tool in the creation of best practices in agricultural management, cultural treatments, and the study of new varieties (genetic improvement).
[3]	2012	Remote sensing technique	In comparison to merely counting canes, the laborious and expensive measurement of early-season yield offers a marginally stronger prediction.
[4]	2019	LED-Refractometer method	The findings demonstrated that, when compared to a digital spectrophotometer used as a reference instrument to measure the sugar content of a solution, the LED-refractometer can measure sugar content of sugarcane plantations in the field with an accuracy of 95%.
[5]	2013	NIR Spectrophotometer	In order to predict sugar content from skin scanning, the potential use of a visible and shortwave near infrared (Vis/SWNIR) spectroscopic method was assessed.
[6]	1972	-	The respected paper reviews about soil condition suitable for sugarcane production and gives positive point to increase maturity of sugarcane.
[7]	2014	Image processing (Sampling Technique)	The main factors to be taken into account when developing a measurement technique and sampling mechanism in the field are also covered.
[8]	2018	HSV (Hue saturation value) technique	The proponents discovered that there is a substantial shift in Hue and Saturation values as sugarcane crops mature through a series of experiments in the HSV color space.
[9]	2016	Sweetness test sensor	The objective of this review is to explore the benefits and drawbacks of taste sensors in assessing the flavor and palatability of various oral dosage forms.
[10]	2007	Lipid polymer electrode	For use as nonspecific amperometric sensors for blind analysis on actual matrices, such as various fruit juices from various fruits or different brands, three distinct electrodes were put to the test.
[11]	2020	Sweetness Detection, Fdc2214, STM32	A gadget that measures the sweetness of sugar water is suggested, and its processor is an STM32 single chip microcomputer. The FDC2214 sensor is used to measure sugar water content.
[12]	2006	Electronic tongue, Sequential injection analysis	An acceptable comparison was also made using the technique to determine anions in synthetic samples and actual water samples.
[13]	2009	Electronic tongue, Bioelectronic tongue	This study contrasts different (bio)electronic tongue types. Applications in food and environmental analysis are addressed along with the design and operating principles of potentiometric and voltammetric electronic tongues.
[14]	2011	Taste sensor, Electronic tongue	The Astree electronic tongue and the Insent taste sensing system are already widely available. Additionally, there are numerous experimental prototype iterations available.
[15]	2010	Taste cell sensor, Electrochemical impedance spectrum	This article proposes a novel sweet taste cell-based sensor for the detection of tastes. On the carbon screen-printed electrode, human colorectal carcinoma NCI-H716 cell lines are grown that express gustducin and the sweet taste receptor T1R1/T1R3.
[16]	2010	Electronic tongue	The outcomes demonstrate the potential of the electronic tongue for analysis of drug masking effects and microencapsulation impact detection.
[17]	2020	Image processing, Data analysis	This study's goal was to ascertain the impact of Funneliformis mosseae KKU-BRP-KK6-2, an arbuscular mycorrhizal fungus (AMF), inoculation on sugarcane physiology during the maturation and ripening phases under field circumstances.
[18]	2012	Object Based Image Analysis (OBIA) Data Mining (DM)	The purpose of this study was to create a technique for automating the mapping of sugarcane over large areas using time-series remote sensing data.
[19]	2020	UAV-LiDAR; random forest regression.	Their research offers recommendations for determining the ideal planting density, minimizing the negative effects of human activity, and choosing the best tillage techniques for real cultivation and production.
[20]	2018	Maturity analysis using image processing	The maturity identification comparison module, which employs the 90.16% accurate RandomForest algorithm, used the Hue and Saturation frequencies of both mature and immature sugarcanes as data.
[21]	2021	remote sensing, orbital images	The study's methodology involved creating forecasting sugarcane production models that combined time-series orbital imaging with machine learning.
[22]	2021	Non-destructive method, Artificial Intelligence	A thorough review is offered, building on earlier reviews that primarily addressed the crop's spectral behavior and takes into account the advancements made with new data analysis methods and better data sources.
[23]	2013	NIR Spectroscopy	They used a portable near infrared (NIR) instrument to explore the non-destructive measurement of the sugar content of cane stalks.
[24]	2012	NIR Spectroscopy	A low cost visible and shortwave near infrared (VIS eSWNIR) spectrometer and an artificial neural network were assessed for their potential in the non-invasive measurement of pineapple's soluble solids content.

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[25]	2018	UAV ,Yield estimation, Remote sensing	The very high spatial resolution of UAV images and OBIA's sophisticated image classification show a lot of promise for enabling farmers and associated sectors to forecast yield prior to harvest.
[26]	2008	NIR Spectroscopy	They used a portable near infrared (NIR) instrument to explore the non-destructive measurement of the sugar content of cane stalks.
[27]	2017	Image processing	Using metrics from time series of the normalized difference vegetation index (NDVI) from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor and an ensemble model of artificial neural networks, the goal of this research is to forecast the sugarcane yield in So Paulo State, Brazil. (ANNs).

CONCLUSION

In summary, the utilisation of cutting-edge methodologies may significantly contribute to an improvement in both the efficiency and accuracy of the sugarcane ripeness testing process. Many cutting-edge methods, such as the NIRS method, sensors and imaging methods, machine learning algorithms, and artificial intelligence, have been developed and deployed within the sugar business. These methods provide rapid, non-destructive, and accurate assessments of the maturity of the sugarcane, which can assist in increasing the amount of sugar that can be produced as well as the overall quality of the end product.

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Experimental Investigations on Novel Geometry Counter Flow Air Cooler

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Abstract— **As there is rapid increase in thermal comfort requirements, more and more advancement is taking place in the field of HVAC day by day. This study investigates the test performance of Dew Point Evaporating Cooler (DPEC). Altered fluid flow channels are used to augment the heat transfer rate. The setup consists of a counter flowing heat exchangers which comprises of vertically placed trapezoidal plates with alternate wet and dry channels. Moisture wicking cotton cloth and coir fiber are used to keep the plates wet for longer period of time. Water is sprinkled in the wet passages with the help of submersible water pump. To study the effect of the setup at different incoming air conditions an air handling unit is used. The performance is based on laboratory trials. The trials resulted in varying wet bulb and dew point efficiencies between 47.8% and 29.7%, 75% and 44% respectively.**

Keywords - Flow Passages, Counter Flow, Coir Fiber, Air handling unit, Dew Point

I. INTRODUCTION

Energy demand has increased sharply for the cooling purpose in the last few decades which results in increased depletion of energy resources and leading to global warming. These problems are caused by using traditional air conditioning systems which uses artificial refrigerants. Since there is need of alternative system which consumes less energy than the traditional air coolers.

Against the flow Indirect evaporative cooling, often known as IEC, is an exciting new technology that shows promise for use in cooling applications in arid and hot regions. IEC uses less energy than conventional air coolers, which require a large amount of power. Against the flow The IEC has a number of benefits that other cooling systems do not have. To begin, it consumes a far lower quantity of energy than other conventional coolers do because it simply needs power to run the pump and fans that are responsible for moving air and water. Second, it does not utilise any toxic refrigerants, which means that it does not contribute to the warming of the planet or the depletion of the ozone layer. It is possible for it to provide a higher level of control over the humidity. A counter flow IEC can achieve energy savings up to 50% compared to conventional air-cooling system [1-2].

Researchers led by Aborhlu Dogramaci and colleagues investigated the potential of eucalyptus fibres as a substantial for use in cooling pads as an alternative to the conventionally employed commercial items. The study reveals, an utmost temperature drop, cooling efficiency and COP as 11.3^0C, 71% & 4.05 respectively. For an inlet air velocity of 0.6 m/s [3]. In this study, Jain and Hindoliya investigated the potential use of coconut fibres and palash fibres as replacements for commercial fibres through the use of controlled laboratory experiments. A temperature drop of 14.9^0C and 16.23^0C for coconut fiber and palash fiber respectively was observed [4].

Evaporative cooling's performance and efficiency are influenced by the incoming air velocity, air mass flow rates, and environmental moisture content. It also depends on the thickness of the evaporative media and the placement of the system[5].

Comparison of both trapezoidal and sinusoidal plates were done and concluded that trapezoidal plates has more heat transfer rate, efficiency and cooling capacity than sinusoidal plates [6].

Results of operational parameters (COP, DPT) of the prototype depends on the space to be conditioned. The cooler can be utilized in buildings with a variety of applications because to its large COP and small geometrical shape. The cooler can reach temperatures near to DPT regardless of the temperature of the input air when R (ratio of emissions to inlet air flow-rate) is high and the inlet air flow-rate is low. By using polymer sheets wrapped with hydrophilic materials to observe water, heat exchangers capable of observing vast amounts of water can be produced. [7]

Compared the 1-D and 3-D model of counter flow DPEC system. The 1-D model gives low outlet temperature nearby 1.86% compared with 3-D model. Air handling unit is used to control inlet air conditions which consists of heating and dehumidifying elements.

The 1D model is used to examine the effects of geometric and functional variables on the various parameters. While mass flow rate only has a minor impact on WBE, the has a significant impact on it. The WBE also rises as the recirculation factor rises, but the WBE falls as the mass flow rate rises. In wet areas, longer channels increase the amount of time and surface area where air and water come into contact. WBE diminishes when the channel width rises. A greater outlet-temperature was the result of a higher inlet-air

temperature. The experimental results showed that WBE of the DIEC Can reach the value as high as 125%. The heat transfer rate of can be increased by using Aluminium foil in the channels than the hydrophilic materials. [8-9].
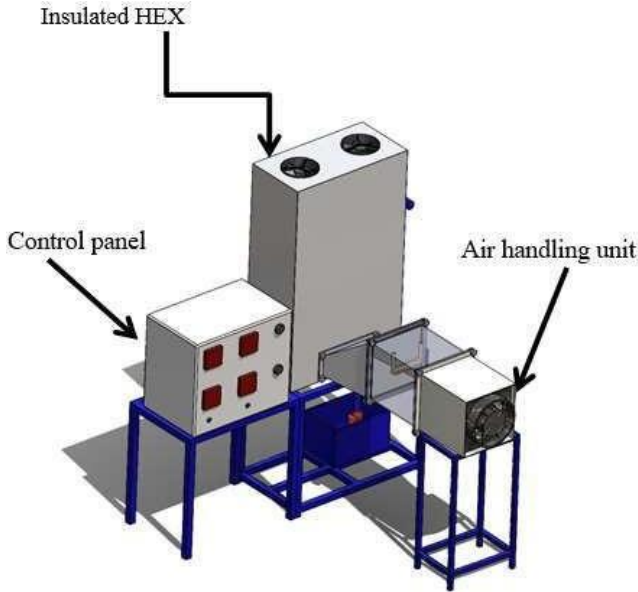

Figure 1 : Layout of the proposed cooler

The innovative DPEC was able to cool the air to a temperature that was below the WBT at the entry point and near to the DPT. This was accomplished by moving the air through a series of heat exchangers. According to modelling studies, the cooler could operate with variable inlet conditions (air temperature and humidity ratio) and achieve WBE of up to 132% and DPE of up to 93%[10-13].

A. Equations

1. Wet-Bulb Cooling Effectiveness

$$E_{wb} = \frac{DBT_1 - DBT_2}{DBT_1 - WBT_1} \qquad (1)$$

2. Dew-Point Cooling Effectiveness

$$E_{dp} = \frac{DBT_1 - DBT_2}{DBT_1 - DPT_1} \qquad (2)$$

3. Cooling Capacity

$$Q_{cool} = C_p(T_{db1} - T_{db2}).(1-\varphi).mass \qquad (3)$$

3. Coefficient of Performance (COP)

$$COP = \frac{Q_{cool}}{P_{fan} + P_{pump}} \qquad (4)$$

Fig.2 Fabricated Prototype

II. EXPERIMENTAL TESTING METHODOLOGY

The laboratory small scale model is subjected to trials at different air inlet conditions. The inlet air and supply air temperatures were recorded by PT-100 thermometers. The relative humidity was recorded by the hygrometer. The power input for inlet and exhaust fans , water pump was recorded by power meters and incoming air velocity by hot wire anemometer.

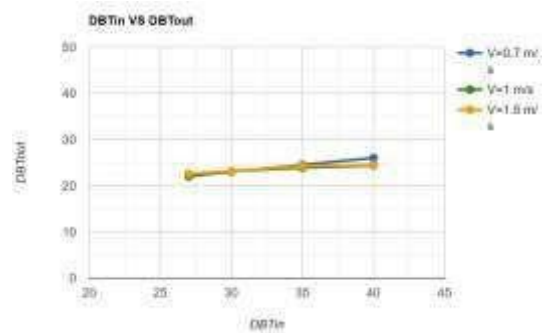A. Inlet air temperature influence on supply-air temperature

Fig.3: Changes in supply air temperature with inlet air temperature

IV. EXPERIMENTAL RESULTS AND DISCUSSIONS

Laboratory trials were done subject to various air inlet velocities (0.7 m/s, 1 m/s, 1.5 m/s) at different air inlet temperatures (27 ^{0}C, 30 ^{0}C,35 ^{0}C,40 ^{0}C).
The experimental results obtained for the prototype are presented below.

The difference in supply air that occurs with varying input air speeds is depicted in Figure 3. The air that is being drawn in has a higher temperature than the air that is being provided, which has less temperature. When the temperature at the entrance is low, there is less of a temperature drop. The research also showed that there is a correlation between a high temperature at the entrance and a large temperature drop.

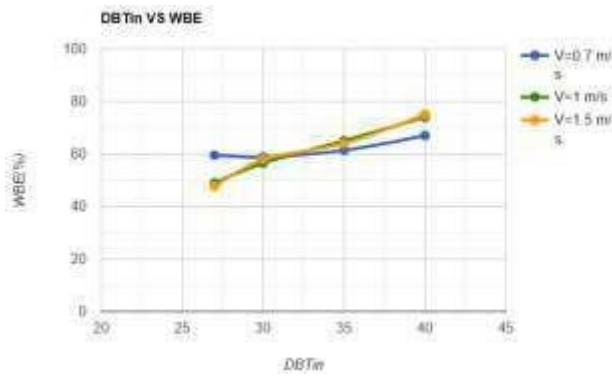B. Inlet- air effect on wet-bulb effectiveness

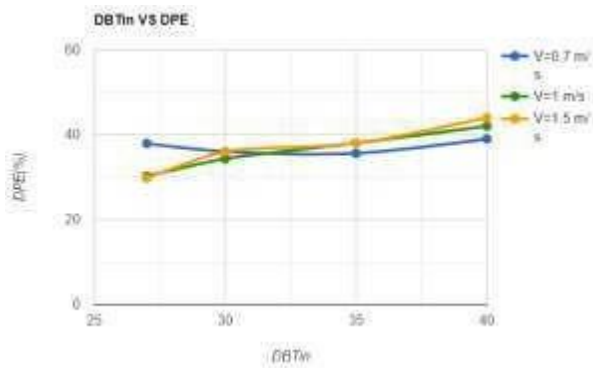Fig.4:Changes in wet-bulb usefulness with inlet-air temperature

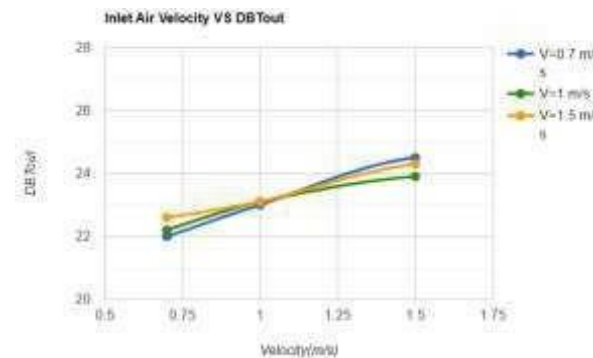Fig.5: Changes in DPE with inlet air temperature

Fig.6: Changes in supply air-temperature with inlet-air velocities

The differences in WBE are depicted in Figure 4 for a range of varied inlet air temperatures. Calculating the WBE requires the temperatures of the incoming air to be known in advance. The WBE varies between 47% to 75% for the modified plate configuration. It is calculated from equation (1).

C. Inlet air influence on DPE

Fig.5 represents the variation in DPE by known variable inlet air temperatures. The DPE goes on increasing with rise in the inlet-air temperature as the temperature drop is high for high inlet-temperature. It is calculated from equation (2).

D. Inlet-air velocity impact on the supply-air temperature

Fig.6 shows the variation of supply-air temperature with different inlet-velocities. The supply-air temperature does not vary for velocity of 1m/s taken as input.

V. CONCLUSION

The In this work, the experimental performance of a suggested cooler that uses a heat exchanger comprised of trapezoidal plates plate configuration has been evaluated. The results of the experiment showed that WBE could be anywhere from 47.8% to 75%, and that DPE could be anywhere from 29.7% to 44%.

ABBREVIATIONS

WBT	Wet Bulb Temperature, ^{0}C
DBT	Dry Bulb Temperature, ^{0}C
DPT	Dew Point Temperature, ^{0}C
COP	Coefficient of performance
E_{dp}/DPE	Dew Point Effectiveness, %
E_{wb}/WBE	Wet Bulb Effectiveness, %
IEC	Indirect Evaporative Cooling

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A Hybrid Approach of Automated Attendance System and Chat Bot for Educational Institutions

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Abstract— **Traditional paper attendance methods can be time consuming and proxy can be marked by the attendees. The use of automated technology increases security and reduces the time required to track the participants. Facial recognition systems use different algorithms to improve accuracy and precision. Large infrastructure institutions need help directing students and faculty to specific locations. Having an automated help desk bot solves a major localization problem anywhere in a large infrastructure organization. The purpose of the project is to provide the attendance offerings, growth the security in opposition to proxy attendance and give directional statistics for the user. The Smart Attendance System utilizes a face recognition algorithm to identify students and record their attendance. The system is designed to be user-friendly and efficient, allowing teachers to easily manage attendance records and generate reports. The system's architecture is built on Flask API, a lightweight framework that allows for the creation of RESTful APIs. The system's backend is developed in Python, which is well-suited for machine learning and data processing. The frontend is designed to be user-friendly, with an intuitive interface that allows users to view attendance records and generate reports. The Chat Bot is developed to assist students with their queries related to attendance, schedules, and other academic-related matters. The system is integrated with natural language processing algorithms to provide a conversational experience for users. The integration of these two systems can enhance the overall academic experience for both students and teachers, reducing administrative workload and improving communication.**

Keywords—Facial recognition, Talking Robot, Smart Attendance, Face detection, Speech recognition.

I. INTRODUCTION

Attendance monitoring is a very important process in almost all institutions and organizations. Current methods are to use paper or books to record student attendance. This method is easy to imitate and timesheets can be lost or damaged. Therefore, attendance through this traditional method takes a long time, so it is necessary to have an automated and reliable system. The Attendance Monitoring System (AMS) will provide the necessary solution. [1-2]

The system will click on the student's photo and generate an attendance excel sheet using OpenCV. Teachers can then download this Excel sheet to further track each student. And the system can even be applied to the receiving bot. By using voice recognition in the system via python, it will be able to communicate with the user. It uses natural language to facilitate turn-based communication between users and bot.

The human-machine dialogue develops through voice interaction, which allows great flexibility and ease of interactivity. Facial detection consists of identifying detected objects as known or unknown faces. The facial recognition problem is often confused with the face detection problem. Facial recognition, on the other hand, decides whether a "face" is a known or unknown person, and for this it uses a database of faces to verify incoming faces. Use the Face Recognition API to learn and recognize faces from a database and generate output to tag student attendance. [3-5]

II. OBJECTIVES

1. Accurate Attendance Tracking: The main purpose of the smart attendance system is to accurately track the student or employee attendance records. The system must be able to register attendance in real time to avoid errors such as repeated entries or omissions.

2. Automatic Reports: Another purpose of the smart attendance system is to automate the process of generating attendance reports. The system should be able to generate attendance reports for each student or employee, and attendance reports for the entire class or organization.

3. Improve efficiency: Using the smart attendance system is expected to increase efficiency and reduce the workload of teachers or HR staff. The system will automatically perform tasks such as attendance, record absences and generate reports.

4. Improved Communication: The smart attendance system can improve communication between teachers, students and parents as it enables real-time updating of attendance records.

5. Increased Security: An intelligent management system time and attendance can increase the security of a by providing a record of who was present at a specific location in the at any given time.

6. Increase engagement: Chatbots can help increase engagement with customers by providing interactive experiences such as games, quizzes, and surveys. It can help build stronger relationships between customers and businesses. [6-8]

III. PROBLEM STATEMENT

The suggested system, as opposed to using the traditional techniques, attempts to establish as the following things:

1. An atomized computerized platform that records the attendance of the learners by making use of technology that recognizes faces.

2. In addition to this, it will be able to facilitate interaction in a back-and-forth manner between the user and the system.

IV. METHODOLOGY

The project methodology is divided into two parts: -
1. Speech Recognition (For front desk application)
2. Facial Recognition (For attendance monitoring)
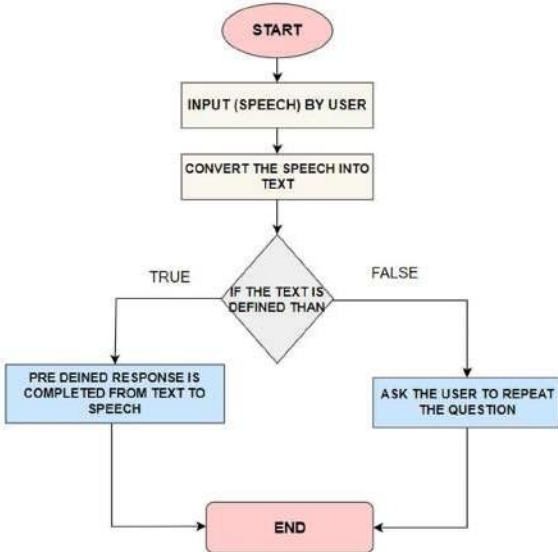
A. Speech Recognition

Fig. 1 Flow-chart for Speech Recognition

In Fig.1 the flowchart of how the speech recognition module works is given. The mic installed on the system captures the speech signal coming from the user and the software running (Python Code) on the processor processes the signal i.e., it converts the speech by user into text using the Speech-to-Text library. Now if the speech converted to text is defined then it responds with the predefined answers fed in the system and if the speech is not defined it asks the user to initial with the predefined questions. The output that is given to the user by the system is in speech form, which is converted from Text-to-Speech library. Visitors or users can approach the system and ask it in which location to find a particular place. Here, speech is used as a reference for the inquiry. The system then indicates the correct location to the visitor using speech as its output. [9-12]

B. External speech recognition module [1]

The robot's interaction capabilities in an application involving a front desk were purposefully restricted to the following three systems: a touch-sensitive tablet, a vision system, and voice communication. Within the framework of the chosen tactic, the capability to communicate with the robot through the use of natural speech (Natural Language Processing, or NLP) approaches was deemed the most important factor in ensuring the effective and alluring operation of the system. [13-15]
• Microphone A, which is more affordable.
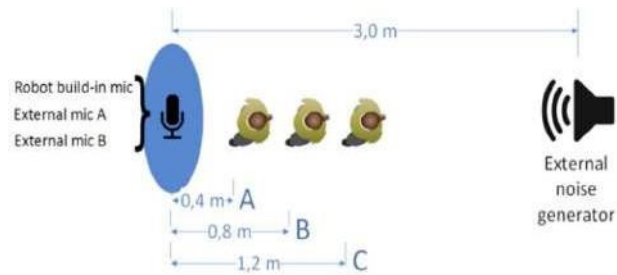• Microphone B, which is designed for professional use.

Fig. 2 Speech-to-Text mic testing system. A, B, C—microphone range Speech-to-text response times service

TABLE I. COMPARISON OF THE EFFECTS OF MICROPHONES HARDWARE PERFORMANCE AND INTERLOCUTOR-ROBOT PROXIMITY ON GOOGLE CLOUD'S SPEECH-TO-TEXT SERVICE'S LEVENSHTEIN DISTANCE VALUE. [9]

Distance to the microphone	Mic A (lower price)	Mic B (professional)
0.40 m	0.25	0.00
0.80 m	0.75	0.00
1.20 m	1.25	0.00

TABLE II. LEVENSHTEIN DISTANCE VALUE FOR THE 2-WORD, SHORT PHRASES

Distance to the microphone	Mic A (lower price)	Mic B (professional)
0.40 m	0.00	0.00
0.80 m	0.00	0.00
1.20 m	0.00	0.00

TABLE III. LEVENSHTEIN DISTANCE VALUE FOR THE 4-WORD PHRASES

Distance to the microphone	Mic A (lower price)	Mic B (professional)
0.40 m	0.00	0.50
0.80 m	0.50	0.50
1.20 m	0.25	0.50

TABLE IV. LEVENSHTEIN DISTANCE VALUE FOR LOHNEG PHRASES

Distance to the microphone	Mic A (lower price)	Mic B (professional)
0.40 m	1.875	5.00
0.80 m	10.500	3.50
1.20 m	15.375	5.25

Local microphones and professional microphones are two types of audio recording devices that are commonly used in different settings. While both types of microphones serve the same purpose of recording audio, there are significant differences in their design, quality, and accuracy. In terms of accuracy, professional microphones are generally considered to be more accurate than local microphones. [16-20]

In terms of accuracy, professional microphones have a higher signal-to-noise ratio, which means that they can capture sound with greater clarity and precision. They are also designed to reduce background noise and interference, which can distort the audio.

In contrast, local microphones are not as accurate as professional microphones, and they may be prone to interference and noise.

C. Code Implementation

Fig. 3 Libraries for Speech Recognition

The above image refers to the code that is to be executed for the speech recognition module using Python. There are different libraries used for computing the speech from the user to generate a predefined solution using speech for the user which includes following libraries [21,22]

- pyttsx3 (Text to Speech Library)
- speech recognition (Speech to Text Library)
- win sound (Pre-installed Windows sound, used for communicating the output)
- Time (display time)

Fig. 4 Output for speech recognition

The above image refers to the output that is generated by the Python code when the user approaches the robot for a particular query. Using the sound available i.e., pre-installed in the Windows OS the robot communicates with the visitor.

When the robot captures the speech by the user, it converts the speech into text using the library available and then the text is then matched in the different set of lists that are predefined in the code. When the input by user matches with the predefined lists it delivers the required output using speech via the speaker that are connected in the system [23-25]

D. Face Recognition

In Fig.5 the flowchart for Facial Recognition is shown in which the image is captured for database generation and then when the same image is captured again the attendance is marked and an excel sheet is generated for faculties or higher authorities to take note.

The two different algorithms used for Facial Recognition are

1. HAAR Cascade [Accuracy Rate of 96.24%].
2. Local Binary Pattern Histogram (LBPH) [Accuracy rate of 94.74%].

The above image refers to the algorithm that has been used in the project for generating as well as identification of faces.

The HAAR Cascade is used for creating the new database of any individual with the use of the following steps:

 HAAR Feature Selection

1. Creating Integral Images
2. Ada-boost Training
3. Cascading Classifiers.

Fig. 5 Flow-chart for Facial Recognition

Fig. 6 HAAR Cascade

Local Binary Patterns Histogram (LBPH) is used for identifying the faces that are already defined in the database. This algorithm cuts the images in small pixels and assigns a particular pixel as its base pixel and thresholds the whole image into a matrix using its different classifiers it converts the image in binary. Then the binary pixels are converted into decimal and a histogram is generated of the particular feature. This histogram is then matched with the histogram of different available databases and generates the desirable output. The step-by-step process for LBPH is as follows: -

- Training the algorithm
- Applying the LBP operation
- Extracting Histogram
- Performing Face Recognition

The process of face detection involves partitioning an image

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into two distinct groups: one of these classes contains faces, while the other class contains clutter. It is challenging because even if the faces are similar, they can have very different ages, skin tones, and expressions on their faces. This makes it tough to tell them apart. Variation in lighting conditions, image quality, and geometry, as well as the possibility of partial occlusion and camouflage, further complicate the challenge. Camouflage and partial occlusion are other complicating factors. For this reason, the perfect face detector would be able to identify the presence of any face, regardless of the lighting or the surrounding environment. The process of face detection can be broken down into two distinct stages. [26-27]
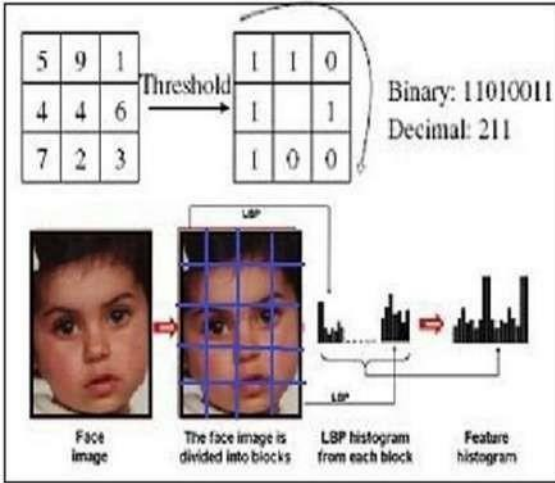
Fig. 7 LBPH Algorithm

Figure 6 illustrates the first step of the process, which is a classification task. This task accepts any arbitrary image as input and returns either a binary value of yes (1) or no (0), indicating whether or not the image contains planes. The face localization problem is the second stage, and its goal is to take an input image and output the location of one or more faces in that image as a bounding box with (x, y, width, and height). The face localization task is the second step in the process.

The system that has been developed is intended to take a picture of each student's face and save it in a database so that it may be used to track their attendance. It is necessary to take a picture of the student's face in a room with adequate lighting in order to recognise the student's facial features and determine the student's sitting and posture.

With this system, teachers do not need to manually record class attendance as the system will record the video. The system takes short videos as input and uses image processing/imaging to recognize faces and update the attendance database in a spreadsheet. [28-31]

E. Flask API

Flask API is a web application built using the Flask web framework in Python that provides a set of endpoints or routes for clients to interact with. APIs, or Application Programming Interfaces, allow different software systems to communicate with each other by exchanging data in a structured way.

Here is a high-level overview method for designing an automated attendance system using Flask API in Python:

1. Identify requirements: The first step is to identify the requirements for the attendance system. This includes understanding the attendance recording process, the type of data that needs to be captured, and the integration requirements with other systems.
2. Choose technology stack: Based on the requirements, choose the technology stack that is suitable for the project.

In this case, we would choose Flask API and Python for the backend development.
3. Develop the facial recognition algorithm: Develop a facial recognition algorithm that is capable of identifying individuals from images captured by a camera. This would involve training the algorithm using machine learning techniques.
4. Create a database: Create a database to store attendance data. This database can be created using a relational database management system like MySQL.
5. Develop the frontend: Develop a user-friendly frontend that allows users to view attendance records and generate reports. This can be done using a frontend framework like React or Angular.
6. Integrate the system: Integrate the various components of the system, including the facial recognition algorithm, database, and frontend. This can be done using Flask API, which allows for the creation of RESTful APIs.
7. Test and deploy: Test the system thoroughly to ensure it is working as expected. Once testing is complete, deploy the system to a production environment.
8. Monitor and maintain: Monitor the system to ensure it is running smoothly and efficiently. Perform regular maintenance and updates as needed.

F. System Interface with Flask API

Fig. 8 Title for the web link

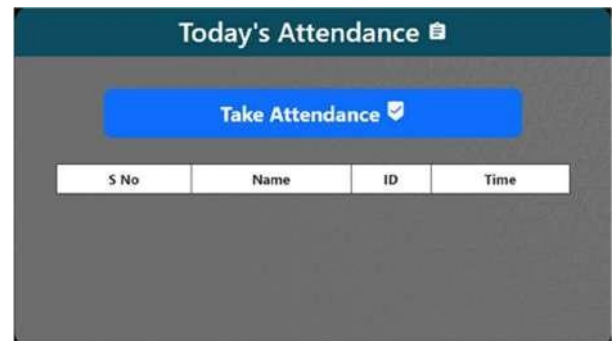Title is displayed for authenticity of the Institutional Record.

Fig. 9 Realtime attendance status record

The real-time data received and the name of student will be displayed after successful recognition of Image.

Fig. 10 Additional User Data Entry sequence

For new entry the User details needs to be enrolled in the database which will be stored for Image training.

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Fig. 11 Complete web interface for User

In the above picture, the system is divided into three main components: facial recognition algorithm, database management, and user interface and reporting.

The facial recognition algorithm component is responsible for capturing images of individuals, recognizing faces using machine learning algorithms, and updating the attendance records in the database.

The database management component stores and manages the attendance records. It includes a database management system, such as MySQL or PostgreSQL, which allows for efficient storage and retrieval of attendance data.

The user interface and reporting component provides a user-friendly interface for managing attendance records, generating reports, and visualizing attendance data. This component includes a web-based user interface, which can be accessed by teachers, students, or administrators.

Finally, the hardware components, such as cameras and sensors, are responsible for capturing data and sending it to the facial recognition algorithm for processing.

G. Code Implementation
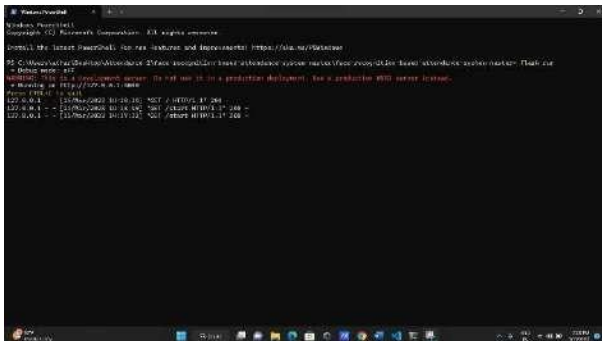
Fig. 12 Execution of Flask API

Fig. 13 Capturing Image

To open a Flask application through the terminal steps:
1. Open terminal on your computer.
2. Navigate to the directory where the Flask application is located.
3. Once in the directory containing the Flask application, you must activate the virtual environment (if you have one).
4. Once the virtual environment is activated, you can start the

Flask application by running the "flask run" command in the terminal.
5. This command will start the Flask application and http://localhost:5000 can be accessed from your web browser.
6. Copy and paste the https link into any web browser of your choice.

The above Fig. (13) shows how the image is captured with the user ID as name and roll number and detects all the parameters which will be used for facial recognition. The above process using LBPH (Local Binary Pattern Histogram) will match all the features with the database that is been available in the system. The algorithm creates a histogram which includes all the features and compares with the data sheets histogram. After comparing it the system marks the attendance and uploads the student's attendance in the available Excel sheet.
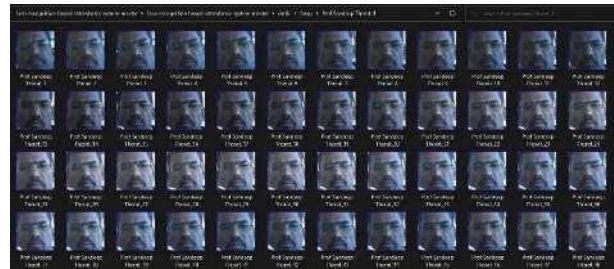

Fig. 14 Training Image Database

We conduct a series of experiments to demonstrate the effectiveness of the proposed method. 50 different images of 5 people were used in the training set. Figure (14) shows an example of a binary image detected by the HAAR cascade method of the extract_faces function.
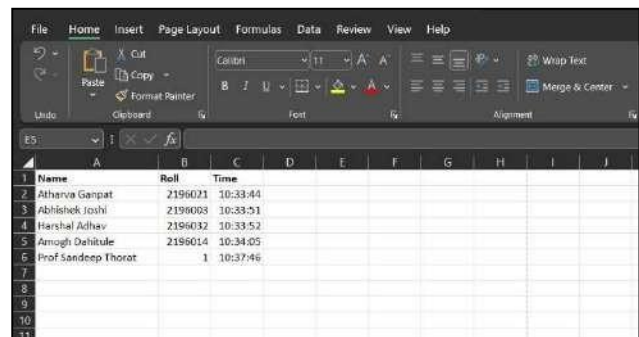

Fig. 15 Excel sheet

Automated attendance systems can be programmed to generate an Excel file containing attendance data for each session. Here are the steps to generate an Excel file in an automated attendance system:

1. First, create a template Excel file with the required headers for the attendance data, such as date, time, student name, and attendance status.

2. In the automated attendance system, create a script or program that captures attendance data. each session and stores it in a database or CSV file.

3. Use a library or tool to read the attendance data from the database or CSV file and write it to the Excel template file.

4. Save the generated Excel file to a specified location.

5. Finally, you can automate the entire process by scheduling the attendance system to run at specific intervals or triggering it using a specific event or action.

By following these steps, you can create an automated attendance system that generates an Excel file with attendance data for each session. The above Fig. (13) shows the generated

excel sheet for keeping the track of attendance records for faculties or administrators.

VIII. CONCLUSION

There are ways educational institutions and organizations can benefit greatly from implementing an automated attendance system. This not only simplifies the attendance process, but also ensures the accuracy and reliability of the recorded attendance data. In addition, the system can generate valuable information and reports that allow teachers and administrators to better understand student attendance patterns and identify potential issues before they escalate. In general, the automatic attendance system represents a major progress in the modernization of education and the organization and management. Its continuous development and improvement of will undoubtedly bring greater benefits to in the coming years. In this experimental study, the system was tested against a very robust, and the actual performance of the should be more accurate. A fully automatic frontal face detection system shows dummies and, in the opinion of researchers, does not require further work in this area. The next step will be to complete the real-time application of the system.

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Low-Cost Automatic Cutting Machine

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Abstract— **Cutting off is an essential first step in every manufacturing process, despite the fact that it does not contribute in any way to the value of the final product. Cutting is typically accomplished with instruments that are totally automatic; nevertheless, the expense of automation requires to be reduced in order to enhance productivity, accuracy, and efficiency. By utilising an electro-pneumatic circuit, a proximity sensor, and only a few moving parts, this is designed to reduce the amount of time that is spent in the cycle. The goal of the project is to identify issues that arise during the process of cutting sleeves from pipes, such as feeding, precision, clamping, power use, cycle duration, and the output, and to develop low-cost automated solutions to address these issues. The theoretical approaches will be used to design the most significant components of the system, and Catia will be used to create three-dimensional representations of those components.**

Keywords— Cutting off, Automation, Clamping, Productivity

I. INTRODUCTION

The operation of a typical cutting machine is depicted in Figure 1, which demonstrates that each stage in the process requires the assistance of a human. However, time and patience are required for the majority of the cutting process. As a result, a brand new cutting machine that can speed up the cutting process is required. During the cutting stroke and the return stroke, certain modern machines are able to automatically feed the work piece and bar stock to the stopper. Before beginning the cutting process, the machine clamps the bar stock and then releases it during the return stroke. The demand for low-cost automation in machines like these is being pushed forward by the presence of a proximity sensor that can recognise the work piece and automatically clamp, declamp, feed, and retract the cutter.
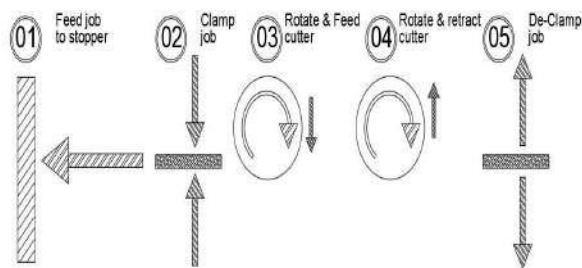

Fig 1. Conventional cutting operation

II. LITERATURE SURVEY

When cutting thin-walled steel pipe using the old approach, deform occurred, which had an adverse effect on both the dimensional accuracy and surface finish of the finished product. In order to solve this problem, there was an urgent requirement for modern equipment that was capable of delivering both great precision and productivity. Because of the nature of the cutting operation, the stainless steel pipe was put through a variety of stresses, including bending, shearing, and twisting. It would appear to be of the utmost importance to conduct research into the real strength of the items in question as well as their mathematical modelling in order to guarantee their safety and dependability. [1].

Other Case Study [2] describes in detail the design and analysis which occurred while developing the latest pipe cut technology. The existing method of cutting demands the employment of labour, which results in a significant loss of time. Furthermore, the amount of precision that could be achieved by using this typical approach was quite low. This piece of machinery is intended to automate the process in question, with the goals of alleviating labour problems, lowering costs, improving accuracy, and increasing reliability. The primary function of this high-tech cutting machine is to precisely cut wire into the number of pieces selected by the user. It is a simple machine that can be transported easily, and it was designed to provide for the lowest feasible prices for cutting procedures while also minimising the overall amount of time spent doing those operations.

Due to the convenient supply of compressed air in confined spaces, the pneumatic circuit was developed in order to address difficulties relating to a decrease of associated costs. A clamping configuration that is tailored to the unique needs of every job is made available. The rollers are there to make the supply of the pipes, which are powered by air motors, easier to accomplish. In order to regulate the climbing movement of the cut operation, a direction control valve is being put into service. [3, 4].

III. TEST SET UP

A 3D isometric representation of the work may be seen in Figure 3, while Figure 2 depicts the layout of the project. During the cutting process, a holder for the grinder is fabricated and mounted on vertical sliders so that the grinder can move along the Z-axis. In order to clamp the pipe, a pneumatic clamping cylinder is placed, and a Z-shape clamp is used to install the proximity sensor on its foundation framework. All of the air that enters the pneumatic system

can be controlled individually by a 5/2 direction valve for control..

A longitudinal slider and a cutting feed mechanism are two of the many constructional characteristics that are included in this piece of equipment. Dual rectilinear bearings and another guiding mechanism make up its constituent parts. It also has an extensive array of helical compression spring as a part of its construction. The forwarded cut operation is carried out by use of a dual-operated pneumatic cylinder, with the air supply regulating the cutter feeding and a normal rapid motion being utilised for the reverse stroke. A piece of work is directed in a guide bars, and a pair of movable clamping is utilised for fastening work-pieces of varying sizes. [5-6]

Additional pneumatic cylinder is utilised to perform feeding, along with to a clamping cylinders that is utilised for clamping and release during the feed and hold processes. The task is recognised by a proximity sensor, which then triggers the pneumatic system. The output of a proximity sensor is connected to the input connector of the relay with eight pins, which then shifts the pneumatic circuit's output. [7]
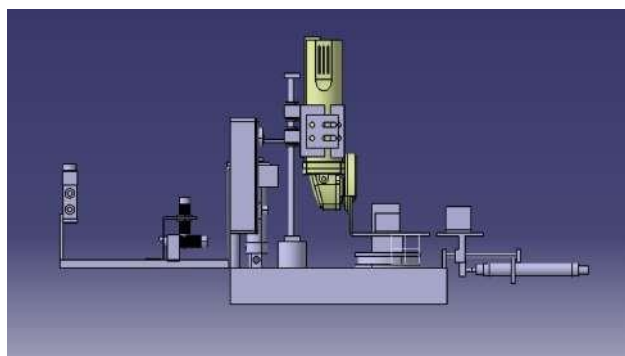

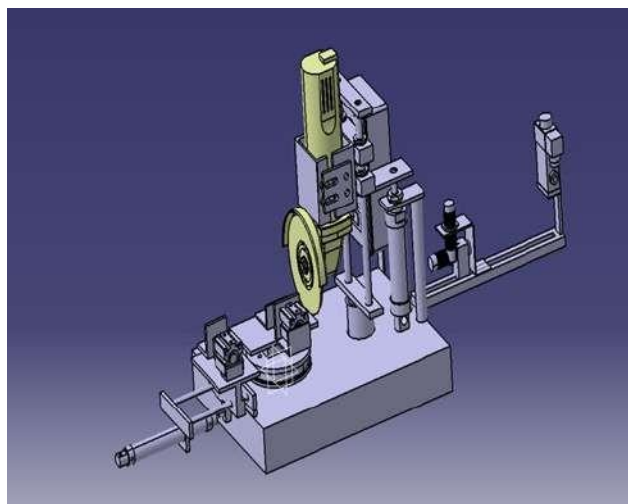Fig. 2. The Layout (project work)

Fig. 3. Isometric Views

IV. DESIGNING METHODOL

A. *Designing the circuit*

Fig. 4 is a schematic of the circuit that was designed in order to accomplish the different tasks of clamp mode, cut, feed, and de-clamp autonomously. In order to do this, it requires a relay that is able to switch at specific intervals and take input. [8-10]
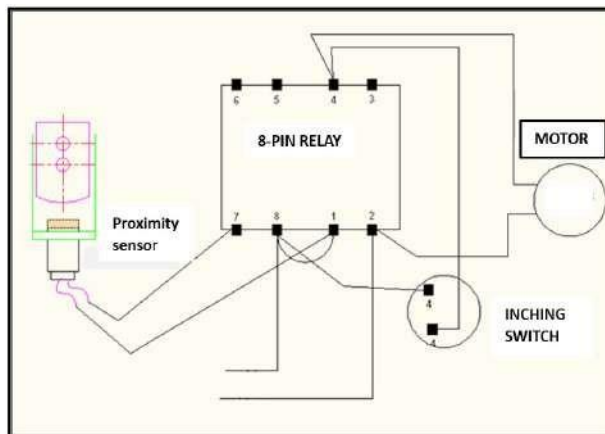

Fig. 4. Circuitry Designing

B. *Crawling switch*

Once the inching switch is activated, it permits temporary functioning of the motor by bypassing the proximity sensor and activating the motor instantly instead. This allows for more precise control over the motor's speed. Since it links among the proximity detector and the electrical relays, if this switch presses, it will trigger each of those parts to take on operational. This is due to what is linked between them. [9-12]

C. *Proximity Sensors*

Mounting the digital proximity detector to the metal sheet panels of the foundation framework requires the utilisation of a clamps in a shape of a Z. A sensor is intended to function like an indication in addition to determining whether or not an object is nearby. When something moves close to of the sensors, it sends a signal to the relay, which then begins the holding process and activates the pneumatic cylinder, which moves the cutter in downward motion. After cutting has been done, the relay will turn down and the cutter will go back to where it was before the cutting began. The relay also resets the clamping device so that it is in its initial setting. At the same time, the feed cylinders is activated and presses the pipe ahead, which enables the action of cutting to continue uninterrupted. [13-15]

D. *To set the cylinder and choice*

Following are the selection with certain assumptions:

Max clamp force	30 Newton
Avg. force required/assumed	27.3 Newton
Calculated area of cylinder	150 mm^2
Diameter	8 mm

Therefore, the type of cylinder that will be chosen needs to be chosen in such a way that the least effort that can be generated at a pressure equal to 2 bar (the working pressure for smooth engage and disengage) is greater than 30 N. In light of the fact that there is only one standard cylinder accessible, and taking into account the fact that 50% of the power is wasted in the friction, cylinder is chosen. [15-16]

E. Choice of the Motor for the Automated Transmission

The following are the parameters for the motor that was selected for the equipment that cuts wire: :

1 Phase AC Motor
Commutative motor
Completely Closed Fan-Cooled design
Continued varying speed range – (0-6000) rpm

The chosen motor is a 1-phase AC motor with an electronics speed variator that enables different speeds operating. By varying the supply of electricity to the motor brush, the power intake to the motor may be varied, which changes the motor's speed. Moreover, commutator motors, a kind of DC motors that are frequently employed in low-power applications. The TEFC structure shields the engine from moisture and debris.

V. Conclusions

Automating a manual pipe-cutt machine improves efficiency and reduces cutting time. After design calculations, CAD modelling, and other costs are calculated and approved, this will be the lowest-cost automated machine in the industry.

Single-phase AC motors with electronic speed variators are used. The motor's speed can be changed by changing the motor brush's current supply. Commutator motors are also used in low-power applications. TEFC protects the engine from moisture and debris.

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Analysis of Robotic Process Automation Tools

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Abstract— **The speed at which various operations are carried out, and therefore efficiency, becomes a significant aspect in this period and time when consistency is demanded from all sectors of the nation. Robotic Process Automation (RPA) is employed to meet these systems' accelerating requirements. Robotic process automation will hasten business administrative tasks, distant IT management jobs, and resource preservation in a range of industries. The purpose of this study is to analyze three of the top RPA platforms: UiPath Studio, Automation Anywhere, and Blue Prism. Many software platforms have been developed to deploy RPA. Our studies will be useful to commercial industries, not just Blue Prism. Our analysis will help the business sectors choose the platform that will work best for front- and back-office workers working together. The speed at which various operations are carried out, and hence efficiency, becomes a significant aspect in this period and time when promptness is demanded from all sectors of the nation. Robotic Process Automation (RPA) is employed to meet these systems' accelerating requirements. Robotic process automation may speed up administrative activities in business, remote management jobs in the IT industry, and resource conservation across a variety of industries. Several software platforms have been created to deploy RPA, and the goal of this study is to analyse three of the top RPA platforms: UiPath Studio, Automation Anywhere, and Blue Prism. Our study will assist the business sectors in identifying the platform that is best suitable for usage by front-office and back-office staff alike.**

Keywords— Robotic Process Automation, UiPath, Blue Prism, Automation Anywhere, Structured Analysis

I. INTRODUCTION

Process automation is a method for automatically controlling manual or logical operations. Industry automation systems may now be used in every sector thanks to recent technological advancements. Hard automation and Soft automation are the two main divisions of process automation. Soft Automation (flexible automation) is a developed form of Hard Automation (fixed automation), as it permits the programming of various tasks in accordance with the requirements of the products. A machine or robot built to carry out a defined yet repeated duty is referred to as hard automation (fixed automation). Soft automation includes robotic process automation. Soft automation includes robotic process automation (RPA).[1,2] To lessen the stress of repetitive jobs, robotic process automation is software that may be configured to automate a range of manual operations carried out by human workers. A workflow with several phases and functions—such as receiving data, writing data, doing mathematical operations, updating and modifying data, etc.—is taught to the software bot. Many technologies, including UiPath Studio, Automation Anywhere, Blue Prism, Workfusion, Redwood, and Kryon, are now being utilized for RPA. [3]

A. What Is Robotic Process Automation?

Robotic process automation results in significant labour and time savings. It saves money in addition to time. Robotic process automation is characterised by intelligence, scalability, and independence from platforms.

Any RPA system has to be able to communicate with other systems via API integration or screen scraping, make judgements, and offer a programming interface for bots.

RPA Tools do not require any programming expertise to utilise. Small, medium, and large-scale businesses can employ RPA tools, but these companies should be able to heavily rely on the programme. [4-6]

B. What is RPA Software?

In order to carry out "if, then, else" statements on structured data, robotic process automation (RPA) systems commonly combine user interface (UI) interactions with application programming interface (API) connections to client servers, mainframes, or HTML code. An RPA tool is put into action by authoring a script in the RPA tool language, which the software "robot" will then follow; runtime is managed through the use of a control dashboard.

Robotics refers to a software-based solution that is designed to carry out repetitive activities, processes, or procedures that are typically carried out by people. As it was just recently introduced, this idea has gained acceptance and is often employed. The purpose of this research is to provide an introduction to the fundamentals of RPA, as well as to some of the technology components that support transactions, data alteration, response-triggering, and communication with other electronic systems.

According to the definitions provided, there are no real physical robots (i.e., hardware) and the goal of RPA is to simply develop an intelligent computer programme that can "learn" how to accomplish a straightforward task that will be carried out repeatedly. RPA is being used in normal business operations by many big organizations, including Amazon, Airtel, Ernst & Young, and American Express.[7-9]

II. ROBOTS

A robot is a machine that is electromechanically constructed, completely automatable, and capable of doing a variety of challenging tasks on its own. A robot must travel into the real world to complete a mission. These robots' perception and behavior are connected in extremely complex ways. Robotics must heavily rely on AI if there is to be an intelligent relationship between AI and robots (Brady, 1985). Electrical, computer, and manufacturing systems engineering are only a few of the multidisciplinary scientific and engineering fields that go under the umbrella term "Robotics". A robot is a machine that is electromechanically constructed, completely automatable, and capable of doing a variety of challenging tasks on its own.

In order for a robot to successfully perform its goal, it needs to venture out into the real world. The perception and behaviours of these robots are intricately related to one another in a variety of ways. According to Brady (1985), in order for there to be an intelligent link between AI and robots, robotics must heavily rely on artificial intelligence (AI). The umbrella word "Robotics" encompasses a wide variety of subfields within the scientific and technical communities, including but not limited to electrical, computer, and manufacturing systems engineering. [10,11]

By this decade, 10% of significant businesses operating in sectors that strongly rely on supply chains will have a qualified worker acting as their chief robotics officer on a day-to-day basis. by Ankush and Douglas in 2017. Robot demand from consumers has increased dramatically. Artificial intelligence technologies are frequently used in industrial settings, especially those that are compatible with robotics. The robots perform better in a variety of applications, including assembly, auditing, driving, warehouse logistics, caretaking, package delivery, home cleaning, and surgery, by utilizing wireless connectivity, big data, cloud services, numerical deep learning, accessibility, and other resource sharing (Kehoe, B. et al., 2015). Assembly, auditing, transportation, warehouse logistics, caring for others, and surgery are a few of these uses. Swarm robotics is a cutting-edge method of managing a number of very basic robots. It draws inspiration from the cooperative behavior of social insects. [12,13]

According to Palgrave and colleagues (2000), the term "evolving robotics" refers to an innovative technique for the automatic generation of self-sufficient robots. This viewpoint, which was influenced by Charles Darwin's theory of natural selection and the phrase "selected reproduction of the fittest," envisions robots as autonomous artificial animals that learn their distinctive skills via continual contact with their environment without the assistance of humans. This viewpoint was shaped by Darwin's theory of natural selection. The development of co-adaptation and compatibility between service robot systems and supportive environments, in both a physical and an informational sense, is the primary emphasis of the field of ambient robotics. Using 3D visualisations, facility planners are able to generate alternative designs, programme robot courses, plan system layouts, collect data for discrete event simulations, and develop cell control programming.

The use of robotics in mundane tasks will become commonplace very soon.

C. Process

The word "Process" is frequently used and even directly influences how individuals go about living their everyday lives. It acts as the activity to complete a job and is a vital component of any system or organisation. One person or item, or a mixture of both, can do the task. No matter if the platform is closed or open, the process requires input from a variety of tools or users and is carried out in accordance with predetermined rules in order to create the required result. The procedure does nothing other than convert input to output. Yet, each technique or system has a unique set of time requirements, costs, labour requirements, and other quality criteria. Several process systems, including as admission, biological, manufacturing, and chemical systems, are well known to people. Analyze how a computer processing system renders.

D. Automation

"Automation" refers to the process of automating a tool, a technique, or a system. On the other hand, automation is already being put to use in ways that are advantageous to society. The computing power of any system can be utilised in robotics. Automation is a challenging process that requires the integration of people and systems. Integration is important. In the design of systems, human elements, particularly cognitive ones, are frequently neglected or handled incorrectly (Sheridan, 2002). A system for the creation, editing, running, checking, and repairing of application programmes for industrial automation mechanisms that involve logic, motion, and/or process control components. This system can be used to create, modify, run, check, and fix these application programmes. The curb energy system is utilised to monitor the amount of energy that is used in residential settings. [14]

A few of the more contemporary examples of smart home appliances include the Ecobee3 Intelligent Wi-Fi, Alexa, and Lutron Dimmer Light Switches. The embedded hardware and software in these intelligent gadgets allows them to carry out tasks on their own. According to Madakam (2015), the most impressive attribute of these high-tech devices is how they improve the quality of human life, the efficiency of processes, and the management of specific issues in circumstances in which the presence of humans is entirely impractical.

Automating routine jobs not only saves people the effort of doing them themselves but also frees them from the tedium of doing the same thing over and over again. These improvements have been made possible by advances in technology. The following is a list of the most advanced automation technologies now available for driverless or autonomous cars, including artificial intelligence and machine learning. Cognitive computing is used in autos that are connected to the internet of things as well as cooperative robots. The industrial sector has already begun using automation, or more specifically, the already available

"Industry 4.0" technology. The robots are responsible for the majority of the work that is done on the assembly lines.

Fig 1-What are the benefits of the RPA [23]

III. ROBOTIC PROCESS AUTOMATION OPERATIONS

Robotic process automation activities do not have any recognized models of standardized operation that have been established. An illustration of RPA activities is provided by M/s. Info-Cap Networks LLC (Info-Cap), which is located in San Francisco, as well as by Mr. Kristina Romero and his technical staff. This technology paradigm, which automates manual work that is more labor-intensive, time-consuming, and visibly error-prone, will replace the entire company's system operations (Kristina Romero, 2017). This will result in the company's system operations being obsolete. The capacity of "Digital Labour" to reduce costs, errors, and dangers is the primary benefit of "Digital Labour" in this view [15-17]. The operational advantages offered by the RPA can be extremely beneficial to a wide variety of transdisciplinary businesses.

Credible Corporate Transformation: The implementation of corporate procedures will undergo significant adjustment as a direct result of the implementation of the new RPA technology. Because of the use of robotic process automation, companies may now significantly improve the effectiveness with which they utilise their labour by complementing a more productive staff with digital labour that is reliable, efficient, and competitively priced. This is made possible by the utilisation of RPA. Because of this, businesses now have the opportunity to cut expenses, as well as errors and risks.

Migrations of content: There is a massive amount of material being produced by all enterprises. If data collection, analysis, and report preparation become more complicated in everyday operations, there is a possibility that labour will be required. Businesses and organisations can only benefit from robotic process automation because it makes transferring content or making links to legacy systems more quickly and simply. This will speed up the consolidation of applications and the integration of older applications. Robotic process automation can only assist.

Web Crawling and Open Source Intelligence Robotic Process Automation (RPA) automates the process of collecting content in any format and from any source using a range of different types of equipment. Formats in the form of text, images, audio, and videos can all be produced. There are three possible formats for the presentation of the data: structured, semi-structured, and unstructured. This robotic

process automation solution is able to acquire data from the deep web since it makes use of deep learning techniques.

According to the blog of the IT Department Enabler, robots are "software programmed to mimic the human conversations as well as implement a repetitive process, governing tasks like obtaining and contrasting data from various systems, reading from and composing to datasets, or retrieving and reconfiguring information into dashboards and reports." Robots are a key enabler for the IT Department. They keep a close eye on the hardware, the software, and the networking in order to spot any abnormalities and ensure that everything runs smoothly.

Fig 2-RPA Operations- Kristina Romero [11]

A. Overview of RPA Software

Robotic process automation (RPA) systems frequently mix user interface (UI) interactions with API connections to either power client servers, mainframes, or HTML code in order to execute "if, then, else" statements on structured data. [18-20].

B. Types of Robotic Process Automation

- Automation processes carried out by these tools will need to be attended by a human.
- Unattended automation: These devices have intelligence and the ability to make decisions.
- The features of both attended and unattended automation tools will be merged in hybrid RPA tools.

C. Industries utilising RPS

The banking, insurance, retail, manufacturing, healthcare, and telecommunication sectors are the principal users of robotic process automation.

- Healthcare: It will assist with scheduling, patient data entry, processing insurance claims, billing, and other tasks.
- Retail: It assists the retail sector with updating orders, notifying customers, shipping goods, tracking shipments, etc.
- Telecommunications: It will assist the telecommunications sector in monitoring, managing fraud data, and updating customer data.
- Banking: RPA is used by the banking sector to increase job efficiency, data accuracy, and data security.
- Insurance: To manage work processes, enter customer data, and create apps, insurance companies employ RPA.

- Manufacturing: RPA tools support supply chain operations in the manufacturing sector. It aids in the administration, reporting, data migration, customer services & support, billing of materials, etc.

D. RPA-Operating Model Design

In their seminal piece from 2017, Rodger Howell and Tom Torlone emphasized the development of robotic process automation technology. They correctly noted that pilot programmers are where robotic process automation is actually coming from. To improve operational efficiency and cut costs, enterprises must create their own RPA models. These authors intend to convey that different businesses and industries have different RPA operational models. They believe that the operating models for robotic process automation are not "one-size-fits-all." But the core of an efficient RPA operating model revolves around three crucial roles.

E. Process Architects

There are many different kinds of processes, such as round robin, priority, First Come First Served (FCFS), and Last in First Out (LIFO). Process engineers are in charge of defining each process in both centralised and decentralised process systems. They must first understand how the present system works, find any holes in its design, and handle jobs while keeping in mind time limits, cost savings, and how well the system works. In some ways, the business experts are also in charge of automating processes. Process engineers come up with the methods, steps, and standards for the robotic process automation system. [21-23]

F. Technologists

There are more businesses on the market right now. These are the programmers who write the code based on the software requirement specs and feedback from the functionalists, designers, and executors (SRS). All of this coded software can help take care of routine jobs automatically and without human help, but only to a certain extent. RPA tools require less complicated technical knowledge than traditional application development.Staff for Ongoing Help and Maintenance.

They do the new tasks that have been automated and change the code as needed. To do this, a software provider or supplier will usually sign an annual maintenance deal. If the system software or apps have bugs or don't work right, they are easy to fix. They offer expert help 24 hours a day, every day of the year. This kind of technical help cuts down on the time and money needed to hire technical staff on the inside. There wouldn't be any costs for training. Continuous support plans are made by the companies to meet the needs of their business clients, not the needs of the general public. Whether a customer wants help with a specific problem or weekly reviews and advice, there is a package that will meet their needs and give them full peace of mind.

IV. ADVANCE TECHNOLOGY USED IN RPA

Business Process Outsourcing (BPO) companies have used RPA for a long time, and more and more end-user businesses are now using the technology on their own to build "virtual workforces" of robot workers. The word "robotic process automation" means that technology is used to do routine work that a person would normally do. The technology mimics an end user by doing things like going through an app or filling out forms like a user would, based on a set of rules (Barnett, 2015).

RPA is a type of cutting-edge artificial intelligence, along with virtual agents, machine learning, computer vision, and the classification of natural language. The insurance business can use artificial intelligence in a number of ways, such as by using image categorization for claims and text analytics for customer service. Because of these new technologies, more insurance processes will be automated and made better.

Blue Prism's programme for robotic process automation gives you some of the best choices, such as:

I. Rules-based processing with digitally organised data for catching fraud and activating credit cards

II. Complex or mission-critical processing tasks, like cashing out a pension or balancing the books, involve repeated transactional tasks, like swapping SIM cards or processing invoices.

III. High transaction volumes, like taking orders for new phones or bills, and problems with process adherence or quality, like policy renewals or policy migrations.

IV. Fluctuations in demand or backlogs, like those caused by the launch of new goods, or "Swivel Chair" procedures, like hiring new employees for human resources or launching a new online service without any integration

M/s. UiPath is at the forefront of the worldwide digital business revolution because of its ability to facilitate the rapid deployment of software robots that greatly improve corporate efficiency, compliance, and customer service across both back-office and front-office processes. According to UiPath, robotic process automation (RPA) systems are able to perform a wide variety of operations, including login into programmes, moving files and directories, copying and pasting data, filling out forms, extracting structured and semi-structured data from documents, scraping browsers, and more. As of March 6, 2018, UiPath was valued at $1.1 billion after receiving an investment of $153 million from Accel, CapitalG, and Kleiner Perkins Caulfield & Byers. Accel led the funding for the investment.

An additional prime illustration of RPA's usefulness in commercial settings is provided by the platform known as Automation Anywhere. This cognitive robotic process automation tool was developed with the goal of automating every business process that may be found in a contemporary company.With the help of the Automation Anywhere Bot Store, which is offered by the Automation Anywhere Company, businesses are now able to construct their digital workforce at a rate that is significantly faster than in the past. This results in an increase in the productivity of human workers and makes it possible for them to focus on more projects that are beneficial to people. For more than 10

years, the most successful companies in the healthcare, financial services, technology, manufacturing, and insurance industries have depended on the M/s. Automation Anywhere organisation to deliver the highest quality robotic process automation and cognitive technology available anywhere in the globe.

Another UK-based specialist automation and cloud consulting company, M/s. Endpoint Automated Services (EAS), is expanding its breadth of automation expertise to the realm of robotic process automation, according to the M/s. Endpoint Automated Services Company. Robot automation can take on a variety of forms, some examples of which include automating a commercial process from start to finish as well as data entry into a financial accounting system. Robotic process automation has enabled the automation of tasks that were previously thought to be impossible to automate, such as those involving the use of the Microsoft Office software suite. RPA has emerged as the dominant codeless automation tool. The robots can be taught to scrape the screen, and once again, they are instructed to locate anchors on the screen rather than utilising a pixel-based coded screen scrape, which is more limited. The information that we have comes from M/s. Endpoint Automated Services Company.

K. RPA Application in Airtel

One of the most effective applications of robotic process automation is in the field of business process outsourcing. The software takes the place of a large number of technical staff employees and performs the same kind of routine work while offering round-the-clock technical help. It's possible that the clientele is dispersed across the entire country. This application is the best one for lowering the amount of labour that is necessary for processes that are performed frequently and continuously. On the other hand, some of the available personnel has been set aside for future responsibilities. For instance, the majority of the fundamental and everyday technical help tasks that the Indian telecom operator Airtel is responsible for are carried out by means of software. The same can be said about the ease with which chores can be completed in various local languages.

To receive support from Airtel operators for whatever reason, customers can contact the toll-free number provided at no cost to them. As a result of this, the programme supports a variety of languages as well as payments, caller tunes, ringtones, internet data usage, sim loss, and new tariff plans, among other things. In order to make use of any of these options, all you have to do is press one of the numbers 1–8 on the number pad, and depending on the characteristics of the option, this will cause it to be enabled. Additionally, voice input is supported. [25-27]

L. Methodology

The automation of robotic processes is currently considered to be one of the most cutting-edge technologies in the fields of computer science and information technology. Automation of robotic processes is a relatively recent development as a field of study. There is a lack of consensus among experts on its precise significance, and there is no consensus regarding its operational definitions,

connotations, tried-and-true models, or derived theories. It carries with it an air of daring and excitement. As a result, the data that was utilised in the creation of this research study came from a wide variety of secondary sources that are available online. These secondary sources include research journals, company white papers, expert blogs, topical videos, and so on. Between the months of April and June of 2018, the information was gathered. In order to locate the study publications, the terms "Robots," "Robotic Process Automation," "Artificial Intelligence," and "AI" were utilised. The search engines Google and Google scholar are utilised in order to locate the articles contained within the databases. Auxiliary data was collected, compiled, analysed, and narrated in a thematic fashion so that a greater understanding of the phenomenon of robotic process automation could be achieved. The descriptive research subfield of exploratory study is the appropriate one to assign to this investigation.

M. System Overview

UiPath

In 2005, an outsourcing company was the pioneer in adopting the use of UiPath. They recognised the need for RPA (Robotic Process Automation) in response to the growing demand in the market, and as a result, they began developing a platform that meets industry standards for the management and training of software robots. Their source code is used on millions of computers all over the world, and it is incorporated into a wide range of products and businesses. Some of the activities that these goods and businesses perform include document management, call centres, healthcare, finance, data migration, process automation, and API enablement.

UiPath Orchestrator is the component that makes it possible to orchestrate robots. The UiPath Studio module is a piece of software that functions as a tool that allows for the development and maintenance of connections between robots, in addition to the convenience of package transfer and the management of queues. In addition to that, it makes it possible to build, model, and carry out workflows.

These features can be found in greater detail in a number of Artificial Intelligence techniques or algorithms, the most notable of which are recognition, optimisation, classification, and information extraction. These features are currently accessible through the UiPath tool through its UI Automation module, and they are disclosed on the tool's official page [28]. When it comes to the algorithms used by AI, the information that is examined makes use of character and picture recognition, optimisation, and classification.

Features:

> ➢ It provides security by managing credentials, offering encryption, and establishing access controls based on the user's function in the organisation.
> ➢ It has a faster capacity for automating processes. In addition, the speed of automation using Citrix is increased by a factor of eight to ten.

➢ It provides a free platform, and it is possible to manage any process, regardless of how complicated it may be, in any number.

Pros:

➢ The user does not require any prior understanding of programming to use it.
➢ User-friendliness made possible by the drag-and-drop functionality.
➢ It provides a variety of helpful features at no additional cost.

Cons:

➢ There are just limited coding capabilities available.

Automation Anywhere

Tethys Solutions, LLC changed its name to Automation Anywhere, Inc. in 2010. The company's products are made to enable the execution of automated business and IT operations across numerous workstations, taking into account differences in system configurations, application load times, and Internet speeds. Users can create automation processes with centralised security, user management, collaboration, deployment, and backup using the Server edition, which is offered. Another tool designed for RPA processes is called Automation Anywhere, which has the unique ability to inform users about the applicability of AI methods and algorithms.

RPA is used in conjunction with a process referred to as "Digital Workers," which is the most automatic or intelligent method. A cognitive automation module as well as tools for applying data analysis to RPA operations are both included in the RPA toolkit. Because it is a multipurpose piece of software, it provides a collection of information that enables the configuration, utilisation, and deployment of RPA processes. The Bot tool of the Automation Anywhere tool uses a variety of artificial intelligence strategies and algorithms, such as fuzzy logic, artificial neural networks, and natural language processing, in order to extract information from documents and, as a result, improve the efficiency of document validation. This is accomplished by using the tool's internal execution of these strategies and algorithms. In this regard, it would appear that the IQ Bot platform, which is the driving force behind the Automation Anywhere intelligent word processing application, is in the process of making some AI strategies or algorithms available to users.

Contains the following features: offers security on par with that of a bank; provides security by means of credentials, encryption, and authentication.

➢ Analytics and reports generated in real time.
➢ enables compatibility with multiple operating systems.
➢ User-friendliness is a strong point.
➢ Cons: There is room for improvement in IQBot.

Blue Prism

Blue Prism was founded in 2001 by a group of people that specialise in the automation of business processes with the intention of developing software that would improve the productiveness and efficiency of companies. They focused their efforts on the white-collar back office, where they observed a significant demand for automation that was not being satisfied.

Among its features are the following:

➢ It enables the deployment model for various environments.
➢ It offers security for both network credentials and software credentials.

V. RESULTS AND DISCUSSION

1.0 COMPARATIVE ANALYSIS:

We have included in the table below the factors that we believe to be the most relevant when comparing the best three RPA platforms to one another. The primary criterion determines whether or not the front and back offices can be computerized and automated. The capacity of an automation tool or platform to automate the very early phases of an industry is one of the most important factors determining its first level of success. After that, the Script Based Designer and the Visual Process Designer are shown to the user, and it is at this point that we establish whether or not a certain tool possesses a graphical user interface. The openness of a platform reveals whether or not the information necessary to use the tool, learn how to use it, and practise using various apps is made available to anybody and everyone. Macro recorders make it possible to apply designs and codes more quickly, which leads to faster development.

The manage by Coding criterion is essential because it demonstrates how well a user can manage how the software operates and the bots that it makes use of. The ability to execute automated test cases on remote machines is a critical factor in determining the level of protection offered by the solution. If there is a tool that can fulfil the requirements listed above without putting users' safety at risk, then significant headway will be made in this area. In terms of the fifth and final parameter, the future scope of a tool is what decides how valuable it will be once other technologies have advanced to an adequate level. UiPath is unequivocally the best option in this regard since, in contrast to the other two options, the endlessly flexible coding algorithms it employs make it possible to cover an infinite range of applications in the future.

A purely objective analysis may not be sufficient to convince the key stakeholders in various industries. This necessitates a thorough examination and comparison of the technical features of the tools. The performance evaluation of the several tools has been collated and organised in a table, categorised according to numerous technological aspects. The data presented in this report is derived on an analysis of reviews on RPA technologies undertaken by various enterprises, as well as our own firsthand experience with the implementation of UiPath. It is important to note that UiPath was the sole product available for examination throughout the period of our inquiry. [30]

The script-based design of Automation Anywhere enables the execution of core functionality and bot development with enhanced accuracy. However, because to its reliance on

scripts, the number of users may be comparatively lower. UiPath and Blue Prism demonstrate exceptional proficiency in various domains, such as control room operations, system administration, reporting, and resilience. [31-32] These domains encompass the operational prerequisites and components of the aforementioned tools. The level of analytical proficiency exhibited by the RPA technology is denoted by the RPA Analytics rating. One notable feature of Automations Anywhere is its exquisite architectural design. Analysis refers to the mentioned Table1 and Table-2.

TABLE 1 COMPARATIVE STUDY ON TECHNICAL ASPECTS [17]

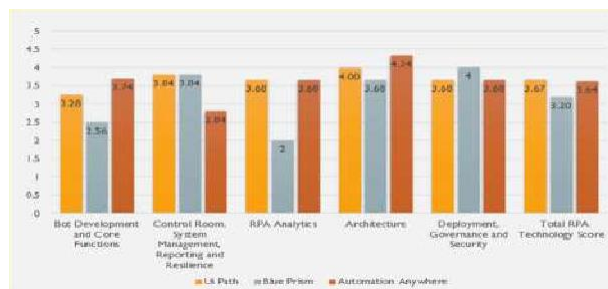| Technology Category	UiPath	Blue Prism	Automation Anywhere
Bot Development and Core Functions	3.28	2.56	3.74
Control Room, System Management, Reporting and Resilience	3.84	3.84	2.84
RPA Analytics	3.68	2.00	3.68
Architecture	4.00	3.68	4.34
Deployment, Governance and Security	3.68	4.00	3.68
Total RPA Technology Score	3.67	3.20	3.64

Fig 3: Graphical Representation of Technical Aspects [19]

A literature review is deemed suitable due to the nascent and insufficiently explored nature of the subject matter, namely Robotic Process Automation (RPA). This approach facilitates the identification of existing knowledge gaps within the field, provides recommendations for further research endeavours, and establishes a foundation for the exploration of novel research domains. Furthermore, this study employs the concept-centric approach advocated by Webster and Watson, as it is based on the examination and analysis of key concepts pertaining to RPA. To conduct an extensive literature review, we initially conducted a comprehensive search for scholarly papers in prominent databases including Elsevier, ASC, ACM, Scholarly Articles, and Research Gate. The search was limited to the period between June and October. The papers were collected by utilising the titles, keywords, and abstracts.

The findings were subsequently subjected to filtration based on the parameters stated below:

Articles that satisfy the above requirements should be published in the English language, have a direct relevance to Robotic Process Automation (RPA), and be readily accessible in an electronic format via internet platforms.
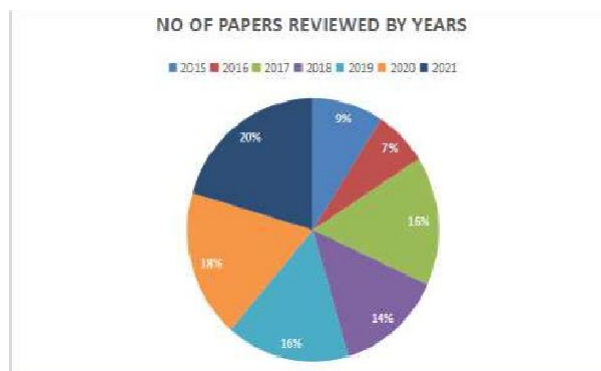

Fig. 4. Pie chart presentation of Research Paper studied

TABLE 2 ANALYSIS OF PARAMETERS ON UiPATH, BLUEPRISM AND AUTOMATION ANYWHERE

Parameters	UiPath	Blue Prism	Automation Anywhere
Front Office/ Attended Automation	Yes	No	Yes
Back Office/ Unattended Automation	Yes	Yes	Yes
Script Based Designer	No	No	Yes
Visual Process Designer	Yes	Yes	Yes but, is more script based.
Openness of the platform	Yes, has free forums and tutorials.	Yes but, all the forums are commercial.	Yes but, all the forums are commercial.
Macro Recorder for Process Mapping	Yes	No, due to their rather Outdated technology.	Yes
Control through Coding	No	Yes	Yes
Execution of Automated Test Cases on Remote Machines	No	No	Yes
Future Scope	Indefinite	Comparatively less	Comparatively less

VI. CONCLUSION

Due As a result of the quick improvements, many different industries are looking for ways to accommodate multiple occupations and processes in the shortest amount of time with the least amount of labour. Because it is necessary to be able to automate this process in order to know which tool to use for the benefit of various industries based on the kind of services they provide, automating the process has become a top priority.

In this work, a full study of all of the tools, including their advantages and disadvantages, as well as the optimal applications for each tool, has been offered. This article claims that UiPath is the greatest automation tool available today, and it presents a test implementation based on the analytic preview and the numerous possibilities for processes that may be enhanced for higher accuracy. In addition, this post contends that UiPath is the best automation tool available today. However, there is a possibility that the total number of users will decrease.

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Study of the Genesis of Fires in Electric Vehicles

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Abstract— **The focus of the study is on the underlying factors that lead to electric vehicles fire incidents. Recently, there has been an abrupt rise in the number of electric vehicle fire incidents, which has resulted in enormous material damage and, to some extent, human harm. This serves as the primary motivation for the study. Due to the rapid advancement of Li-ion battery technology in the last ten years, electric vehicles (EVs) have had a profound impact on the worldwide automotive industry. Furthermore, the danger and risk of fire associated with this battery has proven to be an important concern for EV safety. Failure of BMS optimization, battery rupture, thermal runaway, electrolyte ventilation, rise in temperature, rough handling are some the reasons leading to fire incidents in electric vehicles. Currently, more than 13 lakh EVs are registered in India. According to a survey, Maharashtra, Uttar Pradesh, and Delhi are the top three states with the most electric vehicles on the road. The figures for electric vehicles were fairly small. 52 fires total, with 25.1 fires reported for every 100,000 vehicles sold. In hybrid vehicles, fire incidents may be linked to the combustion of gasoline in the energy-generating engine. But the EV fire incidents are rising, though, as a result of some variables. The study examines various case studies on past electric car fire incidents. It will help one understand the causes of fires in electric vehicles which can avoid future incidents. The precautions for such causes are identified and suggested to the industry. This study includes factors leading to electric vehicle fires, safety measures and firefighting techniques.**

Keywords— Electric Vehicles, Survey, Li-ion battery, Fire incidents, Thermal Runaway, LIBs, BMS

I. INTRODUCTION

There are billions of automobiles on the road today powered by internal combustion engines, and these vehicles consume around 86% of the world's petroleum reserves, which translates to approximately 34% of its total energy. On the other hand, the finite natural resources of the world, an increasing population, and climate change all contribute to an intensification of people's worries about energy insecurity as well as the necessity of growing ecologically friendly transportation options.

For far too long, we have relied upon fossil fuels to power our enterprises, heat our homes, & power our automobiles. Several alternative energy sources are being used today for reduce CO_2 emissions and contribute in the mitigation of global warming, includes nuclear, hydrogen, winds, solar, & geothermal energy [2]. Furthermore, hybrid electric cars (HEVs) & electric vehicles (EVs) are rapidly being developed and are expected to supersede conventional gasoline-powered automobiles. In addition to being the device that is most likely to be nominated as the most likely nominee to stockpile the electric energy that is produced by renewable energy in electric grids, lithium-ion batteries (Li-ion) are viewed as the key technology that will facilitate the transition to electric vehicles (EVs) and therefore replace the conventional vehicle design that is based upon the internal combustion engine [3].

LIBs are currently the most popular power sources for a wide variety of portable electronic devices because of their high working voltage, reduced memory effects, and higher energy density when compared to conventional batteries. As a result of these advantages, LIBs are becoming increasingly widespread. It is fair to assert that LIBs are undergoing phenomenal expansion throughout a very wide variety of business sectors all over the world.

However, the potential for fire and other hazards presented by this type of high-energy battery has emerged as a major concern for the safety of electric vehicles. The most recent concerns regarding the fire safety of electric vehicles are thermal runaway as well as fires in Li-ion battery packs. These issues are the primary emphasis of this review. The conditions of extreme abuse, which may be the result of a malfunctioning operation or traffic accidents, can lead to thermal runaway, which can then result in a fire. In the event that a battery fails, potentially dangerous gases combined with fire, explosion, and jet flames may be emitted. [1].

Road vehicles powered by lithium-ion batteries (LIBs) are expected to be involved in more accidents as they become more widely used. With an on-board energy storage system of conventionally fueled vehicles poses a risk to those involved in accidents or responding to them. While the dangers posed by traditional vehicles are well known and widely accepted in society. It will require time and knowledge to achieve this level of comfort for Li-ion driven road vehicles. When this pertains to EVs, there's the potential that the LIBs will re-ignite from being damaged or extinguished for an extended period of time [2]. This issue affects not only firefighters, but also people who work with damaged EVs in towing, workshops, scrapyards, or recycling operations.

There has been an increase in e - mobility fire incidents since March 2022, mostly involving two-wheelers. There were numerous other incidents in a similar vein. A recent large-scale fire at an Electric vehicle dealership resulted in 8 fatalities and 13 injuries. There was also significant material damage.

In Mangalore, Karnataka, on June 24, 2022, an Okinawa Electric vehicle dealership caught on fire. Okinawa blamed an electrical short circuit for the total destruction of 34 electric scooters in this incident [29]. A 7-year-old boy was killed in an e - scooter battery outburst in Palghar on October 7, 2022, as it was being charged. A 7-year-old boy was killed in an e - scooter battery outburst in Palghar on October 7, 2022, as it was being charged. The incident happened in the Vasai region of the Palghar district. After the event, the boy was transported to a hospital where he succumbed to his wounds after sustaining serious injuries [3].

On October 25, 2022, a significant fire that started in an e - mobility dealership in the Parvatipuram district of Andhra Pradesh destroyed up to 36 electric bikes. On Monday morning, the incident took place at Manam Motors in Palakonda town. The fire destroyed battery packs and e-bikes that have been kept in the dealership for special Diwali discounts. Firefighters quickly responded to the scene and extinguished the flames. Authorities believe that a short circuit started the fire. The mangers of the showroom affirms that the fire caused them damages totaling about Rs.50 lakhs [31]. In Hyderabad, India, an enormous fire started in this e-bike dealership in September 2022, killing eight people [4-5].

The study's primary motivation is the rise in fire incidents. The study includes the causes of these occurrences and methods that first responders should use.

II. BATTERY ABUSE

Typical battery systems are vulnerable to external temperature, mechanical, and electrical influences that may occur during intense operating circumstances or accidents, as well as a low risk of self-ignition. For the majority of portable electronic devices, like the laptop and smartphone, electrical impacts and extreme operational conditions are relatively uncommon, but they are still regarded as the typical operating conditions. The operating conditions for an EV battery, on the other hand, are more demanding due to the frequent acceleration and deceleration in challenging road and traffic situations. Additionally, EVs have thousands of times more battery capacity than portable electronic devices, which increases the risk of fire in the event of thermal runaway and ignition.[6]

The three major categories into which battery abuses are Mechanical Abuse, Thermal Abuse and Electrical Abuse.

Mechanical Abuse: - Without protection of a battery module and/or pack enclosure or an EV structure, the majority of conventional LIB cells are fairly brittle. An EV's lifetime may experience a traffic accident, like any other regular car. However, the majority of collisions won't harm the battery thanks to the modern style of LIBs and EVs. To reduce the chance of being penetrated during a crash, LIB packs are typically integrated into heavily fortified areas of the vehicle [13]. Even the greatest level of protection, however, is insufficient to reliably prevent fire at high speeds, which some EVs seem to be capable of accomplishing in a very short period of time. When a vehicle is involved in an accident and the battery pack is struck, there is a chance that

the internal battery structure will deform and the separator will tear. This will result in a short circuit because the anode and cathode will come into contact [7].

Thermal Abuse: - Users anticipate being able to drive their EV in all conditions, including extremely hot and cold ones, just like they would a conventional internal-combustion vehicle. For instance, EVs are anticipated to function both in the coldest and wettest conditions. The battery works best at room temperature, just like people do. Extreme heat and cold have a negative impact on battery performance and reduce battery life. Overheated batteries can result from unintended chemical reactions that take place in high-temperature environments . Battery thermal abuse can take the form of Over Heating of the battery pack . Such circumstances result in situations like the collapse of the separator in the battery which causes short circuits to happen [8-9].

Electrical Abuse: - The aims of rapid charging and discharge for electric vehicles, in addition to excellent driving performance, have a negative impact on the fire threat that these vehicles provide. LIBs are constructed such that they can take in and store a particular quantity of energy over the course of a defined amount of time. If these restrictions are surpassed, which can happen while charging very quickly or to an excessive degree, the device's performance may suffer, and it may fail sooner. The first one generates heat, whereas the second one might, at some point in the future, cause an internal short circuit. Some fires that start in electric vehicles could have been caused by incorrect operating conditions and internal faults, such as a short circuit in the high-voltage power circuit, excessive charging, or an environment that was too hot. It's conceivable that a major number of "self-ignition" or "spontaneous ignition" accidents are linked to poor manufacturing and design methods, in addition to defective electronically regulated systems, BMS, and electrical gearbox control mechanisms. This is in addition to the fact that battery cell failure is a potential cause of these incidents. [10].

III. THERMAL RUNAWAY

Thermal runaway (TR) is the most disastrous lithium-ion battery failure mode, must be prevented at all costs. Overcharging, internal cell short circuiting, and vehicle accidents are all potential causes of this condition.

A. What is Thermal Runaway?

A thermal runaway is defined as a series of uncontrollable exothermic events that result in an uncontrollable rise in cell temperature. Another definition of a thermal runaway is an accelerated release of heat from within a cell. [11-13]

B. Factors leading to Thermal Runaway in Lithium Batteries.

The term "thermal runaway" refers to an overheating event wherein exothermic chain reactions occur and outpace cooling. It is a commonly observed phenomenon in chemical and combustion processes.
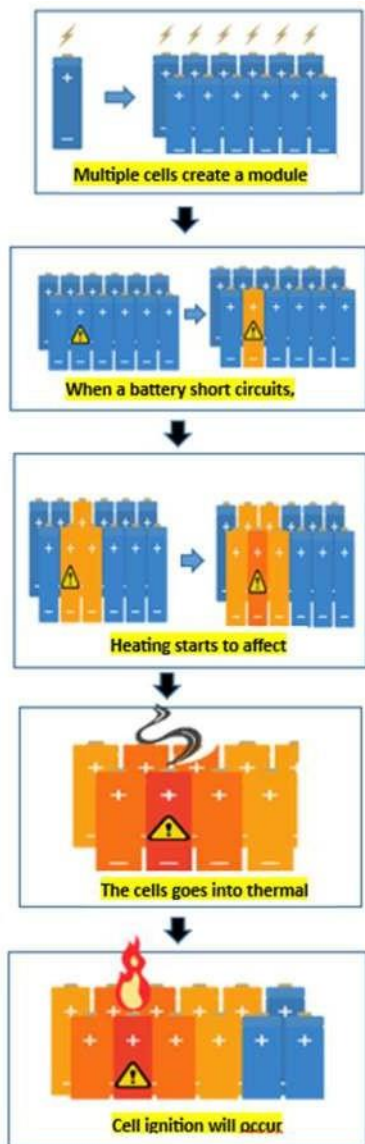
Fig. I Thermal runaway occurrence [25]

Thermal runaway for the LIB typically manifests as a rapidly rising battery temperature (higher than 10°C/min) or the activation of the safety vent, both of which signify the initiation of exothermic thermochemical and electrochemical reactions. When a battery thermal runaway occurs, a lot of black smoke, hot sparks, and strong jet-flames are frequently ejected as well. This process occurs within each individual cell, so the risk potential increases if a thermal runaway or fire is allowed to spread throughout the battery [14].

This study mentions a few of the numerous factors that can cause thermal runaway in lithium batteries.

Over Charging: - When the battery management system (BMS) is malfunctioning, overcharging is yet another common electrical abuse form. There was a lot of interest in the overcharge failure mechanism. The cathode's structure is altered as lithium is permanently removed from the cathode. If the cell is overcharged further, the cathode resistance will rise, increasing the cell's temperature due to Joule heating.

Additionally, the electrolyte will interact with the highly oxidized cathode, rupturing its structure and raising the cell's temperature [15].

Over Discharging: - Dendritic crystals continue to form on the side of the negative electrode during the over-discharging cycle, pass through the separator, and then form a bridge between the positive and negative electrodes. This may result in the separator collapsing and creating an internal short circuit. Over discharging may not result in explosions or fires in the cells, but it may result in internal short circuits, which may ignite a fire [16-17].

Overheating: - Lithium batteries can become too hot for a number of reasons. The battery begins to heat up as a result of the additional charge accumulation when the BMS malfunctions and reduces the charging after it has finished. This might cause the separator to collapse due to development of dendrites. The system develops heating problems if the vehicle is handled roughly, i.e., a heavier load is carried than the vehicle is capable of. One of the main causes of overheating is improper ventilation [8]. Proper ventilation is critical for dissipating the system's heat. The age of the battery can also be responsible for the overheating.

Failure of BMS: - The battery and also the vehicle system are closely related, and the battery management system, or BMS (Battery Management System), is in charge of regulating the charging as well as discharging of the battery and instituting features like battery state estimation. If the red flags are ignored, BMS failure causes thermal runaway and also fires. When the BMS malfunctions, the connection between the BMS and the ECU is unstable or occasionally completely severed, which can result in a power supply that is unstable or non-existent [18]. The BMS is also in charge of estimating the battery temperature and power, so if it malfunctions, that could be irksome for the user or even result in fires [19]. There may be a risk of fires in electric vehicles as a result of these serious factors. The majority of the variables interact with one another.

IV. EV FIRE SAFETY PRECAUTIONS

Electric vehicle risks and hazards are not yet fully understood. Full-scale EVs and large-scale rechargeable batteries require costly fire tests, which are rarely divulged. With the growth of the electric vehicle market, EV owning is steadily rising. The energy density of LIBs keeps increasing despite unresolved fire safety issues [20]. As a result, there will be a greater chance of an EV fire. These fire risks are examined in this study. [20-22]

Safety measures related to the electric vehicle fires are mentioned below.

TABLE I. PRECAUTIONS FOR CHARGING AN ELECTRIC VEHICLE

Sr. No	Precautions
1	To keep the batteries' temperature constant, store them at room temperature.
2	Battery Swapping can be done to avoid the use of warm batteries.

3	Do not charge the batteries within 1 hour of use.
4	Charge the battery using the standard charger provided by the supplier
5	Avoid fast charging, use the slow charger to maintain the health of the battery
6	Charge in a well-ventilated area
7	While charging, first plug the battery side and then the AC side. Do the opposite post charging.

TABLE II. PRECAUTIONS FOR WASHING AN ELECTRIC VEHICLE

Sr. No	Precautions
1	High-Pressure water cleaning is prohibited.
2	Cover the sensitive electric parts while washing the vehicle.
3	Ceramic washing is recommended for the vehicle.
4	Pressure below 0.5 Bar is recommended for washing

TABLE III. PRECAUTIONS FOR HANDLING AND MAINTENANCE OF AN ELECTRIC VEHICLE

Sr. No	Precautions
1	If the vehicle went through an accident, then it should be checked for battery rupture before washing it.
2	Do not park the vehicle as well as charge it under direct sunlight for longer period of time.
3	The vehicles should not carry weight more than its capacity, which directly impact on the controller, battery and motor.
4	Maintain the prescribed air pressure in tire in case of vehicles having In-Wheel / Hub motors. If not maintained it can cause damage to the motor if the vehicle goes through irregular road surfaces.
5	Avoid thoroughly draining the EV battery.
6	When not in use, avoid full charging the battery.

There will be decrease in the Electric Vehicle fire incidents if precautions are taken by the manufacturer as well as the vehicle owners. The manufacturers should not compromise in quality of components used and the vehicle owner should not compromise regarding the timely maintenance of the vehicle.

V. ELECTRIC VEHICLE FIRE FIGHTING TECHNIQUES

Electric vehicle fires differ from conventional vehicle fires in several ways. Compared to conventional vehicle fires, EV fires burn hotter, longer, and use more water and resources [11]. After a fire, there are two different types of responders. The first responders are in charge of taking over and putting out live fires, while the second responders are in charge of handling things like insurance claims, etc. In fire incidents involving EVs, distinct fire-fighting methods are used.

Fire-fighting techniques for Electric Vehicle fires are mentioned below: -

TABLE IV. FIRE-FIGHTING TECHNIQUES FOR EVs

Some EV manufacturers, like Tesla, have started offering first responders instructions on how to handle fire incidents involving various Tesla EV models. First responders can benefit from this education, and vehicle users will gain insight into what to do in the event of such incidents.

VI. CONCLUSION

The study is based on the factors that cause battery cells to enter a condition of thermal runaway, how that state develops, and what can happen if a cell enters that state. EV fires are more challenging to extinguish because of the possibility of battery re-ignition and the challenges associated with cooling the battery pack inside. Water is the most effective way to extinguish a flame in an electric vehicle, and lots of it is needed to cool the battery and to kill the flames. But fewer suppressors are needed when the battery pack is directly sprayed. Unfortunately, very less that is available on the fire risk caused by deserted EVs & battery packs. Additionally, a variety of Electric Vehicle firefighting techniques are included in this research because Electric Vehicles cannot be extinguished using conventional firefighting methods. Not only should the manufacturer take precautions to prevent such fire incidents, but the owner or user of the vehicle should also take the necessary measures to avoid mechanical, electrical, and thermal abuse of the batteries. The electric car

Sr. No	Precautions
1	Use a lot of water to cool the high voltage battery if it burns, and is exposed to a lot of heat, or is damaged in any other way.
2	Never put out a fire with a little water. Always establish a supplemental water supply or ask for one.
3	Check the high voltage power pack is entirely cooled using a thermal imaging camera before leaving the scene.
4	Once it is assessed that the battery has completely cooled, it must be kept under observation for at least an hour.
5	Only after a hour has gone by with no warmth detected should the car be released to second responders such as police enforcement and towing staff.
6	Always warn second responders that the battery could re-ignite.
7	Always keep the car in an open space at a distance of at least 50 feet (15 meters) from any exposure.
8	Consider the whole vehicle to be energized when there is a fire. No part of the car should be touched.
9	When a battery smokes or becomes hot, toxic fumes are produced. Among the vapors are sulfuric acid, CO_2, nickel, lithium, copper, & cobalt oxides.
10	Always put on full protective gear, including a breathing apparatus (SCBA)

manufacturers like Tesla have already begun giving their

customers guides to get them ready for fire scenarios. The same provision should be made by every manufacturer to prepare their customers for the worst-case scenarios. To better inform first responders about EV fire incidents and the fire-fighting methods used to combat them, workshops should be held. Since the two types of vehicles' power sources differ, electric vehicles shouldn't be treated the same as those with internal combustion engines. If these vehicles are used in accordance with the manufacturer's instructions, numerous fire incidents can be avoided. This study's objective is to support researchers and companies engaged in battery, electric vehicle, and fire safety-related work.

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Time Table Scheduling System

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ABSTRACT

In an organization timetable's are accessed by hundreds of users on the daily be it the faculty or students. There are various operations associated with the access of these timetables. The problems associated with the existing manual time table management system are the inability to maintain proper records of lectures, the difficulty to organize and arrange meetings of faculty members and the overall need for manual communication between users in case of rescheduling or exchanging lectures. So with the technology of developing web applications, it is feasible to create a timetable software to streamline this process of managing and effectively utilizing the faculty's time and organizations resources.The aim of this paper is to describe efficient and convenient time table management in academic institutions.

Keywords

Database; Web Application.

1.   INTRODUCTION

The difficulties posed by an ineffective scheduling and time table management system are widely recognized. At the start of every academic year, there is immense pressure to create schedules, arrange time slots, allocate resources and account for unexpected teacher absences, among other things. Although there is computerization of all managerial tasks, the scheduling system is executed without automation. Everyone owns a smartphone in today's world. Therefore, with the technology at hand we can rely completely on the efficiency of this system.

The restraints involved in the manual scheduling system are clashing of one or more than one lectures and inefficient communication. While it is preferable for timetables to fulfill all of the required conditions, it is often challenging to meet them. All of the criteria should not be violated in order to create a feasible schedule that accommodates both students and faculty.

The objectives of this project are - to computerize all lecture details regarding student and faculty; to provide simple and easy to grasp scheduling service for faculty members so that the organization's facilities are utilized effectively and in an efficient manner; to streamline the process of scheduling unregistered remedial lectures if and when required.

In this project, we will be having two end users. To name them are - student and faculty. Therefore the login page will include the following fields - Name, Code, two Radio buttons namely, Student and Faculty. If faculty is selected, then a dropdown will appear which contains subject options. The dashboard pages for both users will include their schedule for the day. If there are any amendments to be made, the faculties can do so with the options at hand. The upgraded iteration will be displayed on the student webpage. The staff will also send notifications to the students 15 minutes prior to the next lecture. Therefore, these features help in the refrain of confusion.

2.   LITERATURE REVIEW

An automated system for generating and managing schedules, such as those for schools, universities, or corporations, is known as a timetable management system. In this review of the literature, we will look at the relevant studies on timetable management systems, their advantages, drawbacks, and distinguishing characteristics.

Advantages of Timetable Management Systems: According to several research, employing a timetable management system has the following advantages:

Enhanced Efficiency: By reducing the time and effort needed to establish and manage schedules, timetable management systems free up administrators' time to work on other projects.

Increased Accuracy: By using these technologies, the likelihood of mistakes or conflicts that may occur when making schedules manually is reduced.

Improved Resource Utilization: With the aid of a timetable management system, administrators may allocate resources like employees or classrooms in the most effective way possible.

Improved Communication: These systems give administrators, teachers, and students a consolidated platform to monitor schedules, share information, and talk to one another.

Despite their many advantages, timetable management systems have a number of drawbacks that make them difficult to apply. Some difficulties include:

Data management: These systems need correct and current data to generate efficient schedules, but obtaining and maintaining this data can be difficult.

Complexity: Configuring timetable management systems can be challenging, especially for businesses with specialized scheduling needs.

User Adoption: It might be tough to encourage users to accept a new system and adjust their old workflows.

Technical Problems: Technical problems might interfere with scheduling, such as system outages, sluggish performance, or compatibility problems with current software.

Key Features of Timetable Management Systems:There are several key features that a timetable management system should have, including:

An intuitive, user-friendly interface that is simple to use and navigate should be provided by the system.

Flexibility: The system ought to be adaptable enough to take into account a variety of scheduling needs, such as various course structures, faculty preferences, and resource limitations.

Automatic Scheduling: The system should have the capacity to automatically schedule classes, taking into account variables like the availability of classrooms, teachers, and prerequisites.

Reporting and Analytics: To track important performance metrics like student attendance, resource use, and teacher workload, the system should give administrators a variety of reporting and analytics capabilities.

In conclusion, a schedule management system can provide organizations with a variety of advantages, such as enhanced productivity, better accuracy, and more effective use of resources. These systems can, however, also be difficult to operate, complicated, difficult for users to accept, and have technological problems. A schedule management system should include essential elements such a user-friendly interface, adaptability, automatic scheduling, and reporting and analytics capabilities in order to handle these issues.
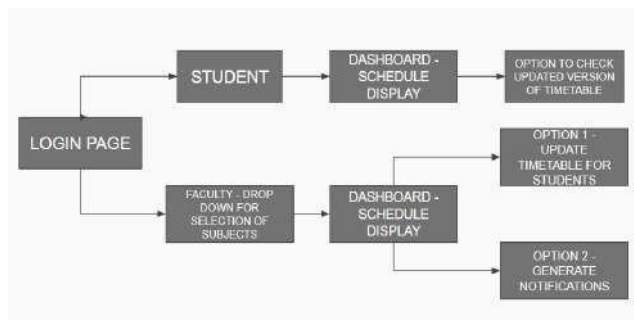
3. FIGURES/CAPTIONS

Figure 1. Flowchart

In this figure, we observe the series of flow of events for both the end users - Student and Faculty.

For student users, they can view the displayed timetable for the specific day and date. If there are any alterations in the day, they

can check them by clicking on the CHECK UPDATES button. Also, they will receive notifications from the faculties 15 minutes prior to the next lecture.

For the faculty users, on the login page itself, they will have to choose their teaching subjects and then their timetables will be displayed too on the dashboard. They have the option of changing or rescheduling any lecture. Accordingly, they can generate notifications.
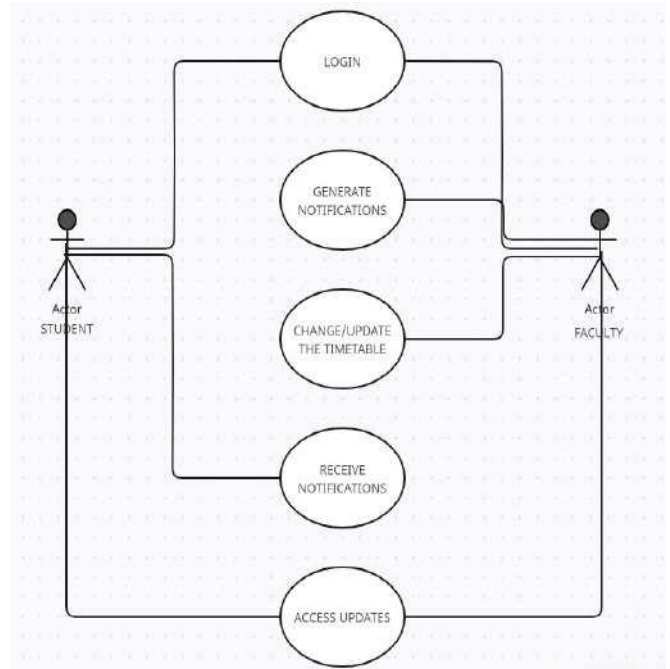

Figure 2. Use case diagram

UML diagram is a class diagram that represents the relationships between different classes in a software application.

Here in this diagram we analyze the factors that influence the requirements and showcase their interactions. As we can see, STUDENT and FACULTY are the actors here. Their relationship is defined through the five functionalities/use cases.
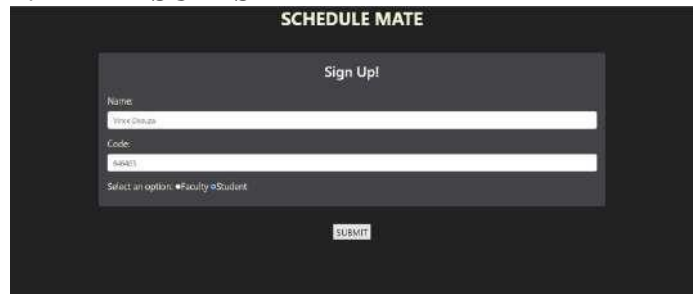
4. RESULTS

Figure 3. Login page - Student

Here, we observe the fields for entering name and code for a user. They will select if they are a student or faculty member using the

radio button. On clicking the submit option, we will be directed to the dashboard.

Figure 4. Login page - Faculty

In this particular page where the faculty radio button is selected, we can witness that a dropdown opens. Here the staff can click on the subjects they teach and proceed accordingly.

5. CONCLUSION

In conclusion, this timetable scheduling system can bring numerous benefits to organizations, including increased efficiency, improved accuracy, and better resource utilization. However, these systems can also present challenges such as data management, complexity, user adoption, and technical issues. To address these challenges, a timetable management system should have key features such as a user-friendly interface, flexibility, automated scheduling, and reporting and analytics tools. To effectively tackle the challenges associated with schedule management systems, it is important that these systems incorporate crucial components such as an intuitive interface, flexibility, automated scheduling functionality, and reporting and analytics capabilities.

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Multiple Object Detection, Object Tracking, Lane Tracking, and Motion Detection Shadow Robotbased on Computer Vision

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Abstract—Multiple object detection, object tracking, lane tracking, and motion detection are the four crucial and difficult tasks in the Shadow robot. A dynamic background, clutter, occlusion, shadows, cluttering, noise, etc. make it difficult. The fundamental processes of a shadow robot's multi-camera video analytics include object detection, tracking, object matching across several cameras, and reidentification. Multiple object recognition and tracking of contents from resourceful city videos may be produced according to the suitability of society like Autonomous/Self-Driving vehicles, far-sighted clever inspection devices, traffic congestion administration devices, vehicle navigation, smart health management facilities, etc. Multiple object detection, object tracking, lane tracking and motion of moving objects are techniques used in computer vision and image processing. Several techniques are used to compare multiple consecutive frames from a movie to see whether any moving objects can be found. Results of the study show that the suggested technique may be used in areas such as object identification, motion detection, autonomous driving systems, and others.

IndexTerms—object detection, object tracking, lane tracking, motion detection, computer vision.

1. INTRODUCTION

Computer vision has emerged as an important technology in different applications such as autonomous driving, surveillance, robotics, and medical imaging. One of the most ambitiousquests in computer vision is multiple object detection, object tracking, lane tracking, and motion detection for moving objects. These tasks are crucial in many real-world scenarios, such as traffic surveillance systems, security surveillance equipment, and human-robot interaction.

Multiple object detection encompasses detecting and localizing multiple elements in a video or image stream. The approach of tracking an item's movement over time in a video stream is termed object tracking. Lane tracking refers to the process of identifying and tracking the routes on a road, while motion detection for things moving is the method for detecting and tracking items that are in motion.

In recent years, considerable improvements have been achieved in computer vision, including the invention of deep learning-based techniques, which have attained progressive level performance in multiple object detection, object tracking, lane tracking, and motion detection for objects moving. These techniques have permitted real-time and exact tracking and identification of multiple objects in challenging conditions.

In this research study, we present a detailed overview of current developments in multiple object detection, object tracking, lane tracking, and motion detection for objects moving using computer vision. We study numerous deep learning-based tactics, like convolutional neural networks, recurrent neural networks, and object detection frameworks, and their usefulness in these tasks. We also analyze the challenges and limitations of these approaches and provide alternative avenues for future research.

2. Objectives
- To find and determine the location of one or more useful targets using still photos or video data.
- To create a robot that can autonomously follow and track a colored item under computer control.
- To determine if an item is moving.
- To design a robot that can follow a course and get where it is going.
- The ESP32 AI Camera on the Android phone will be used to control all of these tasks. e.g., line tracking, object tracking, and object identification.

3. Literature Review
Shijie Sun, Naveed Akhtar, HuanSheng Song, Ajmal Mian, andMubarak Shah, Fellow, IEEE, Deep Affinity Network for MultipleObject Tracking, IEEE TRANSACTIONS ON PATTERNANALYSIS AND MACHINE INTELLIGENCE, VOL. 43, NO. 1,JANUARY 2021.
The proposed Deep Affinity Network (DAN), a

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deep learning-based approach for posture estimation and tracking, trains compact, CNN for simultaneous detection and tracking inside the detection framework R-FCN.

Arindam Sengupta, Lei Cheng, and Siyang Cao, RobustMulti-object Tracking Using Mm wave Radar-Camera SensorFusion, IEEE Sensor council, VOL. 6, NO. 10, OCTOBER2022.

The radar, an electromagnetic device, andcamera readings in a particular frame are connected using the Hungarian method. A tri-Kalman filter-based architecture is employed as the tracking strategy. The suggested technique delivers promising MOTA and MOTP metrics embracing notably reduced missed detection rates that might enable vast and limited autonomous or robotic systems applications with the safe perceived notion. system resilient by constant object tracking even with single sensor malfunctions using a tri-Kalman filter arrangement.

Hui Zhang, Member, IEEE, Liuchen Wu, Yurong ChenMember, IEEE, Ruibo Chen, Senlin Kong, Attention-GuidedMultitask Convolutional Neural Network for Power Line PartsDetection, IEEE TRANSACTIONS ONINSTRUMENTATION AND MEASUREMENT, VOL. 71,2022.

This research attempts to increase the identification precision of the model and offer an attention-guided multi-task convolutional neural network (AGMNet). The refinable region proposal network (RPN) structure and dynamical training method to increase the resilience of the network, CNN algorithm utilized for Object identification

Xiangkai Xu, Zhejun Feng, Changqing Cao, Chaoran Yu,Mengyuan Li, Zengyan Wu, Shubing Ye, and Yajie Shang, STNTrack: Multiobject Tracking of Unmanned Aerial Vehicles bySwin Transformer Neck and New Data Association Method, IEEEJOURNAL OF SELECTED TOPIC IN APPLIED EARTHOBSERVATIONS AND REMOTE SENSING, VOL. 15, 2022,

Swin transformer neck-YOLOX (STN-YOLOX) object detection technique is employed as the detection module and the G-Byte data association method as the tracking module.

Azarakhsh Keipour, Graduate Student Member, IEEE, MaryamBandari, and Stefan Schaal, Fellow, IEEE Deformable One-dimensional Object Detection for Routing and Manipulation,IEEE, VOL. ROBOTICS AND AUTOMATION LETTERS 7, NO.2, APRIL 2022.

Deformable one-dimensional object detection techniques and Traversing contours for the DOO chain are used to identify the color-based segmentation of the DOO area.

4. Research Methodologies
Esp 32 cam typically uses pre-trained models.
There are just 2 pre-trained models available at present i.e., YOLO and COCO SSD models. From which YOLO pre-trained model is utilized for this project.

4.1 OpenCV
OpenCV is an open-sourced image processing toolkit that is frequently utilized not only in business but also in the area of research and development.

4.2 YOLO Model/Algorithm
YOLO (You Only Look Once) is a common object detection model/algorithm that can identify and categorize several things inside an image or video frame in real-time. YOLO has been trained on big datasets such as COCO (Common Objects in Context) dataset to understand how to distinguish distinct items.

Pretrained YOLO models are accessible to be downloaded, which may be utilized for numerous applications without the requirement for training from scratch. These models have been developed on big datasets and have learned to identify a broad variety of objects, making them appropriate for numerous applications.

For object detection, the cvlib library has been utilized. The package employs a pre-trained AI model using the COCO dataset to recognize objects. The nomenclature of the pre-trained model is YOLOv3.

In ESP 32 Cam AI thinker algorithm is applied for object detection and tracking. There is a particular "AI Thinker algorithm" in ESP32-CAM, which is a development kit made by AI Thinker that integrates the ESP32 microcontroller with a

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camera module. Nevertheless, the ESP32-CAM is meant to be utilized for multiple AI and computer application areas, which might include putting various AI algorithms on the boards.

To implement object detection, object tracking, lane tracking, and motion detection on ESP32-CAM, developers can use various software libraries and frameworks such as TensorFlow, OpenCV, and Arduino IDE. These libraries and frameworks provide pre-trained models and tools that can be used to implement various AI algorithms on the board.To perform object detection, object tracking, lane tracking, and motion detection using ESP32-CAM, developers may utilize several software libraries and frameworks like TensorFlow Lite, OpenCV, and Arduino IDE. These libraries and frameworks include pre-trained models and toolkits that may be used to create different AI algorithms on the board.

4.3 CNNs(Convolutional Neural Networks)

Convolutional Neural Networks (CNNs) have been enormously employed in applications involving computer vision including object detection, object tracking, lane tracking, and motion detection. CNNs are a sort of neural network that are especially well-designed to suit image processing applications since they can learn to extract characteristics straight from raw picture data.

Convolutional Neural Networks (CNNs) is a framework of artificial neural network that are meant to interpret and evaluate visual images. They are commonly utilized in computer vision applications like pictorial classification, object identification, and image segmentation They comprise layers of linked processing units that are trained to detect visual elements in pictures. The layers are often stacked hierarchically, with lower layers gaining knowledge of basic elements like edges/corners, and higher layers acquiring knowledge to recognize greater advanced structures and objects.

Convolutional Neural Networks (CNNs) are often employed for object recognition, tracking, lane tracking, and motion detection because they are capable of autonomously learning key characteristics straight from raw picture data.

CNNs may be utilized both for two-stage and one-stage object identification techniques. Two-stage

techniques, such as Faster R-CNN, employ a region proposal network (RPN) to find areas of interest within a photograph, which are subsequently given to a hierarchical web for enabling object classification and localization. One-stage techniques, like YOLO (You Only Look Once), execute object detection straightly on the full picture in a single pass, which may be more rapid and effective than two-stage systems. In summary, CNNs are often used for object recognition because they can learn key aspects out of unprocessed raw image data, can be trained using huge datasets of labeled pictures, and can be utilized for both two-stage and one-stage techniques

4.4 Object Detection

Object detection runs on computer vision methods that comprise of detecting notable things within an image or video stream and estimating their location and boundaries. Object identification techniques commonly apply a combination ofmachine learning and image processing methodologies, like convolutional neural networks (CNNs), to analyze the input data and identify the objects within it.

Figure 1. Object Detection

4.5 Multiple Object Detection

Multiple object detection runs on computer vision that demands detecting and localizing many entities of different types within an image or video stream. Unlike mono object detection, which only detects one item, multiple object detection systems must be able to identify and find several things simultaneously.
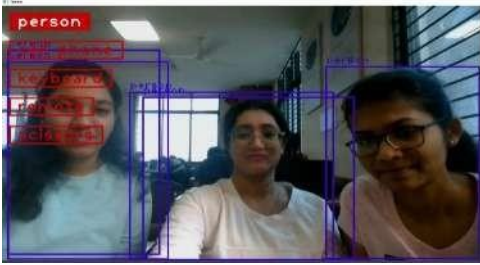
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Figure 2. Multiple Object Detection

4.6 Object Tracking

Object tracking is the process of locating and following an object of interest in a sequence of frames of a video stream. It involves identifying and tracking the object as it moves through the frames, even if the object changes in appearance or motion. Object tracking is a critical component of many computer vision applications, including surveillance, robotics, and autonomous driving.
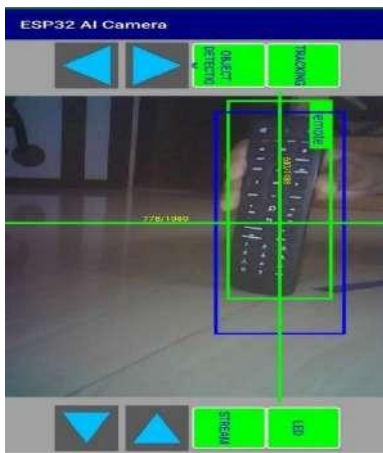

Figure 3. Object Tracking

4.7 Lane Tracking

Lane tracking is the technique of distinguishing and tracking the routes on a highway using techniques of computer vision. Lane tracking is a critical aspect of various advanced driver assistance system(ADAS) technology and self-driving vehicle mechanizations because it enables the car to identify the road layout and keep within the allotted driving lanes. Lane tracking algorithms generally apply image processing techniques to distinguish the lane markers in a video stream recorded by a camera that is affixed to the vehicle. The algorithm then extracts the location and orientation of each lane marker and applies this information to estimate the position of the driving lanes on the road.

Figure 4. Lane Tracking

4.8 Motion Detection

The technique of determining a shift in an object's location in relation to its environment across a period is referred to as motion detection. In this area of computer vision, motion detection is typically used to recognize and trace moving objects in a video stream. The method of motion detection generally includes comparing successive images of a video feed to find locations where there's a substantial shift in pixel values.

This shift may be caused due to the mobility of an item in the frame, changes in illumination, or camera movement.

4.9 PROPOESD SYSTEM
4.9.1. Block Diagram

This diagram is a graphical representation of our system process that shows the components used for our robot. In this block diagram, each block represents the components we have used. The selectivity of our components is as follows:

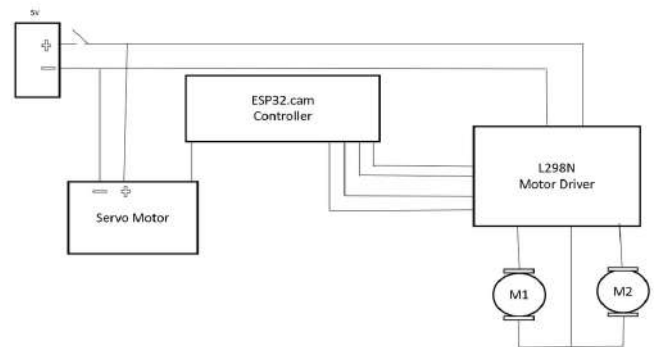ESP32- ESP32 cam used for object detection, lane tracking, and object tracking.

Figure 5. Block Diagram for our robot

Motor Driver i.e., L298N- it is a high-power

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dynamic motor driver.

Use to administer the direction and acceleration of DC motors. Lithium Battery- A lithium battery is a type of rechargeable battery. Constant power is provided. It is temperature tolerant.

Servo Motor- It is an electrical device that can push and rotate objects with great precision.

DC Motors- Converts direct current into mechanical energy helping for rotation of the robot wheels. It operates using direct current.

4.9.2. Circuit Diagram

In this project ESP32 cam for multiple object detection, and tracking of objects and lanes. It is provided with a pocket size lowconsumption of energy, camera module based on ESP 32. It coexists with an OV2640 camera module. It has 10 general input and output pins which are used to interface peripheral devices. It has built-in Wi-Fi, and Bluetooth to develop a web-based user interface that will enable us to operate the robot and give video camera output.
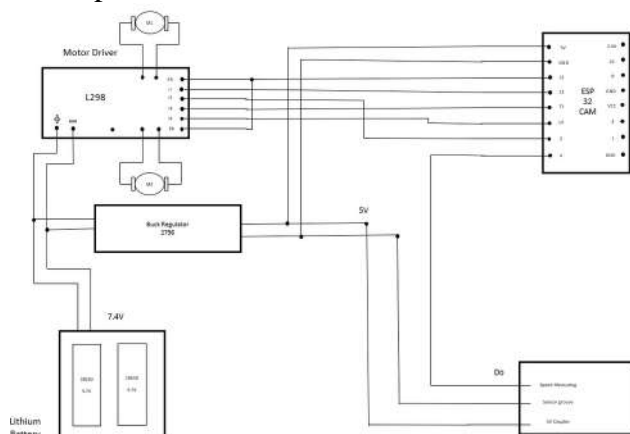

Figure 6. Circuit Diagram

For this project, L298N motor driver module is used. This driver module drives 2 DC motors with 7.4 V DC supplied from a Lithium battery. The direction and speed of the robot are controlled by this unit.

There is a need for 2 lithium batteries each of 3.7V connected in series to give 7.4 V. For ESP32 operating voltage is from the range of 3.3 V to max 5 V. So, for that a buck regulator is used to reduce the voltage from 7.4 V to 5V. A buck regulator i.e., LM2596 is a Step-Down voltage regulator. HC-SR04

module is an ultrasonic sensor module. It is used to measure the distance of the object in front of the robot. Therange of the Ultrasonic sensor is a max of 4m. For speed measurement speed measuring sensor groove couple is used. It counts how many pulses occur per second.

5.Data Analysis and Interpretation

Data analysis and interpretation for object detection, object tracking, lane tracking, and motion detection of objects frequently comprise the following steps:

Data gathering: The first stage in data analysis and interpretation is data collecting. For object detection, object tracking, lane tracking, and motion detection, data is often acquired by different sensors, such as cameras, lidars, and radars.

Data pre-processing: After the data is acquired, it has to be pre-processed to eliminate noise, manage missing values, and normalize the data.

Object detection: Object detection is the act of recognizing items inside an image or video frame. This is often performed by utilizing deep learning-based methods such as YOLO, Faster R-CNN, and SSD.

Object tracking: Object tracking entails monitoring the movement of an item over time. This is commonly done by employing different tracking algorithms like the Kalman filter, Particle filter, as well as correlation filters.

Lane tracking: Lane tracking entails recognizing and monitoring the lanes on a road. This is often done using computer vision-based methods like Hough transforms, Canny edge detection, and Sobel edge detection.

Motion detection: Motion detection entails identifying any changes in the location of objects over time. This is commonly done using background subtraction methods, optical flow algorithms, and frame differencing algorithms.

Interpretation: After the data has been analyzed, object detection, object tracking, lane tracking, and motion detection techniques may be utilized to extract insights and create predictions about the behavior of objects in the environment. Thisinformation may be utilized for a multitude of

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purposes, like automated driving, surveillance, and robots.

Altogether, data analysis and interpretation for object detection, object tracking, lane tracking, and motion detection entail gathering and processing data, using different algorithms to extract insights, and utilizing those insights to make predictions and judgments.

6. RESULTS

True Positive(TP)-the number of cases accurately labeled as the given class.

False Positive(FP)- the number of cases wrongly labeled as the given class.

True Negative(TN)-the number of cases appropriately labeled asthe given class.

False Negative(FN)-the number of cases falsely labeled as the given class.

Accuracy= TP+TN/TP+TN+FP+FN

Table I. Accuracy Result

Total	Identified (TP+TN)	Unidentified (FP+FN)	Accuracy in % TP+TN/ (TP+TN+ FP+FN)
50 people	45	5	90
75 books	69	6	92
150 Cell-phones	135	15	90

Calculating average accuracy from the above table
Average Accuracy = 90+92+90/3 = **90.6%**

6.1. Robot

This figure shows the actual hardware structure of the robot. It's the view of the robot from the front side and upper side.
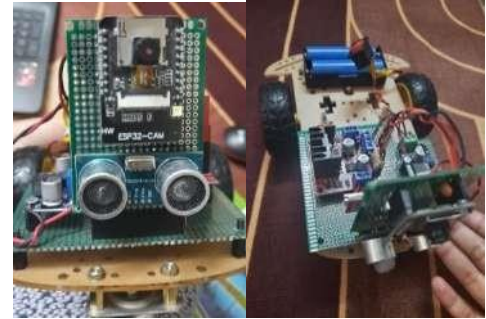

Figure 7. Robot Structure

6.2. Object Detection

The resulting figure of the object detection shows the performance of the model in identifying and localizing objects within an image. It may display the bounding boxes around the detected objects, and any relevant classification labels.

Figure 8. Detected objects such as book, mouse, person, cellphone, scissors respectively.

6.3. Object Tracking

Tracking of the book is done whenever it is moved i.e., it will track whenever the object is moving. In a similar manner, whenever the object is in motion it will track it.

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6.4. Lane Tracking

The robot is following the lane and accordingly will change its direction. The figure displays the detected lane markings, the predicted trajectory of the vehicle, and any relevant performance metrics such as lane deviation. It is also called a line follower robot.

Figure 10. Tracking of lane/path

6.5. Motion Detection

This figure shows how motion detection will detect the change in the position of an object relative to its surroundings the position of the object during its motion will also be detected and from this figure, we can see the x-axis and y-axis values to determine that the object is in motion.

**Figure
11. Motion Detection of Remote**

7. APPLICATIONS AND LIMITATIONS

Object detection, object tracking, and lane tracking are crucial components of several computer vision applications, including autonomous cars, surveillance systems, and robots. Listed below are a few examples of how these strategies may be applied:

Automated cars: Item tracking and detection are needed for automated vehicles to move through their surroundings safely. By recognizing and monitoring items such as people, other cars, and signposts, an autonomous vehicle may make judgments on how to proceed safely through traffic. Lane tracking also is necessary for autonomous cars to remain inside their allotted lane.

Surveillance systems: Object tracking and detection may be used to monitor a certain region for any suspicious activities or items. For instance, if a surveillance system has been set up in a parking area, object detection may be used to identify and track any automobiles or persons moving in the vicinity. Lane tracking may also be beneficial for surveillance systems to monitor any cars that may be attempting to enter or exit the area.

Robotics: Item recognition and tracking are necessary for robots to recognize and operate things in their surroundings. For instance, a mechanical arm in a manufacturing plant may employ object detection and tracking to gather up and move products on a conveyor belt. Lane tracking may also be beneficial for robots to access a warehouse or industrial plant.

Overall, the applications of object recognition, object tracking, and lane tracking are numerous and have many potentials uses in many industries.

Motion detection seems to have a range of uses, including:

Surveillance cameras: Motion detection is also utilized in video surveillance systems to initiate recording when movement is detected. This may assist reduce storage capacity and make it simpler to discover certain moments in the recorded film.

Home automation: Motion detection is widely used in home automation systems to initiate particular activities, such as switching on lights whenever anyone enters a room or shutting off appliances when a room is vacant.

Games: Motion detection is utilized in gaming systems to monitor player movements and enables even more realistic gameplay experiences.

Health monitoring: Motion detection may be used in health monitoring devices to measure

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movement and identify changes in levels of activity, which can be beneficial for persons with chronic diseases or for older folks who might need further support.

Industrial automation: Motion detection is often utilized in industrial automation systems to identify whether the equipment is working outside of typical parameters or when there is an unexpected item or person in an unauthorized area.

The issues thataffect object recognition, object tracking, lane tracking, and motion detection are as specified:

Luminescence variation: Surface light variation carried on by daylight variations, weather, obstructions to light sources, etc.

Noise in images: Noise is the component that most impacts the visual attribute of the video frame. A poor-resolution video might make moving object detection and tracking might be challenging. In real-time, the topic might be obscured by other objects totally or partly. Yet, the approach is prone to complete occlusion.

Existence of shadow: Shadows arise whenever the source of light is obscured. monitor both extremely slow as well as very fast-moving objects.

Clutter: It suggests a complex backdrop that renders detection and tracking harder.

Complicated object motion: It could be challenging to track both extremely slow and rapidly moving objects.

8. CONCLUSION

In conclusion, object detection, object tracking, lane tracking, and motion detection are significant computer vision methods that are extensively employed in diverse applications such as autonomous cars, surveillance, and robots.

Object detection is the act of recognizing and localizing objects in an image or video, whereas object tracking is the process of tracing an item's movement through time. Lane tracking includes identifying and pursuing the lanes on a road, which is helpful for autonomous vehicle systems. Motion detection is the technique of recognizing changes in the location of items in a scene over time.Each of

these strategies has its benefits and disadvantages, and the option of which one to utilize relies on the unique application needs. Item recognition and tracking are especially valuable for security and surveillance purposes, while lane tracking is vital for self-driving automobiles. Motion detection is a pivotal building element for several computer vision approaches and may be utilized in a broad variety of applications.

Overall, these strategies have transformed the way machines see and comprehend the world around usallowing the creation of breakthrough innovative technologies that havethe possibility of enhancing our lives in countless ways.

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Smart Wheelchair for Old and Disabled

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ABSTRACT

To develop a wheel chair control which is useful to the physically disabled person with his hand movement or his hand gesture recognition using Acceleration technology. It is wheelchair which can be controlled by simple hand gestures. It employs a sensor which controls the wheelchair hand gestures made by the user and interprets the motion intended by user and moves accordingly. In Acceleration we have Acceleration sensor. When we change the direction, the sensor registers values are changed and that values are given to microcontroller. Depending on the direction of the Acceleration, microcontroller controls the wheel chair directions like LEFT, RIGHT, FRONT, and BACK. The aim of this project is to implement wheel chair direction control with hand gesture reorganization

Keywords

smart wheelchair, sensor,mobility aid, Accelerometer

1. INTRODUCTION

For handicapped patients: Some patients that cannot manipulate the wheelchair with their arms due to a lack of force. The wheelchair is operated with the help of accelerometer, which in turn controls the wheelchair with the help of hand gesture. The wheelchair moves front, back, right and left. Now with the Hand Gesture Controlled Wheelchair the handicapped person is independent and he need not to ask for help from any other person to move his wheelchair. Just with the movement of his hand the handicapped person is able to move from one place to another without needing anyone's assistance which also makes him self-dependent. Accelerometer would yield an autonomous device small enough to apply to the fingernails, because of their small size and weight. Accelerometer are attached to the fingertips and back of the hand. Arrows on the hand show the location of accelerometer and their sensitive directions, that the sensitive direction of the accelerometer is in the plane of the hand. The gesture based wheelchair is suitable for the elderly and the physically challenged people who are unfortunate to have lost ability in their limbs due to paralysis or by birth or by old age. Elders find it tough to move inside the house for day-to-day activities without help or external aid. Our proposed system makes use of a wheelchair that can be used by elderly or physically needed. The voice stored in IC could be sufficient to analyze speaker's voice Command. Various safety measurements can also be installed on wheel chair like GPS system to track the wheelchair and its user.Electric Smart Wheelchairs are a type of assistive technology that has revolutionized the mobility of elderly and disabled people. These wheelchairs are designed to provide users with greater independence and flexibility by enabling them to move around more easily, comfortably and safely. This research paper aims to explore the benefits of electric smart wheelchairs for old and disabled people, their features, and the latest technological advancements in this field.

2. LITERATURE SURVEY

2.1.P. Upender, P.A. Harsha Vardhini, "A Hand Gesture Based Wheelchair for Physically

Handicapped Person with Emergency Alert System", 2020 5th International Conference on Recent Trends on Electronics, Information, Communication & Technology (RTEICT-2020), November 12th & 13th 2020. The developed system is capable to control the wheelchair motion for disabled people using hand gesture. Improvements can be made by using various body gestures such as eye gaze, leg movement or head movement accordingly. The switching operation for the mode selection that is either touch pad or accelerometer is separated by using a switch. This adds up to the efficiency of the wheelchair and reducing the cost and size of the system. The proposed wheelchair can be used in many applications such as hospitals, old age homes and airports etc.

2. 2 Priyanka Lokhande, Riya Prajapati and Sandeep Pansar Data Gloves for Sign Language Recognition
system 2015 International Journal of Computer Applications (0975 – 8887), National Conference on
Emerging Trends in Advanced Communication Technologies.
This proposed model is for sign language recognition using flex sensors. The project's heart, the
Glove, is where the sign language translator begins. The black glove has nine flex sensors, four touch
sensors, one two-dimensional x-y-axis accelerometer, and one one-dimensional z-axis accelerometer.
The flex sensors are the most significant sensors since most letters can be recognized based on finger
flexes. All fingers, with the exception of the thumb, have two flex sensors, one at the knuckle and the
other at the lower joint. As a result, these fingers can flex to two different degrees.

2.3 Smriti Prasad, Darshana Sakpal, Soukhya Rawool, "Head-Motion Controlled Wheelchair", 2017 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology (RTEICT), May 19-20, 2017, India. This research paper is about head-motion controlled wheelchair that would provide the flexibility of navigation. The tilting movements of the head in the four directions- forward, backward, right or left- would cause the wheelchair to move in the signalled directions. This paper represents a novel approach to developing a headmotion controlled wheelchair and aims to replicate the electric wheelchair on a small-scale

basis and show its working and advantages over other electric wheelchairs available in the market

2. Nida Riaz, Junaid Bin Aamir, "Electrical wheelchair with retractable solar panels" on the proceedings of Energy Systems and Policies (ICESP), 2014 International Conference. This research paper, emphasizes the need to use non-conventional energy like solar energy for powering the wheelchair. The system, as the author admits, has some portability issues. They may be addressed by the future technologies by reducing the size and weight of solar panels. In the present-day market, it is not cost effective either

3. METHODOLOGY

The electric smart wheelchair is designed to assist individuals with mobility issues. They are an essential tool for people who have difficulty walking, standing or sitting. Electric smart wheelchairs are motorized and can be operated with the help of anAccelerometer. The chairs are equipped with sensors that enable them to detect obstacles and avoid collisions. They can be used indoors and outdoors, making them versatile and convenient for usersResearch and User Analysis: Conducting research and user analysis to understand the needs and requirements of the target users. This step involves analyzing the physical, cognitive, and sensory abilities of the elderly and disabled people, and understanding their preferences and limitations.

Concept Development: Based on the user analysis, develop concepts for the electric smart wheelchair. This step involves brainstorming and sketching out several ideas, evaluating them based on the user needs, and selecting the most feasible ones.

Testing and Evaluation: Testing the prototype to evaluate its performance and usability. This step involves conducting user tests to assess the user experience, functionality, and safety of the wheelchair.

Refinement and Optimization: Based on the test results, refine and optimize the design of the electric smart wheelchair. This step involves making modifications and improvements to the design to address any issues or shortcomings identified during the testing phase.

Production and Manufacturing: Once the design is finalized, the electric smart wheelchair can be manufactured and produced. This step involves selecting the appropriate manufacturing methods and processes to produce the wheelchair at scale.

Marketing and Distribution: Finally, the electric smart wheelchair can be marketed and distributed to the target users. This step involves developing a marketing strategy, identifying distribution channels, and reaching out to potential customers.
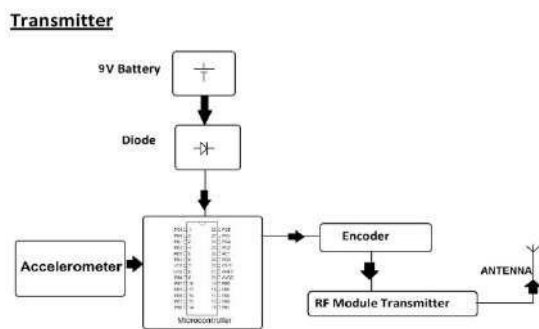
3.1 BLOCK DIAGRAM

Fig 1: - BLOCK DIAGRAM
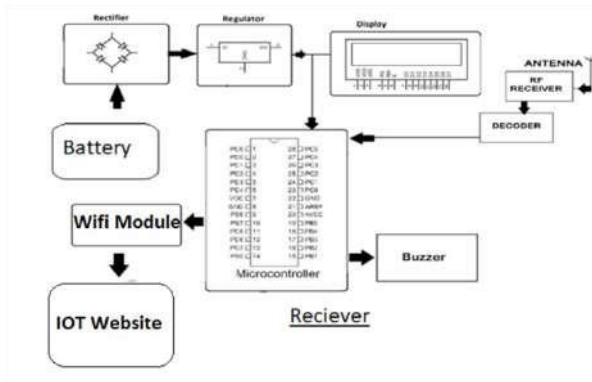
Fig 2: - BLOCK DIAGRAM

3.3 ADVANTAGES

Smart wheelchairs offer a variety of advantages for old and disabled people, including:Improved mobility: Smart wheelchairs allow users to move around independently, which can greatly enhance their mobility and quality of life. With features such as joystick controls, voice recognition, and obstacle avoidance technology, smart wheelchairs can help users navigate their environment more easily and safely.Increased independence: By enabling users to control their wheelchair more

effectively and with greater ease, smart wheelchairs can help people with disabilities and the elderly maintain their independence for longer. This can help boost their confidence and self-esteem, and reduce feelings of isolation or dependence on others. Customized features: Smart wheelchairs can be customized to suit individual needs, with options such as adjustable seating, specialized controls, and add-on devices such as communication aids or environmental control systems. This ensures that users can get the exact features they need to maximize their comfort and functionality. Improved health outcomes: With better mobilityand independence, smart wheelchairs can help improve overall health outcomes for users. Regular movement and activity can help reduce the risk of conditions such as pressure sores, obesity, and depression, and can help maintain muscle strength and joint flexibility. Better connectivity: Many smart wheelchairs are equipped withconnectivity features, such as Wi-Fi or Bluetooth, which can help users stay connected with family and friends, access online resources, and control other devices intheir environment. Overall, smart wheelchairs offer a range of benefits for old and disabled people, helping to improve their mobility, independence, and overall quality of life.

4. HARDWARE

Motors and wheels: These are the primary components that enable the wheelchair to move. Smart wheelchairs often feature advanced motor technology that allows for smoother and more precise movement, as well as better control over speed and direction.

Communication and connectivity systems: Smart wheelchairs may feature Wi-Fi, Bluetooth, or other connectivity options that allow the user to communicate with other devices or access online resources. Seat and backrest: The seat and backrest of a smart wheelchair are designed to provide maximum comfort and support for the user, and may feature adjustable features such as tilt, recline, or height. Additional features: Smart wheelchairs may include additional features such as automated doors, voice recognition software, or specialized control systems for people with specific disabilities. These features are designed to make the wheelchair more accessible and user-friendly for a wider range of people.

4.1 ESP32

the esp32 is a powerful microcontroller developed by espressif systems. it is a successor to the esp8266 and is designed to provide wireless connectivity for internet of things (iot) devices.

the esp32 features a dual-core processor with a clock speed of up to 240mhz, 520kb of sram, and 4mb of flash memory. it also includes built-in wi-fi and Bluetooth connectivity, making it an ideal choice for iot projects that require wireless communication.

in addition to its hardware features, the esp32 also has a rich set of software libraries and tools, including support for arduino ide, micropython, and freertos, which makes it easier to develop applications on this platform.

the esp32 is widely used in a variety of applications, including home automation, smart appliances, industrial automation, and more. its low power consumption, high processing power, and rich connectivity options make it a popular choice for iot projects of all sizes.

4.2 PIC18F4550 :

pic18f4550 is an 8-bit microcontroller manufactured by microchip with nano-watt technology with enhanced flash, usb, and high-performance. it is a 40-pin microcontroller that comes with several features such as memory endurance, self-programmability, extended instruction set, enhanced ccp module, and addressable usart and 10-bit adc (analog to digital converter). it consists of 4 timers or an external oscillator is interfaced for clocking purposes, 13 channels for adc, adc comparators, and other peripherals. it is convinient to program the pic18f4550 controller and easy to interface with many peripheral devices using 35 programmable i/o pins. with the feature of the usb interface, it provides hassle-free communication between the controller and the pc. the watchdog timer can be reset to use the systems without any human interface.

Features & Specifications:

It uses an 8-bit CPU with 12 MIPS speed and consists of 28 pins. The operating voltage is between +4.0 Volts to +5.5 Volts (where +5.5 Volts is the absolute maximum voltage)It has 24 programmable I/O pins and supports various communication interface. Type of communication interface: USB serial interface for programming the controller (pins 15 and 16); Master/Slave SPI Serial Interface is also for programming the controller (pins 7,18,21,22); Serial programmable UART for programmable (pins 17,18) and 2-wire serial interface used to connect peripheral devices like LCDs and sensors (pins 21,22). It has an ADC module with 10 channels and 10-bit ADC resolution. The timer modules contain one 8-bit and three 16-bit counters. It has 2 analog comparators and 2 PWM channels. The size of program memory or flash memory is 32 Kbytes (10K cycles for

write/erase). The size of RAM is 2 Kilo bytes and the size of EEPROM memory is 256 Bytes. The watchdog timer is the programmable type with a separate on-chip oscillator.

4.3 ADXL335

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ± 3 g. It is a capacitive accelerometer. It works on the principle that when the acceleration is applied to the sensor, the capacitance inside the sensor changes. This change in capacitance is then used to measure the acceleration of the object. It reads off the X, Y, and Z acceleration as analog voltages. By measuring the amount of acceleration due to gravity, an accelerometer can figure out the angle it is tilted at with respect to the earth. Rather than using additional temperature compensation circuitry, innovative design techniques ensure that high performance is built in to the ADXL335. As a result, there is no quantization error or nonmonotonic behavior, and temperature hysteresis is very low (typically less than 3 mg over the — 25^0C to +70^{0}C temperature range).

FIG 5 :- ADXL335

We can calculate angle of inclination or tilt by using X, Y, Z's value. Also, we can calculate Roll, Pitch and Yaw angles with respect to X, Y and Z axis. So first we need to convert 10-bit ADC values into g unit.
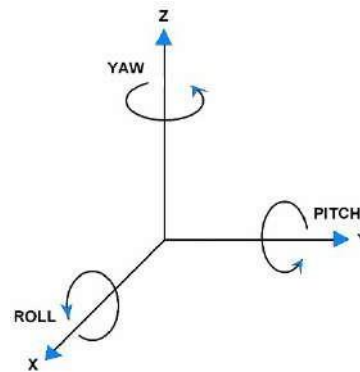
4.4   L293D

L293D is a typical Motor driver or Motor Driver IC. We use motor drivers to give high power to the motor by using a small voltage signal from a microcontroller or a control system.It is a dual H-bridge motor driver IC. One H-bridge is capable to drive a dc motor in bidirectional. It is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. The L293D is most often used to drive motors, but can also be used to drive any inductive load such as a relay solenoid or large switching power transistor. It is

capable of driving four solenoids, four uni-directional DC motors, two bi-directional DC motors or one stepper motor.

FIG 6: -DC MOTOR DIAGRAM

4. DC motor uses Direct Current (electrical energy) to produce mechanical movement i.e. rotational movement. When it converts electrical energy into mechanical energy then it is called as DC motor and when it converts mechanical energy into electrical energy then it is called as DC generator. The working principle of DC motor is based on the fact that when a current carrying conductor is placed in a magnetic field, it experiences a mechanical force and starts rotating. Its direction of rotation depends upon Fleming's Left Hand Rule. DC motors are used in many applications like robot for movement control, toys, quadcopters, CD/DVD disk drive in PCs/Laptops etc. In order to appreciate the benefits of DC motors, it is important to understand the various types. Each type of DC motor has beneficial characteristics that must be examined before purchase and use. Two of the main advantages of DC motors over alternating current (AC) motors are how easy they are to install and that they require little maintenance. DC motors are differentiated by the connections between the field winding and the armature. The field winding can be connected parallel to the armature or connected in a series. In some cases,

the connection is both parallel and in a series. A further distinction of DC motors is how the rotor is powered; it can be brushed or brushless. In brush DC motors, current is applied to the rotor by brushes. In a brushless DC motor, the rotor has a permanent magnet. The main components of the DC motor are stator, shaft and the rotor.
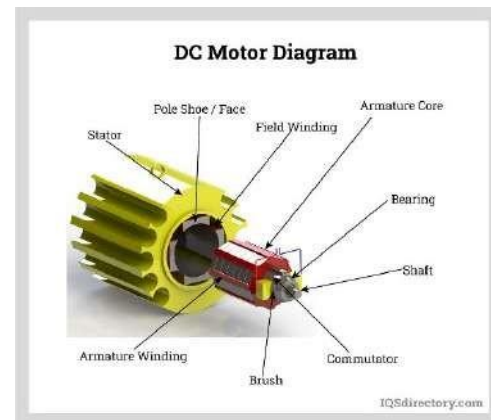
4.6 DHT11

the dht11 is a commonly used temperature and humidity sensor. the sensor comes with a dedicated ntc to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. the sensor is also factory calibrated and hence easy to interface with other microcontrollers. the sensor can measure temperature from 0°c to 50°c and humidity from 20% to 90% with an accuracy of ±1°c and ±1%. dht11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. the humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. change in the capacitance value occurs with the change in humidity levels. the ic measure, process this changed resistance values and change them into digital form.for measuring temperature this sensor uses a negative temperature coefficient thermistor, which causes a decrease in its resistance value with

increase in temperature. to get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers. this sensor is used in various applications such as measuring humidity and temperature values in heating, ventilation, and air conditioning systems. weather stations also use these sensors to predict weather conditions. the humidity sensor is used as a preventive measure in homes where people are affected by humidity. offices, cars, museums, greenhouses and industries use this sensor for measuring humidity values and as a safety measure. it's compact size and sampling rate made this sensor popular among hobbyists. some of the sensors which can be used as an alternative to dht11 sensor are dht22, am2302, sht71.

FIG 8: DHT11
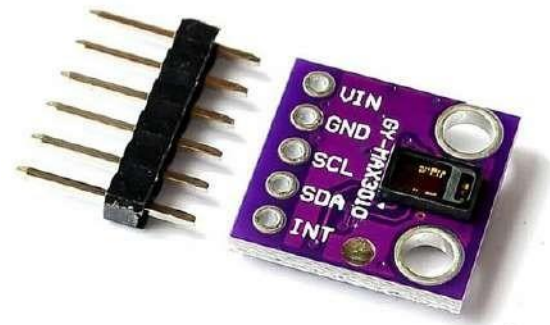
5. MAX30100

MAX30100

The MAX30100 is a pulse oximetry and heart-rate sensor module developed by Maxim Integrated. It is a low-power, integratedsolutionthat uses reflective photoplethysmography to measure blood oxygen saturation (SpO2) and heart rate.

The MAX30100 uses a combination of red and infrared light to measure SpO2 by detecting the amount of light absorbed by oxygenated and deoxygenated blood. It also measures heart rate by detecting the pulsatile signal caused by blood flow in the arteries.

The module consists of an integrated LED driver, photodetectors, analog signal processing, and a digital interface. It is designed for use in wearable health and fitness devices, medical monitoring devices, and other applications that require accurate and non-invasive measurement of SpO2 and heart rate.

The MAX30100 is easy to use and can be interfaced with a microcontroller using the I2C interface. It has a low power consumption, making it suitable for battery-powered applications. The
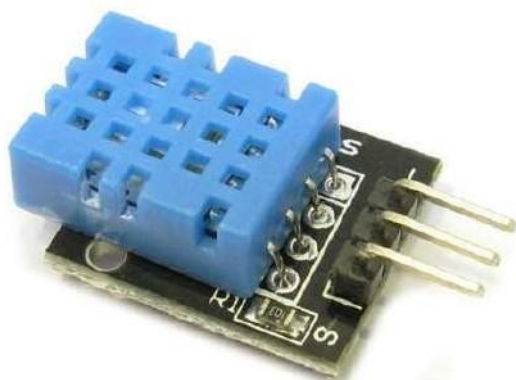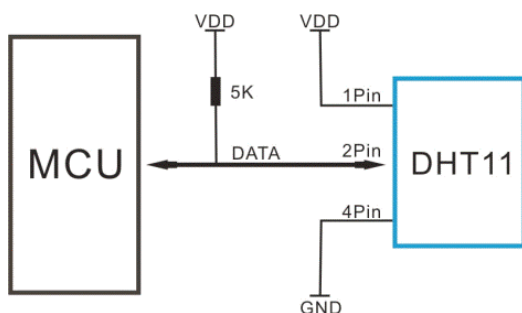
module also includes built-in ambient light rejection and motion artifact detection, which helps to improve the accuracy of the measurements.The MAX30100 is an integrated pulse oximetry and heart- rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals. It is an I2C-based low-power plug-and-play biometric sensor. It can be used by students, hobbyists, engineers, manufacturers, and game & mobile developers who want to incorporate live heart-rate data into their projects.

. CONCLUSIONS

The electric smart wheelchair is an essential tool for old and disabled individuals who have difficulty walking, standing or sitting. These chairs are equipped with advanced technologythat enhances the user's quality of life. They offer a range of benefits, including increased mobility, convenience, safety, comfort, independence, and ease of use. However, they also have some limitations that need to be considered, including cost, maintenance, battery life and weight.Overall, the electric smart wheelchair is an excellent tool for enhancing the quality of life for old and disabled individuals.Electric smart wheelchairs are a valuable addition to the mobility aids for elderly and disabled people. They provide numerous features and benefits that traditional manual wheelchairs cannot match. The development of these wheelchairs has made a positive impact on the lives of many people by improving their mobility, independence, and quality of life. As the demand for mobility aids increases with the aging population, it is essential to continue developing and improving electric smart wheelchairs to meet the needs of users.

Benefits of Electric Smart Wheelchairs:

Electric smart wheelchairs have a variety of benefits over traditional manual wheelchairs. They offer users greater independence, freedom, and flexibility, enabling them to move around more easily and quickly. Smart wheelchairs are also designed with advanced features like intelligent controls, automatic obstacle avoidance, and advanced seating options. These features provide users with greater comfort, safety, and convenience.

Some other benefits of electric smart wheelchairs are:

Automated navigation: The wheelchair can be programmed to navigate through different environments, using sensors and mapping technologies to avoid obstacles and find the best routes.

Remote monitoring: Caregivers or family members can remotely monitor the wheelchair's location and condition, ensuring that the user is safe and comfortable.

Improved Mobility: Electric smart wheelchairs are designed to provide users with greater mobility and flexibility. These wheelchairs can easily move over uneven surfaces and climb slopes, enabling users to explore their surroundings and enjoy their daily activities with greater ease.

Enhanced Comfort: Smart wheelchairs come with advanced seating options like adjustable backrests, headrests, and armrests. These features enable users to sit comfortably and reduce the risk of pressure sores, back pain, and other discomforts.

Increased Safety: Electric smart wheelchairs come with advanced safety features like automatic obstacle avoidance, anti-tip mechanisms, and

remote monitoring systems. These features ensure that users are safe and secure while using the wheelchair.

Features of Electric Smart Wheelchairs:

Intelligent Controls: Electric smart wheelchairs come with advanced control systems that enable users to control the wheelchair with greater ease. These controls can be operated by voice, joystick, or other input devices.

Automatic Obstacle Avoidance: Smart wheelchairs are designed with sensors that detect obstacles and automatically steer around them, preventing collisions and injuries.

Advanced Seating Options: Smart wheelchairs come with adjustable backrests, headrests, and armrests, which enable users to sit comfortably and reduce the risk of pressure sores and other discomforts.

Remote Monitoring Systems: Smart wheelchairs can be remotely monitored by caregivers or family members, enabling them to keep an eye on the user's location, speed, and other vital signs.

Technological Advancements in Electric Smart Wheelchairs:

Artificial Intelligence (AI): AI technology is being used in smart wheelchairs to improve their intelligence and decision-making capabilities. These systems can analyse user data, detect patterns, and provide personalized recommendations to users.

Robotics: Robotics technology is being used to develop advanced smart wheelchairs that can move on their own, without any manual input. These wheelchairs can be controlled by voice commands or other input devices.

Augmented Reality (AR): AR technology is being used to develop smart wheelchairs that provide users with enhanced visual feedback about their surroundings. These systems can detect obstacles, provide directions, and highlight important landmarks.

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Labour Safety & Skill Training Using Virtual Reality, A Case Study- Of Higher Altitude Work.

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Abstract—**As the construction industry has boomed, urban migration has surged, triggering an increase in demand for housing in crowded urban spaces, which leaves us with only one option besides high-rises.**
With a background in high-rise construction, labor safety is one of the foremost concerns. This type of construction has a relatively high accident rate. Researchers and professionals have been motivated by this scenario to find innovative ways to solve the problem. To address this issue, after a given period of time, regular safety training should be implemented. Effective training may refresh the comprehension of existing employees as well as convey critical safety knowledge to new personnel. Virtual reality using hardware meta oculus has enabled us to better understand work fatalities without putting our lives at risk. This paper is based on a case study of planning and creating a VR module for high-altitude safety training. Using an experimental methodology, several features of the VR module were investigated. The results showed that the VR module positively improves high-altitude professionals' perceptions of VR applications as additional training tools.

Keywords—*Virtual Reality, Training, Technology, Project Management, Construction, Meta-Oculus.*

I. INTRODUCTION

According to the Occupational Safety and Health Administration [OSHA], the construction sector has one of the worst rates of work deaths, and the best way to improve the industry's safety performance is to prevent accidents from occurring in the first place. One approach to achieve this goal is to raise construction workers' awareness. Previously, various tactics such as video recordings, handouts, and hands-on training were utilized to instruct construction workers on safety. Each of these strategies has benefits and drawbacks. Virtual reality and other forms of mixed reality technologies have completely changed several facets of the building sector. It provides a distinctive and efficient training technique for personnel in the construction industry, reducing the need to expose them to hazardous site situations. In the context of safety instruction, this immersive and realistic technology outperforms more conventional training choices like movies and handouts. The capacity of this technology to recreate high-risk scenarios is one of the main goals of using it. There are several potential advantages of new technologies for construction training, including cost-effectiveness, accessibility, repeatability, and user customization. They do, however, have certain shortcomings. High upfront expenditures, protracted development times, difficulties with customization, and restrictions on hardware and software are a few of these. However, efforts are still being made to improve VR technology, eliminate these drawbacks, and increase the number of applications for VR-based solutions.

II. AIM

Analyzing the safety issues associated with high-altitude construction work and developing an effective solution utilizing Virtual Reality (VR).

III. OBJECTIVE

1. To study the concept of Virtual reality in labor safety programs working at high altitudes.
2. To analyze problems associated with high-altitude construction work.
3. To find the issues regarding the existing safety training model for high-altitude work.
4. To propose a safety training module for high-altitude construction work using virtual reality.
5. To study the impact of Virtual reality training for high altitude on user groups through survey forms.
6. To suggest Preventive measures for the high-altitude safety training model.

IV. HYPOTHESIS

The construction industry should adopt to VR-based training to overcome accidents & fatalities on-site.

V. SCOPE

The research work is undertaken at Pune locations for the use of VR in the safety training of high-altitude construction work.

VI. LIMITATION

The paper is limited to higher altitude construction work for the Pune region.

VII. LITERATURE REVIEW

Extensive research conducted in recent years has focused on the utilization of VR technology in construction training. Numerous studies have demonstrated that training programs based on VR can lead to significant enhancements in both safety and skill levels among workers.

Similar to this, research by Gok et al. (2018) discovered that VR-based training was successful in enhancing employees' abilities to carry out electrical activities. The study concluded that workers' knowledge, abilities, and confidence in carrying out risky activities may all be improved with the use of VR-based training programmes. Another research by [Rajan et al., 2019] looked at the efficiency of VR-based training in enhancing construction workers' safety and productivity. According to the study, VR-based training programmes increased worker productivity and safety more than conventional training techniques.

When it came to monitoring site activity in the past, safety managers in the construction sector depended on their professional expertise and visual observations. Virtual reality (VR), on the other hand, has become a potent method for visualising digital information as a result of the rapid improvements in information technology (IT). Users may fully immerse themselves in computer-generated models thanks to VR technology, which allows for the construction of immersive and realistic settings. Highly responsive and dynamic computers that can react fast to human interactions, choices, and manipulations underpin this technology. Different inputs, including speech, movement, sound, and location, can be included in VR models. The discipline of advanced construction management has benefited greatly from VR as a result. Virtual reality (VR) technology has been successfully applied in numerous facets of construction

management in recent years. They are useful resources for worker training, safety management, quality and defect control, and visualization. VR technologies help to lower the number of accidents on building sites by offering platforms for monitoring, regulating, and teaching projects. [Ahmed, 2018]. The use of VR in safety management was explored by Li et al. in 2018, and they emphasized the technology's potential in a number of safety-related fields, including hazard risk detection, workforce education, skills transfer, ergonomics, and more. By simulating building operations with VR technology in 2020, Getulietal also enhanced the traditional planning procedure on construction sites. Li et al. divided the uses of VR methods in construction safety into three primary areas in a review study published in 2018: safety planning, safety inspection, and safety training. A minimum level of acceptability for VR in safety training, which attempts to improve danger awareness skills, was typically seen among safety professionals, who frequently favored hands-on activities.

To sum up, VR technologies have demonstrated a great deal of promise in the management of construction safety, delivering prospective advantages in a number of domains while acknowledging the desire for hands-on training among safety experts.

VIII. METHODOLOGY

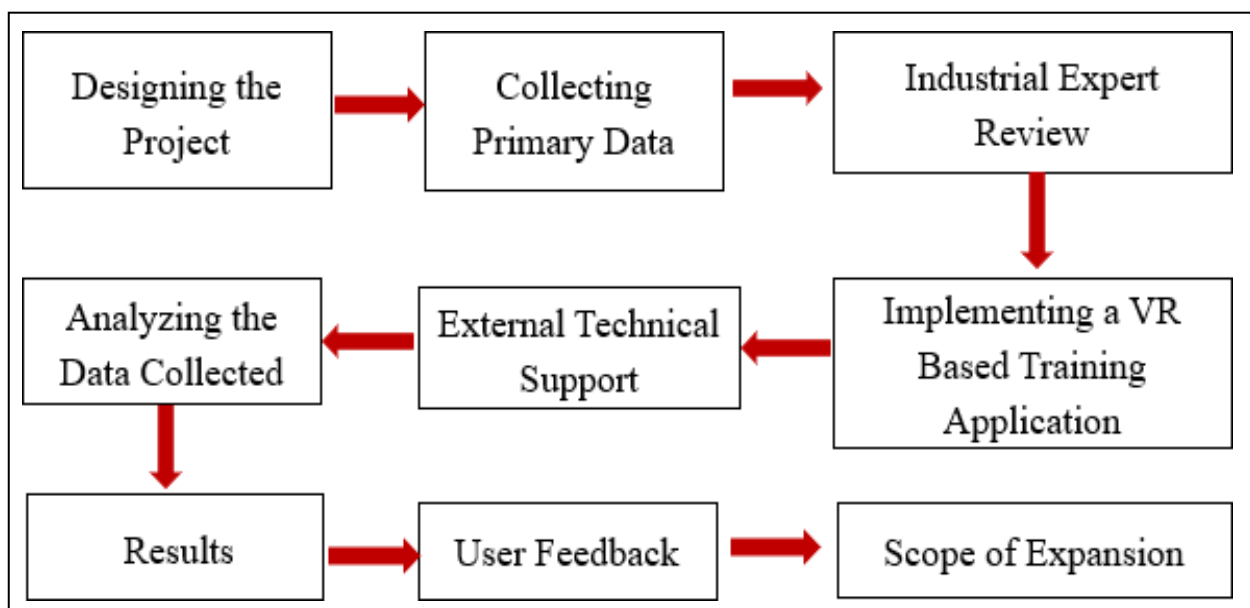This project's primary goal was to determine whether VR technology might be used for safety instruction.

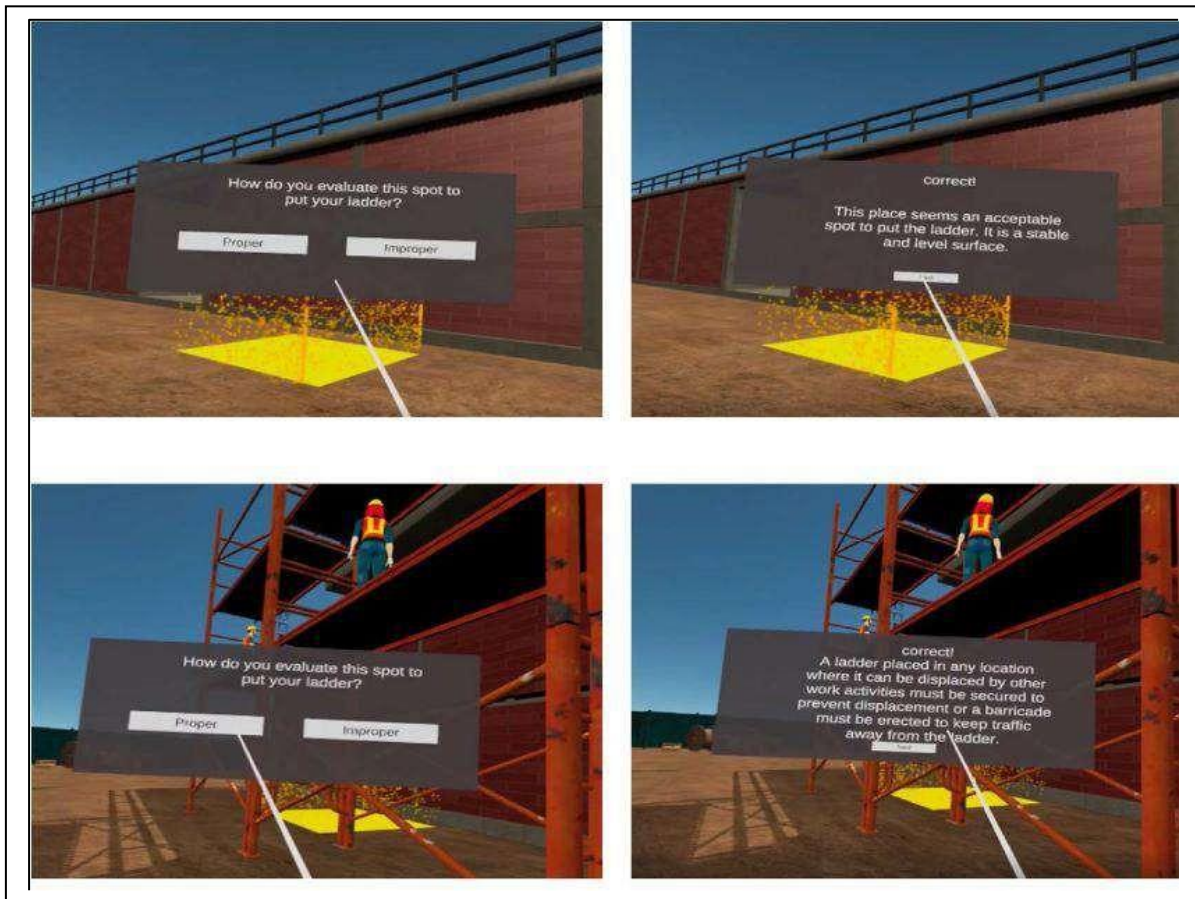FIG. 1. RESEARCH METHODOLOGY FLOW-CHART.

FIG. 2. VR INTERACTION SNAP SHOTS (SOURCE: SAEED ROKOOEI ET-AL (2022)

In addition to user impressions. As the primary users of the module, high-altitude working professionals were given priority in the study's approach. After reviewing the ten distinct parts made utilizing the software programs 3D Sketchup and Unity to do ladder-related duties, a scenario was presumptively created.

Participants in the Saeed Rokooei et al. 2022 research were immersed in a pre-designed 3D model utilizing virtual reality technology called Oculus or online meetings. The participants completed a standardized questionnaire, which was given to the researchers via an Internet platform. After a section on demographics, a five-point Likert scale was used to gauge participants' degrees of agreement or their perceptions of the significance of various impacts. Participants were asked to respond, and the researchers collected their replies. After analyzing the data, the researchers found that 30 responses were appropriate for further examination. Using software like Microsoft Excel or Word for descriptive analysis, the replies were collated, processed to remove any mistakes and inconsistencies, and suitably categorized to assure accuracy.

IX. ACTION PLAN

After reviewing the 10 distinct portions that were created using the 3D Sketchup studio and unity, software, and duties

linked to ladders. Action plans included safety guidelines and directives for the corresponding circumstances.
The area's primary topics include:
1) determining the optimal placement for the ladder on the job site.
2) Choosing the ladder to use depending on the weight rating and height of the structure,
3) Examining the ladder for mud, grease, structural damage, and missing parts; 4) erecting the ladder; 5) securing the ladder; 6) maintaining secure contact with the ladder; 7) using the ladder to transport materials; 8) dismounting the ladder at the roof; 9) un-securing and descending the ladder and lowering the ladder to the ground; 10) safe roof work inspection; and 11) loading the ladder on the truck for safe transport. The study's approach Every part made the premise that the user was a freshly hired high-altitude worker who was responsible for assessing the hazards and safety issues associated with various ladder-related jobs. The primary topics of traditional safety training and the viability of VR technology as supplemental aids were covered by the survey's questions.

The VR interaction window shows where a ladder should be placed and underlines the important details to consider while utilizing it at a high height.

The VR training program educates workers on potential risks and dangers through a variety of situations.
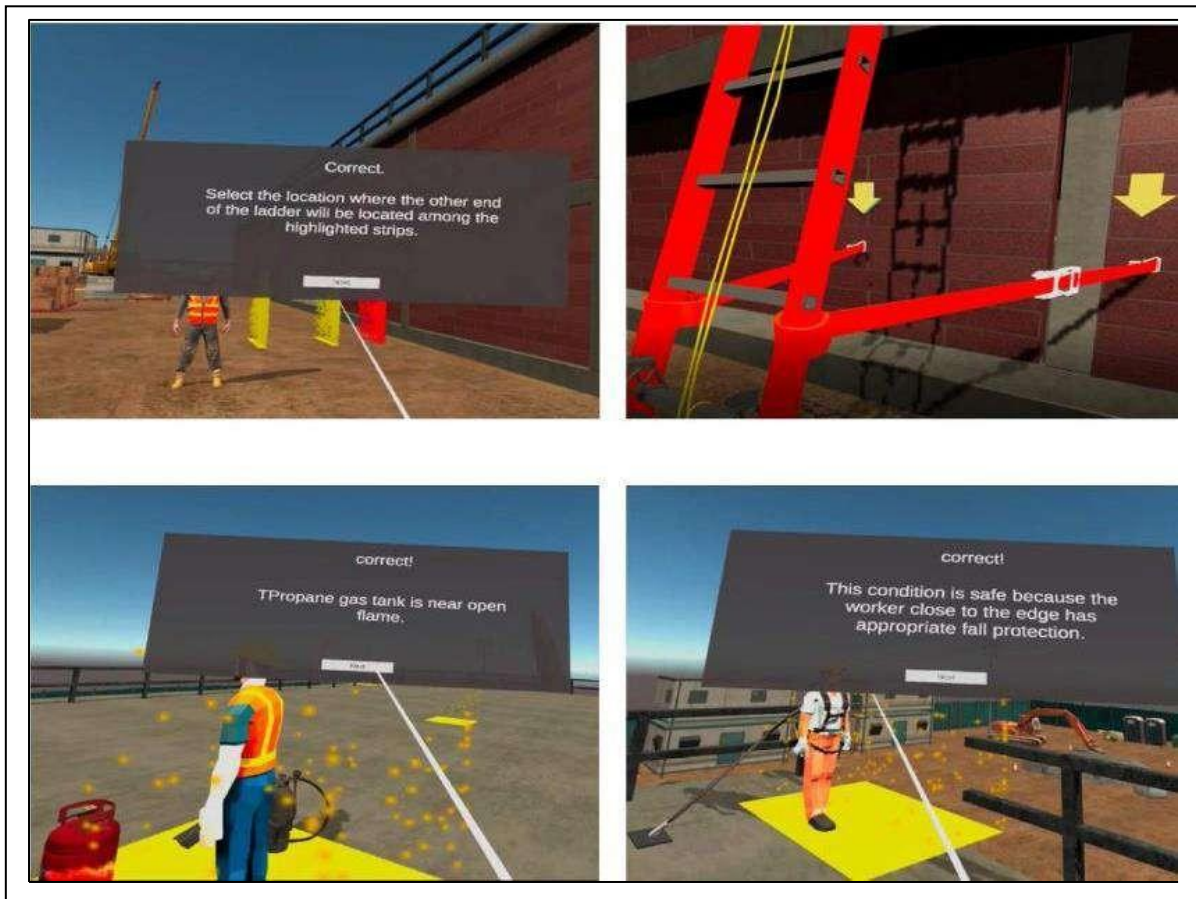
Fig. 3. VR Interaction Snap shots (Source: Saeed Rokooei et-al (2022)

safety precautions necessary for working at heights, enabling them to make decisions with knowledge in the worst-case situation.

X. DATA ANALYSIS

The demographic information of the participants In [Table 1]. Shows that the majority of Participants were male, above 51 years old, and with experience above 25 plus years. Also, the participants were mostly high-level executives from companies. The next questionnaire was safety-related.

hours of training that must be mentioned for new hires As shown in Table 1, forty-five percent of participants said that new

More than 16 hours are spent on staff training. Moreover, 85% of interviewees said that their present workers must

Gender	Male (%)	Female (%)			
	68	32			
Age	21-30 (%)	31-40 (%)	41-50 (%)	51-60 (%)	61+ (%)
	28	9	20	39	4
Experience	1 to 3 (%)	4 to 7 (%)	8 to 15 (%)	16 to 25 (%)	25+ (%)
	12	40	24	10	14
Position	CEO (%)	Project Manager (%)	Sales Manager (%)	Office Engineers (%)	Labors (%)
	9.5	48	14	19	10
New Hires Experience years	1 to 3 (%)	4 to 7 (%)	8 to 15 (%)	16 to 25 (%)	25+ (%)
	51	39	4	2	4
Training Hours	0 to 4 (%)	5 to 8 (%)	9 to 15 (%)	16+ (%)	
	20	22	13	45	
Training Interval	Within 3 mo. (%)	Within 6 mo. (%)	Within 1 year (%)	At will (%)	
	56	18	21	5	

TABLE 1. DEMOGRAPHIC PROFILE

attend training programs on safety to update their expertise. Participants were also questioned on the frequency of ongoing safety training that their staff members must attend. [Table 1] displays the proportion of time intervals.

The following inquiry asked participants to identify the primary cause of accidents in the high-altitude industry. Although a substantial majority of workers showed a reckless attitude, 51% of participants said that accidents were caused by a lack of information or insufficient training. [Fig. 4].

Using a Likert scale with a maximum score of 5, participants also judged how much they think various factors have an influence on high-altitude industry accidents [Very Low: 1; Very High: 5]. [Fig. 5.] displays each level's percentage.
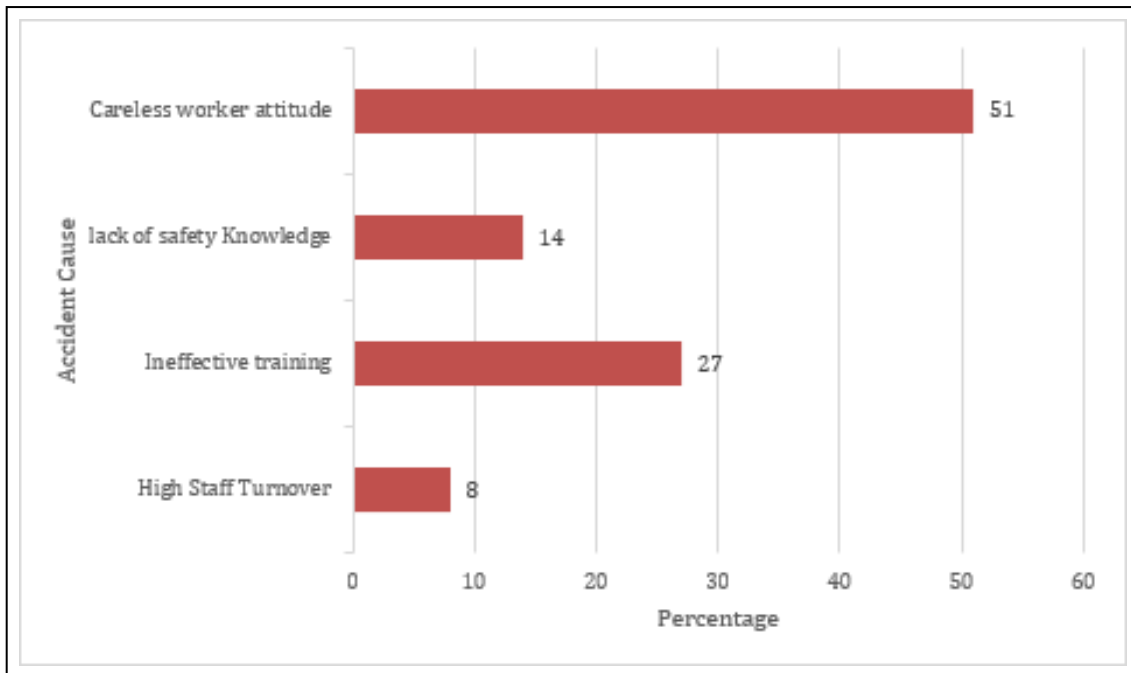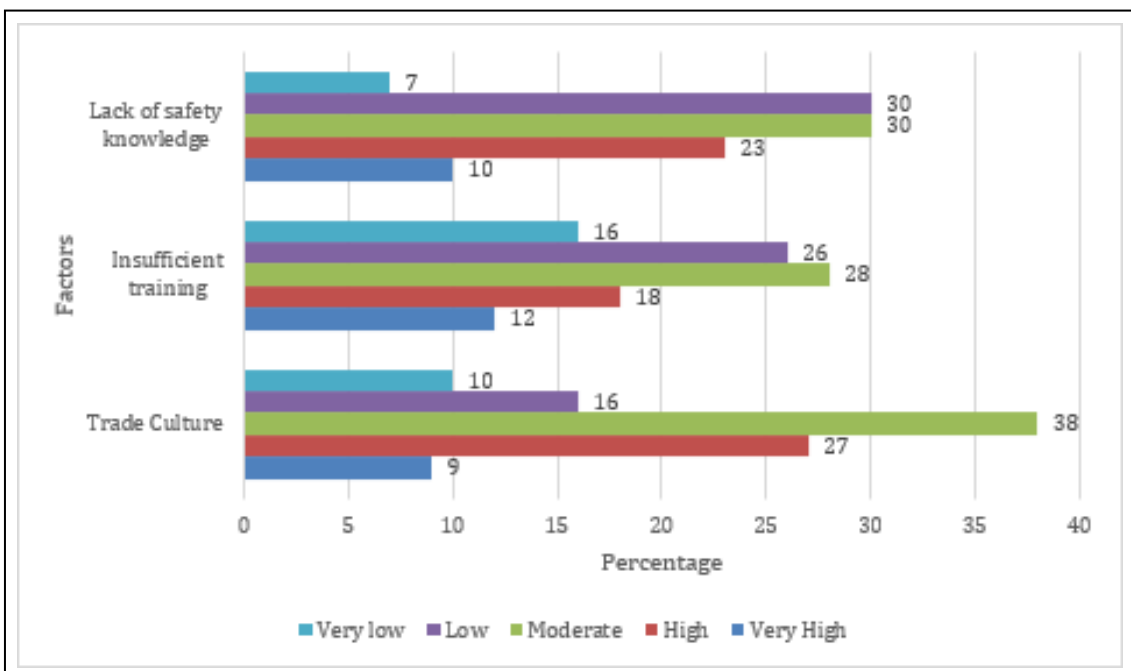

FIG. 4. MAIN CAUSE OF ACCIDENTS

FIG. 5. FACTORS IMPACTING ACCIDENTS

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The survey's next portion included inquiries about virtual reality and its use in safety instruction. First, using a five-stage Likert scale, participants were asked to assess how familiar they were with VR in general. [Fig. 6.] displays each level's percentage.

high-altitude industry," showed the contributors' level of settlement. Only 5% of participants disagreed with the statement, while 30% agreed and the rest 54% were neutral [Fig. 7].
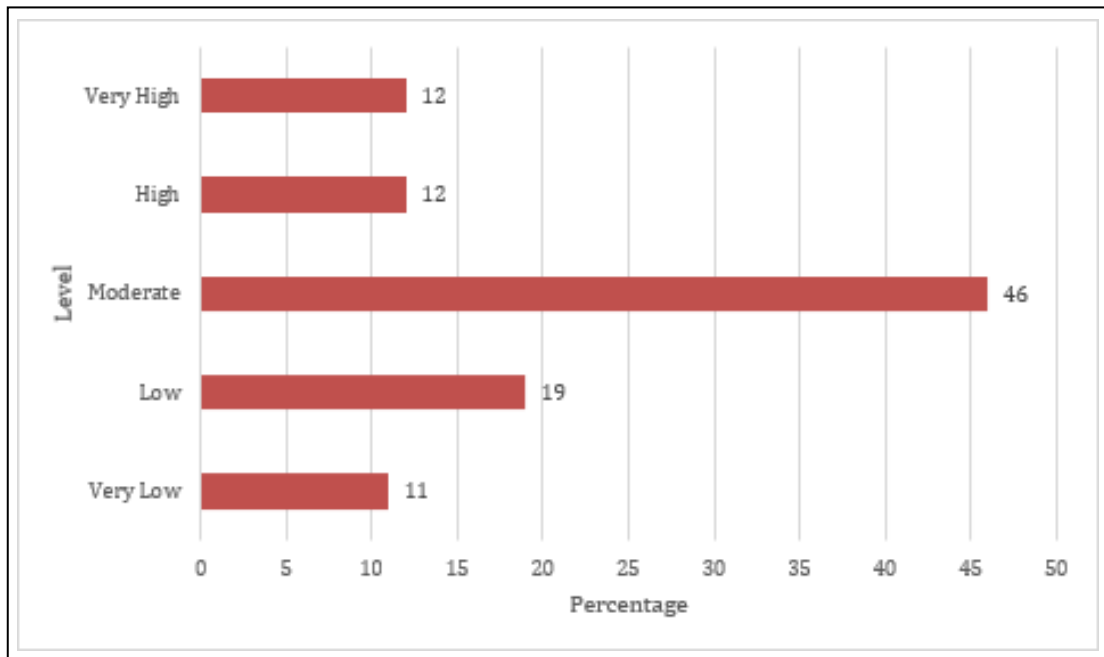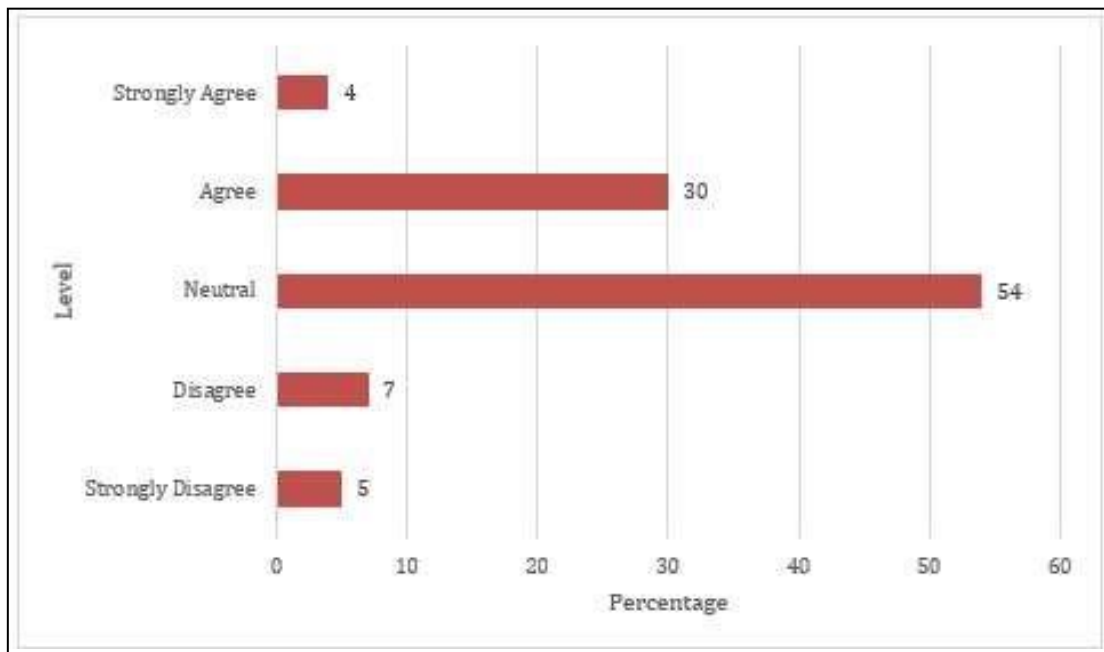

FIG. 6. VR FAMILIARITY.

FIG. 7. VR APPLICABILITY

The answer to the following question's statement, "Virtual reality is highly appropriate for workforce development in the

In a similar vein, participants were questioned about whether they thought virtual reality may assist the next generation of workers in learning the necessary safety guidelines while still

enjoying the surroundings. The majority of participants (63 percent agreed, 28 percent were indifferent, and 9 percent disagreed) had favorable opinions about VR's suitability for

Only 9% of participants disagreed with the strategy, while 55% were indifferent and 36% of participants said that they
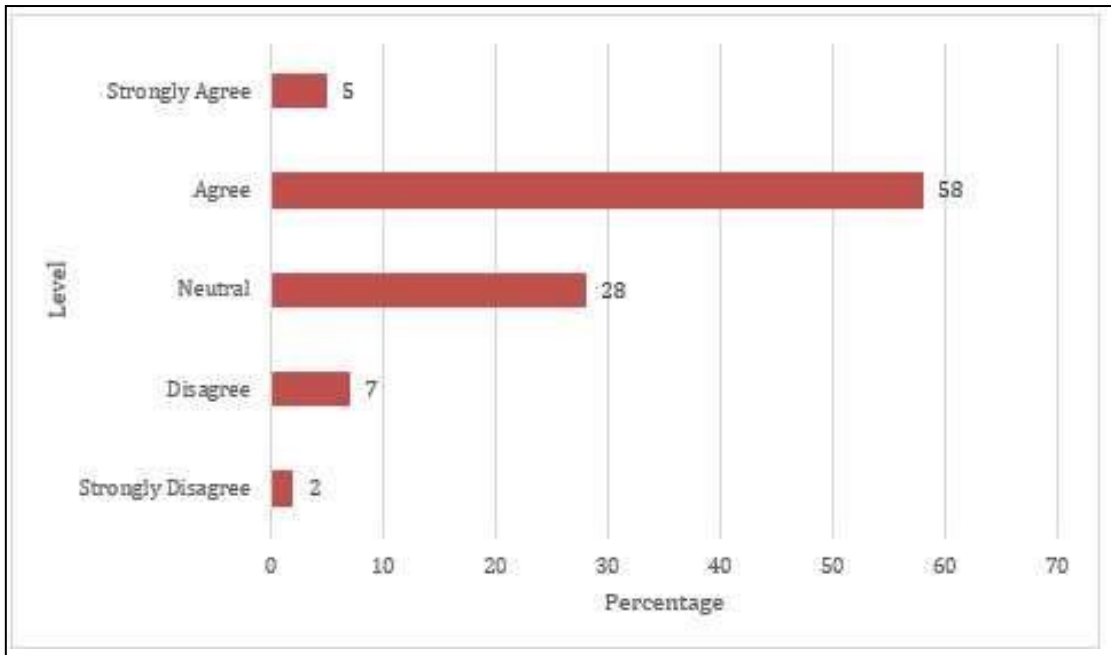
modern training. In [Fig. 8], the proportion of each level is displayed. Participants also stated that they intended to look for chances to implement virtual reality programs for safety training in their organizations. Only 9% of participants disagreed with the strategy, while 55% were indifferent and 36% of participants said that they were in favour of using VR for training.

were in favor of using VR for training.

The proportion of each agreement level is displayed in [Fig. 9]. After taking part in the safety lesson, participants also responded favorably to the VR application. On a five-stage Likert scale, participants were asked if their confidence in the usage and application of digital reality increased after they gave it a try.
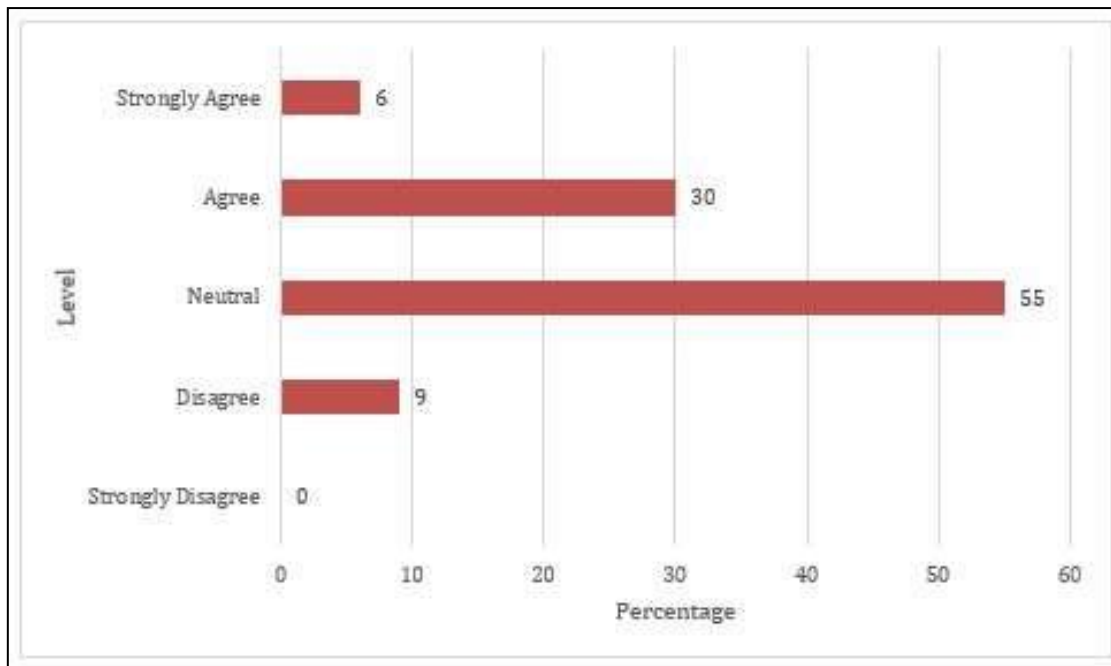

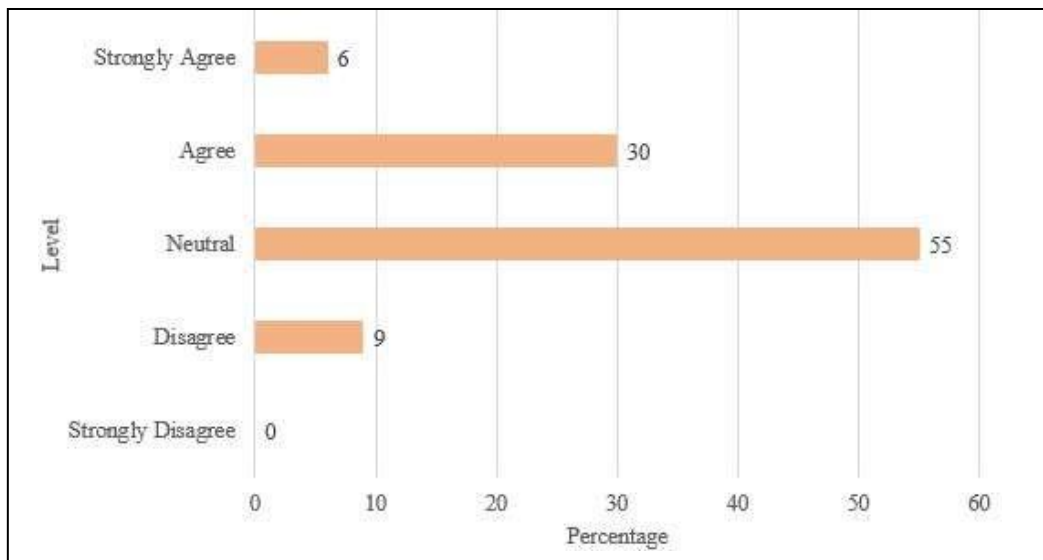FIG. 9. VR AGREEMENT FOR TRAINING PURPOSE
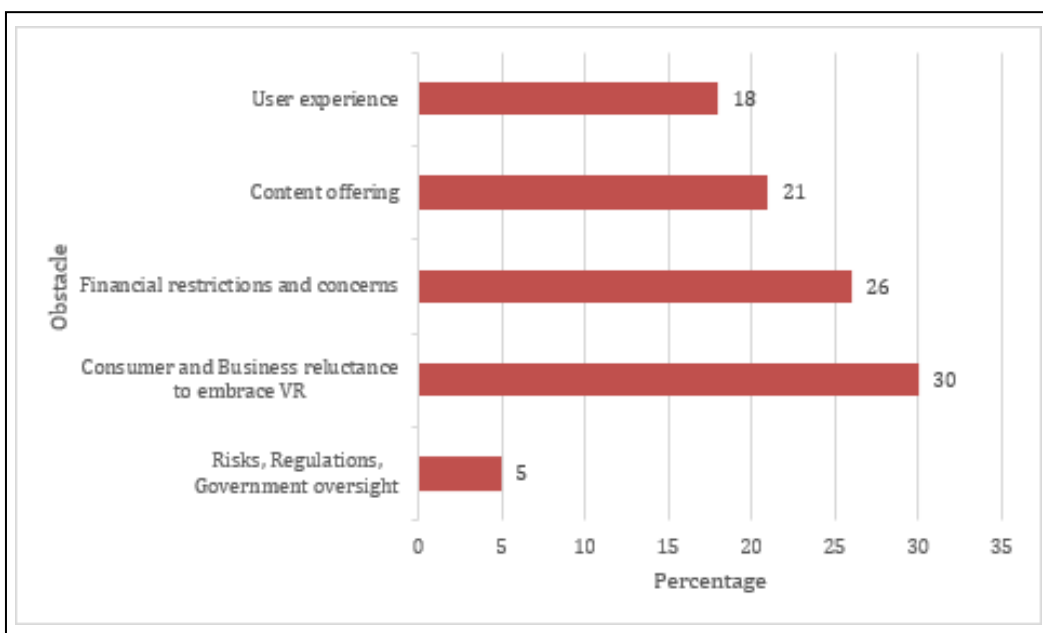
FIG. 10. VR AGREEMENT FOR ENGAGEMENT

FIG 11 MASS ADOPTION PERCENTAGE OBSTACLE

On a five-stage Likert scale, participants were asked if their confidence in the usage and application of digital reality increased after they gave it a try.

The proportion of each agreement level is displayed in [Fig. 10]. Participants were also given a variety of VR characteristics to score on a Likert scale with a total of five stages. the average of all factors, weighted. The three qualities of "ease of use," "detailed and complete instructions," and "engaging audio/visual components" were among the most sought-after features, despite the fact that all elements were judged as being of interest (above mid-point). The top five well-known hurdles were conditioned to be chosen when participants were asked to identify the largest barrier to the widespread use of virtual reality technology in the high-altitude working sector. [Fig. 11] displays each obstacle's proportion. As shown,

XI. DISCUSSION

VR has created a new platform for immersive learning. It is especially useful for simulating potentially hazardous locations, like construction sites. Construction employees may receive safe training there without having to worry about failing or suffering any negative consequences. The findings of the safety-related section questions revealed that most businesses require new hires to undergo more than 16 hours of training, with breaks typically occurring every three months. This demonstrates the value of safety training for employees who work for the questioned organizations. On the other side, some businesses mandate shorter training sessions and don't mandate breaks. This demonstrates that some businesses still do not prioritize safety. Nearly half of the participants had some VR experience, however the majority of the relaxation had little to very low VR experience. Contrary to interior design, this fact is supported by statistics from more established crafts in the building

sector, such as concrete, structural, and cladding. Therefore, raising public knowledge of VR applications in safety training needs to be a top focus.

XII. CONCLUSION

The results of this study point to the potential of VR-based training programs to improve worker safety and skill development for those doing higher-altitude construction work. The study's findings suggest that by offering accurate simulations of hazardous circumstances that workers may come across when working at high altitudes, VR-based training programs can dramatically increase workers' safety and skill levels.

Given the enormous advantages of VR-based training programmes, it is advised that construction organisations use these initiatives to raise the safety and competence levels of their workforce.

Additionally, construction firms want to keep spending money on creating tailored VR-based training courses that address the individual requirements of their employees. In conclusion, VR-based training initiatives have the power to fundamentally alter how employees are prepared for dangerous professions like high-altitude construction.

These training programmes may greatly increase employees' safety and skill levels by giving them accurate simulations of dangerous circumstances, thereby lowering the likelihood of accidents and fatalities in the construction sector.

The few negatives of VR training include eye irritations, high investment costs, the need for ongoing site-specific adjustments, and the inability to use it in crowded areas.

ACKNOWLEDGMENTS

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Digital Interventions Of 3D Printing Technology In Architecture

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Abstract—The architecture and planning industry is constantly evolving, and digital technologies are driving many of the emerging domains and innovations in the field.

In this research paper, the aim is to study application of 3D printing technology in architecture and construction industry

Through digital interventions, the use of 3D printing technology in architecture and planning has the potential to radically transform the design and construction process.

With the review of existing literature and book case studies, this paper will examine the ways in which 3D printing can improve various aspects of design customization, sustainability, and efficiency in building construction. Additionally, this paper will also explore the future potential and current limitations of 3D printing technology in architecture and planning.

The results of this research are mainly to explore advantages over conventional construction methodologies and valuable insights for architects and designers on how to fully leverage the capabilities of 3D printing technology to improve the built environment.

Keywords—Architecture, 3D printing, digital interventions

I.   INTRODUCTION

The integration of digital technologies has brought significant changes in architecture and planning in the last few years. The advent of 3D printing technology has revolutionized the way architects design and construct buildings. This paper examines the application of 3D printing technology in architecture and planning, highlighting its potential to improve the design process and construction industry.

3D printing, also referred to as additive manufacturing, is creating objects using layers of material to form three-dimensional objects. The technology has been applied to various industries, such as healthcare, fashion, and even food. Despite being a relatively new idea, the implementation of three-dimensional printing in both architecture and construction is already demonstrating significant prospects.

The advancement of technology is changing the construction industry. The introduction of 3D printing has proved many advantages over Conventional Construction Methodologies. Architects can take benefit of 3D printing for creating anything from concept models to fully functional buildings.

Here is a list of the some of the many major advantages of the use of 3D printing for architecture, whether in the design or construction phases.

A. Advantages :

• Speed and Efficiency: 3D printing can significantly speed up the design and construction process, compared to traditional construction methods that require manual labor and tooling.

• Customization: 3D printing allows for greater customization, as the printing process can produce complex shapes and geometries that are difficult or impossible to create with conventional methods.

• Improved Accuracy: 3D printing offers improved accuracy and precision, as the printing process can be precisely controlled and errors can be easily corrected.

• Reduced Material Waste: 3D printing uses significantly less material than traditional construction methods, reducing waste and conserving resources.

• Increased Design Freedom: 3D printing enables architects and builders to explore new design possibilities and push the boundaries of what is possible with conventional construction methods.

• Improved Sustainability: 3D printing can have a positive impact on the environment, as it can use recycled materials, reduce waste, and minimize the carbon footprint of the building process.

• Flexibility: 3D printing enables the creation of complex and customized building components off-site, reducing the time and disruption on construction sites.

• Prototype Testing: 3D printing can be used for prototyping and testing of building components, allowing for improvements to be made before full-scale construction begins.

• Safety: By lowering the need for human labor and removing the requirement for humans to work in hazardous situations or at heights, 3D printing technology has the potential to increase safety on construction sites.

• Innovation: 3D printing technology has the potential to inspire and facilitate the development of new and innovative building designs and construction techniques.

Though some are still in an experimental stage, but it's foreseen to have a significant impact in the near future.

II. RESEARCH METHODOLOGY

To achieve this aim, this paper draws on an extensive review of the existing literature on 3D printing technology in architecture and planning. The review includes a range of case studies and research articles from various sources, including academic journals, and industry reports. The data was analyzed to identify the main advantages, limitations, and trends in the application of 3D printing technology in architecture and planning.

Literature Review: The use of 3D printing in architecture and planning has the prospective to advance numerous elements of the design and construction process. The ability to create intricate designs and structures using the technology of 3D printing is one of the most important benefits over conventional construction techniques. In addition, the process of printing can reduce the quantity of waste material generated during construction and improve efficiency by reducing the time needed to produce components and structures.

Case Studies

A. *Office of Future, Dubai, UAE*

World first 3D Printed fully functional Office building constructed using 3D printing technology. The building was constructed in just 19 days at site, reducing the on-site construction time significantly than a traditional building. The building's exterior has a unique design with curves and undulating shapes that were difficult to achieve using conventional construction methods. The building components were printed in workshop in china and assembled onsite.

Key benefits

• Minimizes on-site wastage, reducing environmental footprint

• Efficient and rapid printing process shortens construction time to 19 days.

• Improves accuracy and reduces manual labor.

• Reduces carbon footprint of transportation and delivery of building materials.

3D printing technique known as wire and arc additive manufacturing, which allows for the printing of metal structures. The bridge's design was based on generative algorithms, resulting in a unique and intricate design that would have been difficult to achieve using traditional construction methods.

Key benefits

• Reduces material waste and energy consumption

• Allows for precise construction, reducing excess materials and rework

• Made entirely of durable, low-maintenance stainless steel, reducing environmental impact

• Offsite production reduces carbon footprint of conventional constructions logistics.

• Supports sustainable transportation modes like walking and cycling, reducing carbon emissions.

• Installed on site in one day, reducing all the logistics, environmental impact and carbon footprint of conventional on-site construction.

Office of the Future, Dubai. [1]

MX3D Bridge: fully functional stainless-steel bridge [2]

B. *MX3D 3D Printed Bridge, Amsterdam*

The MX3D 3D Printed Bridge, is a 3D printed steel pedestrian bridge that was designed by Joris Laarman Lab. The bridge was constructed using a

C. *Tecla house, Massa Lombarda, Italy*

The Tecla house, a pioneering example of 3D-printed eco residential architecture, was created using mainly local earth and water, making it the

first house in the world to be 3D-printed entirely from a clay-based mixture. The word "technology" and "clay" are combined in the name of the house, which was created by Mario Cucinella Architects (MCA) and constructed by Italian 3D printing experts WASP.

Key benefits:

• Composition of the earth mixture responds to local climatic conditions.

• Use of biodegradable and recyclable material which makes the building zero-waste.

• Parametrically optimized filling of the envelope to balance thermal mass, insulation, and ventilation in accordance with climate conditions.

• Delivered in 200 hours of printing,

• Use of minimal energy- 60 cubic meters of natural materials and less than 6 kW of energy on average.

Tecla 3D printed house [3]

III. CHALLENGES

However, despite the many benefits of 3D printing, there are also challenges that must be overcome before the technology can be fully integrated into the architecture and planning industry.

Cost: One of the main challenges of 3D printing in architecture and planning is the cost. While the technology has the potential to save time and money in the long run, the initial cost of a 3D printer can be substantial. In addition, the cost of materials and other supplies can also be high, especially for large-scale projects.

Technical Challenges: Another challenge is the technical knowledge and expertise required to use 3D printing technology effectively. Architects and builders need to have a good understanding of the technology, as well as the skills to operate the printers and produce high-quality prints.

Regulation: There are also regulatory challenges associated with 3D printing in architecture and planning. Building codes and regulations may need to be updated to take into account the use of 3D printing, and there may be safety and performance requirements that must be met.

IV. APPLICATION/FUTURE SCOPE OF THE RESEARCH

The research conducted in this paper has highlighted the potential for 3D printing technology to be used in various applications in architecture and planning. In addition to the case studies discussed in this paper, 3D printing technology has a wide range of other possible applications, including the construction of big buildings and use in restoration and preservation projects.

Moreover, the future scope of 3D printing technology in architecture and planning is promising, with ongoing research and development in the field. As the technology continues to improve, it has the potential to reduce construction time and costs, improve energy efficiency, and increase design flexibility. On-site 3D printing of building components and structure has the prospects to completely transform the construction

sector by lowering the amount of waste and transportation required and boosting productivity.

Furthermore, the integration of 3D printing technology in architecture and planning has the potential to address some of the most pressing issues in the field, such as sustainability and customization. The ability to 3D print structures using sustainable materials reduces waste and contributes to the development of eco-friendly buildings. Additionally, the ability to customize building components and structures using 3D printing technology allows for greater flexibility in design and the creation of unique structures that can meet the specific needs of clients and communities.

As 3D printing technology becomes more affordable and accessible, it has the potential to empower communities and individuals to participate in the design and construction of their own homes and structures. This could lead to greater community involvement, as well as the development of more sustainable and efficient structures.

Overall, the research conducted in this paper demonstrates the immense potential of 3D printing technology in architecture and planning. By incorporating this technology into the design and construction process, architects and designers can improve efficiency, sustainability, and customization while also creating complex and unique structures that would not be possible using traditional construction methods.

The case studies presented in this paper provide concrete examples of the versatility of 3D printing technology in construction, including the construction of large-scale structures, the creation of unique shapes and forms, and the use of sustainable materials. These case studies serve as valuable examples for architects and designers seeking to incorporate 3D printing technology into their own projects.

Looking to the future, there is significant potential for further development and application of 3D printing technology in architecture and planning. Ongoing research and development in the field are likely to result in improved efficiency, greater design flexibility, and increased sustainability. Additionally, as the technology becomes more affordable and accessible, there is the potential for greater democratization of design and construction.

V. CONCLUSION

The application of the technology of 3D printing in architecture and planning has the ability to fundamentally transform the process of designing and building. The three case studies presented in this research paper demonstrate the diverse range of projects that can be constructed using 3D printing technology, including an office building, a house, and a pedestrian bridge. However, while 3D printing technology has many advantages, it is important to consider its limitations, such as the size of the 3D printer and the cost of the equipment. Despite these limitations, the future scope of 3D printing technology in architecture and planning is promising, and further research in this area is essential to fully leverage the potential of this technology. Architects and designers can benefit from the insights provided in this research paper, to better understand how to incorporate 3D printing technology in their designs and construction projects, and to contribute to the advancement of the field.

In conclusion, the integration of 3D printing technology into architecture

and planning represents a significant opportunity for the field.

By leveraging the capabilities of this technology, architects and designers can create more efficient, sustainable, and unique structures that are tailored to the needs of their clients and communities.

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Digitally Reconstructing the Past: Mapping the Historical Water Storage Structures at Gwalior Fort using GIS-based Inventories

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Abstract— Gwalior Fort is one of the known examples for its Architectural as well as engineering interventions, one of its significant marvels is water management, including an extensive system of water collection and storage through a network of tanks, Baolis, wells, reservoirs, etc. This paper aims to use Geographic Information Systems (GIS) as a tool to develop heritage inventories which could help decision-makers in the cultural significance of these structures. The site visit was conducted to collect the required data and further GIS techniques adopted to achieve the objectives. The paper structure first highlights the historical significance of the study area and how water management evolved over a period of time through primary and secondary data. Looking at the present scenario these structures have lost their importance and their functionality has declined to leave behind them as a tourism element. With the help of GIS, their spatial context could be understood along with architectural, historical, social, and cultural significance. The paper depicts the results which will include a study area map with prominent structures and associated attributes that may be an efficient tool in Heritage management. The paper concludes by highlighting the potential for GIS technology to be used in future research on historical sites and structures.
Keywords— GIS, Heritage Inventories, Water storage structures, Gwalior Fort

▮ INTRODUCTION

1.1 Background of the Study

The integration of Geographic Information Systems (GIS), Remote Sensing, and modeling technologies have become increasingly important in recent years, providing decision-makers with a crucial tool for analyzing spatial data and developing management strategies for the preservation and protection of cultural heritage sites (Droj, 2010).

GIS can prove to be a powerful tool for the inventory and mapping of heritage sites and facilitates the identification, documentation, and conservation of cultural heritage. GIS-based inventories can provide detailed information about the existing conditions and determine the values/ significance of these structures which may help prioritize their protection measures as per the present conditions and determine the level of interventions. This information can help heritage managers develop effective conservation and management plans that consider the water structures' importance and sustenance to the site's heritage.

Gwalior Fort, located in the state of Madhya Pradesh, India, is a significant historical monument that has played a crucial role in the history of India. The fort has witnessed the rules of the Gupta, Hunas, Pratihars, Kachhwahas, Tomars, Pathans, Mughals, English, and Marathas who have left their significant landmarks (Archaeological Survey of India, n.d.).

One such landmark includes its effective Water management system which has also addressed various cultural diversities. To better understand the evolution and management of this complex site, a GIS-based inventory was created to explore the Historic Water management system.

Through the case of the water structures of Gwalior Fort, the possibility of GIS-based inventories has been explored to manage and

1

preserve cultural heritage over the traditional inventory procedure.

1.2 Objectives

Objective 1: To create a comprehensive inventory of the historical water storage structures at Gwalior Fort using the GIS tool by adding attributes related to location, age, capacity, present status, associated values, and conservation needs.

Objective 2: To digitally document the historical water storage structures using GIS, thus contributing to the documentation and preservation of cultural heritage and also analyzing the historical, social, and cultural significance of the water storage structures in the context of the fort's history.

Objective 3: To leverage the information collected through GIS-based inventories of the historical water storage structures at Gwalior Fort for effective management.

▮ METHODOLOGY

2.1 Primary Data Collection

The site visit was conducted to collect tangible data for the documentation of water structures and intangible data through stakeholder interviews.

After having a basic idea about the site context through a literature study, the site visit was conducted to have an insight into the water structures to be listed. A set of structured questionnaires has been made for the collection of on-site data to develop digital inventories.

For understanding the current usage and maintenance status of water structures a qualitative survey for different stakeholders has been conducted through open-ended questionnaires. The stakeholders identified to extract such data were local tourist guides, management staff, and residents living in site proximity for ages.

2.2 Secondary Data Collection

The historic books and maps (**Error! Reference source not found.**) were collected from the local library and museums. Historical and cultural significance has been referred from the Archeological Survey of India published reports. The historic text has also helped in identifying the quantitative data (like, year of construction, dimensions, reconstruction if occurred, etc.) of targeted water structures.

Figure 1 Historic Map of Study Area (Gwalior Fort), *(Murray, 1911)*

2.3 Base Map Preparation

GIS tool has been used to synthesize data on a single platform, accordingly, the base map of the study area is created through Google imagery and later the historical map of the study area has been georeferenced to have the location of water structures. The site contours at the interval of five meters have been extracted from the digital elevation model (DEM). The road networks have been taken from the open street map. The neighboring built-up of fort water structures have been marked within the study area to understand their influence and dependency on the water structures.

2.4 Making Digital Inventories

Through GIS all the collected data were synthesized on a single platform. To achieve that the questionnaires and survey forms provide all the available information for each water structure and were converted into digital format i.e. excel format. This file shows the inventories which are ultimately linked with the spatial dataset on GIS in the form of attributes. The attributes listed

below have been incorporated for water structure inventories-

- Historic name of Water structure
- Typology (tanks, baolis, wells, reservoirs, etc)
- Water source (runoff, groundwater recharge)
- Age
- Indigenous/New
- Dimension
- Construction Material
- Current condition
- Significance/Relevance
- Associated Values
- Grading/Prioritization

■ LITERATURE REVIEW

3.1 About the Site

Gwalior Fort is a hill fort measuring about 3 km long and 1 km wide, measuring about 3 square km located in Madhya Pradesh at a latitude and longitude of 26.2313° N, and 78.1695° E respectively. The fortress is rich in cultural heritage including Palaces, temples, water structures, etc.
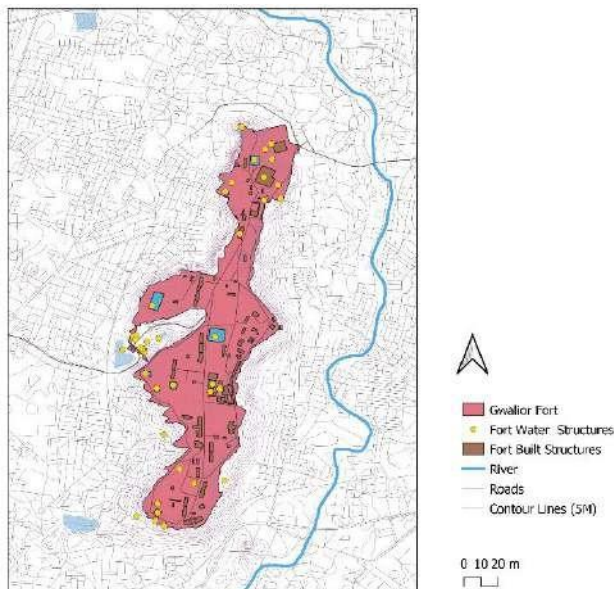

Figure 2 Study Area Map (Gwalior Fort) with water Structures

Figure 2 above represents the base map of the study area which has been generated on QGIS. The map represents the road network which is connecting the city to the fort complex, along with other details of the fort complex like buildings (fort-built structures), water bodies of all typologies (fort water structures), and others.

3.2 Existing Literature and Secondary data

Gwalior Fort lies at an elevated citadel that rises to a height of around 100 meters where a network of natural and manmade water sources was integrated to collect, store and supply the water demands of the fortress. Varied water heritage structures here include structures for water collection and structures for water storage. The water-collecting structures are composed of Taals (which serve as a catchment area that collects rainwater), Baolis (step-wells that store the rainwater), and Kunds (small reservoirs that collect water). The water storage structures include Tanks and Baolis.

The Fort has witnessed various reigns which have also evolved its water management system in terms of functionality as well as in terms of social, political, and cultural events. Gwalior's fort has been successful in terms of water supply because in historic times no enemy could ever capture it due to lack of water, its reservoirs are of adequate size and do not dry up even in extreme heat, and water supply in times of crisis.

For the management of water on the Gwalior Fort, ponds and step-wells were constructed so that the water requirements of the residents of the fort, members of the royal family, and soldiers could be met throughout the year (Batham, 2016).

The various water structures explored during the research includes about 39 water bodies including Gujari Baoli, Assi Khamba, Dhondha Baoli/Ek ankh ki Baoli, Shrad anar, Gargaj Baoli, Suraj Kund, Trikoniya taal, Johar Taal, Shah Jahan Taal, Mansarover taal, Rani Taal / Cheri Taal, Gangola Taal, Katora Taal, Ek Khamba Taal, Dhobi Taal, Noori Sagar, Saas Bahu Taal, Ek Pathar ki Baoli, Laxman Talaiya, wells, etc. which were mapped and laid based on various attributes like Location, Historic name of Water structure, Typology (tanks, baolis, wells, kunds, reservoirs, etc), Water source, Age, Indigenous/New, Dimension, Construction Material, Current condition, Significance, Associated values, and Grading.

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These mentioned water structures have not only served the water needs of the population but have also contributed to shaping historical, cultural, political, scientific, architectural, and religious significance. Few water structures are discussed highlighting their value and significance.

a)   Suraj Taal: The Suraj Kund, the solar reservoir, is an important historical and cultural structure in Gwalior. It is the earliest tank in the city, measuring 350 ft. x 150 ft., and was dedicated to the all-purifying sun by Sürajpál, who was cured of leprosy after drinking from its bed. The temple of Surya, located on the west bank of the tank, is a testament to the religious significance of the structure. Additionally, the large fair held at this place every year on the last Sunday of Kartik showcases the cultural importance of the Suraj Kund. (Chakravarty, 1984)

b)   Gujari Baoli: The Gujari Baori is a small deep tank with steps down to the water's edge about 80 feet long by 30 feet broad. It is situated at the foot of the cliff in the Gujari Mahal outwork (Cunningham, 2000). Its historical significance lies in the fact that the establishment of this baoli was due to the water source which was to come from Rai village through canals and drains for Mansingh Tomar's beloved wife Mrignayani. (Dr. Shanti Dev Sisodhiya, 2016)

c)   Johar Taal: Johara Talao is a 200-foot square tank situated at the north end of the fort, named after the Johar sacrifice performed by the females of the garrison when the fortress was captured by Altamsh in A.D. 1232. It holds historical significance for the sacrifice and the events surrounding the capture of the fort. (Cunningham, 2000)

d)   Ek Pathar Ki baoli: The rock-cut Jain caves in Gwalior fort were built by Tomar rulers and consisted of 24 caves and a stone stepwell, showcasing the religious significance of Jainism in the region during that time. (Dr. Shanti Dev Sisodhiya, 2016)

e)   Assi Khamba Baoli: There are three different parts of this Baoli, which there are doors, pillars, and steps. Large stones have been used in its construction. The doors are made in Mughal style and the building is mandapnuma which is dependent on the pillars. The number of pillars in the mandap is about 80, which is why it is called Assi Khamba. According to popular legends, at the time of Rajamansingh, this construction was a Shiva temple, in which he used to worship Shiva in the morning. On one side of the building, there is a stone stepwell in which stairs have been constructed to go inside. The water in the stepwell does not dry up even in summer and probably its water was used for drinking purposes. (Dr. Shanti Dev Sisodhiya, 2016)

f)   Shard Anar Baoli, is constructed by making a small arched entrance in Sharad and Anar Baoli, a square tank has been made by cutting it inside the hill, in length, width, and depth. Its roof is based on pillars cut into the hill (Batham, 2016) significantly demonstrating the procedure of rainwater harvesting, water filtration, and the collection of clean water into the stepwell.

g)   Man-Sarovar: This lake is in the west part of the fort and near Urvahi Gate. It is said that the lake is built by Tomar Raja Mansingh Sir from 1486 to 1516. It is believed that the stones for the building of various monuments have been drugged, shaping this area as a pond that came to be known as Mansarovar. (Batham, 2016)

3.3 Heritage management through GIS Based Inventories

Heritage Protection and management is a complex issue in a country like India, catering to varied typologies and scales of heritage, and varied social, political, geographical, and cultural circumstances. Heritage inventory may emerge as an important tool in Heritage Management. It may include the Identification, Location, Boundary, physical features, functions, present conditions, and value as well as in prioritization which may be helpful in decision-making related to conservation and management (Shah, 2016). GIS may emerge as a tool to protect and manage all typologies of heritage under one umbrella so that the overall layers can be looked upon

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together as well as in isolation for efficient decision-making.

It can offer a variety of features including automated cartography display, historic property characterization and inventory, past landscape visualization and view sheds, impact assessment, and predictive modeling, etc (Limp, 1999). In terms of heritage protection, GIS can provide the following benefits over regular inventories accessibility and dissemination of information, efficient and accurate map storage and updating, Monitoring and risk preparedness, Site maintenance, and preservation plan and analysis (Hardy, 1997).

The paper covers the listing of water structures and linking inventories spatially through GIS. Figure 3 attached below shows the attribute table linked to each listed water structure.

Figure 3 GIS Atributte table showing Inventories

RESULTS

Our analysis of the historical water management system at Gwalior Fort revealed several key findings.

First, we were able to identify the location and spread of water resources throughout the fort. We found that there were numerous natural springs and wells as well as numerous manmade baolis, tanks, kunds, etc. located throughout the fort, which were used to supply water to different areas within the fort complex. Visualization of the overall Historic water landscape could be done through the produced maps.

Second, we analyzed the water network designed to supply water to different areas of the fort,

including the palaces, temples, and residential areas as per the distribution pattern. Thirdly, the current conditions were explored as compared to the historic maps for clear demarcation of shrinkage of existing water bodies and the evolution of newer ones. As a result, it has been the observation that the water structure footprint does not look much changed compared to that of historical data. Also, the current conditions give a fair idea of the functionality and level of interventions required for protection and management. In most cases, the water is covered by a layer of algae and the structures are facing deterioration. If the water harvesting channels could be revived, it may ensure clean water.

Finally, we determined that the water system had a significant impact on the fort's development over the centuries, and GIS can be an effective tool for its management and sustenance as varied stakeholders are involved in its protection. The produced set of inventories can be updated and maintained centrally, with ASI and other stakeholders. A centralized monitoring system can help in effective and collective decision-making for the protection and management of the site as well as visitors. The status of heritage could be monitored.

Through GIS we have synthesized all the above points on a single platform. The collected data has been converted to excel format (inventories) which is ultimately linked with the spatial dataset on GIS. Kindly refer to the GIS map (Figure 4) mentioned below showing the typology of structures. With the help of GIS, the collected inventories (example-typology) have been marked on actual location/coordinates.

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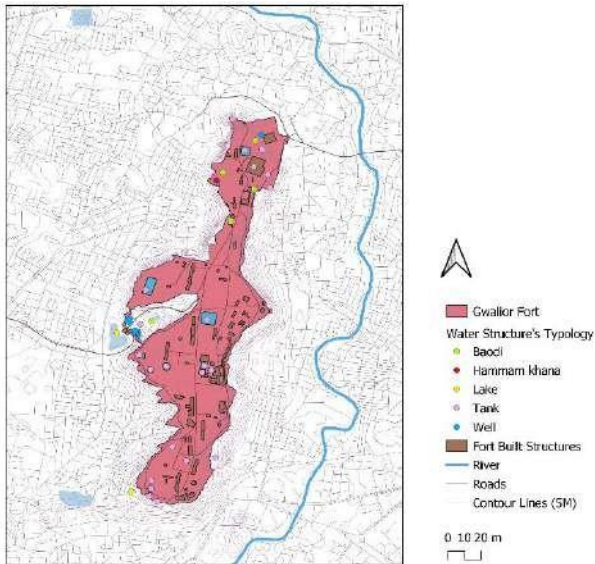
Figure 4 Map showing different Typology of water structures

Similarly, Figure 5 and Figure 6 depict the used construction material for each water structure and the status of restoration or reconstruction that occurred in the past for each water structure within the fort complex respectively.
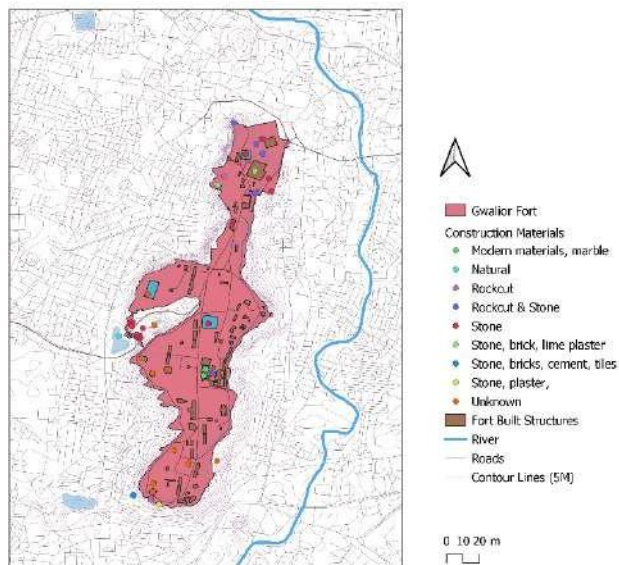
Figure 5 Map showing construction material used per water structure
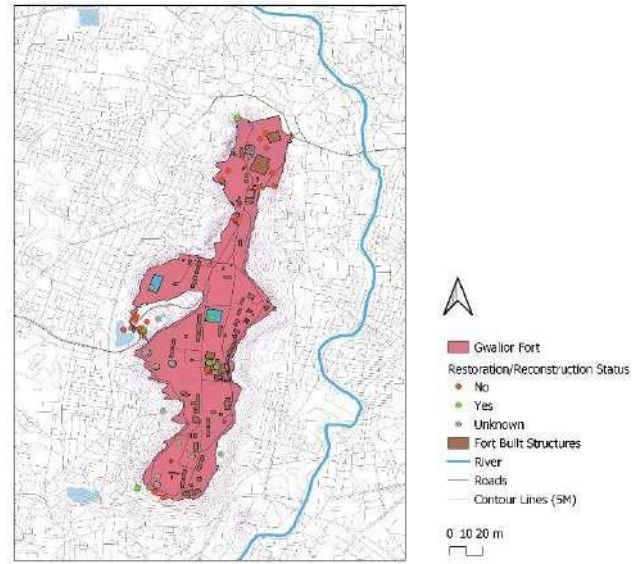
Figure 6 Map showing the restoration/reconstruction status of water structures

Thus various attributes could be analyzed and help in coming up- with effective actions and measures to protect and conserve historic structures by helping the decision-making process.

CONCLUSION

In conclusion, our research demonstrates the potential of GIS technology for mapping and analyzing historical water management systems. Our analysis of the historical water management system at Gwalior Fort provides new insights into the fort's history and highlights the importance of water management in ancient times. Our findings also demonstrate the potential for GIS technology to be used in future research on historical sites and structures.

According to (M.G. Masciotta, 2019), for effective Conservation and monitoring of cultural heritage, integrated documentation is crucial to support decision-making processes for preventive conservation purposes as well as for accessibility and longevity of the information. Digital Tools like G.I.S may prove beneficial in implementing such integrated decision-making.

Overall, this paper demonstrates the value of GIS as a tool for reconstructing and analyzing the past, and for informing the management and conservation of historic water storage structures.

ACKNOWLEDGMENTS

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Analyzing BIM use and application in the building industry from 2008 to 2023

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Abstract

The Construction Industry (CI) is in a moment of enormous change. By 2025, India is anticipated to grow significantly and overtake China as the third-largest building market worldwide. Building Information Modelling (BIM) has become a potentially useful technique for improving construction projects. BIM is currently considered the most innovative methodology in the building industry as a model-based talented/enclosed nD ('n' dimensions) aims to provide tools for Architecture, Engineering, and Construction (AEC) experts to plan, design, and control construction projects further skillfully. In this paper study more than 130 papers are studied in-depth, out of which 79 papers found on review-based use of BIM in the CI. Among these, 42 are general reviews, 9 bibliometric and scientometric analysis, 8 papers each for a systematic and 9 critical reviews, 7 papers for overviews and 8 are for miscellaneous. Literature review research papers based on BIM use in the.CI, published during the last 15 years are analysed. Some BIM features like: Adoption (18), Benefits (14), Barriers (10), Challenges (10) and Risk Management (8). Rest of articles are based on safety, practice, scope, and framework, use and implementation are elaborated in the present study. Integration of BIM reviews with IoT, AR/VR, Digital Twin, Drone Technology, and AI offer enormous potential to enable a range of future applications in the construction business. It is equally important to incorporate BIM, its integration with cutting edge technologies academic institutions seeking to comprehend the significance and apply them in AEC in university curricula. The future of BIM in usage and applications in construction industry, construction management (CM) and construction projects (CPs) are discussed.

Keyword: BIM Dimensions, Barriers, Benefits, Risk Management, Construction safety, Challenges

1. INTRODUCTION

Building information modeling (BIM) is a trying to cut technology/process that makes it possible to construct structures that are better. Building Information Modelling (BIM) proffer a unique method to design, construction, and facility management in which a digital representation of the building product and process is employed to promote the sharing and the compatibility of digital information. Building information management (BIM) is a process that provides flexible design, simple interoperability, and other characteristics. This method has many benefits, including increased efficiency, lower costs, less rework, better coordination, and more. There are various BIM service categories, including 3D modeling, mechanical, and structural BIM services. India's population is growing at an exponential rate. By 2025, India's population is predicted to overtake China's as it would have 1.4 billion people, according to sources.

Amongst the most significant advancements in the architectural, engineering, construction, and operation (AECO) sector during the past 20 years is building information modeling (BIM). Government agencies have made using BIM while completing projects a requirement for contractors. BIM technology has been embraced by several nations, including the United States, the United Kingdom, Singapore, China, the Scandinavian nations (Norway, Denmark, Finland, and Sweden, among others), France, South Korea, etc. Government companies have an important role in advocating the use of BIM and raising public knowledge of it by establishing regulations, producing BIM standards, and developing BIM best practices that the private sector can accept and put into practice.

The deployment of BIM technology by the whole Indian AEC industry made the turn of the new millennium rather remarkable for India. Due to technological constraints, there was initially some

hesitation and resistance to adopt fully-featured BIM technology for building, although this has changed recently. The necessity for infrastructure arrangements like building Public Utility amenities like roads, highways, ports, hospitals, etc., has been prompted by the rapid industrialization and urbanisation of society. Drones, robotics, augmented reality, and other technologies have changed how construction activities formerly took place on job sites. Integration of BIM technology into modern information technology has guaranteed that projects are streamlined with a low chance of differences resulting in changes.

India is not an exception to the emerging nations' quick adoption of BIM technology. The introduction of BIM technology in India has been a lengthy process, but in recent years AEC professionals have taken a huge interest in it. Future trends tend to be beneficial, and BIM technology has a promising future in the Indian construction industry (ICS).

II. LITERATURE RESEARCH REVIEW

The implementation of BIM in India is still in its infancy due to a lack of knowledge on its advantages. Also, there aren't many case studies about BIM that have been done in India. According to past study (2008–2015), there are a various reasons for which BIM is not being adopted in the Indian construction sector in a meaningful way. Some of these include technical know-how, qualified managers, technicians, and operators, ignorance of BIM's methodology among industry professionals, a passive attitude

towards researching cutting-edge technology, and a reluctance to switch from traditional practice to new technology. Several literary sources are used in the current paper. It includes studies pertaining to recent aspects based on literature sources. A review of the literature on BIM technologies that are often used in building processes was conducted by gathering references from journals, websites, conference papers, books, theses, surveys, and other reports. Journals make up the largest proportion of the resources discovered since 2015, followed by conference papers, websites and blogs, theses, books, and surveys, reports, and initiatives. This holds true for the use of BIM in building. The current paper uses published review research sources for literature-based BIM. Only 35% of literature review available Indian origin, however, worldwide is 65%. We have divided this paper description in (i) reviews (ii) critical reviews(iii) over reviews (iv) bibliometric and scientometric analysis (v) study on (semi review) i.e., very close paper to review(vi) theses (vii) research papers on BIM use in construction. Emphasis has been given to analyze reviews recently published particularly during post Covid 19 period. Table 1 gives distribution of various types of reviews, research papers on BIM use and application in CI studied during 2008-2022.Here is the description of BIM reviews for preparation of fresh review-based use of BIM in the CI. Figure 1 gives year-wise distribution of reference sources on BIM use in CI and Figure 2 shows various types of resources use to synthesis this review paper.

Table 1: Distribution of different types of reviews

Type of Paper	Review	Over review	Critical review	Bibliometric review	Semi review/other paper	A study on	Thesis	Report/survey/ Conf. paper	Web site	Total
No.	42	7	9	9	52	6	6	4	08	143
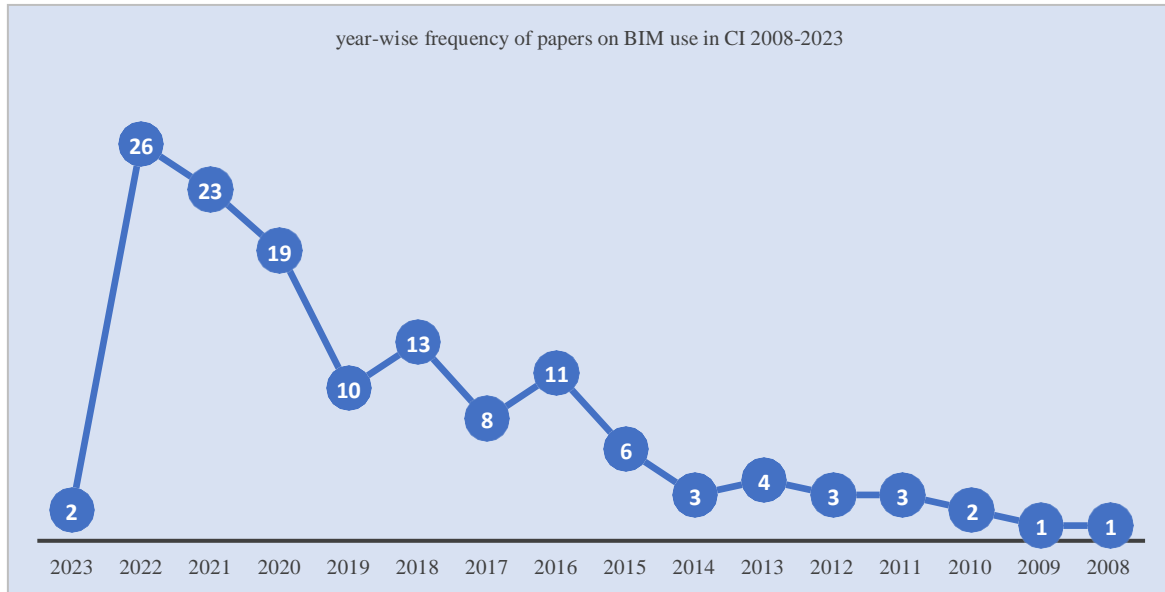
Figure 1: year-wise frequency of papers on BIM use in CI 2008-2023

The Architecture, Engineering, and Construction (AEC) business has emphasised Building Information Modeling (BIM) as a potent collection of design management's tools. BIM has significant advantages throughout the whole building lifecycle, including design, construction, and facility management. The entire implications of BIM on the advancement of design tools in the AEC sector have been the subject of recent research. Two major forms of BIM risk are legal (or contractual) and technological [1]. The first issue is that it is impossible to determine who is the owner of the BIM data, necessitating its protection through copyright laws and other legal channels. Another contractual concern is how to enter information into the model and who is accountable for any inaccuracy. BIM contributes to minimising physical risks and raising construction safety by spotting problems before they arise and anticipating site logistics. Safety evaluations and visual risk analysis can help ensure safety throughout project execution. The BIM technology still has to be developed, and it will take some time for the AEC industry to fully adopt the technology [2].
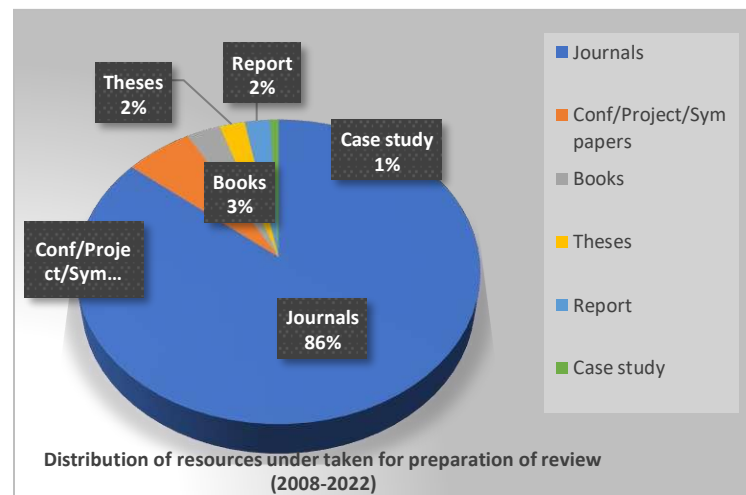
Figure 2: Distribution of resources under taken for preparation of review (2008-2022)

There has not yet been a BIM mandate in India. Recent research has revealed that the Indian construction industry (ICI) is adopting BIM technology/process for the reasons listed below: The benefits of BIM include: I a realistic image of the construction project; (ii) the elimination of unplanned alterations; (iii) cost monitoring; and (iv) the streamlining of the activity (v) Clash detection in BIM aids in addressing possible conflicts. It is noted that the distribution of references worldwide on BIM for CI review papers corresponds to Indian References 35% and International references 65 %. The construction business today demands high precise in planning, scheduling, and control of the project's progress in order to enable total cost, time,

and resource optimization. It has been discovered through the analysis of real building data from the construction site and the building simulation model that any duplication and rework can be prevented [3].

Building information modeling (BIM) is an integrated process for generating and managing buildings by examining a digital model both before and after the project is actually built, as well as during installation, use, and maintenance. According to [4], BIM has been embraced by architects and building contractors in the US and UK to enhance the planning and administration of construction projects. However, at that this was not a situation for Indian architect, contractors as they were lacking skill and fully aware of its use in building construction. In our country, architects have not fully incorporated this new thinking and technology into their working methods. And suggested need for development of a BIM implementation strategy. A comprehensive and exhaustive account on a guideline of various issues raised for adopting BIM in CI.[5] has investigated and summarized various strategies for adoption of BIM in construction industry. With the implementation of BIM to enhance the design, construction, and facility management of construction projects, the Indian architecture, engineering, and construction (AEC) sector is still in its very early stages. Indian AEC firms have been given advice on how to successfully integrate BIM into their current working procedures by [6]. The study methodology created by her provides a sense of the current level of BIM expertise in the ICI along with an online survey used to obtain information about the problems experienced by Indian AEC firms. Inferential statistics analysis of the data provides the most efficient means via which Indian AEC firms can use BIM.

In India, the BIM is a new and exciting strategy which is increasingly satisfying over owners, architects, engineers, and builders. BIM enables effective work processes and smarter judgements when utilized in the field to better communicate and integrate construction information across many trades. According to [7], using BIM allows for significant material and time cost savings, and architects and engineers in the CI greatly value its advantages. The adoption of BIM, [8] has brought a new approach to building design and construction management that has altered how industry professionals and people collaborate. [9] has demonstrated that BIM does supplement conventional scheduling and cost-estimating techniques with automated and more trustworthy technology. According to the data, the following conclusions can

be drawn: (i)if BIM technology advances, higher levels of detail (LOD) will be possible; (ii) To give a scheduled financial analysis, building model BIM components will be linked to time and cost parameters concurrently; and (iii) resource allocation on a 4D BIM model will allow for analysis and planning of resource usage based on the most recent design, and also simulation of resource allotment. [10] has defined and identified thirty-two different BIM applications for commercial construction, with clash detection, 3-D modelling, team collaboration, constructability difficulties of design, and sales being the most used ones. Businesses reported that using BIM have a positive effect on profitability, construction time, and marketing.

According to [11], India needs to set up centres that will focus on broadly promoting BIM. As has been done in many other countries, the government must work with enterprises in the private sector and take the initiative to encourage the use of BIM. It is vital to research[12] both the favourable and unfavourable elements influence the adoption of BIM in the AEC sector. The principles for using BIM on a wide scale are discussed in [13]'s conclusion. [14] outlines three significant findings that revolve around employing BIM in the scheduling and management of construction projects. This study focused on enhancing the effectiveness and successful completion of building construction projects by examining the grade of BIM application and the BIM tools used in the Port Harcourt, Nigeria, construction industry. In his work, [15] outlines several crucial details regarding the practical application of the project management function using the BIM paradigm. By synchronising all these parameters, BIM allows us to integrate virtual three-dimensional models with real project time and actual construction cost, making it simple to maximise the project's overall efficiency. BIM is a holistic and collaborative methodology for the management of information for construction projects that has revolutionized the CI. The management of information for construction projects using BIM has completely changed the construction industry. India is now one of the nations with more potential for investors and BIM-qualified personnel due to the recent growth of BIM execution in the country's construction industry, in the public and private sectors. IBIMA is the primary national professional society for building information modeling and digitalization in the Indian AECO-Architecture, Engineering, Construction, and Operation sector. He founded the India BIM Association, or IBMA, which supports and advocates

on behalf of the entire Indian BIM community in order to create a favourable business environment for the successful usage of BIM technologies, procedures, and guidelines. [16]. Studying Ahmadabad City as an example,[17] implementation of BIM for real estate.

BIM is an innovative approach to design, construction, and facility management that uses a digital representation of the building product and process to enable information sharing and interoperability. Structures' appearance, functionality, and construction are starting to change as a result of building information modelling (BIM). Rafael et al. An in-depth overview of BIM technologies, as well as the commercial and organizational difficulties related to its implementation, is presented by [18] in their BIM Handbook (2018). [19] asserts that the use of BIM by Indian architectural firms is still in its "experimental" stages, with managerial backing, trialability, and expertise having a strong positive influence on its acceptance. The adoption status of BIM in India is also described in the paper using a multi-level social construct. With the use of this construct, the micro- and meso-levels of organizational sizes in India is where BIM adoption is at its highest level. The report discusses parallels and differences with prior studies in order to highlight the findings of this investigation.

Building Information Modelling (BIM), among the most intelligent 3-D models now showing promise, improves the administration and construction of design projects. One of India's largest and fastest-growing industries is the built environment. [20] has done research on the parameters that affects and hinder the use of the proposed paradigm. Design and construction information are both included in BIM. It includes both visual display and a simulation of state creation. [21] has examined the application of BIM in various construction phases, the barriers to its acceptance, and discussed how using BIM technology might be advantageous over using the traditional method employed by architects or designers and buildings built by contractors. The breadth of and obstacles to implementing BIM have been thoroughly discussed by Maan Singh [22] in his thesis[23] has demonstrated the significance of BIM application in the Indian construction and management business through awareness of BIM, implementation, and utilities in the country's established building structures and industries. The AEC sector needs to adopt BIM as soon as feasible in order to keep up with expanding technologies and developing problems. The authors discuss the general adoption of BIM in India at various levels of the construction procedures as well as

challenges encountered throughout subsequent implementations. BIM software. [24] has substantially altered the architectural design process is organized, and it is anticipated that it will have a big impact on future advancements in product quality and industry productivity. Using questionnaire surveys for various users, [25] has highlighted the growth factors and the obstacles experienced for the usage of BIM in Indian construction projects with an emphasis on the risk, challenges, cause, and interest in adoption for ICI. He suggested that organisations make use of his findings to assess their existing BIM appropriation. [26] examined the volume of research on the application and uptake of BIM in several construction project domains. Author has analysed and established a cumulative analysis of the study disciplines and publishing advancement after looking at 130 publications from various sources. This report shows a steady rise in research into many aspects of construction projects. [27] concluded that the lack of government leadership for SMEs in the CI is the reason why New Zealand's BIM adoption assistance system is ineffective. The AEC industry has seen loose collaboration and a lack of coordination among its participants due to inconsistent standards and classifications. The research results are anticipated to deepen our understanding of the obstacles to BIM adoption in New Zealand. [28] has conducted study to comprehend the role that BIM plays in the improvement and application of Knowledge Areas (KAs) in the AEC business in Palestine. The findings showed how far BIM technology has advanced the application of KAs in the AEC industry.

The Architecture, Engineering, Construction, and Operations (AECO) sector typically adopts new technology slowly, which inevitably limits performance growth. According to preliminary results from [29], BIM drivers have a notable influence on BIM understanding during the project lifecycle's operating stage. The average R2 value for the Structural Equation Modelling (SEM) model is 23%, which is moderate. As a result, this research contributes to the pool of knowledge by providing crucial insight into how BIM drivers affect BIM awareness across the project lifecycle. Acquired information would assist government officials and industry stakeholders in creating policies that would promote the use of BIM in modern practise. BIM is quickly becoming a cutting-edge method for visually managing and designing projects. [30] discovered that the lack of modelling standards and the constant requests for design variation make the deployment of BIM in Malaysian CI somewhat ineffective in terms

of time and cost. The findings also suggest that Malaysian BIM has the potential to be as effective as that in other industrialised nations, provided that the key issues raised are resolved. [31] has expanded her research on the use of drone, BIM, IoT, and AR/VR technology in the field of digital construction technology trends. She places emphasis on the inclusion of these technologies in architectural engineering graduate and postgraduate curricula in Indian universities. These claims about using BIM in the educational ecosystem are backed up by a review published by [32]; [18]; [33]; and [34] as well as other recent academics.

Building information modelling (BIM), one of the most recent advances, offers the potential to manage safety on the construction site. This study examines the current level of BIM awareness in Indian construction, as well as its advantages and potential challenges. The advantages that BIM deployment can have for safety management are also discussed in this paper. According to a survey [35] performed on the Indian construction industry, there are three key areas that must be improved: corporate training in construction organisations; knowledge of BIM and its benefits for enterprises; and accumulation of BIM in the tertiary education system.

The collaborative BIM technique is growing in popularity in the building sector. BIM is a methodical procedure that combines all other geometric computer-generated models, or data, to produce simulations that the project manager, owners, facility manager, or other parties can use to manage the project and complete it more quickly. Due to ignorance about the benefits of BIM, the deployment of BIM in India is still in its infancy. A case study of a residential project in Gujrat has been presented by [36] for the study of benefit-cost analysis. Before construction, 8 flaws in the project's 3D and 4D models were found and detected.

The management of business information (BIM) has become an essential strategy for reducing project risks. The project life, starting with planning, design, and construction management, depends on BIM technology. BIM has been used successfully in many projects, but its application in the construction sector

III. MAJOR STUDIES AND CHARACTERISTIC FEATURES OF BIM FOR CI

The architecture, engineering, and construction (AEC) sector is undergoing a digital change. The way information is shared, how procedures are employed, and how things are handled are all being changed by

is questionable. BIM has been looked into and its relevance as the best solution for reducing project risks has been examined and studied [37]. Although many stakeholders use BIM as a modelling tool, he has stated that the first step in avoiding dangerous projects is defining clearly how these stakeholders can use BIM.

Very significant technology that covers a range of dimensions and maturity levels (Level 0, 1, 2, and 3) is building information modelling (BIM) (3D, 4D, 5D, 6D and 7D). Numerous past studies have demonstrated that the construction sector is however adopting technology at the rate that it should be, particularly in emerging nations like India [(https://biblus.accasoftware.com/en/), [38]; 39].

The literature on the obstacles to BIM adoption in the CI has numerous references. According to [40], BIM is not important for construction projects in India. [41] has looked into the dynamics of various BIM capabilities and used the Interpretive Structural Modeling (ISM) technique to understand how BIM capabilities are represented as a collection of connected pieces. This study provides a road map for BIM implementers by highlighting the driving and dependence power of each BIM element that is deemed to be helpful for enhanced delivery of construction projects. For both researchers and project managers, the findings of this study are anticipated to have major theoretical and practical consequences. This study [42] was expanded upon with more thorough research on the variables influencing the adoption of BIM in emerging countries, namely the instance of India. In the context of Indian architecture firms, the technological, environmental, and organizational aspects responsible for the adoption of BIM are investigated. [43] has thoroughly studied the development of BIM in the Indian AECO industry, with an aim in the past 15 years. Recently, [134] examined a real-world circumstance involving the use of project management knowledge areas (PMKA) in the sector of the construction business. Moreover, advantages and disadvantages of using technology as a tool to promote the implementation of PMKAs. BIM and knowledge technologies have an impact on how effectively building projects are managed.

technology. BIM is the method used to incorporate these technologies into a construction project. In what ways is BIM affecting the construction business, then? What are the advantages, obstacles, difficulties, risk management, and safety? To address these inquiries, please see the description below.

3.1. Benefits use of BIM in the Construction Industry

Initial literature text on benefits of BIM for CI before 2015 has been appeared in the literature as a basic guideline for use of BIM in CI in the form of textual text(matter) and not noted as a strong review. Figure 3 depicts some benefits for use of BIM in CI.[1] and [2] has given very initially some benefits and barriers of BIM use for construction industry.

Figure 3: Some benefits of BIM in construction Industry [Source https://www.bimspot.io/blogs/]

BIM has provided a detailed overview of the trends, advantages, dangers, and difficulties facing the AEC. The project benefits of BIM have been highlighted by [44]; in the same year, [45] and [46] have assessed the advantages of adopting BIM for the efficiency of construction projects. [47]]has examined the advantages of adopting BIM to boost performance in Iraqi CI. The advantages, characteristics, applications, and implementation of BIM for construction projects have recently been examined by [48]. The same year, [49] conducted a critical analysis of BIM implementation for CI with regard to adoption, difficulties, and advantages. BIM has provided a detailed assessment of the trends, advantages, risks and difficulties facing the AEC. [44] has given importance of the project benefits of BIM, and in the same year [45]] and [46] has reviewed BIM benefits on adopting BIM for construction project effectiveness .[47]has reviewed on benefits of BIM adoption to improve performance in Iraqi CI. Recently, [48] has reviewed on benefits, features, applications and implementation of BIM for construction project. In the same year [49,] has critically reviewed BIM implementation for CI with respect to adoption, challenges and benefits. [39] has analysed the n-dimensional BIM's underutilised features with relation to an Indian building context. Many reviews on the advantages of BIM in CI were also published at the same time. [50] has discussed the advantages and difficulties of adopting BIM in UK residential projects. [51] has provided a summary of BIM adoption in the CI with regard to two concerns, namely advantages and industry constraints. Figure 4 highlights the drawbacks of safety application in addition to the advantages [https://springer.com].
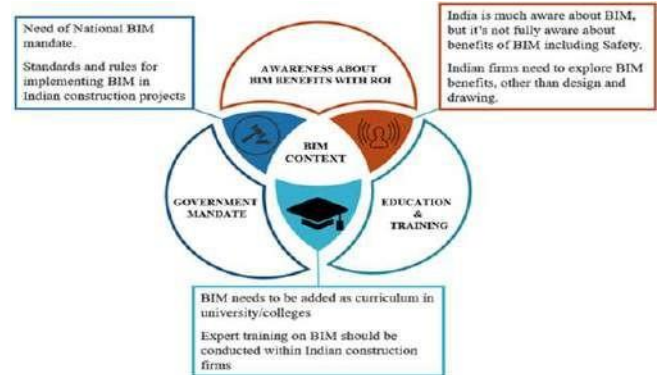
Figure 4: BIM usage benefits and challenges for safety application (https://link,springer.com/10.007/s42107-021-00379-8

3.2. Barriers in BIM for CI

Figure 5 displays an overview of the challenges to implementing BIM in CI. In order to execute the BIM process in construction projects, [45] examined the obstacles preventing BIM adoption in the AEC sector. The challenges to the implementation of BIM and the barriers to the implementation of BIM to the CI have been examined and investigated, respectively, by [52] and [53]. The factors, hurdles, and enablers of BIM Innovation in Developing Countries were recently reviewed and comparatively analyzed by [54], while [51] highlighted 18 barriers in his study.
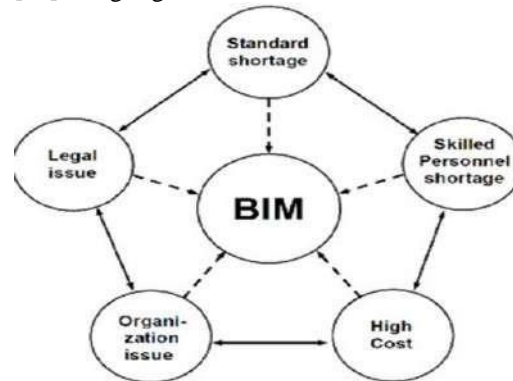
Figure5: Relationship between main barriers

(Source:https://www.researchgate.net/figure/Summary-of-barriers-in-BIM-implementation_tbl1_285630389

BIM compiles numerous project-related data into a centralised and easier-to-access format. Sharing this

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with other team members and planners is simple. From the standpoint of project management, it enables more cooperative decision-making. This is due to the fact that everyone engaged has the opportunity to study building designs at most stages of the project life cycle [https://www.bimspot.io/blogs/]. Implementing BIM for construction safety is hampered by a lack of internal expertise, a lack of BIM training or education, a shortage of awareness, a lack of cooperation, consumer interest, ambiguity regarding the government's commitment to BIM, as well as the high cost of software. The following are some major obstacles to BIM adoption in the ICI: (i) Lack of knowledge, (ii) ignorance, cost-effectiveness for minor projects, (iii) cost-effectiveness for large projects, and resistance to change.(iv) Lack of collaboration among stakeholders[40].

3.3. Challenges in use of BIM in AEC

A paradigm shift is occurring in a variety of industries as a result of the creation and uptake of innovative technologies. The construction industry is not an exception. Since the introduction of BIM Technology and particularly in the last several years, the way the construction industry operates has undergone tremendous transformation. In many countries, including the UK, using BIM has become crucial for large-scale public projects. [https://excelize.com/blog/the-most-common-bim-adoption-challenges. The difficulties in applying building information modelling in the construction industry have been reviewed by [55]. We have already seen how [25] has discussed the ICI's knowledge of BIM, its motivators, and obstacles. [40]. Applications and difficulties with implementing BIM for the creation of smart buildings have been reviewed by [56]. Recognising the challenges of using immersive technologies in CI and architecture has been well reviewed by [57] the identical year. A critical analysis of the effects of successful technological applications in building has been done by James O. (2022) [58]. The ranking study's findings revealed that the top five important barriers were "lack of rules and guidelines," "lack of BIM schooling," "lack of skills," "high cost," and "lack of study and BIM implementation."

3.4 Risk and risk management in use of BIM in CI

Construction risk management is the process of determining and implementing strategies to mitigate the effects of hazards in construction projects. This methodical planning process results in the development of a risk management strategy that enables project managers to identify, monitor, and mitigate risks as they emerge. Building schedule risk simulation utilising BIM and the Monte Carlo technique has been evaluated by [59]. Critical risk considerations for the use of modular building have been assessed by [60]. A study of the literature on the combination of BIM and risk management has been conducted by [61]. The use of BIM in reducing hazards for construction projects has been examined by [62]. [63] studied how risks affected the implementation of BIM throughout the building phase and listed the critical success factors for BIM. [64] has examined the risk factors associated with applying BIM in the operation and maintenance phase of construction projects. A systematic literature review on collaboration and risk in BIM has been written by [65]. The observations of [37] on project risk mitigation provide strong support for the conclusions of earlier authors.

3.5. The future of BIM is being shaped by innovative trends, and it will be integrated with new digital technology.

Several authors working in the field of study have described recent rising digital trends addressing the types of innovative trends driving the future of BIM through its integration with emerging digital technologies. [58] [,66]. [67],[68]. Building information modelling (BIM) software had a successful year in 2021 in the architecture, engineering, and construction (AEC) industry. Yet, because technology is advancing so quickly, new BIM trends are continually showing up in the building industry. The use of digital information tools in the building sector fosters an atmosphere that is favourable for the establishment and growth of companies that specialise in the use of technology to design and construction. While some of the technologies are unique, many of them implement ideas from construction research that were impracticable decades ago without a strong digital building knowledge base. Building information modelling (BIM), ideas for artificially intelligent design and code checking tools, and construction robots have all been present since the middle of the 1980s and have spent decades working in research labs. [69] explores their reliance on digital information, their known past, uncertain present, and increasingly optimistic future to give a number of recommendations for advancements in digital construction. The evaluation finds new problems, producing a list of research questions that could lead to a variety of potential uses for artificial intelligence (AI) in the future. [70] has examined the application

of Blockchain Technology (BT) and given a summary of the various BIM adoption levels in the building industry. In order to comprehend the current research trend, authors looked at the numerous application areas within the BIM process. Also, they spoke about drawbacks and provided advice on how to best carry out upcoming BIM-blockchain integration work.

In recent years, cloud technology has developed into an extraordinarily practical way for users to store data and quickly retrieve it as needed. Throughout time, the BIM industry has gradually increased its adoption of this technology. As many participants in the project as possible can access the most recent project information in real-time thanks to cloud computing, which also fosters enhanced cooperation, productivity, and idea sharing throughout every stage of the project [https://www.digitalschool.ca/]. There have been four things made extremely clear: (i)BIM Software may become more (ii)cloud-focused, and cloud technology may speed up project processes (ii)sustainability and environmental friendliness are also hot topics with BIM (iv)AR/VR are current and upcoming trends in BIM technology in CI and CM (i)BIM Software may become more (ii)focused on the cloud [71] . According to [72], the primary study themes are BIM, IoT, and DT in the construction industry, Heritage BIM (HBIM), Smart Contracts, BIM, and Ontology, and VR and AR in BIM and DT. Also, they documented and noted a number of potential research fields, including BIM and Metaverse technology, BIM and Artificial Intelligence (AI), Metaheuristic algorithms for BIM optimization, and the Circular Economy using BIM and IoT. In order to advance end-of-life decision-making, [73] has contributed by installing the software module that creates a link between BIM and machine learning technologies.

BIM implementation in CI is evolving towards greater adaptability. The purpose of [www.intechopen.com, 2022] was to provide students, academic researchers, and practitioners with an in-depth, current analysis of the significance of integrating BIM with developing technologies in architectural educational programmes.

These technologies included artificial intelligence (AI), cloud technologies, the internet of things, virtual and augmented reality (VR/AR), laser scanning, 3D printing, and drone technology. The time is right for the construction sector to embrace cutting-edge, innovative technologies like BIM, GIS, and Digital Twin. It must be required by the decision-makers throughout the course of the project. By utilising geospatial and other digital technologies like BIM, Digital Twin, and Artificial Intelligence, projects are delivered on schedule and run smoothly on the job site [65]. The foundations for increasing productivity and efficiency in the Indian building and infrastructure sectors are BIM and Digital Twin [74]. In order to comprehend the difficulties encountered when mainstreaming immersive technology (ImT) within the A & C business, [58] undertook a systematic review. 51 publications published between 2010 and 2019 were found using a systematic process (inclusive). The research develops a broad taxonomy with several features. The results led to the identification of nine major challenges, which were then ranked in the following order: infrastructure, algorithm improvement, interoperability, universal health and safety, virtual content modeling, cost, skills availability, multi-sensory constraints, and ethical considerations. The phases of the construction project life cycle are, in fact, at dramatically varied levels of automation and digitalization, as shown by [67]. The phases of initiation, design, and planning all had low levels of automation and digitalization, while the execution phase had higher levels of automation but lower levels of digitalization. Since the subject is always evolving, this research might be carried out soon to see how far the current findings have progressed. [75] has conducted a thorough analysis of the benefits of BIM and IoT technology. He introduces the fundamental work and explains how to design a sophisticated management system for building materials using IoT and BIM technology. Further reviews based on usage and applications in CI are elaborated with respect to authors name, year, title, key findings, significance and remarks in the tabulate form (Table 2-7).

Table 2: Reviews on implementation of BIM in CI

Sr No.	Author/Year/Reference No.	Contents	Key Findings
1	Annilise Nairne Schamme and	Contributes to the analysis of the improvement of BIM research and helps to clarify the limitations of its	BIM supports in reaching some sustainability goals, but the software's interoperability issues make it impossible for an integrated study to pull

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	Andre Nagalli (2022). [76]	applicability to sustainability rating systems. (ii) highlights the need for increased BIM use in building sustainability assessments, (iii) Using BIM to manage waste and meet material and resource needs on building sites.	data directly from the programme to satisfy the needs of building sustainability assessments (BSAs).
2	Chavan Sayali, and Gorade S. B. (2022). [48]	(i) Studied literature for application of BIM. (ii) Implementation of BIM for 3D,4D,5D,6D,7D & 8D	The paper explores the features and advantages of BIM, its uses, and the state of BIM adoption in various nations. This study also clarifies the application of BIM and the difficulties encountered in doing so.
3	Hafez Mohammad Faisal Shehzad et al. (2022) [77]	Identifies the study's challenges and evaluates the models utilised, the state of BIM adoption, and technology acceptance theories. acknowledges the roles played by mediators, independent and dependent constructs, and moderators in the analysis of BIM adoption.	(i) Finding provides an detail description of the various stages of BIM adoption. (ii) Maslow's theory and the diffusion of innovation theory both shed light on how cognitive concerns affect adoption.
4	Moustaf S. Algjamdiet et al.,(2022). [78]	Identified some issues in South Arabia(i) the failure to achieve sustainability (iii) the failure to use BIM in both public and private projects (iv) the development of BIM-supported methodologies for both public and private projects.	(i) Findings and evaluation of the many perspectives on sustainability held by specialists and the general public; (ii) creation of a framework of sustainable design measures for buildings that takes into account particular elements. (iii)indicating the present level of BIM technology use.
5	Pinti Lidia; Codinhoto Ricardo; Bonelli Serena (2022). [79]	(i) Use information on BIM-FM that is already in the public domain by examining and categorising articles that were written between 2010 and 2021. (ii) examines the application of BIM for FM purposes in various public buildings.	(i)Findings indicate there are number of publications concerning BIM-FM. BIM-FM for public and private companies differ, although not equally. (ii) BIM-FM research is still in its infancy for public organisations and is not uniform.
6	Sahil Salvi et al. (2022). [80]	Reviews the use of BIM for life cycle assessment (LCA) of buildings. This technique aids in understanding the effects of the built environment.	The findings of the research imply that BIM can be utilised to lessen the negative effects of building on the environment.
7	Silva, T. F.et al. (2022). [63]	Identified areas for improvement and the direction of upcoming research in the realms of risk management and BIM. It also looks into the connections between project success factors and risks related to BIM deployment.	(i)The three concerns that are identified the most commonly are technological programme interface, interoperability problems, and a lack of understanding. (ii) The risks connected to BIM, particularly during the design phase, are shown to be positively correlated with key BIM success factors.
8	Shubham A. Bhendkar, and. Prakash S. Pajgade (2022). [81]	Increasing use of BIM in civil and structural engineering, professionally practice and focus research on BIM use.	BIM aims to increase project efficiency and produce better outcomes. Construction management can more efficiently collect and communicate data and information from the relevant disciplines thanks to BIM.

9	Sood, R. and Laishram, B.,(2022). [39]	Various key factors reported. (i)various dimensions, (3D, 4D, 5D, 6D and 7D).and level of maturity and present situation in ICI (ii) presented some future research work.	Policymakers and practitioners may find the findings to be extremely helpful in implementing a BIM-based framework that is mandatory for ICI and other developing countries.
10	Zul-Atfi Bin Ismail (2022). [82]	(i)employing BIM technology that includes automated evaluation methods, (i)identified the various system approaches (ii) The majority of BIM research has been on theoretical frameworks for acceptability in the green building (GB) maintenance sector.	(i)Building information modelling (BIM) offers the ability to improve building control instrument performance and design understanding (BMC). (iii)BMC and its impact on maintenance planning have not received enough attention.
11	Abubkar Altohami,Nuzul Azam (2021)' [83]	(i)Covers obstacles that prevent BIM-IoT integration while also addressing interoperability problems and cloud computing. (ii) investigates and discovers common growing application areas and common design patterns of the traditional BIM-IoT integration, then develops better integrating IoT in BIM methodologies.	(i) This method and discovery are based on combining real-time data from IoT devices with BIM studies in order to increase operational and construction efficiency and produce high-fidelity BIM models for a variety of applications. (ii) draws the conclusion that a high-tech solution is necessary to connect IoT devices more effectively across the Internet infrastructure.
12	Ang Yang et al. (2021) [56]	Provide the key findings and implications regarding the research needs and trends, including (i) enhancing the software's interoperability; (ii) examining the role of BIM during the maintenance and renovation stage of smart buildings; and (iii) concentrating on BIM technology in the field of transportation infrastructure.	(i) Provides a thorough understanding and encourages critical thought about how BIM and smart buildings are related. (ii) Proposes a three-dimensional framework with BIM attributes, project stages, and smart attributes for the intersection of BIM application in smart buildings.. (iii)Explicitly defining the financial advantages of BIM projects
13	Manoj U. Deosarkar et al., (2021). [84]	(i)Designed building by using Autodesk Revit Software. Autodesk Revit BIM software for landscape architects, landscape architects, structural engineers, MEP engineers and contractors(ii) estimations of building also using Revit Architecture (iii)planning, modelling, scheduling commercial building.	provides authentic families of furniture and lighting fixtures, as well as the ability to import pre-existing models from other programmes like Auto CAD. Authors have developed families for both residential and commercial structures.
14	Narendra A.1., L Pinky Devi (2021).[85]	(i)BIM may be able to satisfy an owner's desire for predictable pricing, high quality, and on-time delivery. (ii) . Implementation of BIM for ,4D,5D, and ,6D,	recognised the essential components of BIM awareness, benefits, obstacles, and implementation options.
15	Yidan Zhang, Yi Yang, Wei Pan and Mi Pan (2021). [86]	Key performance indicators (KPIs) for Construction Supply Chains (OSC) supply chains from December 2000 to March 2021 have been identified. Additionally, by examining and analysing current measurement efforts from a variety of angles, this research	Authors created a measurable assessment technique, built on the framework, and gave ignored KPIs, particularly those related to social and environmental issues, greater attention.

		helps to improve understanding of OSC supply chain performance..	
16	N.Zaini et al.(2020). [87]	(i)Identify the essential components of BIM implementation, including its benefits, methods, and execution. (ii)Top ten ranking of BIM awareness, advantages, obstacles, and adoption methods for industry players (ii) The application of BIM technology is focused on meeting customer demands in Sarawak CI	(i)BIM process execution, productivity improvement through efficient teamwork, increased return on investment, and decision-making assistance (ii) increased effectiveness brought about by an integrated design process, (iii) precise and trustworthy cost estimates, (iv) decreased financial risk, and (v) avoided possible conflict.
17	Vimal kumar, et al .(2020). [88].	Use of BIM in industry and comparison and synthesis of pertinent research findings. The BIM tools intend to expand their industrial applications in the future.	The outcomes demonstrate many effects from BIM adoption, including 3D/4D/5D/6D functionality. The article's final goal is to promote the full range of BIM capabilities that can be used in construction activities.
18	Jingming Li et al.(2020) J.of cleaner production (2020). [33]	The first review-based study evaluating current BIM developments in AEC-related fields in higher education. This study presents the most recent developments in BIM adoption in AEC education and surveys the state of the BIM education literature.	The current research predicts that there will be some ongoing effort in BIM education, including (i) interdisciplinary collaboration to reduce fragmentation among AEC disciplines and (ii) creative teaching techniques that include both technical and management aspects of BIM.
19	Wang, L, Huang, M, Zhang, X and Jin, R (2020). [34]	Identified relevant publications of BIM educational research outputs, such as journals and conference proceedings, and examined current research keywords.	This Technical Note examines current BIM adoption patterns in higher education for AEC and (AEC)-related fields and is one of the first review-based studies in the area.
20	Zaid Saad Hadi (2020). [47]	(i)The key reasons for Iraq's poor project performance were highlighted (ii) exploited to improve project performance, raise project competency, time, and cost, and (iii) strengthen stakeholder engagement and communication.	(i)BIM has significantly enhanced all phases of the project life cycle—design, pre-construction, construction, and post-construction. (ii)BIM offers comprehensive, cutting-edge management and maintenance plans.
21	Mohammad Firdaus Razali et al., (2019) [89]	The deployment of building information modelling (BIM) over the course of building life cycles is reviewed in this article with an eye towards addressing problems and identifying potential areas for further research. The report finishes by stating that the majority of BIM research primarily focuses on the planning and construction phases (iii) Three phases were studied.	Classified Virtual Design and Construction (VDC) development into three main phases: Phase 1 (Visualization). II. Phase 2 (Integration). III. Phase 3 (Automation). (ii) The AEC industry will reap the most financial benefits from BIM through ongoing professional development and increasing awareness. (iii) The AEC industry acknowledged the advantages of BIM.
22	Sachin Nalawade et al (2019) [24]	The architectural design process has undergone significant organisational change as a result of BIM technology, and it is expected to continue to play a significant role in improving product quality and industry efficiency.	BIM use, application, benefits and limitations of BIM are discussed.
23	Yin Rui (2019). [90]	(i)analyzes BIM application in practices and compare(ii) explores relevant	(i)The outcomes show different effects from BIM adoption, including 3D/4D/5D/6D functionalities.

		articles systematically, including BIM 3D/4D/5D/6D applications.	(ii)promote the full implementation of BIM functionality in construction-related activities.
24	Ziwen Liu, Yujie Lu and Lu Chang Peh (2019). [91]	(i)Outlines the difficulties the AEC sector has had adopting and implementing BIM technologies. In this regard, differences are noted between emerging and (ii) established nations in terms of the pros and cons of adopting BIM, as well as potential issues and fixes.	(i)Researchers and industry experts believe that the widespread use of BIM in the construction industry would result in many benefits and increased efficiency. (ii)SWOT analysis was performed when researching the usage of BIM in construction.
25	Debasis Sarkar and Harsh Shah (2018). [61]	The risks associated with the deployment of BIM ensure the potential advantages. Model the risks' routes and identify the dangers related to BIM AEC projects.	Explores an integrated BIM and risk management model for infrastructure projects possibility of develop
26	Ensar Ademu and Selin Gundas (2018). [92]	Explains the difficulties BIM adoption and implementation have experienced in the AEC industry.	In this regard, a distinction is drawn between emerging and established nations in terms of the strengths and weaknesses of BIM adoption as well as potential issues and solutions.
27	Shakil Ahmed (2018). [53]	In this study, a number of factors were discovered, including (i) social and habitual reluctance to change, (ii) conventional contractual practises, (iii) expensive training expenses, (iv) high software acquisition costs, and (v) a lack of knowledge of BIM.	Because BIM technology offers so many advantages, it is critical to eliminate the barrier based on priority with the aid of the government and other project stakeholders. A barrier that prevents the use of BIM technology in the construction sector has also been documented.
28	S.Meganathan and N.Nandhini Jan (2018). [55]	(i) Advocates a plan for Indian construction companies' current working procedures to properly incorporate BIM. (ii) The research method entails examining the current BIM information situation in the Indian manufacturing sector.	Inadequate project experiences, management process damage difficulties, a lack of top management commitment, high software costs, low client demand, inadequate project experiences, unclear legal liabilities, and a lack of skilled and trained employees are just a few of the numerous factors and conditions.
29	Srimathi. S and R.N.Uma (2017), [93]	Presented (i) BIM tools with 4D capacity (ii) use of 4D BIM tool link the 3D BIM model with project schedule	(i)BIM creates competence and enables users to gain a number of advantages (ii). helps to better manage the construction process, increase collaboration, and schedule the work.
30	Subhi,M and Uma ,R.N. (2017). [127]	Current study is concept of BIM derives a platform (ii) recognize potential design, construction and operational problems	This review gives a clear view on implementing the 5DBIM technique in the residential projects
31	Yang Zou,et al. (2017). [94]	(i)Designing a framework for general risk management developing a knowledge-based system (ii), proposing safety risk management using reactive IT-based safety systems (iii), and concentrating on analysing technical advancements and managing risks related to the safety of construction workers	Future study is recommended to: (i)have a multidisciplinary system-thinking approach, (ii) examine implementation methods and procedures, (iii) integrate conventional risk management with new technologies, and (iv) assist the development process in order to close this gap.
32	Saundharya R .and Uma R.N. (2016). [128]	Due of their distinctive features, BIM is commonly employed in major construction projects. The usage of BIM technologies has also spread to the small-scale construction sector. They provide	Using BIM in CI is explained in this study. BIM has a helpful method for CI that increases customer satisfaction and cuts down on time.

		thorough descriptions of a structure, which aids in documentation.	
33	Abuzar Aftab Shaikh, et al.(2016) . [133]	The survey information is (i)gathered from various research materials, including the Smart Market report, NBM National BIM reports, and BIM surveys. (ii) The study looked at the awareness and acceptance of BIM in various countries; (iii) India had the lowest levels, at 22%.	(i) involves the identification of BIM adoption and awareness in a subset of eight nations with significant construction markets. (ii) investigates the usage % for BIM.
34	Rafed Sackset al.,(2016) . [95]	(i)The set of guidelines offered for significant construction client organisations to assist with the creation or updating of their own BIM guides (ii)contributes a checklist of the crucial topics that must be covered, including subjects that are not yet covered in the majority of the ground-breaking BIM documents	In order to find both recurring themes and unrecognised details, the author presents a qualitative content analysis of fifteen BIM guidelines, standards, and protocol documents that have been published thus far. While the primary subjects covered by all of the standards and guidelines - interoperability, cooperation modes - are identical, there is still a need.
35	C.Allen and W.Shakantu (2016). [96]	(i) Indicates a rethinking of the structure of the construction industry and the manner in which projects are delivered; (ii) indicates the development of more effective project delivery methods and the onset of a process that will fundamentally alter the construction industry.	(i)BIM, a tool for business process re-engineering, can be utilised as the foundation for changing the project delivery process, enabling the construction industry to undergo a digital revolution. (ii)BIM will be essential for enhancing project delivery outcomes.
36	Doumbouya, L., Gao, G. & Guan, C. (2016). [46]	(i)It is important to better understand the advantages of BIM, study its adoption, and assess its value at different phases of construction projects. (ii) Identifies pertinent BIM elements and results, and establishes a framework for further research. Reviewing the advantages of BIM adds to the corpus of material already written about AEC and BIM.	(i) Throughout all stages of the construction project, BIM succeeds in achieving its objectives, offering benefits like improved design quality, simplicity in implementation, and information sharing capability. (ii) Reduction of construction costs and design errors, quicker work and shorter construction times, increased energy efficiency, and support for construction and project management.
37	Nam Bui, et al. (2016). [97]	(i)Discusses various BIM implementation challenges and offers solutions that are specific to low- and middle-income economies. (ii) identifies gaps in previous studies on the use of BIM in underdeveloped nations	According to research, construction companies in developing nations frequently outsource their IT needs or create workarounds to cut costs and enable BIM, such as employing "fake" IT licences. (ii) offers recommendations for implementing BIM in poor nations
38	Volk, R., Stengel, J. & Schultmann, F. (2014). [98]	BIM implementation in existing buildings will be encouraged and extended by new technologies like cloud computing, semantic web technology, and mobile BIM devices as well as long-term trends like increased digitalization and automation, a growing stock of existing buildings, and sustainability requirements.	Results show that BIM implementation in existing buildings is still risky due to difficulties with (i) high modeling/conversion effort from captured building data into semantic BIM objects, (ii) updating information in BIM, and (iii) handling of uncertain data, objects, and relations in BIM occurring in existing buildings.
39	Hassan Suhall and Yaqoob	(i) The value of teamwork in design management and what it can contribute	When used in design management as a collaborating tool, BIM was found to be most

	Nowsheeba (2013) . [99]	to collaborative design (ii) The discovery that organisational culture and the human element are still lacking in collaborative design using BIM (iii) The automatic introduction of lean thinking into the industry	effective (i) in collaborative environments (ii) for reducing the amount of rework (iii) and for detecting collisions much earlier in the design stage (iii), among other benefits covered in the paper.
40	Cristoph M erschbrock. ans Bjerm E. Munkvold, (2012). [100]	Research reveals that, to a certain extent, IS serves reference discipline. Modern BIM research is informed by (i) IS research theories (ii) the planned and recognised value of BIM	Area identified: interactions between functional affordances, human agency, and BIMs adoption and application of BIM for cross-organizational cooperation, the impact of corporate culture on BIM practises, and the capacity of BIM to change industrial practise
41	Maria Bernardete Barison and Eduardo Toledo Santos (2010). [130]	(i)The procedure of content analysis was utilised as the research methodology to investigate a collection of articles and course outlines that detail experiences in schools that have been recognised as leaders in BIM education. (ii) a focus on course preparation, including prerequisites, aims and objectives, material, teaching methods, evaluation, and activities	determined types of BIM courses based on students' actions and to propose a fundamental structure for a BIM-enabled curriculum along with recommendations
42	Jorge Jerez Cepa, et al. (2023). [135]	The key drivers of smart construction include the usage of BIM in various project phases together with IoT, Big Data, Blockchain, and GIS.	BIM's integration into FM through ICTs enables decision-making based on data analysis and resource optimization.

Table 3: A systematic review on BIM use in construction building sector

Sr.no	Author	Content	Key findings
1	Ali, K.N.; Alhajlah, H.H.; Kassem, M.A. (2022). [65]	Focuses on the research materials gathered from databases and WOS that are connected to risk management and BIM cooperation.	(i)Talk about the BIM for CI collaboration risk concern. (ii) Supports the need for research on the subject in order to increase the likelihood that a BIM project would be successful.
3	Bernardus Ariono, et al. (2022). [54]	(i)identified the influences on BIM innovation in six developing nations from three distinct continents, including their motivators, constraints, and facilitators. (ii) Developing countries have developed BIM adoption in light of global problems.	(i)investigated the value of BIM's innovation aspects in underdeveloped nations (ii). The findings of this study will help AEC stakeholders develop effective BIM deployment strategies.
3	Ali Saad, and Ajayi, SO and Alaka, HA (2022). [101]	(i)presents a framework that makes it easier to comprehend the programming dynamics involved in creating BIM-based plugins (ii) captures how BIM has evolved to have additional problem-solving capability.	Indicate that key building is a crucial feature of custom-built plugins that has been shown to: (i) increase productivity and efficiency towards cost (ii) decrease time spent and the likelihood of error.
4	Alia Besné , et al. (2021)	According to the analysis, there is agreement that academic guidelines that	A set of legislative standards that could serve as a uniform framework for institutions to boost this

	[102]	are common to all university centres and specify a plan for curricular changes as well as teaching and learning techniques are needed. Future study directions are then determined.	integration process is identified after analysing the methods higher education institutions used to implement BIM in AEC degrees around the world.
5	Behzad Abbasnejad et al. (2021). [131]	Identified to contribute wide utilization of BIM at organizational level in AEC firms.	AEC companies in assessing organisational preparedness for the implementation process, as well as the necessary innovations and capability development for BIM application.
6	Yu Cao, et al.(2022) [103]	The goal of the authors was to encourage the use and enhancement of BIM capabilities during the development of green buildings.	Facilitate for BIM during three construction phases of the green building
7	Min Deng et al. (2021). [74]	As a starting point for more research, they suggest the idea of an advanced digital twin for building management..	It was discovered that the majority of earlier research projects have not fully utilised or realised the imagined concept of the Digital Twin, which inspires trends in ongoing study.
8	Hamid, A., & Dossic, C.S. (2016). [104]	(i) Brings attention to the need for additional varied study settings and designs to close the gaps seen in the BIM curriculum research conducted so far. (ii) developing pedagogical methodologies for BIM teaching in AEC programmes	Outlines a framework for BIM curriculum design methodologies based on the literature as (i)a list of suggestions that BIM educators and researchers (ii)can utilise as (iii)a guide for creating or assessing their BIM curricula in future studies.Discussion of benefits and drawbacks

Table 4: An overview review on BIM in construction building sector

Sr no	Author /year	Contents	Key Findings
1	Bipin Kumar (2022). [105]	Published BIM- overview as a book chapter Author explains the concept of BIM-ecosystem, include client and service organization in AEC industry	Identified and suggested various elements of BIM-ecosystem
2	Gayatri Mahajan (2022). [106]	This study extends & cover objectives based on (i) to set a revolution in construction technology (CT)trends (ii) How technology is changing the CI and CT (iii) Advanced BIM application in CI (iv) the new age of Civil Engineering CE&. Practicing these technologies, in CT/CI/CE increases levels of quality, efficiency, safety, sustainability, & economics.	The results reveal that construction trends vary from 5 to 10; however, it reaches 27 in case of CE. In the near future, a perspective on the most recent innovations, trends, tools, problems, and solutions used in the fields of building construction and civil engineering has evolved. (ii) Tabulated various aspects and significance of BIM technology adoption in CI for the period 2016-2020
3	Keshav Er. and Harvinder Singh (2022). [71]	(i) increasing curiosity, being able to increase project facilitation through 3D modelling and 3D viewing, (ii)implies the advantages of CM integrating BIM AR with CM to create transparency in design, costing, and progress.	(i)visualization for the addition of 3D-live viewing to do away with time-lapse and local data impediment (ii). Also, this study offers future paths for dealing with technological changes that could significantly increase on-site efficiency.
4	Corbett, (2021) [107].	(i)includes information about restoring buildings and other stationary structures, building roads and operating service facilities. (ii)From planning	The study provides information on market dynamics like drivers, barriers, and opportunities in this industry. The profiles of current leading companies provide an overview of the Indian

Sr	Author /year	Content	Findings
		through completion, the process of building a structure, a piece of infrastructure, an industrial facility, as well as other operations, is referred to as construction.	construction market's competitive environment .The paper also includes market effects and forecasts for COVID-19.
5	Georgiadou, M. C. (2019). [50]	investigates which general BIM ready drivers and barriers are more pertinent to the planning and execution of housing projects.	Widespread knowledge of BIM but a financial barrier preventing investment in developing digital capabilities, especially for small- and medium-sized firms (i)indicates that the most frequently highlighted advantages are linked to collaboration, usage of software, and process innovation.
6	Kaleem Ullah ,Irene Lill and Ernlyn Wilt (2019). [51]	(i) A survey can be used to model the barriers to BIM adoption in the Estonian CI based on the results. (ii) This study offers information on BIM adoption in the CI and will lay the groundwork for further investigation.	This study looked at how BIM was used in the construction industry across several countries and showed how it was advantageous at every stage of the building lifecycle. There is study on the widespread use of BIM and discussion of 18 barriers.
7	Noor Akmal Adillah Ismail et al.et (2017). [108]	The adoption of BIM in several Asian developing nations is reviewed in the paper, which also looks at how widely it is used in Asian regions.	Given the forces driving and impeding the adoption of the technology in these nations, and how this is expected to alter in the near future, (i) In the majority of underdeveloped nations, BIM is not as advanced. (ii) Share some information about how BIM is evolving in those countries.

Table 5 : Critical review/analysis on BIM in CI

Sr no	Author /year	Content	Findings
1	James O. Toyin and Modupe Mawomo (2022). [58]	(i)Researched how BIM-t installation affected how quickly construction projects were completed. The information in (ii) includes reports on knowledge gaps and suggested future research initiatives. (iii)used a methodical study of pertinent literature from 2008 to 2021 on the subject of BIM-t.	The results show that out of 41 examined papers, there have been seven (17) favourable impacts. The various building phases were used to group the stated advantageous effects.
2	Satyajit B. Patil (2022). [49]	(i)offers a workable answer to a variety of problems (ii)listed numerous strategies for overcoming the difficulties encountered throughout the construction project. focuses on recent research conducted between 2015 and 2022	Examines the adoption, challenges, and benefits of BIM in CI by taking into account studies from the greatest number of nations in the world.
3	Abdulkadir Ganah and Gavin Lea (2021). [68]	(i) Identifies and contrasts BIM guidelines, standards, and templates from throughout the world (ii) Used a qualitative research methodology approach supported by document analysis of BIM standards created in various nations across six continents.	(i)Provided suggestions for standards development based on the gaps identified (ii) government, industry organisations, or academic institutions to assist in the establishment of BIM standards to close the gaps in contract and design documents
4	Albert P.C. Chan et al., (2018).	The institutional framework and regulatory governance of BIM in putting	(i)analyses data to create a study plan for project management BIM studies. (ii) concentrates on

	[109]	project management strategies into practise, the scopes and integration issues of BIM research for project management, and studies of the outcomes and strategies of BIM adoption and implementation in projects	how the various research trajectories relate to one another as well as the contributions and theoretical ramifications of this review.
5	Druv Gor, et al. (2018) [132]	The perceived relevance of 6 variables varied significantly between BIM writers and BIM consumers, according to an analysis of perception variations across different respondent groups. There were 26 factors used in total.	The findings show that the questioned architects and contractors concur on the majority of the offered features, including model economy, model usefulness, and model productivity.
6	Rajesh Gangani, et al.(2018). [110]	Each phase of the project—Pre-Construction, Construction, and Post-Construction—uses BIM. Construction materials cost between 40 and 60 percent of the entire project cost. Cost	BIM-based dynamic inventory control model with an emphasis on inventory management in the construction industry
7	Y. Araya and Shakilmeya S. Malek (2018). [111]	Provided a mixed review of prior reviews, compared benefits of BIM	(i)Discussed BIM use in different phases of construction (ii)Stated the future of BIM as a compulsory practice in India.
8	F.H. Abanda et al. (2015). [126]	The various BIM software systems now being used to handle construction project information are thoroughly and critically evaluated using the following five key methodologies.	Examines the entirety of BIM systems; the study employs a holistic approach, looking at 122 application cases that are typical in the AEC sector and most of the major BIM system types.
9	Z. Sriyolja ,N.Harwin and K. Yahya (2021). [113]	Recognises, classifies, and examines the challenges that come with implementing BIM as a digital information technology in the CI and offers critical insights for future research to overcome those challenges.	According to the study, from the 26 articles that were selected, 15 categories of barriers could be successfully retrieved and addressed. Among the 15 different types of barriers are those related to cost, legality, knowledge, interoperability awareness, culture, processes, management, demand, project scope, technology, skills, training, contracts, and standards.

Table 6`: Bibliometric and Scientometric analysis on BIM use in CI

Sr no	Author /year	Content	Findings
1	Shishehgarkha neh, M. et al. (2022). [72]	The study demonstrates the application of Heritage BIM (HBIM), Smart Contracts, BIM, and Ontology in the construction industry, as well as BIM, IoT, and DT. The usage of BIM and Metaverse technology, BIM with AI, Metaheuristic algorithms for BIM optimisation, and the Circular Economy with BIM and IoT are among the recognised trends.	The study's key findings include (i) the use of metaverse technology in BIM and the construction sector; (ii) the integration of AI and digital twins with BIM; and (iii) the implementation of the circular economy in the construction sector utilising BIM and IoT. The primary study themes are VR and AR in DT and BIM.

2	Amarnath C.B. (2021). [124]	(i)A study provides a bibliometric examination of the global and ICI use of BIM. (ii) The analysis was done twice, taking keywords into consideration. as well as the volume of materials and research	Reviewing adoption globally while focusing only on BIM adoption in ICI, (i)examines the use of BIM in worldwide construction for safety and restricts the outcomes to BIM usage for safety in India
3	Shalaka Hire, et al. (2021). [114]	gives a bibliometric examination of the worldwide construction industry's and Indian CI's use of BIM. The use of BIM for safety in the international and Indian CI is also reviewed. examines the global adoption of BIM	(i)Examines the implementation of BIM for safety in worldwide construction, focusing on India, and presents the findings. (ii) BIM could provide the ICI with significant advantages. (iii) Several supplementary products for building site safety, such as VOSviewer and iMapbuilder
4	Saka, Abdullahi B., and Daniel W. M. Chan. (2019). [115]	(i)Provides a scientometric analysis and meta-synthesis of BIM development in the African AEC sector. (ii) Examines the conceptual development of BIM, the current state of BIM in various areas, and any potential roadblocks to BIM adoption.	The key obstacles to BIM adoption were identified as being people- and process-related. I Results demonstrated a diverse amount of BIM growth, with North Africa, West Africa, and Southern Africa leading the research development, while East Africa and Central Africa are slightly lagging behind.
5	Tatjana Vilutience et al., (2019). [116]	shows that efforts to conduct study in this area have mainly focused on addressing generic BIM issues, such as information management; however, technical structural challenges in engineering that could be resolved using BIM capabilities have gone ignored.	(i) Shows how after 2014, research on the application of BIM in structural engineering grew rapidly. (ii) Discusses a variety of issues relating to research gaps and crucial areas required for project completion.
6	Ziwen Liu, Yujie Lu and Lu Chang Peh (2019). [91]	(i) Create the 3 stages of formulating, accelerating, and transforming. (ii) examined Singapore's BIM policy and noted the connection between the development of BIM policy and international BIM research.	Findings highlight the need for additional study in the field of BIM and visualise the current state of the subject's advancement for researchers, practitioners, and policymakers.
7	Ruben Santos ,et al. (2017). [117]	(i) Recognized interoperability and collaborative settings, sustainable building (ii) The academic contribution of BIM, parametric modelling, and quantity take-off is quite limited.	It was noted that the creation of BIM tools, analysis of BIM adoption globally, energy simulation using BIM-based data, and, more recently, semantic interoperability and ontology, were the topics that had received the most research.
8	Yalcinkaya, M. & Singh, V. (2015). [118]	The study's twelve main research areas are revealed by applying Latent Semantic Analysis (LSA), a method of natural language processing, to the abstracts of 975 academic papers.	Recognized numerous distinct research themes connected to each major area These main research issues and areas of study highlight the patterns and developments in BIM research.
9	Tsengunn Ganbat Et al. (2018).	Research trends and possibilities for risk management in BIM-enabled international construction have been identified and explored, and frameworks for BIM risk management in international construction (BIM-RM-INTL) have been developed.	findings demonstrate the increasing BIM adoption not only piques the interests of all stakeholders but also carries some dangers. Current research findings and their connections were mapped for use in risk management in BIM-enabled international building.

Table 7: Miscellaneous research paper on BIM for Construction industry

Sr no	Author /year	Contents	Findings
1	Sonali Dhopte and Arti Daga (2022). [43]	(i)Examines the past, present, and future of BIM adoption in India from the viewpoint of the business community. (ii) Studied and Excelize, an Indian BIM service provider with nearly 20 years of experience in the AECO sector.	(i) Finds that BIM offers a number of benefits for a project's general efficacy and wellbeing throughout its entire life cycle. The study includes both project participants and BIM service suppliers (ii). BIM adoption still encounters a variety of challenges.
2	Abdullahi B. Saka and Daniel W.M. Chan (2020). [120]	(i)The SMEs that make up the construction industry's backbone are examined holistically from the standpoint of existing BIM research in this article. (ii) Created a conceptual model based on a literature review and the framework, model, and institutional theory of innovation diffusion.	(i)Results showed a lack of BIM studies in SMEs, the adoption state, and identified motivations, benefits, and constraints. (ii) The report makes significant arguments for promoting BIM in SMEs.
3	M F Antwl-Afari ,et al. (2018). [112]	Analysis shows that certain nations have created distinct critical success factors (CSFs) for gauging the success of BIM deployment. Common CSFs include: Planning and site safety; cooperation between design, engineering, and construction stakeholders	(i)research on CSFs used for BIM deployment from 2005 to 2015. (ii)better site layout, coordination and planning of construction projects, sooner and more accurate 3D representation of designs, increased information exchange, and knowledge management
4	Sharma Piyush, Gupta; (2016). [121]	(i)Presented an overview of BIM with a focus on its core ideas, difficulties, applications, and management issues among project stakeholders at all phases of the project life cycle. (ii) The ACE industry needs more time to use BIM technology.	Software addresses project complexity while managing the diverse demands and standards of designers and contractors. BIM is backed by its potential to bring about positive, long-lasting change and by its commitment to continue playing a vital role in the industry's efficiency gains and enhancements to product quality.
5	Sawhney, Anil (2014). [129]	According to the report, 27% of respondents stated they are aware of and actively considering utilising BIM, while 22% of respondents currently use BIM. Unexpectedly, 43% of respondents claimed they were aware of BIM but weren't sure if they will implement it in their organisations anytime soon.	In order to accelerate the adoption and adaptation of BIM in India, emphasis is placed on developing tripartite centres of excellence, which unite government, business, and academic organisations.
6	Benedict D. Hozor and David J. Kelly (2012) [122]	The BIM/IPD Integration Model is a novel conceptual framework for comprehending the technologies and their interactions that: (i)identifies important advantages/deficiencies in the literature; synthesises the material with comparative analysis; and (ii) conceptualises the major benefits/deficiencies.	(i)Establish relationship between BIM and/or IPD adoption (ii)project performance measures (e.g., cost, profit, ROI, schedule, safety,

7	Anthony Muttai, Bowling and Stan Guidera (2010). [32]	Provides a framework for advice to construction engineering professors interested in incorporating BIM technology into their curricula by analysing data and methods.	Students in all AEC-related areas may benefit from this kind of professional training if civil engineering, construction, and architectural instructors collaborate and integrate their programmes.
8	J. Vinodkumar Mahua Mukherjee, (2009). [123]	Examines the BIM application status in India. A survey has been created to gauge BIM uptake through 2009.	In many different countries, this acceptance for managing project information with capabilities for cost management and FM is well acknowledged.

IV. CONCLUSION

The most intricate component of the AEC sector is the BIM model. Practically every aspect of a building's operation can be carried out by it. BIM is helpful. [https://www.united-bim.com] BIM may be used to reinvent collaboration across everything and everyone.

BIM has the potential to bring about a variety of direct and indirect advantages for the built environment industry, such as: (i) improved information sharing throughout the entire value chain; (ii) cost and time savings; (iii) improved quality; (iv) increased accountability and transparency in decision-making; (v) increased sustainability; and (vi) improved end-user/customer satisfaction.

With the use of BIM, it is possible to improve collaboration and communication, model-based cost estimation, structural analysis, structural design, 3D modelling construction, increase productivity through prefabrication, design structural steel, detail steel structures, and create 3D, 4D, and 5D BIM services. This (xiii) improved scheduling and sequencing also includes the extraction of structural components, high-quality construction records, conflict identification, and risk reduction.

BIM has a significant impact on CI because it enables companies to prevent costly mistakes caused by human error. BIM is yet another method for bringing cutting-edge technologies to the building industry and raising project quality. Due to its incredible visualisation, simulation capabilities for diverse data sources, and capability to merge numerous stages into a single process, BIM technology has the potential to dramatically revolutionise how organisations carry out construction. Teams involved in design and construction can work more productively thanks to BIM, which also enables them to record the data they

generate during the process for use in operations and maintenance. BIM data can help with project, city, and national level planning and resource allocation. This is the reason that more countries are requiring BIM.

On the basis of the literature review research, below are some inferential points summarized on adopting BIM use in the CI.

The results of BIM :The capacity to exchange accurate and useful information with many different groups of people, such as designers, managers, stakeholders, etc., is one of the key benefits of BIM as a process and platform in general. The BIM process's main objective is to force collaboration and make it easier for all project participants to cooperate and work more efficiently. Building a solid relationship between the two is made feasible through BIM.Projects could achieve sustainability with the use of BIM.

By providing architects and engineers with access to more sophisticated technology tools than ever before to properly integrate and analyse aspects like heat gain, solar, ventilation, and energy efficiency in BIM may improve facility management, BIM has, in particular, made sustainable design possible.Facilities managers may optimise their performance and foster a more data-driven culture to deliver facilities management (FM) services more efficiently and improve building performance thanks to BIM, which enables the management of knowledge throughout a building's entire life cycle.

[iv] BIM increase productivity: BIM significantly improves productivity during the project's design and construction phases. Its advantages include minimising the amount of errors produced, completing jobs faster, and discovering prefabricated material uses to reduce expenses.

[v] Construction industry change brought on by BIM

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Using BIM allows the construction team, which consists of architects, engineers, and contractors, to provide the owner with more meaningful information much earlier in the process. A contractor can often provide a very accurate construction cost estimate when the BIM documentation is about 40% complete.

[vi] BIM can increase construction productivity When compared to non-BIM projects, the ability of BIM to identify and resolve problems before construction begins minimises unplanned modifications in construction by 40% and can save as much as 10% of the total cost of the project.

[vii] BIM helps keep construction expenses down. A case investigation was carried out in a building project that made use of BIM. The results show that BIM may save costs by 52.36% and time by 50%. Because fewer people are needed and the project is completed faster, there are time and money savings that have an impact on funding.

[viii] Projects can be completed with the help of BIM, on schedule, and with effective teamwork. Owners of buildings and projects can lower risk by effectively employing BIM. With BIM, owners can expect improved project quality and easier lifecycle management.

[ix] Further, with the help of AI the BIM in construction, The AEC market is predicted to increase at a CAGR of 15.20% during the forecast period of 2023-2028, aided by the incorporation of artificial intelligence (AI) in BIM software. By 2027, the market will be worth approximately USD 7.6 billion [https://www.uniquescadd.com]. The construction market is in good shape for the balance this year and next.

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Web resources

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[2] https://www.bimspot.io/blogs/
[4https://www.researchgate.net/figure/Summary-of-barriers-in-BIM-implementation_tbl1_285630389
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A review on "Sustainable Solutions for Housing Construction with Advanced Technologies in Indian Context"

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Abstract -**The study aims at investigating the role of advanced technologies to achieve sustainable solutions in housing construction. As per the current scenario there is a huge housing demand in India which needs to be completed by 2022 under the mission of "Housing for all by 2022(MHUPA 2012)". Catering to this need, the Government of India added a technology sub mission of creating awareness and benefits of advancement in technology to be adopted for housing construction was done in 2019 through "Global Housing Technology Challenge (GHTC)". The concept of "built it fast or built it well" within the most conservative way can be achieved with the help of advanced innovative technologies. The base for research paper work is done by review of the available literature associated with advanced technologies used for housing construction like Precast or Pre fab Construction, Steel Structural System, Alternative Formwork System, Sand-witch Panel system etc. For inferences comparative analysis of selected papers are carried out. The review helps to discuss a set of guidelines for future housing proposals in Indian Context.**

Keywords-Housing, Sustainable, Innovative Technologies, Government initiatives

I. INTRODUCTION

India is one of the developing country. The rapid growth in all sectors is becoming more and more prominent. Keeping this in mind this research work is about the urban development in relation with Innovative advance construction technologies and sustainability.

According to the annual report of India for 2020-2021 by "Ministry of Housing & Urban Affairs", "Urbanization is gaining momentum and cities play a crucial role in the development and act as engines of growth for the country. It is estimated that more than 50% of India's population will be living in cities by 2050." (Marina m.,Ashwini K.,Rupesh D., & Mukund J. ,May 2022)

The aim to decide and promote the use of advanced construction methodologies worldwide which were environment friendly and structurally stable. This concept has initiated by the "Ministry of Housing & Urban Affairs" in India. This mission was titled as "Global Housing Technology Challenge –India". The advanced construction technologies were of high quality, affordable, suitable for different climatic conditions, fast and fulfilling the functional aspect of houses. (Dinesh B. Bandiwadekar, Dec. 2021)

There is a grave necessity for the large scale housing projects in India to meet the social requirements, the environmental impacts of such mass construction should also be given due contemplation. This is an ongoing study and a simulation based computational framework is being developed that facilitate analyzing the impacts of various challenges and opportunities associated in realizing sustainable and affordable housing, (Ann F.,Dr. Jinu K.,& Dr. Albert T., NFiCE 2018)

This study is done for National Conference under the theme of Sustainable solutions & Emerging domains & innovation in Housing Construction.

A. Innovative Technologies

The technology adopted for construction which are safer, environment friendly, climatically suitable, speedier, superior quality, functional, flexible cost and resource effective, affordable are calld as Innovative Technologies.

B. Sustainability in Construction Industry for Housing

It is the way in which construction industry achieves technics to make it environment friendly in a various ways, like reduece waste, recycle the material, reduce carban footprint etc.

II. METHODOLOGY

For Literature review the technique of consolidating the answers for 5W's and 1H's is used. Answers to 5W's i.e. When, What, Why, Whom, Who and 1H's i.e. How were found from the selected 16 papers.

This enables to do comparative analysis of all research work done by different authors.

III. LITERATURE REVIEW

The research Papers selected for review are from Oct. 2009 to Oct. 2022 and of different types like White Paper, Working Paper, Technical Paper, Reports etc. All these papers address the Advanced Housing methodologies adopted for construction which are ecofriendly and affordable to be adopted and implemented.

TABLE I.   COMPARATIVE CHART SHOWING 5W'S & 1H'S

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
1.	Research paper	"Sustainable performance criteria for construction method selection in concrete buildings"	Oct.- 2009	Work out a suitable method for construction of given reinforced cement concrete building. Enlist the standard procedure and key drivers which will be useful for stakeholders working in construction industry.	To find out guidelines and set of instructions for the stakeholders working in construction sector. To allow a typical alternative way for construction sector making the construction environment friendly.	The surveys conducted with US construction Industry along with registered authorities working in construction industry. The sample data collected were then analyses by statistical methods.	Ying Chen, Gül E., Okudan C, David R. and Riley B.	The literature review & detailed comparative study of conventional & advanced technology was done for different sites and stakeholders. For completion of this 33 parameters for sustainability were identified and based on those the data were collected to find out conclusion and results.
2.	Research Work	"Helping CIOs Understand 'Smart City' Initiatives"	Feb.- 2010	Explaining the factors, making urban spaces more resilient through different services provided and basic physical systems for technologically modern urban areas. Responsible authorities in their hierarchy of three layers were main leaders to take the mission ahead.	To clear the concept of technologically modern urban areas to responsible authorities. To take and hand over the aim, objectives of technologically modern urban areas to responsible authorities.	Studying the recent technologically modern urban areas globally. Seven important key drivers of infrastructure components & services of existing technologically modern urban areas. To study factors of quickly growing urban areas.	Doug Washburn, Usman Sindhu, Stephanie Balaouras, Rachel A. Dines, Nicholas M. Hayes, Lauren E. Nelson.	Authors interviewed Alcatel-Lucent to study the system called as "Cisco Systems" and "IBM". This methodology enable author to get acquainted with the techniques used for developing modern urban areas.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
3.	A Report	"Improving construction Efficiency & productivity with Modular Construction"	2010	The way to increasing the output and performance with standardized units or modules in construction work.	As per study overall productivity for construction industry were usually decreasing from 1995 to 2001 with respect to the other industries. Hence to increase performance through basic advance techniques and equipment's in construction Industry.	Identified 5 key points were –proper resource management to increase the onsite performance, use of advance technologies at design and execution stage of project, adopting new identified methods for getting high quality, speed and smart resource management, by adopting advancement in construction increasing the high end output results, study interface at different stages of project through "Building modeling Information (BIM)" software,	Experts from: "Advancing the competitiveness & efficiency of the U.S. construction Industry" and The modular building institute	Reviewing of 3 white papers by experts in advance technologies in construction field. Doing 2 day workshop with 20 experts in the advance construction field. Analyzing the data 5 key factors were identified which at end enhance the construction industry.
4.	A white paper	"India Concept House"	Dec. - 2011	Working solution for housing sector by production of cost effective, speedy, ecofriendly building elements.	Addressing the problem of housing in India a big challenge.	The demonstration 11 sites were identified in composite climate zone for study purpose where study of all key drivers impacting on the construction industry. Aims & objectives to enhance the better utilization of all resources were also studied further as mentioned in Red report focusing on the points like thermal comfort, transportation, offsite construction methods etc.	Sam Circle Venture, Kieran Timberlake	Project endeavors, supporting drawing sets & an ideal building type through program development & conceptual development along with construction system analysis was done to deal with the challenge.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
5.	Research Article	"Promoting precast concrete for affordable housing – An overview on promotional policies worldwide and challenges and possibilities in India"	May - 2016	Creating awareness and encouraging for use of offsite construction system for cost effective housing construction.	With the conventional system of construction, the current & future need of housing is seems difficult to fulfill. We need to use the alternative technology such as "PCC", in terms which is appropriate to achieve the goal of housing for all in India.	Studied the PCC adoption criteria's in identified developed countries and its effect in those countries.	B. Arifullah P. Sherfudeen, Nitish Kumar, Raghavan N., Radhakrishna Pillai & Satyanarayana Kalidindi	Conducted interviews with key members of organizations and firms working in PCC field. Analysis of data collected were done with the help of comparison between the different methods & techniques. Also the comparative analysis of guidelines promoting such techniques and need is done.
6.	Research paper	"Identifying and Addressing Critical Issues in the Indian Construction Industry: Perspectives of Large Building Construction Clients"	Nov.- 2017	This research work focuses on finding out the likely difficulties in Indian Construction industry and provide a forum to come out with proper guidelines.	To summarize and state again the main points of finding out the likely difficulties in Indian Construction industry.	By involving the members, organizations & groups involved in Indian construction industry to initiate "Ci3 India "mission, new initiatives which are important and environment friendly to achieve improvement in Indian Construction Industry.	Santhosh Loganathan1, Purushothaman Srinath1, Mohan Kumaraswamy, Satyanarayana Kalidindi, Koshy Varghese1	The international level meetings were held to discuss about issues faced by construction industry. These key 19 issues were enlisted, confirmed and studied. To come to conclusion 4 focus group sessions with 2 roundtable meetings of 54 experts from building construction industry.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
7.	Research Paper	"Construction Costs in Affordable Housing in Kerala: Relative Significance of the various Elements of Costs of Affordable Housing Projects"	Sept.- 2017	The study was focused on cost of various factors and components of housing construction to make the project cost effective or affordable. The related importance, factor of cost of components which at end help to work out suggestions for new policies.	To achieve the best quality in construction of housing. To work out the strategies for making housing construction affordable. To identifying the critical check points in construction process.	The focused study sites and survey is limited to Kerala state only.	Dr. Manoj P. K.	Primary data was collected through literature review & interviews with industry expert in Kerala State. The Secondary data analysis is focused on patterns, ideal trends, housing sector etc. The building typologies considered were Villas, apartment buildings, residential housing.
8.	Research Article	"Smart Villages: Comprehensive Review of Initiatives and Practices"	July- 2018	Study of existing "smart village concepts" and digital change over in rural areas was done to understand the best practices and policies adopted. The study was also focused on "EU policies" adopted and implemented, which is helpful to decide the further guidelines for adopting same.	To understand the implications of smart development. To understand the adoption criteria's by common man. To review the technologies, methods, government policies and startups.	Study of all parameters of existing smart villages. Main focus is addressing the issues of development rules or protocols followed for completing the mission.	Veronika Zavratnik, Andrej Kos, Emilija Stojmenova Duh.	The case of Slovenian pilot practice is considered for focus study. Where analysis of findings and parameters from different regions is done. Which is base for explaining evaluation of construction practices. These statements were supported by Fab Village Concept.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
9.	Research Paper	"Prefabrication As A Solution To Improve Productivity Of Construction Industry, Tamilnadu, India"	Apr.- 2020	To work out the challenges faced in adoption of prefabrication technology in Tamilnadu, India.	To reduce or minimize the issues faced by construction industry key stakeholders in identifying an appropriate technology for construction in Tamilnadu, India.	The study of critical problems faced by key organizations, members and firs using prefabrication construction technology in Tamilnadu, India.	Murali, K., Sambath, K.	Through Summary of literature review was enlisted total 24 key factors, Amongst them 10 key factors were representing benefits of adoption of technology, 7 key factors indicating difficulties faced and 7 key factors were indicating guidelines of adopting the technology.
10.	Research Paper	"Sustainable Performance Criteria for Prefabrication Construction System"	Apr.-2020	To identify the potential of prefab construction technology in respect of conventional construction methods.	To enlist the key drivers playing an important role in selecting and adopting the prefabrication construction technology. To provide solution to the issues faced by construction industry for adopting the prefab technology.	Reviewing of Environment friendly construction criteria's during the construction phase of a project highlighting its aspect of social consciousness, economy and eco-friendly criteria's.	Murali, K., Sambath, K.	Comparative analysis considering the key aspects such as economy, social concerns, sustainability etc. between conventional construction technology and Prefabrication construction technology.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
11.	Research Paper	"Quantitative Analysis of Precast and Cast in-Situ Residential High Rise Building"	Jun.-2020	The conventional & precast construction technologies were compared for cost and time required to complete the identical project.	To identify suitable construction technology for high rise housing construction. To identify suitable construction materials for high rise housing construction.	2 construction technologies were analyzed considering cost & time in Bengaluru, India. Rate analysis was done considering market rates in Bengaluru, India. Typical G+7 storied building consisting of 48 houses was considered for case study purpose.	Akshay Jagannath Rajagopal	Comparative analysis of 2 technologies was done considering the two basic points- estimation & project planning or scheduling. Estimates were done manually & scheduling was done using Primavera software.
12.	Research Article	"Application of Sustainable Prefabricated Wall technology for energy efficient social housing"	2021	Comparative study of conventional and prefabrication construction regarding economical and energy consumption points.	To review the current practices in cost effective building construction in India. To address the issues of solid waste and industrial waste management in India.	A comparative study of model house with 17 different materials like "co-fired blended ash (CBA)" an industrial waste was done. With different criteria's involved in prefabrication panel system.	Ravijanaya Chippagiri, Hindavi R. Gavali, Rahul Ralegaonkar, Mike Riley, Andy Shaw, Ana Bras	The statistical analysis of all identified 18 model houses using computer software's for two key factors- cost & energy consumed in 2 considered technologies was done.

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
13.	Research Paper	"A Study of the Scientific and Logical Step By Step Process of Sourcing and Implementing New Technologies for Construction of Low Cost and Related Housing Initiatives in India"	Dec.-2021	To study scientifically parameters of new construction technologies for affordable housing construction. To study methodology for implementation of new technologies in detail step by step.	To make awareness about using new construction technologies in construction industry.	Detailed study of "GHTC- India" and other sub missions and missions.	C. Dinesh Bandiwadkar	Literature review of GHTC-India published by Government of India and interviews of different stakeholder involved in it
14.	Research Article	"The advancement of precast development in India : A Critical survey of challenges & benefits within the rising residential sector"	2022	To study challenges faced by Indian construction industry to adopt advancements in precast construction technology. To find out benefits of adopting new technology in growing housing sector.	To aware the importance of Precast technology in Indian construction industry	The construction technologies like cast in situ and Precast Construction were studied in detail.	D. Abhi K Rakholiya , Pravin R Minde	For literature review, comparative analysis of precast technology with conventional technology in reference to time , cost, productivity& quality

Sr. No.	Category of Paper	Title of the Paper	When	What	Why	Whom	Who	How
15.	Working Paper	"Alternate Construction Technologies for Mass Housing: Challenges to adoption in India"	Jan.-2022	To study issues faced for using advanced construction technologies in Indian construction industry for mass housing projects.	To find out the issues for using new technologies for mass housing construction in India.	The detailed study of four new construction technologies involved in construction industry.	A. Ayush Khare , Deparpita Roy, ,Triveni Nanda.	A literature review along with interviews with industry experts and stakeholders. Also discussion with government authorities, Academicians, civil society experts were done.
16.	Review Paper	"Technological & Sustainable Perception on the advancements of prefabrication in Construction Industry"	Oct.- 2022	To study the key factors those make prefabrication construction an efficient, environmentally, sustainable technology.	To enhance the existing information of Prefabrication construction technology with the data and work of 3 decades. To detail out the spectrum of different key factors which has impact on construction industry.	The review of more than 80 research articles written on prefabrication construction technology implemented or used in approximately 10 countries worldwide.	Ravijanya C. Ana Bras, Deepak Sharma, Rahul Ralegaonkar	The study of 3 decades research work from 1990's about the progress of technologies in construction world, different materials available etc. along with its implementation in construction industry.

IV. Conclusion

After reviewing a wide range of Research literature the conclusion is –

It is impactful to cater the need of high housing demand due to rapid urbanization with sustainable and environment friendly innovative technologies; that need to be adopted for urban development in India.

Lots of government initiatives are taking place to promote, adapt these sustainable innovative technologies for smarter cities with built to fast concept.

Focus of stakeholders towards adopting futuristic innovations in housing construction is becoming essential day by day.

Acknowledgments

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Process Standardization for Mango Leather

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ABSTRACT

The super fruit base leather was prepared from Mango (*Mangifera Indica L.*) which naturally represent elevated nutritional status. The mango leather was dehydrated at 40, 50, 60, 70° C drying air temperature in cabinet dryer. The drying rate curves showed that 60° C temperature was suitable for obtaining good quality leather with a moisture content of 19.13% for 7 hours of drying time Mango pulp was found to have a moisture content of 80.63%. The proximate composition of mango leather (Protein 15.89%, crude fat 1.56%, carbohydrates 58.26%, total dietary fiber 14.06%, ash 1.98%) recorded significant increase than fruit pulp (Protein 0.61%, crude fat 0.42%, carbohydrates 14.39%, total dietary fiber 0.79%, ash 0.52%). The mineral profiling of fruit leathers demonstrated similar increasing trend due to concentration of nutrients during pulp to leather processing.

Keywords

Mango, fruit leather, dehydration

1. INTRODUCTION

Fruit puree is dehydrated to prepare a product called fruit leather. Mango, apple, and other tropical fruits are just a few examples of the many fruits that may be used to create fruit leathers. However, the composition considerably relies on the type of fruit added to the puree combination due to changes in the quantities of pectin, sugar, and acid. The formulation might occasionally include different kinds of carbohydrates as well as additives like hydrocolloids and preservatives in order to enhance the rheological qualities or preserve the fruit's original color. These fruit treats were first created as a small-scale alternative preservation technique, but recently they have become more popular due to their nutritional benefits. The processed fruit products offer less calories than traditional snacks and are a rich source of fiber as well as micronutrients (Diamante *et al*., 2014; Ruiz, *et al.*, 2012; Vatthanakul *et al*., 2010).

Fruits are a valuable source of nutrients that are good for your health, including minerals, vitamins, antioxidants, and fiber. Fruits are a good source of energy, but the time it takes to make them and their high perishability are obstacles to increased fruit intake. Fruit eating every day helps to strengthen the immune system that keeps illnesses at bay. Among the other nations, India is the one that produces the most fruits and vegetables. Fruits are subsequently processed into various value-added products to prevent post-harvest losses (Anonymous, 2002).

The Anacardiaceae family plant, the mango (Mangifera indica L.), has a variety of beneficial compounds. Mangoferin, quercetin, catechins, anthocyanins, ellagic acid, kaempferol, methyl and propyl gallate, benzoic acid, gallic acid, and protocatechuic acid are the primary phytochemicals in mango fruit that have antioxidant effects. The primary antioxidant in mangoes, mangiferin, is well-known for its therapeutic and nutraceutical properties and is still gaining popularity, particularly for its ability to fend off degenerative diseases like cancer and heart disease. (Masibo and Qian, 2009). Similar to other polyphenolic compounds, mango polyphenols are primarily antioxidants, protecting human cells from oxidative stress, which can result in lipid peroxidation, DNA damage, and a number of degenerative diseases (Raab and Oehler, 1976).

Hidden hunger is more common among urban residents and is exacerbated by urbanization, dietary change, and sustainable food systems. Therefore, one strategy for addressing hidden hunger is diet diversity using super fruits. This study aimed to establish the nutritional significance of fruit leathers prepared from mango fruit and the comparative analysis (Pulp vs leather) to emphasize and rejuvenate the nutritional profile of fruit leathers.

2. MATERIAL AND METHOD

2.1 Materials

The good quality of mango fruit pulp, sugar, pectin was procured from local market of Pune. The Department of Food Process and Product Technology laboratory at MIT ADT University in Pune provided the processing and further working tools.

2.2 Methods

2.2.1 Preparation of fruit leathers

In mango leather, the fruit pulp was mixed with sugar and pectin. The mixture was mixed thoroughly and heated at 70℃ for 3min. Mix and heat mixture, pour into stainless steel tray, smeared with butter, and dry in cabinet dryer at 60℃ for 6 hours. The dried fortified mixed fruit leathers were prepared. The process was followed for fruit leather preparation with slight modification as reported by Vijayanand *et al.,* (2000) as well as the fruit leather was prepared as per the method described by Patil *et al.,* (2017) where the date and mango leather (60:40) dried in cabinet tray dryer at 65 ± 5^0C for 12-14 hrs.

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2.3 Chemical analysis

2.3.1 Determination of the proximate composition of the fruit pulp and leathers

The method of A.O.A.C. (2005) was adapted for determination of ash, crude protein and crude fiber. The moisture and crude fat were determined by methods described in Ranganna (1986), while carbohydrate was calculated by difference method.

2.4 Statistical analysis

Each experiment was run in triplicate. For each treatment, the mean and standard deviations of the data were calculated. The statistically significant changes (p < 0.05) were found using ANOVA. The Statistical Analysis System version 9.21 was utilized for the statistical computations, and Microsoft Office Excel was used to examine the sensory assessment data. To find any significant differences between the mean values, a one-way ANOVA was performed after the means and standard deviations were calculated.

3. RESULT AND DISCUSSION

3.1 Influence of temperature on drying rate

The mango fruit leather drying curves shown in fig. 1 revealed fluctuations in moisture content with regard to time (7 h) for drying at 40, 50, 60, and 70 ºC. In all temperatures, it was found that fruit leathers moisture content dropped dramatically as they dried. As the drying air temperature increased from 40-70ºC, the drying curves exhibited steep slope indicating that the rate of moisture loss increased with increased in drying air temperature in cabinet dryer. The similar trend of results was notated by (Asabe *et al.,* 2021). The moisture loss at 70ºC was observed to be faster compared to 40, 50, 60 ºC temperatures. However, this resulted in colour degradation of the leathers and gave chewy texture to the leathers. Hence, the experimental finding showed that 60ºC drying air temperature was suitable for obtaining good quality dried leather with a moisture content of 19.13 % and drying time of 7 hours. The drying temperature range of 50-60ºC for drying of fruit leather is supported by (Kaur and Godara 2022).
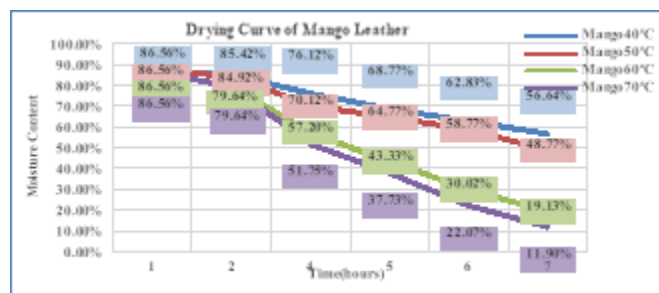

Figure. 1: Drying curve of mango leather

3.2 Comparative nutritional profiling of pulps and leathers

3.2.1 Proximate composition of raw materials

The moisture content of mango pulp was found to be 80.63%. On the other hand, mango pulp was high in

carbohydrates (14.39%) and crude ash (0.52%), as depicted in table no. 1. The mango pulp contains 0.61% crude protein, 0.42% crude fat, 0.79% crude fiber. The mango pulp results are similar to those reported by Pawase *et al.,* (2019) and Chakraborty *et al.,* (2020) respectively. The protein-rich ingredient that is whey protein concentrate was specifically chosen to fortify mango fruit leather. According to Jangale and Ghanendra (2013), the substances mentioned above had an average protein level of 82.3%.

Table 1: Proximate composition of raw material and fortified leather

Raw materials	Moisture (%).	Carbohydrate (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ash (%)
Mango pulp	80.63±0.045	14.39±0.86	0.61±0.040	0.42±0.021	0.79±0.020	0.52±0.04
Mango leather	19.13±0.02	58.26±0.015	15.89±0.40	1.56±0.015	14.06±0.015	1.98±0.01

(The values were mean ± standard deviation of three independent readings)

3.2.2 Proximate composition of leather

The proximate composition of mango leather revealed a significant increase in crude protein (15.89%), carbohydrate (58.26%), total fiber (14.06%) and crude fat (1.56%). The increase in crude protein, crude fat, carbohydrate and total fiber values is due to the addition of 12% whey protein concentrate to mango pulp. The findings are in agreement with Chauvan (2013) for mango leather that the nutritional goodness of the prepared product was improved by dehydration process which causes concentration of nutrients.

3.2.3 Comparative mineral profiling of fortified pulp and leathers

The processing of fruit pulp to leather resulted in concentration of minerals such as calcium, potassium, magnesium, iron. The calcium content in the leathers significantly increased from 30.62 to 141.01mg/100g, 176.37 to 662.12mg/100g, 20.14 to 54.16 mg/100g and 1.92 to 2.23 mg/100g in mango. This could be due to the dehydration process causing evaporation of moisture from the fruit pulp and concentration of dry matter in leathers. The trend of increase in the mineral content in fruit pulps to leather processing has been reported earlier by Karabacak *et al.,* (2021) for pumpkin fruit leather.

Table 2: Comparative mineral profiling of pulp and leather

Parameters	Calcium (mg/100g)	Potassium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)
Mango pulp	30.62	176.37	20.14	1.92
Mango leather	141.01	662.12	54.16	2.23
SE±	0.024	0.5	0.03	0.009
CD @ 5%	0.094	0.19	0.11	0.035

(The values were mean ± standard deviation of three independent readings)

4. CONCLUSION

In this study the super fruit-based fruit leathers were prepared to improve the nutritional potential of super fruit leathers in terms of the concentration of nutrients, phytochemicals and antioxidant activity. Fresh mango is a high source of macro and micronutrients such as vitamins, minerals, fibers, carbohydrates and other bioactive substances. Dehydrating fruits into leather reduces post-harvest losses due to their perishable nature and extends shelf life for seasonal fruits like mango. It can be concluded that Conversion of perishable fruits to fruit leathers preserves surplus harvest and minimizes postharvest losses globally. The drying process for preparation of leather was standardized at 40, 50, 60, 70ºC for 7 hours drying time in a cabinet dryer. Air drying temperature above 60ºC affected the color and texture of leathers. Hence, 60ºC for 7 h was found to be optimum temperature (Final moisture content 19.13%) in fortified fruit leather. The drying process increased the ash, carbohydrate, protein, ash, fibre, mineral total phenols, and carotenoids contents of the fruit leathers significantly when compared to their comparable fresh fruits. The present investigation thus rejuvenates the nutritionally superior status of fortified fruit leathers as a healthy snack.

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Development and Nutritional Assessment of Herb Fortified Pomegranate Beverage

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Abstract

The herbs such as ashwagandha (*Withania somnifera*) and tulsi (*Ocimum sanctum*) are rich in phenols, minerals and strong free radical scavenger activity. The extract of selected herbs was fortified in pomegenate juice to improve the health and nutritional requirements. The different levels of a tulsi extract (3%, 4%, 5%, and 6%) and ashwagandha extract at (0.6 %) were fortified in pomegenate juice to prepare ready to serve beverage. Each sample was subjected to sensory evaluation by a panel of semi-trained individuals. The results of sensory evaluation show highest acceptability (overall acceptability 7.8) for sample with 0.6 % ashwagandha and 4% tulsi extract. The same sample was analysed for mineral, antioxidant and total phenol content which recorded potassium 121.32, magnesium 9.87, sodium 59.7, copper 0.3, DPPH scavenging activity 52% and 8.4 (GAE/100g) respectively.

Keywords: pomegranate juice, basil extract, ashwagandha, sensory evaluation, physicochemical evaluation, antioxidant, phenol, storage.

Introduction

The pomegranate (*Punica granatum*) is fruit well identify for its nutritional benefits. The ratio of fruit such as peel: arils: seeds is approximately 50:40:10. The fruit arils contain 85% water, 10% total sugar (fructose and glucose), 1.5% pectin, organic acids (such as citric acid, ascorbic acid, and malic acid), as well as bioactive compounds like phenolic and flavonoids. Pomegranate fruit offers a significant health advantage by combating oxidative stress and reducing levels of inflammatory mediators (Panth *et al*., 2017). Juice from pomegranates contains a lot of polyphenolic components. The main groups are tannins and flavonoids, which suggest the pomegranate's medicinal potential due to its high antioxidant and preservation properties.(Zarfeshany *et al*., 2014). Pomegranate juice is a reliable source of vitamin B5 (panthotenic acid), polyphenols (tannins, flavonoids), minerals (potassium, sodium, iron, copper), ascorbic acid (Heyn,1990).

The roots of Ashwagandha primary compounds known as withanolides (steroidal compound) which deliver extraordinary medicinal properties for the disease (Verma and Kumar, 2011).In Ayurveda medicine Ashwagandha is called a Rasayana herb (*Withania somnifera*) is a medicinal plant that extends over a large area. The botanical liquid extract of the herb can be used in effective beverages to help improve the health (Mishra *et al.,* 2000). Indian Basil (Tulsi) comes with loads of health benefit as it is a rich source of vitamin C, β carotene. Basil is useful in treatment of fever, common cold, antispasmodic, appetizer, carminative, and anti-inflammatory properties (Sethi, 2020). A mixture of herbal extracts will be used in the current research for development of novel pomegranate juice based beverage

Basil (*Ocimum sanctum Linn.*) is well known medicinal plant in traditional medicine from back several 1000 years. Tulsi or Holy Basil from the family *Lamiaceae* is known as the "Queen of plants" and the "mother medicine of nature" for presence medicinal qualities. Tulsi present in different forms like fresh extract from leaves or dried powder in herbal teas or mixture with other herbs like in to honey enhance the medicinal value. Extract from Tulsi leaves is claimed for numerous useful properties such as expectorant, anti-asthmatic, and anti-inflammation, hypoglycemic, hypolipidemic (Yamani *et al*., 2016). Therefore, the ashwagandha and basil extract where used for developed herb fortified pomegranate beverage. The developed was assessed for chemical and nutritional properties.

2. Materials and methods

2.1 Raw materials

Raw materials such as fruits (Pomegranate- variety *Arakta*), sugar, Ashwagandha extract, Tulsi (holy basil) leaves were purchased from the local market Loni Kalbhor, Pune.Other raw material like sugar, pectin, preservative was also procured from the local market pune.

2.2 Methods

2.2.1 Extraction of pomegranate juice

The fruits were washed, peeled and arils were separated. The pomegranate juice was extracted in food processor and the seeds were added as a part of waste with peel.

2.2.2 Preparation of extract

The Tulsi leaves were washed, cut and steam blanched in laboratory steamer at 100°C for 2 minutes. The Tulsi juice was filtered through muslin cloth to remove the fibres and sediments. The method for tulsi extract preparation was as per (Hingne *et al*., 2020) with slight modification.

2.2.3 Development of pomegranate herb fortified beverage

The Ashwagandha extract and prepared Tulsi extract were mixed in the pomegranate juice 0.6% and 4% respectively as per the formulation depicted in table 1. All the ingredients were properly blended and the finished beverage was undergone pasteurization at 90° C for 15 sec. The hot filling process was carried out at 75° C in sterile PET and glass bottles. The beverage was then allowed to cool at ambient temperature before being kept chilled at 8 to 12 C for additional storage research.

2.2.4 Formulation of herbal pomegranate beverage

Table 1: Standardized formulation of herb fortified beverage

Sr. No.	Ingredient	T0	T1	T2	T3	T4
1	Pomegranate juice (%)	25	25	25	25	25
2	sugar (%)	10.8	10.8	10.8	10.8	10.8
3	Citric acid (%)	0.25	0.25	0.25	0.25	0.25
4	Ashwagandha (%)	-	0.6	0.6	0.6	0.6
5	Tulsi extract (%)	-	3	4	5	6
6	Pectin (%)	-	0.7	0.7	0.7	0.7
7	water (%)	63.95	59.35	58.35	57.35	56.35

2.3.1 Sensory evaluation of herb fortified beverage

The MIT School of Food Tech loni used a semi-trained panel to assess the new beverage's sensory quality. Twelve semi-trained members used a nine point hedonic scale to evaluate the qualitative aspects of color, flavor, taste, consistency, mouthfeel, and overall acceptability. (Amerine *et al*., 1965).

2.4 Chemical analysis

2.4.1 pH

The pH of juice was measure by using perkin-Elmer meter.

2.4.2 Acidity

The acidity of juice were measured by using titration method with 0.01N sodium hydroxide (Ranganna, 1986).

2.4.3 Total soluble solid

Total soluble solid (TSS) was measured by using Erma hand refractometer. Take a drop of a juice on the prism and hold the refractometer into the light, then look through the eyepiece to get reading.

2.5 Nutritional composition

2.5.1 Minerals estimation

Minerals content *viz.,* potassium, magnesium, sodium, copper was analysed by as per standard method Ranganna, (1986).

2.5.2 Antioxidant and radical scavenging assay

The level of antioxidant activity was assessed using DPPH (1, 1 diphenyl 1-2 picrylhydrazyl) radical scavenging assay.

2.5.3 Total phenolic content

Using the folin-Ciocalteu reagent in triplicate and an absorbance measurement at 650 nm, the total phenolic content was ascertained.

2.5.4 Estimation of Vitamin C

Vitamin C estimated as per the method prescribed by Ojukwu and Nwobi, (2017).

3. Statistical analysis:

Triplicates of each experiment were run. Data were statistically analysed using one-way ANOVA. Package to evaluate the significance at $p < 0.05$.

4. Result and Discussion

4.1 sensory analysis

The sensory evaluation of pomegranate herbal beverage at different concentrations of Ashwagandha and Tulsi extract was carried out in comparison to control (pomegranate beverage without herbal extracts) beverage. The rubric for sensory evaluation comprised of colour, taste, flavour, mouth feel, consistency and overall acceptability parameters. The semi-trained panel set-up at MIT School of Food Technology was used to assess the quality parameters of developed test samples (S_0, S_1, S_2, S_3 and S_4) on Hedonic scale of a 9-point .

The herbal extract fortified beverage samples recorded significant improvement in sensory scores compared to control beverage sample. The sample S_2 (0.6g Ashwagandha + 4g Basil extract per 100g beverage) was found to have the highest significant difference ($p < 0.05$) scores for colour (8.1), taste (7.9), flavour (7.2) consistency (7.5), mouth feel (7.8) and overall acceptability (7.8) compared to control sample with overall acceptability (7.6). The improved sensory score because of fortification of herbal extracts such as basil was notified by (Lall *et al.,* 2019; Hingne *et al.,* 2020) Goat milk based herbal beverage and in herbal milk fortified with basil and aloe Vera. And ashwagandha extract by Dhumal *et al.,* (2006) in beverage it contains Ashwagandha extract.
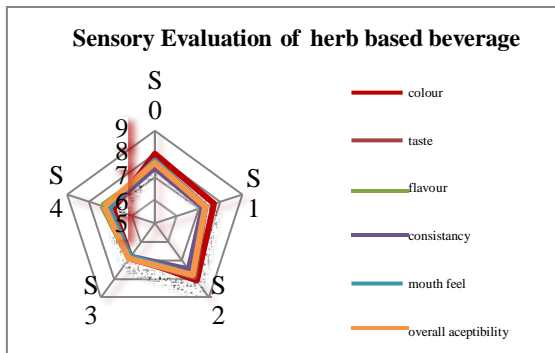
Fig 1: sensory evaluation of herb based beverage

S r. n o	Sample	Potassium (mg /100g)	Magnesium (mg /100g)	Sodium (mg /100g)	Copper (mg /100g)
1	Control pomegranate beverage	95.7	5.31	54.00	0.05
2	S2(0.6gAshwagandha + 3g Basil extract per 100g pomegranate beverage)	121.32	9.87	59.7	0.3
3	SE ±	0.47	0.41	0.42	0.03
4	CD@5%	1.85	1.62	1.65	0.12

4.2 Physicochemical analysis

The herb fortified and control beverage was prepared according to the formulation. The physicochemical properties were analysed and are tabulated in table 2. Which revealed that TSS of pomegranate herb fortified beverage is 15 Bx, acidity 0.33, pH 3.3 and vitamin C is 5 as it during the preparation of beverage.(Sandhan *et al.,* 2009)**;** (puranik *et al.,* 2013).

Table 2: Physicochemical analysis of beverage

Sample	TSS (˚Bx)	% Acidity	pH	Vitamin C (mg/100g)
control	13	0.31	3.0	3
S2 (0.6g Ashwagandha + 4g Basil extract per 100g pomegranate beverage)	15	0.33	3.3	5

4.3 Nutritional composition

4.3.1 Mineral estimation

The selected mineral profile (sodium, potassium, magnesium, and copper) of control and S_2 beverage sample is calculated. The significant difference observed in mineral content of control and fortified beverage values. An increasing trend for potassium from 95.7 to 121.32 (mg/100g), magnesium from 5.31 to 9.87(mg/100g), sodium 54.0 to 59.7(mg/100g) and copper from 0.05 to 0.3 (mg/100g) was observed in present investigation due to fortification of herbal extracts. The similar result was recorded by (Maiman and Ahmad, 2002); (Akhtar *et al.,* 2013). The rise in mineral content of S_2 sample could be due to the inherent mineral richness of tulsi and Ashwagandha which after fortification improved the mineral profile of pomegranate beverage.(Vidhani *et al.,* 2016);(Gulati *et al*., 2017).

Table no 3: minerals content in herb fortified beverage

4.4 Antioxidant and radical scavenging assay and total phenolic content

The total phenolic content and % DPPH inhibition of control and fortified pomegranate beverage. The significant difference was observed in total phenolic content and DPPH scavenging activity of control and fortified beverage. The values for total phenolic content increased from 2.06 to 8.4 (GAE/100g) and %DPPH from 25.27 to 52% for control and fortified beverage respectively. The results % DPPH scavenging activity and total phenolic content are in agreement with Gil *et al., (*2000); Puranik *et al*., (2013).The significant increase in %DPPH scavenging activity could be due to increased total phenolic content. The positive correlation between a for mentioned components was notified by Soha *et al.*, 2015; Gaur *et al*., (2019).

Table no 4: nutritional composition in herb fortified beverage

Sr. No.	Samples	Total phenolic content (GAE/100g)	% DPPH Scavenging activity
1	Control pomegranate beverage	2.06	25.27
2	S2 (0.6g Ashwagandha + 4g Basil extract per 100g pomegranate beverage)	8.4	52
3	SE±	0.07	0.44
4	CD @5%	0.28	1.73

5 Conclusions

The evaluation showed clear preference for selected sample (25% of pomegranate juice + 4% tulsi leave extract + 0.6% ashwagandha root extract) sample which was found to have the highest scores for colour (8.1), taste (7.9), flavour (7.2) consistency (7.5), mouth feel (7.8) and overall acceptability (7.8),So selected sample formulation was highest acceptability than other sample. The developed pomegranate herbal beverage having nutritional composition (total phenolic content 2.06 to 8.4 (GAE/100g) and %DPPH from 25.27 to 52%)

and requires health benefits for commercial exploration with technological and economic feasibility.

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