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Development of Decision Making Android Model for Farmers

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Abstract: ***Agriculture is the backbone of our country and contributes almost 18 percent of the GDP, according to the Department of Agriculture, Cooperation, and Farmer Welfare's 2018–2019 annual report. Agriculture is the largest sector of the Indian economy, employing about half of the labour force. However, farmers might not always benefit from the market for their products. Producing the fruits and vegetables, India is second largest in world according to Department of Agriculture, cooperatives and Farmer Welfare's annual report for 2020–2021 yet, farmers there are experiencing financial hardship due to crop failures. Marketing veggies from growers to consumers is fraught with issues. Transportation and the seasonality of fruit are the two rather significant obstacles that farmers who grow vegetables must overcome. The perishability of the goods, the seasonality of manufacturing, the bulkiness of the products, and the price difference between buying and selling were the less severe constraints. The objective of this project is to create a system that helps farmers choose the best crop based on soil characteristics, environmental factors like temperature, soil humidity, humidity and market demand, as well as technological advancements like crop suggestions and decision-making models to help farmers understand the demand for perishable crops.***
Keywords: Android Application, Decision making model, Crop demand prediction, crop recommendation and KNN algorithm.

I. INTRODUCTION

If cultivation is put down and distant from the corn field, ploughing may be simpler. Starting with our progenitors, the FERTILE CRESCENT, it all began in the globe around 10,000B.C. Hunters, who were nomadic people that moved from place to place in quest of sustenance, eventually started gathering wild gourds that they discovered growing on the soil. The extra grain was then dispersed to help grow additional food. But today, there is no food crisis, no agricultural development, no use of pesticides, and no need for specialised farming machinery. Things are much better and very different than they were in the past. They nevertheless lead a healthy lifestyle, are free from marketing disputes, and do not had any farmer suicides. This is due to the fact that the agricultural land was fruitful and overfilling the land was not a problem at the time. The current state of agriculture deviates from what farmers anticipated. Although agriculture in our country has improved, the yield of our main horticultural and agricultural crops is still quite poor when compared to other nations. Our agricultural sector still lacks in technology. In our country, food grain, fruit, and vegetable yields per hectare are much below average globally. Our rice yield is roughly half that of Vietnam and Indonesia, and it is only a third of China's. Even the most productive regions of India under perform the world. Similar to this, by paying attention to seeds, soil health, pest management, crop-saving irrigation, and post-harvest technologies, the production of pulses and oil seeds may be boosted by 2.3 to 2.5 times. By 2025, India's population is predicted to exceed 1.5 billion, making food security the most pressing societal issue and necessitating a significant increase in food production to accommodate the expanding population. A quarter of all undernourished individuals worldwide, or 217 million people, live in India, according to the FAO. To increase agricultural productivity, it is necessary to adopt new technologies including biotechnology, nanotechnology, high-tech protected cultivation, and contemporary irrigation techniques.

A. Fruits and Vegetables Sector Scenerio

As of the end of 2019 (NHB, 2019), India produced a total of 88.97 million metric tonnes of fruits and 162.89 million metric tonnes of vegetables, placing it second only to China in terms of fresh agro-food output. The proportion of fruits increased from the 2019–2020 period to 88.97 million metric tonnes, while the proportion of vegetables increased from 88.62 million metric tonnes to 162.89 million metric tonnes. Despite being the second-largest producer of fruits and vegetables in the world, supply chain losses and waste make it difficult for customers to get the ideal items at the ideal time and price. India is one of the top wasters in the world due to a significant portion of its production going to waste. It is also discussed how the very inefficient fruit and vegetable supply chain in India results in significant losses and waste, as well as lower profits for stakeholders.

In addition to the farmers losing money, it increases other costs across the supply chain, forcing the final customer to pay exorbitant prices out of his own pocket. Numerous investigations of postharvest losses in India have unequivocally demonstrated that the quantity of food wasted there annually is equal to the quantity consumed there. According to a recent assessment conducted in India, fruit and vegetable producers lose out on an estimated Rs. 2.13 lakh crore annually as a result of losses in the supply chain.

B. Problems

1) *Poor Infrastructure:* Infrastructure serves as the backbone and a key component of the supply chain in every sector. The transportation infrastructure, connection and network of roads, port infrastructure, marketing facilities, processing technologies, and other components make up the supply chain for perishable fresh goods. One of the primary reasons why food is lost or wasted in India is due to the very inadequate infrastructure supporting perishable food supply chains. Fruits and vegetables lose up to 40 percentage of their value due to inadequate infrastructure support for supply chains under government control. Post-harvest losses occur at various points in the supply chain as a result of weaknesses in the cold chain, such as inadequate infrastructure, a lack of cold storage facilities nearby farms, poor transportation methods that take too long to deliver fresh fruits and vegetables to markets and compromise their quality and condition, which leads to wastage. The communities, farms, and marketplaces in the hilly area are also not well connected, so the farmers had to find a way to get their crops to the neighbouring road, which increased the amount of produce that was wasted. More fresh food is lost on the way to market due to inadequate infrastructure amenities.
2) *Transportation:* Supply chain and logistics for perishable food production are discussed in this part along with the transportation-related causes of losses and wastage. It has been noted that transportation losses, which primarily happened during the transit of fresh produce to markets, are one of the largest and most significant operational sources of waste in the perishable food supply chain, followed by inventory management. The extent and size of post-harvest losses, as well as the finding that transportation and distribution of agricultural goods is the factor causing such losses, all add more to this issue. The author discovered that transit loss contributed about 24 percent of the overall loss. When it comes to transportation, timing is essential for providing fresh fruit on time and in good condition. There are numerous losses at the farm level as well because of the ignorance of the time element, which causes delays in getting freshly harvested produce to market. Due to the difficulty in gathering and transporting tiny quantities of fresh product from the different small farms, there are significant post-harvest losses. The poll revealed that most farmers gather their products in the morning, pack them into wooden boxes, and then drive a pickup or truck to the outside market to deliver them. Market-level losses are mostly caused by the methods of transportation used in marketing channels, the supply chain management of fruits during regular transportation, negligent driving, and difficult roads, which are also factors in postharvest losses. The lack of particular facilities, such as temperature-controlled shipping, for some crops is what caused the marketing failure. Produce is rough-handled and driven in open trucks. After harvesting, it takes at least 24 hours for the fresh product to reach the retailer, who is often an open market vendor or a pushcart. The fresh product loses quality when it is stacked into huge cane baskets or into truck beds without padding or packing, leaving it exposed to the heat of the sun. Waste occurs in the retail industry as a result of a flawed transport infrastructure and delayed fresh produce deliveries.It arrives on the shelf of the store too late and has a short shelf life left, which wastes perishable food at the retailer level and results in the penalty. Fresh produce is difficult to handle and transport due to its size, which results in significant wastage of roughly 35 percent of the crop, or over Rs. 23,000 crore (CII, 1997). India faces many transportation-related difficulties due to a lack of efficient transportation methods, high transportation costs, a shortage of vehicles that can convey goods at a controlled temperature, etc. The demand for specialised vehicles like reefer trucks, which can maintain the quality of fresh produce and extend shelf life while also reducing transit losses, will rise with the adoption of more efficient means of transportation.
3) *Large number of Intermediaries:* Fresh produce that is perishable has a highly inefficient supply chain due to the numerous middlemen and chain fragmentation. The extensive and disjointed traditional supply chain for perishable fresh fruit in India allows for the collection of a sizable portion of the price that buyers pay for the goods. In the fresh produce supply chain, there are a lot of middlemen, including farmers, agents, pre-harvest contractors, wholesalers, commission agents at the level of whole sales, auctioneers, retailers and customers. A horticultural product travelled through six to seven different distribution channels before reaching the consumer. A large number of middlemen increases waste and the cost of consumption per unit. Market middlemen cause a number of losses. Fresh vegetable losses were examined, and it was discovered that they are influenced by the length and quantity of participants in the marketing channel.India's horticulture supply chain is disjointed because the vast majority of farmers are small, marginal, and have extremely small landholdings. Due to their small land holdings, these farmers

produce very little, which complicates transportation and increases their reliance on middlemen to market their goods. The losses that the farmer suffers are typically unimportant to the intermediaries, and they are generally unwilling to invest in better cold storage and other facilities. This results in a drop in produce quality and quantity, which lowers the value of fruits and vegetables by 40 percent across the supply chain. Companies are developing a variety of strategies for acquiring fresh vegetables directly from the grower. Another novel idea is contract farming, which lessens the dependence of farmers on middlemen by removing the layer of intermediaries.

4) *Information of Market Demand:* In order for the supply chain to function smoothly, information flow is absolutely essential. Due to their perishable nature and short shelf lives, fresh fruit supply chains place an even greater emphasis on it. The causes of loss resulting from inadequate information about demand in the supply chain are categorised in this section. One of the main reasons of waste, according to the report, is a lack of demand data. One of the major factors contributing to waste was a lack of demand information. One socioeconomic aspect generating post-harvest losses is a lack of information. The majority of the time, fresh food is left unsold in retail establishments after its expiration date has past. This is the primary cause of waste at the retail level. This happens when a store orders more than what is actually needed since there is no knowledge about demand. With the use of timely information about market demand, farmers must plan and manage the planting and harvesting processes since poor planning and management methods are one of the reasons why losses occur in the supply chain for fresh produce. The next part addresses the farmer's knowledge and experience as the cause of post-harvest losses in the fresh produce supply chain. Farmers' Expertise and Information Farmers are the main producers and suppliers of all fresh produce, and their technical expertise, market awareness, and understanding of new equipment are the things that lead to losses in the chain of production for perishable fresh produce. Thus, farmers' technological and market-related knowledge is crucial to the supply chain for perishable fresh food products. Most farmers, or 82.95 percent, were illiterate, this may have contributed to the large losses in tomato output since farmers without post-primary education are unable to understand and utilise the bulk of post-harvest equipment. The vast majority of farmers are small-scale sharecroppers who have little understanding of modern technologies, consumer demand, and financial incentives. In ImekoAfon local government area of Ogun state, the author also discovered that the majority of farmers, 68.17 percent, had less than 16 years of experience in tomato cultivation. This could have an impact on losses in the tomato output. Ozcan added that one of the causes of post-harvest losses was a lack of staff experience and training. According to an economic analysis of post-harvest losses in vegetable production in India, grower-level losses are the result of farmers' ignorance of post-harvest management. Additionally, they know very little about the right fresh produce maturation and harvesting times, which leads to losses. In the following section, we discuss how inefficient harvesting contributes to losses in the supply chain for perishable fresh foods. Supply chain for perishable fresh produce can experience losses due to improper and poor harvesting of the produce at the wrong time or before they are fully mature. Poor harvesting was cited by many researchers as one of the causes of post-harvest losses, which primarily happened during crop picking. The biggest cause of post-harvest losses in tomato crops, according to the author, is inappropriate harvesting at the wrong stage, poor handling during harvest, and post-harvest issues. In their study of tomato producers in the Imeko-Afon local government area of Ogun state, Babalola et al. (2010) discovered that the age of fruits at harvest and the quantity of baskets gathered were the main drivers of post-harvest losses. This is because harvesting more than what is actually needed at the wrong time can result in loss and wastage, while harvesting at the wrong maturity causes erratic ripening and poor quality. In Turkey's Tokat province, early or late harvest, an inappropriate method of harvesting the product and use of the wrong tools and machinery by the farmers to harvest farm fresh produce were all determined to be the causes of the marketing losses, respectively. Early or late harvest, an inappropriate method of harvesting the product, and early or late harvest were also listed as the causes of the marketing losses. There are anticipated to be post-harvest losses in fresh vegetables at the farm level, and it has been discovered that these losses are primarily due to improper harvesting techniques and equipment. In the supply chain of perishable fresh fruit, wastage starts at the harvesting stage. To prevent waste, it is crucial to utilise the right equipment and machinery and to harvest the produce at the right time. handling and storing Fresh produce that is perishable has a very limited shelf life, thus after post-harvest, it needs to be properly stored and handled. The quality of fresh produce can be preserved and protected against deterioration due to improper handling, bacteria, fungi, mildew, insects, etc. by proper storage. The biggest cause of post-harvest losses is that farmers stacked their goods into huge cane baskets or into vehicles without taking the required precautions and leaving them exposed to the sun and temperature. The operational causes of waste in the supply chain are a number of storage and handling process inefficiencies. The incorrect handling and storage of fruits and vegetables results in a spoilage rate of over 25 percent. Fresh produce is not properly cared for by farmers. Poor handling, grading, and packing practises exposed fresh fruit to severe temperatures, air modification or contamination, and parasite and disease attack. Pests

and infections in the fields, fruit pressing and crushing in markets, and injury to fruits from pressing in retail are the main causes of loss as a result of improper handling and storage. One of the causes of marketing losses in fresh product is the absence of suitable storage conditions. The supply chain for fresh food is losing money due to poor packing. Farmers lose money by using incorrect packaging techniques and wooden crates. Losses result from packaging produce in bulk without sorting and grading; these issues have also been identified as the sources of economic losses to perishable crops. When fresh produce is handled carelessly, the bruising results in splitting and skin breaks in the produce. When the produce is unloaded, rough handling leads to damage, which results in a high percentage of losses in the fruits and vegetables.When moving the fruit from the farm gate to the market, baskets are carelessly staked over one another. The handling of fresh produce is especially challenging during transit due to its bulkiness. Most farmers employ improper cleaning, drying, and storage techniques.

C. Measures for Improving Supply Chain of Fruits and Vegetables and its Effectiveness

1) The Entire stakeholder group involved in the sector's supply chain for fruits and vegetables must work together to develop an efficient and effective system. At various points throughout the supply chain, including with farmers, neighbourhood intermediaries, wholesalers, retailers, and customers, structural modifications are required. Government, business, public-private partnerships, cooperative societies, technology providers, educational institutions with an agricultural focus, and NGOs can all have a big impact on supply chain conditions.
2) Information and communication technology (ICT); dependable transportation infrastructure; agricultural-specific infrastructure such cold chain, sorting, grading, and packaging facilities, collection centres, and road connectivity from fields to collecting centres; Training programmes and agricultural exhibitions are essential components of success.
3) A successful supply chain must have accurate demand forecasting as one of its fundamental components if it is to satisfy future demand. There is an imbalance between the actual demand and the surplus supply because forecasting and knowledge of market demand are lacking. Demand forecasting requires the development of an appropriate methodology.
4) Effective cooperation between farmers and cooperatives would make it easier to deliver goods, lower market risk, provide better opportunities and infrastructure, draw in public investment, acquire better services, and contribute to raising awareness of market information and newly emerging technologies. • An effective supply chain from the farm to the consumer end requires infrastructure. To fulfil market needs, all-season roadways are also important. This infrastructure development requires significant financial investment, as well as political involvement.
5) A system of information that will enhance collaboration between all stakeholders, from farmers to consumers, is urgently needed. The growing technology era may make use of the internet and mobile phones to make it easier for parties to share information and money.
6) Private sector involvement must be encouraged in the creation of facilities and the provision of services like washing, waxing, sorting, grading, packaging, pre-cooling, and processing in order to add value to the supply chain for the fruits and vegetable business.
7) The concept of packing house businesses does not exist in India. Fruits and vegetables are often packaged in the field with no prior planning. Even some things arrive unpackaged. Farmers' cooperatives and other organisations should be encouraged to establish packaging stations at key sites in order to increase the sale of fruits and vegetables.
8) In the logistical management of fruits and vegetables, loading and unloading are essential steps that are usually skipped. Individual handling of packaged product causes handling problems and large post-harvest losses in India. The use of mechanical loading and unloading of produce, particularly with the use of forklift trucks, as well as palletization, should be carefully considered in order to decrease produce abuse.
9) In India's distant and inaccessible regions, on-farm storage is necessary to prevent losses of highly perishable fresh horticulture output. The use of refrigerated storage is prohibited in many places of India due to the high cost, high energy consumption, and difficulties in establishing and operating refrigeration facilities in distant areas. In answer to this issue, evaporative cooling-based cool chambers that are low-cost, low-energy, and ecologically benign can be created using materials that are readily available locally.
10) Processing can create value-added goods from sizable amounts of unmarketable and physically harmed fruits and vegetables that are free of infection.

Objective of the Proposed system are:

- To predict the crop demand by taking input data from farmers with a survey model.
- Recommendation of crop analysing data sets of year, PH value, rainfall and humidity.

II. LITERATURE SURVEY

Middle-class people are more profitable than farmers as the link between producer and customer; this is especially true in agricultural marketing. As a result, a lot of money is being lost by farmers. To tackle this, developers have built a mobile and internet application that enables farmers to sell their products to clients.[1].

Due to social media, eroding relationship ideals, demanding schedules, and possibly a wide range of possibilities, some wish they were alone in today's culture. Sometimes, though, all they want are close friends who they can confide their feelings in. To address these concerns, they have developed a smartphone app that enables users to find their closest friends and invite them to join them. This three-layer structure is composed of a website as the third layer, an event controller and manager as the second layer, and user interaction as the first layer.[2].

A client-client application using ASP.NET was created to provide good fruit quality to end users and to obstruct communication between producer and customer due to the overall increased productivity of fruits and vegetables. This makes it possible for customers to buy fruit straight from the grower.[3].

The final user can define the kind of crop they need and how much they need (in kg). Farmers will evaluate the crop kind, the number of hectares they have planted, and the fair price. The programme will give a list of farmers who meet those criteria by evaluating the needs of end customers. Then, if he decides to purchase the crop, he can send the farmer an application so that they can communicate.[4].

One of the most important facts is that transportation is crucial to advertising, and for that to happen, the roads need to be in decent condition. Additionally, this paper outlines a method for finding a quick and safe route in the presence of damage or impediments. By measuring the length and width of the roadways, a certain remote sensor image can be precisely removed from the road network (both damaged and good).

Road instability is found using multi-level search by repeatedly increasing the jump point by pixels (caused by damage or blockage). The test results demonstrate the accuracy and efficiency of the suggested procedure.[5].

This model is recommended to implement a chain of food supply using blockchain technology to prevent third parties from entering the market, as well as market intelligence using building blocks of big data analytics and an all-in-one mobile application to assist farmers for an easy accessibility so that farmers register to use facilities by providing personal details and adhar services. For their farm, they might also oversee various food chain operations and keep an eye on recent market trends, weather predictions, projections, and neighbouring market locations.[6].

In reaction to meteorological and geographic changes, this programme, which was developed using a machine learning algorithm, compels farmers to choose what crops to produce. They have also developed a secondary model that forecasts rainfall for the coming 12 months in order to help farmers.[7].

For farmers, a crop suggestion and prediction model based on variables including humidity, rainfall, and temperature was developed. It makes use of collaborative filtering, multi-condition collaborative algorithms, Naive Bayes, KNN, SVMN, random foresight, and SVMN. It classifies the crop according to the user-provided high, low, and moderate parameter ranges; it then lists the top 5 crops in order; and it displays the crop.[8].

A virtual simulation is run by analysing how the government, the farmer, and the consumer make decisions. In order to increase the safety of agricultural goods and attain food safety, this is done by analysing behaviour to an ideal state. Proper monitoring may also persuade the farmer to switch from using non-green pesticides to employing green pesticides.[9].

A web application has been developed to help farmers get a fair price. Through it, an administrator can post an image of agricultural products with information from the seller, users can log in and place bids on the product, the seller sets the bidding period, and at the end of the bidding, a fiercely competitive consumer purchases the product, cutting out the middleman.[10]

The paper offers details on how blockchain technology is applied and how it is used in the farming sector. The technical elements were well documented, including data structures, cryptographic methods, etc. After that, an assessment of all blockchain technologies was conducted in the second sector to clarify how they were used. Additionally, illustrations of typical techniques were provided to illustrate how they could be used to develop agricultural applications. The third section identifies the challenges that various facets of the agriculture system face to aid in understanding.[11].

By offering an excellent agriculturist certificate based on the previous crops that they have grown, the model is introduced with the help of the leaders of the farmers union and businesspeople, allowing the farmers to improve the quality of their production and prevent a loss of agricultural products from farmers who grow the crop without knowing the demand for the crop, without a proper plan, without checking a current market trend, or climatic change.[12].

To address this, they used Python to construct the application, allowing them to communicate with consumers directly and offer advice, notably regarding what crop should be planted when based on various criteria, as well as supply farmers with notifications of popular crops. In the current world, brokers are increasing their profits by preying on farmers' ignorance as they toil round-the-clock to cultivate a crop.[13].

In order to analyse the effects of mobile technology, this research largely focuses on how it is used. By questioning farmers about the daily applications they use and how much time they spend on them, researchers have also looked at how farmers communicate. [14].

Price forecasting has become a significant agricultural problem in the current era that can only be solved with the facts at hand. The objective of this article is to forecast crop price for the upcoming rotation. The goal of this research is to identify suitable data models that provide high accuracy and universality for price prediction. A variety of data mining techniques were investigated on various data sets to address this issue.This article describes a system that estimates agricultural prices using data analytics techniques. The suggested approach would forecast agricultural prices based on a number of factors, including crop area harvested and area seeded, among others, using machine learning algorithms.[15]

A farmer can also get an idea of the price of the produce he will gather in the future. The goal of the study is to create a system that can foresee the crop's target price and help farmers over the long term by combining data from various sources, data analytics, and prediction analysis. The overall study's findings suggest that the optimum approach for this project is XGBoost.[16].

The agricultural industry has a considerable impact on the Indian economy. The bulk of Indians, either openly or surreptitiously, depend on agriculture for their livelihood.

Agriculture's importance to the country is therefore undeniable. The vast majority of Indian farmers feel that choosing which crop to sow during a specific season should be left to their senses. They find comfort in just following the patterns and customs of traditional farming, refusing to acknowledge that crop productivity is dependent on the current weather and soil conditions. However, it is unrealistic to expect a single farmer to take into account all the various factors that affect crop development when choosing which crop to grow.

A farmer could make a hasty or negligent judgement that has unfavourable effects on both him and the local agricultural sector. Machine learning and big data analytics can work together to solve this problem. In the work, present the AgroConsultant intelligent system, which intends to assist Indian farmers in selecting the optimum crop based on the sowing season, the location of their farms, the characteristics of the soil, and environmental factors like temperature and rainfall.[17].

study compared and contrasted the conventional statistical maximum likelihood method with random forests and support vector machines using 126 features from Sentinel-2A images. In 2017, Sentinel-2A photos were successfully used to extract spectral reflectance of 12 bands, 96 textural features, 7 vegetation indicators, and 11 phenological parameters. According to the classification results, when 13 features are correctly combined, both traditional classification and machine learning obtain total classification accuracy of 88.96 percent and 98.8 percent, respectively. Short-wave infrared data can be used to identify rice, corn and soybeans significantly. Water vapour band can be used to distinguish between rice and corn. While the conventional classification result shows uneven accuracies for different crops, machine learning approaches show resilience with identification accuracy of greater than 95 percent for each crop variety. [18].

Agriculture is essential to human existence. It is one of the primary sources of employment in India. More over half the population is supported by the agriculture sector. It serves as the cornerstone of our economy. Crop productivity is affected by numerous factors. One of the main factors affecting crop productivity is soil. By improving the techniques used to forecast agricultural yield under varied climatic conditions, farmers and other stakeholders may be able to make better agronomic decisions. Crop yield prediction is process of estimating a crop's production using historical information, which may include elements like temperature, humidity, pH, rainfall and crop's name. It provides us with a general concept of the best crop that can be grown under the field weather conditions at the moment. Machine learning algorithms have been employed in the proposed study to compare soil properties and forecast crop production and fertility. To estimate agricultural yield, the Decision Trees classifier, Nave Bayes algorithm, and K Nearest Neighbor algorithm were utilised.[19].

Teaching computers how to use data or past knowledge to solve problems in the real world is the core goal of machine learning. Through supervised learning, unsupervised learning, and reinforcement learning, it can be used as association analysis. In this investigation, we will concentrate on applying machine learning to pertinent issues in agriculture. We'll concentrate on innovative uses of machine learning in agriculture. We also investigate using machine learning to grow wheat. Finally, we pinpoint the production gaps in wheat harvests and present a supervised machine learning-based method.[20].

The Hellenic Agricultural Organization constantly supported Ecodevelopment S.A.'s RD activities, which were focused on offering precision farming services to rice producers and produced this study (Demeter). Within this framework, a novel machine learning-based topdressing nitrogen prediction method was developed. Nitrogen is a key component of rice cultivation and can be wisely controlled to increase yield, save costs, and protect the environment. Thessaloniki Plain in Greece's 110 ha experimental rice field was continuously monitored for four years, resulting in a multi-source, multi-temporal, and multi-scale dataset that included optical and radar pictures, soil data, and yield maps. In order to identify waterlogged fields and, consequently, to pinpoint the specific growth stage of the crop, Utilizing computer vision, Sentinel-1 (SAR) imagery was simulated. Before applying topdressing treatments, leaf nitrogen concentration (LNC) was precisely mapped using Sentinel-2 image data. To define management zones, RapidEye imagery underwent image segmentation. To estimate yield for different nitrogen levels, a number of machine learning techniques were used, with the XGBoost model showing the highest accuracy. Utilising yield curves, the nitrogen dose that would maximise production was selected, and the farmer was counselled to use that amount. Inundation mapping ended up being a huge help to the prediction strategy. Ecodevelopment S.A. is currently expanding the new method's application over a wide range of topic areas in an effort to boost its applicability and operationality.[21].

The agricultural industry has a considerable impact on the Indian economy. The bulk of Indians, either openly or surreptitiously, depend on agriculture for their livelihood. Agriculture's importance to the country is therefore undeniable. The vast majority of Indian farmers feel that choosing which crop to sow during a specific season should be left to their senses. They find comfort in just following the patterns and customs of traditional farming, refusing to acknowledge that crop productivity is dependent on the current weather and soil conditions. However, it is unrealistic to expect a single farmer to take into account all the various factors that affect crop development when choosing which crop to grow. The farmer can suffer negative consequences as a result of one rash or unwise decision, which would affect both him and the local agricultural sector. To overcome this issue, big data analytics and machine learning complement one other nicely. In this article, we introduce AgroConsultant, an intelligent system that will assist Indian farmers in selecting the optimum crop for their land based on the sowing season, their farm's location, the soil's characteristics, and weather factors like temperature and rainfall.[22].

Climate change, diminishing productivity, and a lack of knowledge of agricultural innovation are all current issues in agriculture. One of the main factors contributing to low agricultural production and the underdeveloped state of agriculture is the division, slicing, and segmentation of land holdings. Moving cattle, manure, seeds, and pesticides from one piece of land to another costs farmers a lot of time and energy.Agriculture is significantly impacted by a change in the climate. In this instance, greater temperatures discourage the growth of pests and weeds while lowering crop yields to their ideal levels. Changes in rainfall and precipitation patterns raise the possibility of both short-term crop failures and long-term output declines. We proposed a method for crop suggestions that bases its forecasts on elements such soil type, weather conditions, and the location of agricultural land. We also develop a platform where farmers may list vacant land for cultivation and get agricultural land to lease in exchange. Through the news feed interface, users of this programme can learn about the most recent advancements in agriculture. search the appropriate location and select Agri assistance.[23].

A. Existing Technologies

1) *Kisan Suvida:* The Ministry of Agriculture and Farmers Welfare has created the Kisan Suvida Mobile app for farmers to make it easier to share information about the weather, market prices, plant protection, agro-advisories, extreme weather alerts, dealers for seeds, pesticides, fertilisers, farm machinery, and Call to Kisan Call. This app teaches farmers advanced farming techniques and technologies. Farmers can immediately consult agricultural specialists for advice on their farming-related issues. This user manual contains information on how to download the Kisan Suvidha app and the features it offers.
2) *Pusa Krishi:* An agricultural innovation centre called Pusa Krishi is renowned for its cutting-edge technology, extensive industry expertise, and revolutionary effects. We work tirelessly to improve lives by making agriculture simple, inclusive, and profitable as the sole nodal agency under the Ministry of Agriculture Farmers' Welfare, Government of India. RKVY-RAFTAAR is the largest agri-business incubation initiative. It assists idea creators, innovators, and entrepreneurs in building capacity, technology, and market-navigation skills. With more than 3 lakh farmers, 500+ scientists, 200+ alumni startups, and some of the top industrial partners in the nation, we have the strongest agriculture network in India.
3) *MKisan Application:* With the help of C-DAC This software was developed by the internal IT team at DAC in Pune.Farmers and all other stakeholders can access the mkisan site without registering to obtain recommendations and information from experts and government officials at various levels.

4) *Shetkari Masik Android App:* Since it began publishing in 1965, Shetkari Masik has been one of the most read monthly publications in the agriculture industry. The Maharashtra Department of Agriculture is in charge of publishing it. The Shetkari magazine Android app's user interface is rather basic, and in order to sign up and download issues, you must have a data plan or Wi-Fi access. The magazine may be downloaded and read offline.
5) *Bhuvan Hailstorm App:* Mobile app have been created to record crop losses brought on by hailstorms. The mobile app will be loaded onto the tablet or phone that the agriculture officer will take into the field. The following parameters can be captured by this mobile app. With latitude and longitude, a field image. Variety of Crop Date of planting, anticipated date of harvest, and source of irrigation.
6) *Farm-o-pedia:* Created by the CDAC in Mumbai. Multilingual Android programme is intended for Gujarat's rural areas. Anyone involved in agriculture or who is a farmer will find the software beneficial. Both English and Gujarati versions are offered. Get the best crops for your soil and season, learn more about certain crops, check the weather in your area, and manage your cattle are the primary features of the app.
7) *Crop Insurance Mobile app:* The Insurance Premium for notified crops can be calculated using the Crop Insurance mobile app based on the region, the amount of coverage, and the loan amount in the case of a loanee farmer. For each crop that has been notified in any notified location, it may also be used to determine the standard amount insured, extended sum insured, premium information, and subsidy information.
8) *AgriMarket:* The AgriMarket mobile app can be used to find out the current crop price in markets located 50 kilometres away from the device. With the help of mobile GPS, this app locates users automatically and retrieves the current crop price in any markets within a 50-kilometer radius. If a person does not want to use GPS location, there is another way to obtain the price of any market and any crop.
9) *Horticulture,Sikkim Horticulture And CashCrop Assistance:* Farmers in Sikkim use this software to submit an online application for departmental help.
10) *Animal Husbandry, Sikkim Breeding Bull Allotment:* This app is used to request a breeding bull from the government of Sikkim's Animal Husbandry department.
11) *Application for Poultry:* Created by the CDAC in Mumbai. The Himachal Pradesh Animal Husbandry Department has launched the Backyard Poultry Program under the Centrally Sponsored Scheme, which offers farmers in the state low-input technological fowl of coloured strain yet disease-resistant variety. Using this app, a candidate can apply online for the Government of Himachal Pradesh's Poultry Chick and Backyard Poultry Schemes.
12) *Pashu Poshan:* An android-based programme created by NDDB can be used on tablets and smartphones. The animal's profile, including its age, milk production, milk fat, and feeding schedule, among other aspects, is taken into account in order to design a balanced ration while minimising expenditures. The amount of locally available feed ingredients and mineral mixture that milk producers offer their animals should be changed.
13) *MSCS (Multi State Cooperative Societies):* Both phones and tablets can use an android-based mobile app developed by MSCS. Cooperative Societies can use this app to check the progress of their registration, and users can look up registered cities near them.
14) *Digital Mandi India:* This app assists in examining the most recent Mandi pricing for agricultural products in India across all states and districts. The app's user-friendly interface makes it simple for farmers, traders, and everyone else to access the most recent Mandi price information. Its primary attributes are: Explore different commodity categories View pricing for various states. A commodity's mandi price may be found by copying it, syncing data from the Indian government website Agmarknet.nic.in, and then following the flowchart.
15) *MNCFC:* The National Remote Sensing Center, ISRO, Android app is helpful for gathering field data for crop appraisal utilising satellite data in the FASAL project of the Ministry of Agriculture. The tool may be used to collect field information such crop kind, condition, sowing date, soil type, GPS coordinates, and field photos (640x480 resolution). As part of crowdsourcing, farmers can also post photos taken using their mobile devices that show the condition of the crops, their types, and the soil. The creation of a national geospatial database of crops will greatly benefit from the information provided. The option to Send Later allows you to send the information later rather than immediately. Using this programme, all data is received and sent to ISRO's Bhuvan Server.
16) Karnataka Bhoomi: The project for managing and delivering land records online in Karnataka is called Bhoomi (which means land). Karnataka framers can use this app to check the status of their application.

17) *HP Soil Testing:* C-DAC Mumbai created this software for the Himachal Pradesh agriculture department. Farmers can use this app to send soil health samples from their property to the relevant district/block soil health testing facility. By CDAC, Mumbai, an intelligent advisory system for farmers. Farmers can get information on various farming seasons, month-based weather patterns, and ideal conditions for a range of crops.
18) *Crop Info:* In Bangalore, Karnataka, Nirantara Livelihood Resources Private Limited created it. The Crop Info App for cellphones offers Production Technology of significant economically essential horticultural and agricultural crops. It provides market data, post-harvest technology, processing alternatives, and information on the production process. An app called Crop Info was created exclusively for agricultural and horticultural university students and teachers, subject matter experts and extension officials from those departments, professionals in the private sector, farmers, and anybody else interested in crop cultivation.
19) *PMIS - Brinjal:* One of the most significant vegetable crops, brinjal suffers from numerous pests that significantly reduce yields. These pests still result in 30 to 40 percent production losses despite frequent insecticide application. The growers of the brinjal crop employ an enormous amount of insecticides to reduce losses brought on by pests. They over-rely on chemicals for pest control because there is no effective alternative, which not only harms the environment but also impacts human health owing to pesticide residue in the fruits. Integrated pest management (IPM) technology is the most effective replacement for chemical-based pest control. IPM integrates a number of environmentally friendly pest management techniques, reducing the need for pesticides and preserving both human and environmental health. IPM is a knowledge-intensive method that places a strong emphasis on making suitable decisions and largely relies on accurate and timely information/knowledge availability for field implementation.
20) *PMIS-Tomato:* One of the most significant food crops, tomatoes are plagued by several pests that significantly reduce yields. These pests still result in 30 to 40 percent production losses despite frequent insecticide application. The growers of the tomato crop employ a significant amount of insecticides to reduce losses brought on by pests. They over-rely on chemicals for pest control because there is no effective alternative, which not only harms the environment but also impacts human health owing to pesticide residue in the fruits. Integrated pest management (IPM) technology is the most effective replacement for chemical-based pest control. IPM integrates a number of environmentally friendly pest management techniques, reducing the need for pesticides and preserving both human and environmental health. IPM is a knowledge-intensive method that places a strong emphasis on making suitable decisions and largely relies on accurate and timely information/knowledge availability for field implementation.

B. Drawbacks of Existing Models

As we've seen, farmers' aid has a variety of uses, including marketing, crop suggestions, crop yields, crop price forecasts, and more. However, farmers utilise these types to predict their yield, earnings, markets for their crops, and what they can grow in their fields. However, there is no set methodology for guiding farmers prior to planting in order to dispel the misconception of overproduction of the same crops. And there isn't a perfect decision-making tool that can help farmers decide how much of each crop to plant where and how much of a given crop to produce.

III. PROPOSED SYSTEM

A. Methodology

This Section shows the methodology used in the work: The application is based on the three construction phases mentioned below:

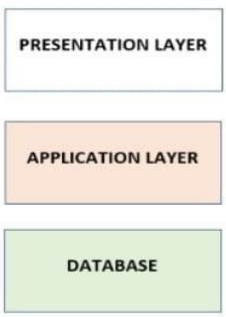

Fig. 1: Architectural layer

- *Presentation Category:* This component is utilised on a computer device with the android app and is made up of HTML5, cascade style sheets (CSS), and JavaScript. Through application programming interface (API) calls, the launch section interfaces with other layers.
- *Application Category:* A business notion that supports the primary functions of the application is contained in an application category, which is referred to logic category. It created a programming language that is comparable to Java. Depending on how much processing power an application requires, a sub-application category may be hosted on a single internal server or on a distributed network of cloud servers.
- *Data Class:* A website and a system for controlling website literacy access make up the data category. This stage, which may alternatively be referred to as the last stage, can be hosted on a XAMP server.

B. Design Modules

It is possible to download this decision-making model for Android. Farmers enter their username, phone number, and password while registering for the application. They will then enter their login information, upload crop information, and have this app download the farmer's current location. This will allow them to check other farmers' crop information and determine whether a market exists for the product they have just launched. they develop, have the ability to choose whether or not to plant crops, and can use the crop recommendations model by supplying information about agricultural land.

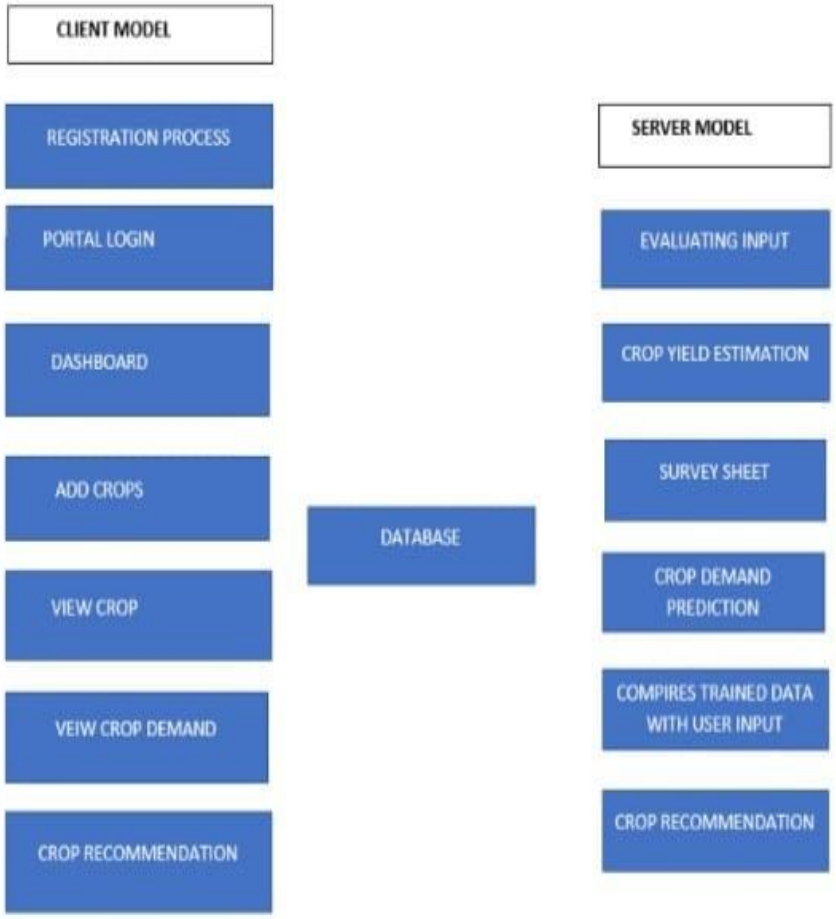

Fig. 2: proposed methodology

1) *Manager:* The overall yield is determined using the number of hectares of land and the amount of seed sowed after all the information provided to farmers is stored in a database. Additionally, the website stores the obtained live location in order to avoid the representative.

2) Farmer

a) Add Crop: contains details like your login, phone number, location, the type of crop you are growing, how many hectares you have, and the kind of seed you are planting.

b) View Crop Details: It displays all the details that are given to farmers so that they may comprehend plant production and availability in order to conquer crop production.

c) Crop Demand: We can obtain a forecast of the crop's current demand by supplying the crop and location.

d) Crop Recommendation: This module, which is based on the knn algorithm, proposes the kind of plant we can plant depending on the soil type, pH value, and other characteristics.

Algorithm: The Traditional KNN Algorithm

Input: the training set D, test object x, category label set C
Output: the category c_x of test object x, c_x belongs to the C

begin
  for each y belongs to D do
    calculate the distance $D(y, x)$ between y and x
  end for
  select the subset N from the data set D,
  the N contains k training samples which are the k
  nearest neighbors of the test sample x
  calculate the category of x:
  $$c_x = \arg\max_{c \in C} \sum_{y \in N} I\left(c = class\left(y\right)\right)$$
end

Fig. 3: knn algorithm psuedocode

For division (frequency) and regression, the Close Neighbor method, which belongs to the field of Supervised Reading, is employed. It is a versatile approach that may be used to resample data sets and insert missing values. K's Nearest Neighbor, as the name would suggest, relies on K neighbours (Data Points) to forecast the class or continuous value of the new Data-point.

IV. RESULTS AND ANALYSIS

The android-based decision-making model was created to support farmers by giving them accurate and complete information on which crops are in demand and which should be planted on their land based on soil fertility.

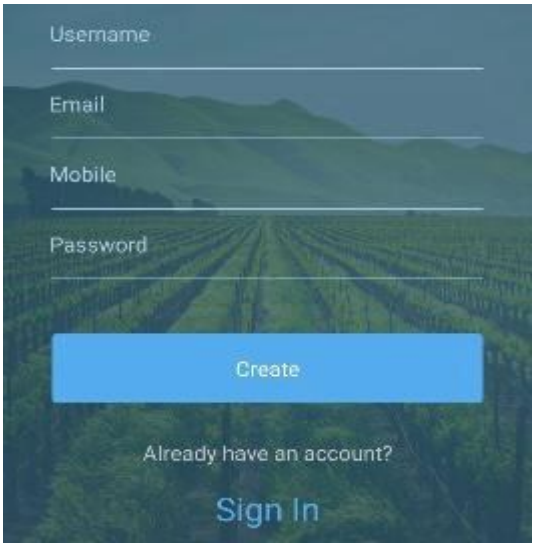

Fig. 4: registration page

The farmers provide their name, email address, mobile number, and password to register on the website. The user's information is verified, and if it is accurate, the account is activated. If the information is false, an error notice is displayed. The user can then log in using their registered mobile phone and the password they chose when registering. Additionally, the database stores the user's information for later use.

Fig. 5: crop details

After successfully logging in, the user provides the relevant crop information, such as the crop they cultivate, the month they grew it, the number of acres they grew it on, and the number of seeds they planted in their agricultural property. The farmers' current location is retrieved in order to prevent the user from providing incorrect information and to verify that the data they supply is accurate.

Fig. 6: view crop

Here, farmers can access all the agricultural information that has been submitted by users, including the location, type of crop, month, number of seeds sown on the specific acres of land, and expected yield.

Fig. 7: crop demand estimation

By specifying the sort of crop and the location where it will be grown, the user may determine whether or not the crop is in demand.

Fig. 8: crop Recommendation

The appropriate crop is suggested to farmers based on the specific soil characteristics, such as the year, region, nitrogen, phosphorus, potassium, PH, temperature, humidity, and rainfall in their area.

V. CONCLUSION

As part of our proposed work, we created an Android-based framer assistance application using Java, and we also analysed and forecasted crop demand as well as made crop recommendations. We did this by first creating a dataset using the information we had collected from various websites, blogs, and other sources

We chose the knn algorithm as the best algorithm that fits the regression model for this work, as mentioned in the implementation and results section, after implementing the decision-making model, predicting, and analysing various algorithms. We used the elbow technique to analyse, assess, and perform clustering using the knneans algorithm. As a result, we obtained a best decision making model to assist the farmer overall.

A. Future Scope

The extensive adoption of cutting-edge management aids is not feasible in a situation where there are many geographically distributed, relatively small agricultural companies that are individually managed. Few farms have enough customers to warrant hiring operations research personnel, even on a parttime or consulting basis. A certain amount of decision modelling is done in an advisory context by some government extension services, but the adviser-tofarmer ratio is rarely favourable enough for the majority of farmers to benefit from such an approach. It is simple to understand why decision modelling is not used more frequently in these situations. Similarly, it is difficult to feel upbeat about the likelihood of any significant change in the future.

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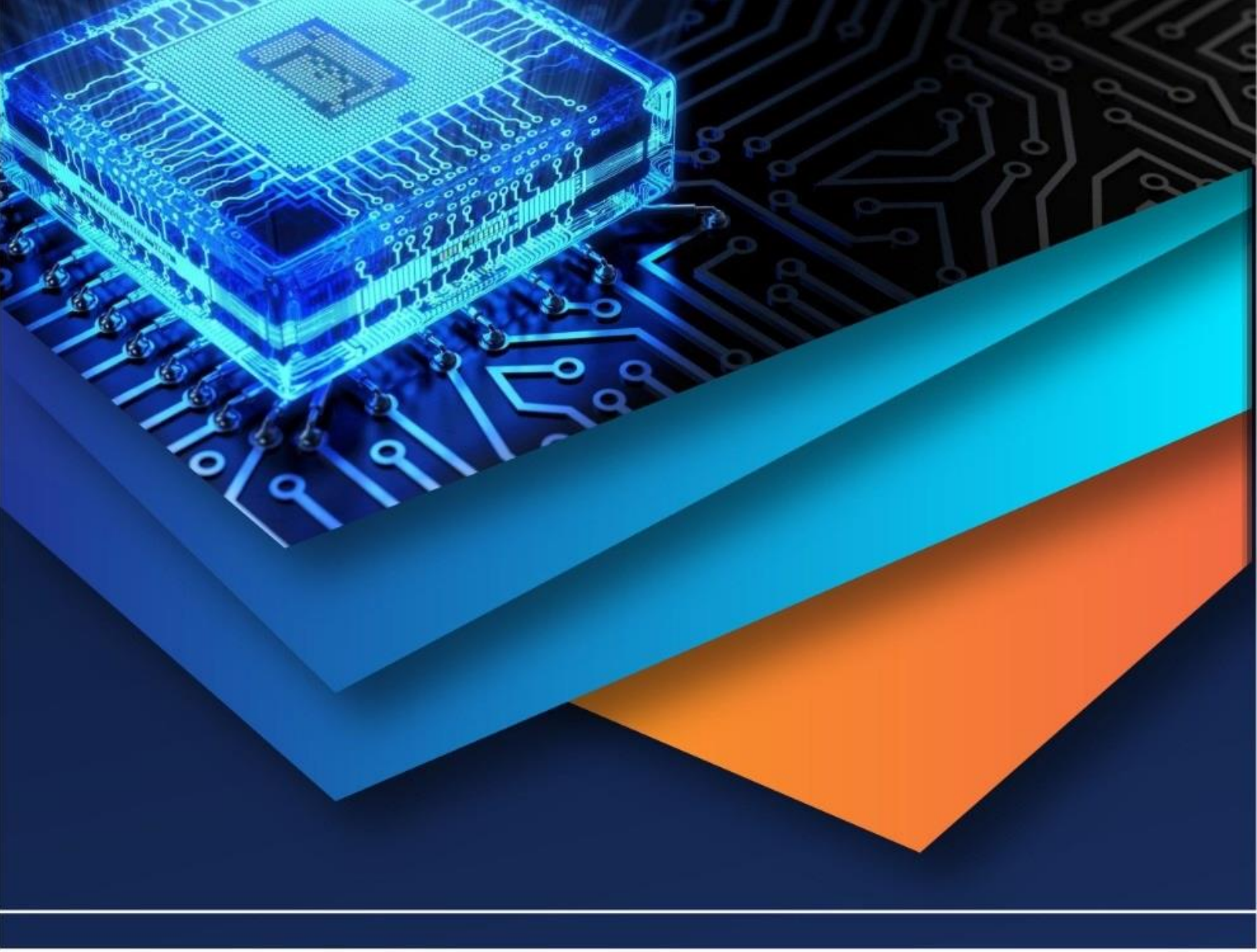

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