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Research Article

Integrating the Web of Things in Agriculture: Trends, Challenges and Opportunities

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Abstract: The last few years have introduced the Web of Things (WoT) as a revolutionary technology in the agricultural field that provided new approaches to existing problems IoT applications face in agriculture. WoT promotes integration and cooperation among different devices, structures, and platforms and contributes to the evolution of other technologies. The objective of this research is to present the state of the art in the research on WoT based agriculture, its current problems, and future opportunities. To this end, this paper provides a systematic literature review (SLR) of the articles published from 2010 to 2020 based on the research type, approach, and application domain of the selected studies. Besides, this study gives a classification of WoT-based agricultural applications and offers the notion of WoT-based Smart Agriculture by presenting a conceptual model. Last but not the least, this SLR presents the emerging research areas and directions, issues for further research at the end of this paper.

Keywords: Web of Things (WOT); Agriculture; Smart Farming; Applications; Semantic web technology; Internet of things (IOT); Taxonomy; Systematic literature review (SLR);

1. Introduction

Technological development also influenced the people's life style along with shifting the old agricultural style to Smart Agriculture (SA) and Smart farming (SF) [1]. Technologies evolved to make agriculture a manageable and smart Farming or the Smart Farming [2]. Another term that has been adopted for smart agriculture is Precision Agriculture which is defined for managing the soil, water, weather conditions through ICT technologies [3]. PATs approached for maximum production and for decreasing the environmental causes [4]. The relevant information concerning the cost, the policy of long-term payback and the farms is provided by offering the training and technical assistance for the farmers [5]. The European Union has made it its political aim to foster agricultural productivity and sustainability through increased generation and diffusion of innovations that enhance the sector's overall competitiveness [6]. Precision agriculture could be a processing cycle whereby agricultural data is gathered for analysis, evaluation so that particular decisions can be made in managing the fields that were categorized under smart farm technologies (SFT) that includes GNSS [7] and mapping technologies. However, the idea of precision agriculture was inherent in the process or farmers' judgment even decades ago. Thus, the idea was called Precision Agriculture. A technical explanation for the selected agricultural industry was also provided in detail [8]. Internet of things (IOT) also paved a new opportunity to the agriculture field as it brought technological advancement in each agricultural sector [9]. It is vital to understand that the evolvement of the Internet of things did not only increase numbers of devices but also the amount of data it produced and was expected to be 50 billion in 2020 [10]. The increase is not only in the quantity of devices but also in the of data they produce as estimated by CISO [11], 500 zett of data have been generated This rapid growth in devices and data has in a significant rise in the number of APIs. This research presents the Web of (WoT), emphasizing its main, the function of Web Technology (S), and its role in API design [12]. The Web of Things improves the efficiency and usability of the expanding smart ecosystem by incorporating web services into the creation of smart devices. These devices feature web capabilities, which allow for interaction and communication online [13]. As countless devices connect to the internet, a new Web of Things is taking shape, showcasing virtual representations of both physical and conceptual entities that become more accessible through web technologies [14].

Primary characteristics about three main technologies are defined in Figure 1 below:

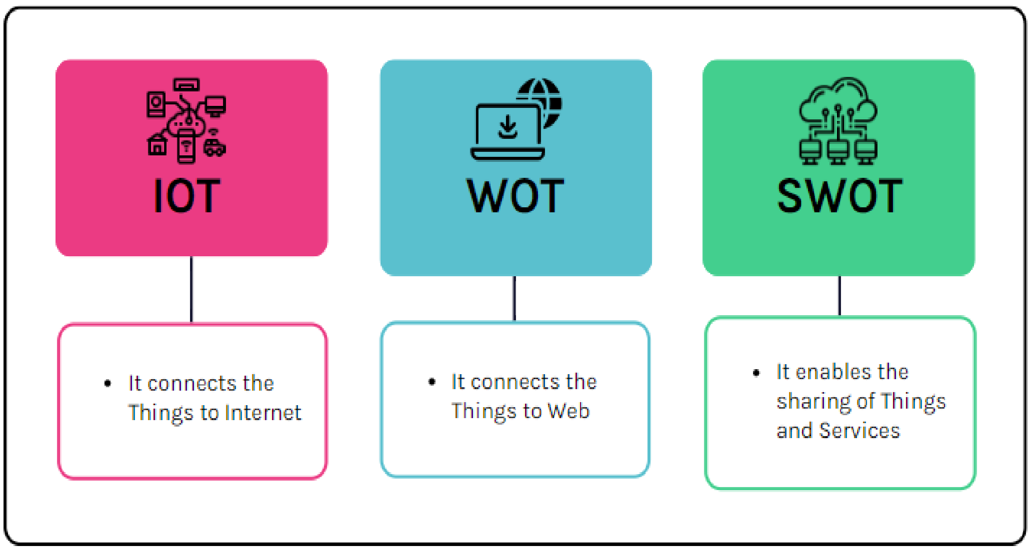

Figure 1: Primary idea of IOT, WOT, SWOT

The Web of Things (WoT) has created new research opportunities in agriculture, allowing innovative techniques such as the redesign of farmland and alternative farming practices that meet current market needs. This is made possible through the implementation of web-based decision-making systems [15]. One study [16] suggested a framework utilizing the Virtual Test Environment for Distributed Systems (VTEDS) to create smart sensor hubs with plug-and-play functionality. The system showcased remarkable efficiency, with intelligent sensors in Europe capable of self-registering and configuring remotely via a cloud service in South America in under three seconds, and delivering data to users in less than two seconds. Additionally, frameworks have been established to facilitate the shift from the Internet of Things (IoT) towards the Web of Things (WoT) [17]. Although the application of WoT has recently seen significant growth, many devices encounter various encryption issues. Semantic Web Technologies are regarded as the most effective means to address these challenges [18].

1.1. Integrated WOT Model

The agricultural sector is experiencing a swift rise in the adoption and incorporation of various new technologies. A range of systems, frameworks, infrastructures has been created that leverage IoT, wireless devices [19], machinery, and cameras for monitoring and managing crop activities. Multiple studies have suggested infrastructure diagrams that depict solutions integrating Web of Things (WoT) services to improve interoperability and communication among devices and various levels of the models., [20], [21].

The model is shown in Fig. 2 below:

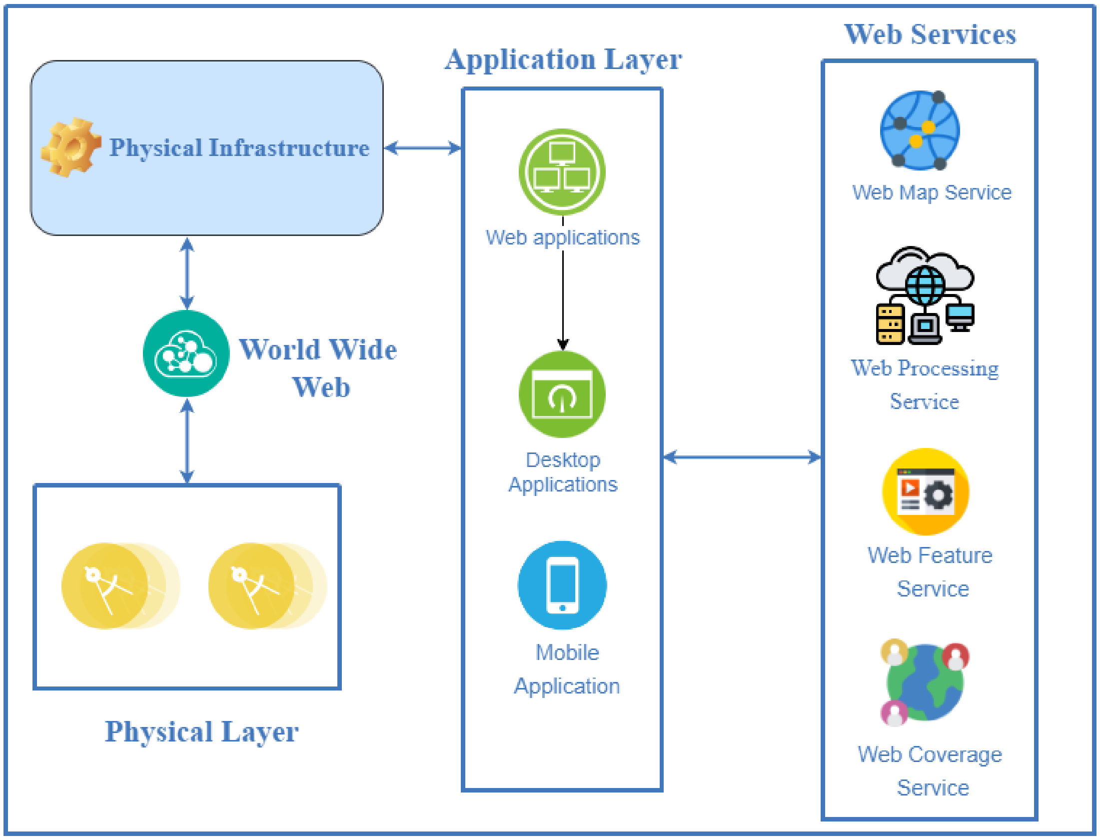

Figure 2: Open geospatial web physical model for PA

This model explains the integration of various web services that provide the interfaces for different analysis in the agriculture system by which the farmers can check, control and monitor the farms by using their mobile or web applications. A physical infrastructure layer added that provide the web services such as Web Map Service (WMS) for to provide the map of farms, Web Processing Service (WPS) to perform processes like to predict the level of water and production of crops. Web Feature Service (WFS) provide the deploying points of wireless sensors in soil as well as observe the weather state. Web Coverage Service (WCS) used to get the data collected from the farm's locations. All these services provide the interfaces for getting and sharing the agricultural data and enhanced the agricultural analysis and operations. Data can be published and share on different devices with the help of these web services and farmers can control and monitor the farms through web applications, Mobile applications and Desktop applications.

1.2. WOVT Model for Communication

In order to link IoT smart devices to the cloud for data exchange, storage, and communication purposes, another infrastructure incorporated the WOT technology. The model is shown in Figure 3 below.

This model is showing that a Web of Virtual Things layer is added between the IOT smart objects layer and Cloud layer for the purpose of interoperability, data management and abstraction to make the communication easy between diverse devices, protocols and cloud servers. This layer provides the standardization for storing and sharing the data with secure connection and abstraction feature hide the complex functions of diverse protocols and services of different clouds. This WoVT layer is used to integrate the diverse devices and clouds services for their smooth communication purposes. In the last few years, Linked Open Data has merged multiple sorts of data, which makes it accessible and valuable in a variety of industries globally [22]. The exponential proliferation of data has accelerated the rapid growth of incorporation of data on the World Wide Web, which is presently moving toward the World-Wide Semantic Web (WWSW) [23]. The linked community of humans, gadgets, and services across the internet has generated significant real-time data in numerous forms, codes, and forms, lead to massive volumes of knowledge and operations [24]. Several algorithmic strategies have been created to effectively save and retrieve the data in real time in required forms, combining both current and unique technologies [25].

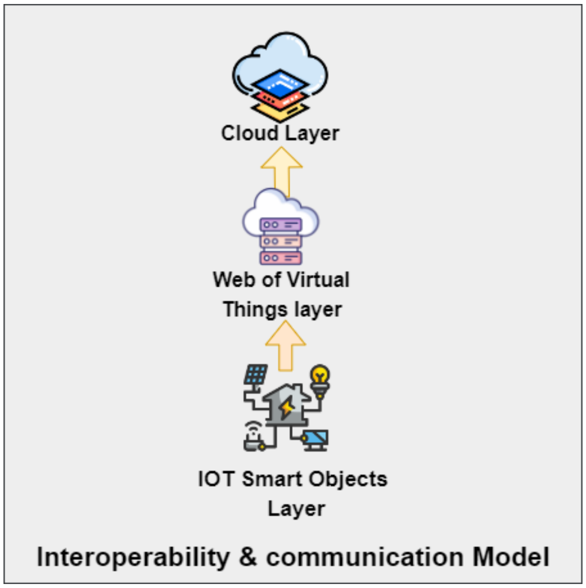

Figure 3: WoVT communication Model

Semantic web approaches improve the intelligence and efficacy of internet applications [26]. MIMOS developed a semantic technological foundation that improved and introduced new functionalities [27]. To help organizations publish agricultural data as well as models, the FAO developed AGROVOC, the world's biggest multilingual agricultural vocabulary [28]. As wireless connection has grown in popularity, smart devices and sensors have become indispensable for monitoring and controlling in real time in agriculture, changing traditional farming techniques into smart farming [29]. The use of big data, AI, and cloud technology have improved data quality and security, but they also have met with drawbacks such as high processing costs [30–31]. Furthermore, Automation of Aeronautical Vehicles (UAVs) have already been integrated with IoT to increase crop development and virus detection [32-33].

The integration of multiple technologies into smart farming has lowered fertilizer consumption while increasing efficiency and lowering costs [34]. Technologies such as 3D graphical visualizations for growth of crops and blockchain for transparent food supply networks are improving precision agriculture [35]. Blockchain technology, in particular, has gained importance for applications in precision agriculture by increasing transparency, decentralized governance, and trustworthiness. A study on combining blockchain and IoT in precision agriculture identified corresponding possibilities as well as challenges [36-37]. Several nations have created schemes for smart farming that include IoT, Blockchain, the Web of Things (WoT), web-based message protocols, and other technologies including MQTT, AMQP, DDS, REST HTTP, and WebSocket [38].Such technologies and procedures have been assessed for their efficacy, usefulness, and productivity, with recommendations for modifications to help the agricultural sector [39].

The study's primary objective is to provide a thorough literature review of previous research that has identified the value of WOT integration with agricultural applications in resolving issues with the handling, monitoring, and control of gadgets, software, and other interconnected technologies in the agricultural sector. The study looks into cutting-edge research that is being done to use WOT to solve problems. This study is novel because it offers a taxonomy of the agricultural sectors where applications of WOT are used to address technological and technical issues in agriculture. Finally, the remaining portion included various sections that summarized this paper's contribution. The background of the WOT-agricultural sector is described in Section 2. The research method is presented in Section 3 and involves the use of defined research questions, inclusion and exclusion criteria, and a search string to locate directly relevant research articles in the WOT-agricultural field. The outcomes of the selected studies that were obtained by retrieving the data for conducting the research are defined in Section 4. A wot-based model about the smart agriculture, opened issues and encounters, research gaps, future directions for further research movements, and a description the threat to the validity study are all explained in Section 5. The paper's conclusion is given in the final section, number 6.

The sections of paper have shown in Figure. 4 below:

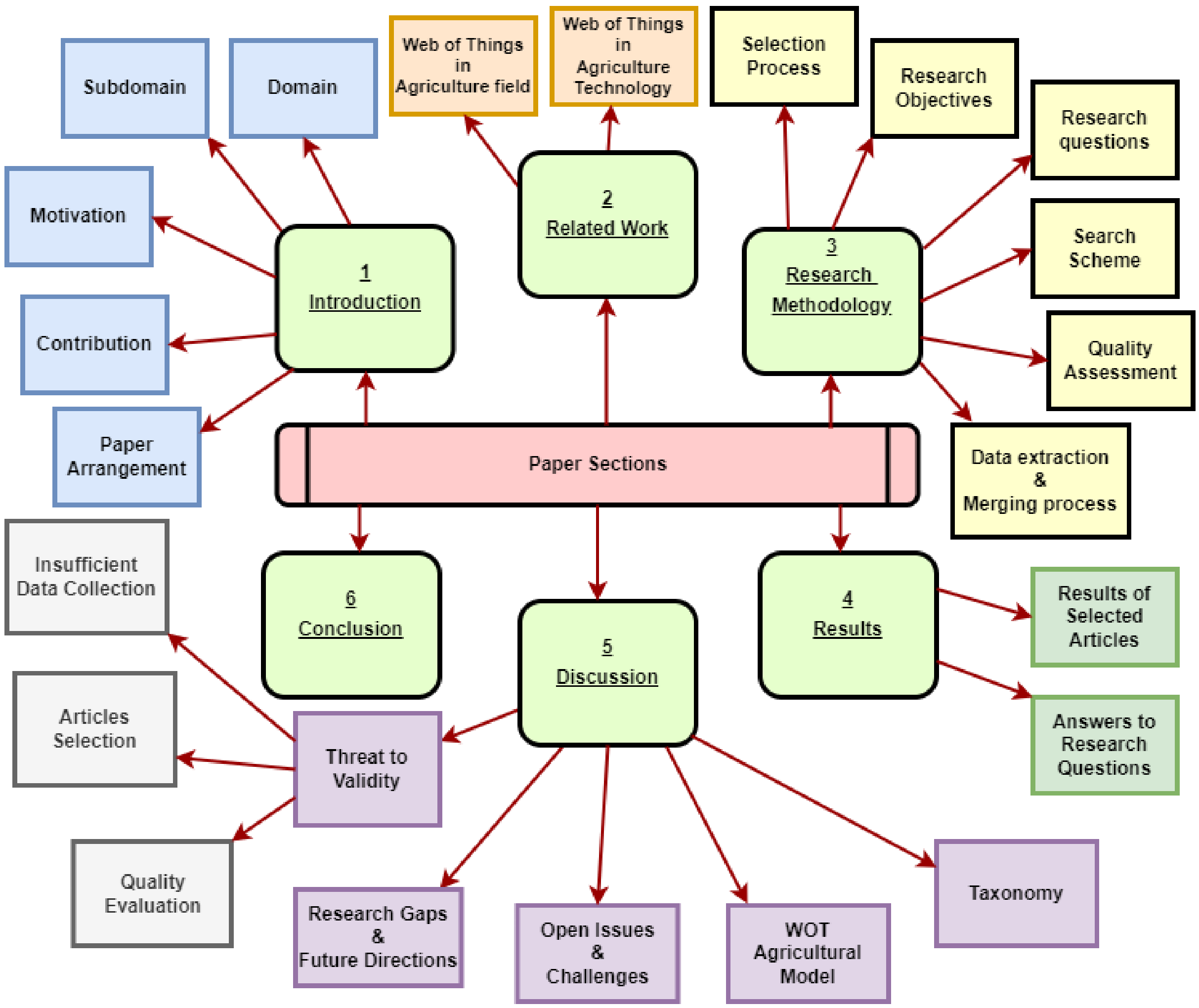

Figure 4: Paper Sections

2. Related Work

Web of Things has been a promising innovation for settling a few farming applications, frameworks reconciliation, their taking care of, checking, and dynamic issues. Incorporating effective precision features, data analysis, and remote sensors into the existing agricultural frameworks, infrastructures, and systems was WOT. In order to find solutions to the challenges that are arising, a number of studies have been carried out on the emergence of WOT in the field of agricultural technology. Subsequently, hardly any commitments have been made to assess the investigations that introduced the answers for the agrarian issues.

On [20], research on the Web of Things was conducted. For monitoring purposes, both wired and wireless [19] sensors played a crucial role in Precision Agriculture. However, the interoperability of disparate sensors in systems became a problem, so a physical infrastructure with open geospatial service integration was offered for processing, disseminating, and incorporating the surveillance details on the web information servers. Many people have access to Precision Agricultural data thanks to a web sharing service. A Service Oriented Architecture (SOA) placement was made for the purpose of keeping and upgrading Precision Agriculture (PA) setups by joining distributed workable web services. Numerous web service configurations were planned and offered, but they lacked the ability to share information and incorporate with a variety of devices. In addition, numerous studies have attempted to resolve security issues arising from disparate networks, devices, and services. This study compared a number of previous infrastructure features, including SOA, which lacked support for sensors, process sharing, unknown models, and complexity issues. As a result, the proposed method now incorporates all of these solutions as well as a few more features. The physical, application, business, and sensor layers comprised the proposed SOA-based architecture. Sensors and devices for transmitting measurements of environmental factors are found in the physical layer. The application layer provided a means of communication between systems and devices. A SOS detecting layer in light of SWE utilized for dispersing and putting away the information over different detecting gadgets. The business layer is the more elevated layer for dissecting rural cycles as well as information. Workers can get measuring facts along with a great deal of information on the Web by using a basic observation, which offers statistics with absence of detecting systems to communicate with it. Using SOS, WCS, WMS, and WFS services, an advanced observing device offers the crucial information results. The following work offered the web enabled detectors plan and accomplished the detecting devices, procedures coordination, and ready to move, offer, and incorporate the information on Internet. However, there are still some features for multi-web facilities that needed in further work [40]. WebGIS and IOT, two technologies, were the focus of a study [41] on their use in precision agriculture. Subsequent to examining their placement, pros, and cons in China, a Framework (PAMS) installed in a chosen farmland by coordinating the WebGIS and IoT advances. It involved the IoT for having discernment precision capacity and WebGIS handled organization geological data effectively. There were four modules in this system: Agribusiness the board stage, spatial data foundation stage, and versatile client and IOT framework stage. This framework had the combination of a few high-level strategies, for example, IoT, WebGIS, Web and correspondence, Area Based Assistance, GPS, RS to gather, move as well as distribute information and facilitated the clients in checking and dealing with the creation. PMAS consists of six parts called: the informational structure, catalogue, local setups, WebGIS, productivity handling setup, and mobile client. By studying the available insights, circumstances, and farming conditions, the method could be upgraded, innovative modules can be adopted and make it useful in the Particular area. Another related study [42] was subject of additional investigation. Data can prepare to groundbreaking thoughts, ideas connected with the concerned disciplines. The associations have fabricated information-based frameworks that could be useful to the scientists and overall population to figure out the data, holes, and limits of their connected trains and could give groundbreaking thoughts and upcoming effort. Although agrarian research with information remained accessible on the internet, they were not arranged in software or catalogs. The informational frameworks have been utilized for exploring dismissed yields by using data for getting valuable outputs. Data directory strategy observed the guideline vocabularies and fostered libraries quite a while by the agricultural local area and these libraries facilitated in the improvement of meaningful items to give immediate inquiry responds to office. CFF UCKB (Harvests for the Future's Underutilized Yields Information Based Framework) gave path to agrarian scientists, associations, and people in general for instructive and research purposes. The plan contained the information gateway as the Internet interface, Information data set, and information toolbox for mining and tracking down limits through semantic items. Information was stored, shared, and exchanged in large part thanks to the knowledge-based systems and tools. This term was used in agriculture to refer to book systems, social forums, the internet, and knowledge networking systems. Agriinfo is an expert-developed web-based agricultural system, and the document management system AGRIS database can be found at agris.fao.org. An information the board framework (KMS) was one more innovation that aided to discovery of examination holes out of available works.

Knowledge-based systems, which use "if-then" question to answer questions, make up a large number of decision and expert systems [43]. Numerous web-based systems are utilized in the agricultural sector for various purposes [44, 33].

Linked-Data, which makes use of meta-data standards to create templates for sharing and publishing data online, is another method for providing data online. In order to connect the knowledge and data systems and provide the datasets necessary for research, the system made use of the same standards. Person to person communication has begun building the area explicit component for giving field-related data. The harvests interpersonal organization frameworks utilized this office to connected the ranchers, researchers, and analysts to speak with one another to takes care of the issues. The development of a collaborative research environment (CRE) for underdeveloped harvesting issues was yet another objective of utilizing semantic technologies. These were likewise utilized for creating archives and studies regarding meaningful towards devices and people. A different method of incorporating IT into integrated pest management was defined in a subsequent study. This Decision-making computing device carried multiple strategies to control all pest species to their best advantage. A tool that could forecast the pest based on the specific area was needed by agricultural experts and researchers. Thus, a forecasting the pest and web-based data framework with real-time functionality was introduced. This work resulted in the creation of software that utilized Web technologies for weather data storage and data mining. It downloaded files with the.txt extension and connected the network stations of the NOA. This software was upgraded during the subsequent phase to become a real-time pest forecasting system that made use of the internet. There were two phases to the software development process: On the first stage, a customized WebGrabber opened the NOA (National Observatory of Athens) climatic system to obtain weather data. On the second stage, a web interface was used to perform daily real-time population calculations from the web and store the data on a MYSQL local server. For forecasting and decision-making systems, an algorithm was developed. The first step of this blog is BIOFIX, which examines the progression of pest classes. A subsequent stage put away information. Tertiary stage assessed the heat status. Later a state monitors the level of temperature was implied. The next step was to calculate input for generating the results. It was simple to use, inexpensive, and virtually extensible thanks to its straightforward architecture [45].

The traditional and smart agriculture differences have shown in the Figure 5 and Figure 6 below.

Figure 5: Traditional Agriculture

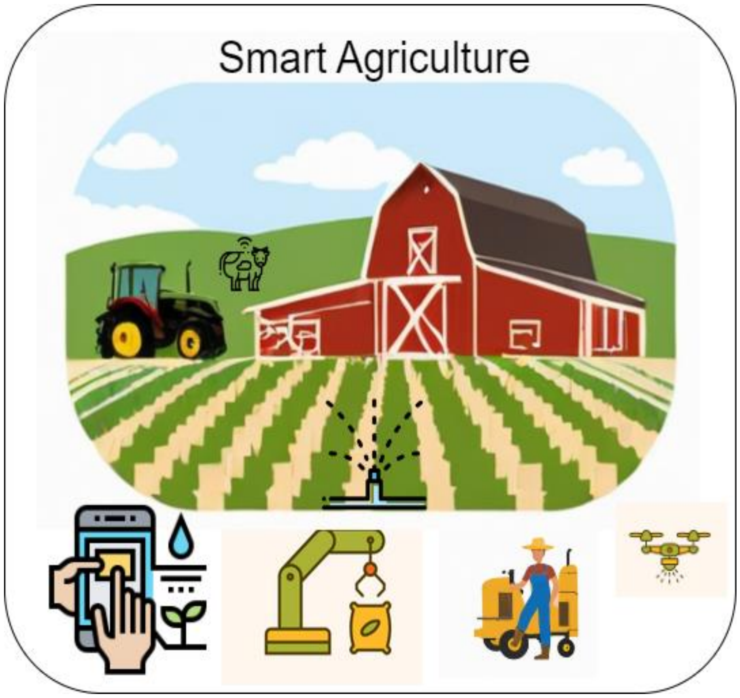

Figure 6: Smart Agriculture

"A Web-Based IoT Solution for Monitoring Data Using MQTT Protocol" [46] was the title of another study. An online engineering was proposed to track, screen, and examine continuous rural information. The primary objective concerned about observing tasks of IoT device of agrarian sector. Systems kept and shared the data from the sensors over the Internet. A platform of three-tiered, with various components such as the dashboard and storing part made up the Web application architecture. The data that was sent to the users from sensors and other monitoring devices was transferred through a protocol known as Message Queue Telemetry Transport (MQTT). Asynchronous communication, lower complexity, and lower power consumption were the main features of this protocol. Data was captured and transferred to servers before being given out to users. Yet, there is a chance of advancement in provincial region organizations. Further related work was done [47]. Giving crops the proper watering to obtain desired output is crucial. Weather patterns impacted the procedure for supplying water thus the ranchers required a framework aided to settling on great as well as effective choices. Constant cautions and independent direction expected to control the circumstances. By joining IoT and WOT, WSN (Wireless Sensor Networks) [19] served as an important and useful technology for farmers to effectively monitor and control various crop-related situations. Through the WOT, farmers were able to monitor changes in crop-related processes thanks to web services. exhibited a graphical representation, a real-time soil monitoring system, an SMS alert service, an irrigation management application, and an alerting setup for guessing the requirements. In order to make decisions more effectively in the future, this system can be improved further. A different study about farmers' knowledge requirements for crops' water quality revealed that their complicated farming practices were endangering the ecological space because of the low quality of their water. This could assist ranchers with improving their agrarian cycles as they knew about the water supply. Rather than giving attention to the ranchers, the water frameworks were created to target acquiring the water supply as indicated by the guidelines. For the purpose of providing farmers with real-time information, a user-centered 1622WQ web application was developed. There are some obstacles, such as a restricted net connection; 2) Unsatisfactory data; 3) Within the program, technical difficulties discovered and addressed to ensure the provision of excellent assistance. Information about precipitation boundaries were additionally added. Using an open-source R package and the Shiny framework, the 1622WQ application prototype was developed in multiple versions. The interaction part has three Tabs: " Locn" displaying locations and allowing users for distinguishing; "Map" selecting located area; and "Data" displaying data position. By combining various technologies, the web-based application provided farmers with unified interacted place for a variety of initiatives for the delivery of water. The effort featured meaning of cooperation and combination of varied methodologies with advances and drove old techniques towards brilliant level [48]. A work about "Improving Crop and Farm Productivity," was conducted and inferred, output ought to be accomplished through exact ecological necessities. Be that as it may, the most common way of gathering the information was not productive because of their various old methods. For taking care of this issue, the development of IoT and different advances was utilized that incorporated the various IoT gadgets, remote sensors, and organizations, brilliant frameworks, observing cameras, and weather conditions stations. SmartFarmNet, a platform built on the Internet of Things, was shown created by incorporating the Semantic Web [26] Innovation that empowers the programmed assortment to information of necessary conditions, sifted through pointless information, accuracy towards improved yield execution. It could practically coordinate the different gadgets and sensors and put away the information to perform examination on them recommended the thoughts. The management of a large number of distinct networks and devices was the most difficult aspect of the SFN platform's development. The answer for this challenge was planning a typical Programming interface for every one of the coordinated gadgets and sensors for addressing their information through SWT. By combination of SWT, this stage had the option to perform constant examination on information, stretched out its reach to additional spaces, and could analyze the mistakes and execution of gadgets. SWT made it feasible to make use of semantic web standards. The real farming data used in the evaluation and experiments confirmed the platform's performance and ensured its scalability. The world's first infrastructure was this SmartFarmNet to support several systems and gadgets and provide services about data collection, storage, analysis, and crop performance forecasting. Another system presented advancements for upgraded highlights to help variety of gadgets, detecting devices, and continuous information delivery in agribusiness applications. The current systems were enhanced in terms of instant of processing data, analysis, and decision-making, but they only supported a limited number of areas and network grids. The suggested method maintained the reconciliation of a few stages with the assistance of semantic web innovations. It was able to interoperate heterogeneous devices, sensors, and networks and offered an accessible foundation on which pipeline processing applications could function, capable of interpreting massive amounts of facts and identify unidentified occurrences. On medium-to-large range farms, this framework performed well, according to evaluation. Additionally cleared the new way for the reconciliation of open norms and semantic web advances in future farming [50]. According to the findings of a study regarding WOT involvement [51], use of WOT requires improvements. This study gave an answer for transformation in the savvy climate using multi-reason options and reusable components. Relied upon the semantic advancements for getting data instantly, the arrangement was decided on account of the Brilliant Horticulture structure that utilized the ASAWoO standards. Also talked about how to make models from old sources of information. The ASAWoO project defined avatar, a component-based software for manipulating and handling. Because the WOT apps had a stepping-tool of operations, these avatars, which are dependent on the semantic design, could converse with one another and have unquestionable capabilities to integrate WOT applications for comparable objective achievement portrayed in a point-by-point structure in [52]. The WOT applications are now able to respond to questions about domain-independent adaptations thanks to the availability of a context adaptation process with multiple uses. The proposed method for achieving implementation and evaluation accuracy and performance was demonstrated using a Smart agriculture framework. The objectives regarding development of questions and answers were confirmed by outcomes. Additionally, the planned method was equated to methods for locating and overseeing relevant literature. Additionally, the WOT application established for gathering application management workflow requirements and contextual data. In the end, some perspectives on the work that should be done in the future for particular adjustments and transformations were established. An earlier study [53] combined actual time Web technology into the current networked devices for farming in cities using a specialized Middleware architecture. Another layer was added by this paradigm in between the application and organization layers. The web framework continuously comprised of numerous principles and conventions. The fundamental capability of coordinating the online application was for collecting the information of each gadget through a one-of-a-kind separate identifier. This web innovation gave the capacity to information as well as introduced the information in graphical perception. Albeit this model was specific electronic proficient engineering there is as yet a need of improving it to store, examine and control the gigantic measure of information produced from now on. Combination of two technologies was described in a study [27]. As of late the Connected Open Information that coordinated the various types of information made it helpful for everybody on the planet in each field developed dramatically with heterogeneous organizations and sorts that prompted the advancement of information and reconciliation with the Internet as Overall Semantic Web (WWSW). The Assistance situated methods prepared for the advancement of semantic innovation to beat many difficulties connected with execution, proficiency, and accessibility of different administrations over the web world. Standards developed by the World Wide Web alliance made the it accessible to businesses, farmers, as well as financiers and businesspeople from all walks of life. The interconnected universe of individuals, gadgets, and administrations over the web produced a ton of continuous information in various structures, codes, designs, gigantic data, and cycles. Techniques for the semantic web [26] turned every single thing sensible as well as productive. Data from a variety of organizations was made available online for experiments and models, algorithms, and methods that were already in use. The semantic technology platform, developed by MIMOS, not only added new features but also enhanced existing ones. Joined Country's FAO fostered the biggest farming metaphysics on the planet as a multilingual horticultural jargon that gave numerous offices and assisted the associations with distributing their rural information and their models through AGROVOC. In more than 20 languages, AGROVOC had 40,000 ideas related to various fields like agriculture, fisheries, and forest, among others. It connected the other ontologies, such as chili, tomato, generic crop, corn, and so on. The four rural information models were distributed in MIMOS. The machines and frameworks can involve the two ontologies by involving connected information for looking through the assets. According to a study [54], semantic web technologies have been crucial in transforming unstructured data into usable form. As a supporting domain, SWTs were also used to tackle issues in the agricultural field. Semantic technology resources for the agricultural sector were developed by numerous large NGOs, including FAO. A review was deliberately finished to support future exploration on SWTs for issues in horticulture. This survey included a survey of current SWTs applications and a comprehensive evaluation on SWTs, procedures, and data interchange quality. The reviews of the articles for the survey came from conferences, books, and peer-reviewed journals. Processes in farming depended on crop types as well as on different factors like soil, water, climate, and natural circumstances. Semantic web technologies could be used to integrate data from time-based to time-varying means into a single standard structure or platform. This study looked at the agricultural semantic resources, which included taxonomies, controlled vocabularies, thesauri, and ontologies [55] with a lot of agricultural sub-domains. Two ways to deal with making the focused semantic assets for horticulture were depicted. One was to establish a brand-new one [56], and alternative included grouping the resources that were already in place [57]. The study also looked at and talked about agricultural-specific applications of semantic web technology. As there was a gigantic measure of SWTs assets that were determined for the farming space yet not many of them were utilized to tackle the issues. There were less works in the literature review that were related to semantic web technologies (SWTs) in agriculture, it’s to be a significant option for agricultural issues. Even though there was not a lot of research on this technology in the literature, it may open the door for future research on how SWTs can be used in agriculture. A research project was carried out that examined the Web of Things work in the agricultural sector [58]. The analysis was carried out in three stages: 1. wants and gauges of expert's area, 2. Production of agricultural machinery's movements, Status of existed achievements in the area. Agrarian field shifting towards modern one, thus analysts predicted a upcoming change in farming. Agriculture faced two primary obstacles in achieving the key solutions: changes in the weather and the environment's long-term safety. Agriculture benefited from IOT's fluctuating frequency. Through WOT, the data from a variety of sources as well as IoT devices were merged to find solutions to various agricultural issues and make decisions for improved production. The fundamental components of smart agriculture and precision farming are WOT and IOT. Numerous US associations made the accomplishments in the horticulture field like AgJunction Inc., Monsanto and DuPont, Deere and Company, Raven Enterprises, and Trimble Route Ltd. In Europe, Future Web Program development in agro-industry gave 14 million euros to the development in this field [89]. Robot innovation likewise played out an immense job by presenting sensors, crop machineries as well as checking and handling gadgets that involved various innovations. The smart farms of the future are the result of all emerging technologies, protocols, and smart systems. This study inferred that the WOT is the principal character for a shrewd cultivating future, so the ranchers need to concoct game plans for their high efficiency and benefit as indicated by these innovations' thoughts. To furnish the ranchers with significant data for better direction, IT assumed a crucial part in the horticultural field. An exploration "Semantic Electronic Coordinated Farming Data System" was directed that proposed an online information model for social occasion, mining, coordinating the information from different places [59]. Web technologies were utilized in the integrated Agriculture Information Framework (IAIF) model for linking data as well as metadata for gathering information. A technique was likewise given to metaphysics to get the necessary information from various sources. IAIF likewise consolidated a dynamic module named PC based Conversation Emotionally supportive networks (CBDSS) to help the ranchers in better choices thoughts. The IAIF cosmology included three sections: Domain, Link, and Resource sections provide crops related details for great output. The XML parser and D2R systems were utilized to access data. The link subsection of cosmology connected the data sets and the Resource segment addressed the connecting sources on the WWW. This was all conceivable by web advances to associate the data sets for data and information gathering. It served as an extension of the previous investigation. A conversation was likewise held to connect the few different information assets for upgrade in this work. Thoughts about wireless involvement and device linking was fundamentally altered as a result of the involvement of the Web of Things. People taken advantage by combining WOT to food trade because they understood its value. Research presented the WOT coordination for information exchange as well as boosting production [60]. The Web of Things Supply Chain was utilized by numerous nations for the quality and safety of agricultural food items. The facility for sharing information about agricultural products in real time was made possible by the integration technology of RFID. The Internet of Things has benefited a lot to systems, devices, architectures, and applications in recent years, but it hasn't been able to work together because of different protocols, networks, and descriptions of objects. Regarding these integrations of IoT and WOT technologies, a study was carried out [21]. Numerous businesses attempted, but were unable, to develop standards to address issues arising from various platforms, networks, and objects. The investigation examined various IoT applications, projects, and services and offered an approach to handle these problems. There were three stages, each serving a distinct purpose. It had a server Web of Virtual Things installable between the cloud and Fog Layer of IoT, the middle layer, to solve compatibility issues. It likewise gave a point of interaction REST to gadgets to consolidate at the most minimal insight. There is no need for the other intelligent devices to wait for requests or to respond to questions. In a non-realistic device, it can express the received messages consistently in realistic way. Once the device reaches its real active state, it responds to queries and keeps the user informed of any responses. The examination and valuation task were carried out in order to evaluate the capacity, safety measures, and power of working. The outcomes proved WOT and IoT joining extremely beneficial. The role that WOT plays in agriculture was the subject of another study [61]. The combination of IoT improved the horticulture arena. As a result, enhancement also resulted in obstacles to and disclosure of agricultural data during data collection. This study presented a framework called "ASAWoO" to address this issue. It made it possible to control devices using WOT recommendations and computational methods to obtain the interconnections between different sensors. WOT aided gadgets to convey and connect with one another. To determine whether the proposed framework was effective, a four-month farm experiment was carried out. The emerging Internet of Things (IoT) and WOT provided outcomes of this deployment, and they have the potential to greatly benefit agriculture. In order to easily and freely obtain agricultural data, research was conducted [62]. As of late the efficient information opened up online with the expectation of complimentary use. The semantic web advanced development made the information accessible for public use with liberated from cost office. Many nations' states involved these advances and gave free information to public. The notable states UK and USA likewise used the recent fads and gave helpful free information in many fields like in wellbeing, instructive and farming areas for boosting the economy. In addition to making the data freely accessible, combining web techniques with Linked Open Data made it possible to connect various sources and easily collect data. Yet, this information more often than not was not in the outfitted structure that made it difficult to involve it for examination and continuing purposes and furthermore made it hard to associate with different data sets. This study suggested using a Danish-language web framework called "RDF" for the Danish government to collect, process, and connect with various databases to address this issue. Also made it possible to connect agricultural data to organizations, making it easier for them to find answers to difficult questions. After acquiring the data, this model procedure analyzes it, cleans it, and connects it to various sources. Eventually, it was decided via testing and getting great outcomes. A report regarding handling of historical items was released [63]. In most recent years, organizations, public establishments, and neighborhood bunches have devoted creating interest to the character of good strategies for survival of old resources. Plans for controlling cultural property are entirely based on a lot of different standards. A strategy for selecting multiple standards was presented to rate beneficiation procedures with the goal of increasing cultural and financial well-being. A solitary programming of the A'WOT for assessment in helping the arrangement and work of control strategies of deserted foundation properties of culture. The AHP and SWOT techniques in this application helped with decision-making, resource management, problem-solving, and tourism-related resource management. The integration of all methods and the proper step-by-step arrangement of processing stages are necessary for this method to produce effective results. In the past, many concepts were proposed for constructing a distant study environment with the option of practical teaching for students in four subject areas such as science, engineering, mathematics, and technology. "Contribution to the Setting Up of a Remote Practical Work Platform for STEM:" was the subject of research. The Instance of Agribusiness" expressed that the overviews of regular and life sciences concentrate on regions showed that the subjects given to the understudies were not totally well-educates [64]. A pragmatic part ought to be added for better concentrate however the visit to the organic unique locale could be risky for people. By combining the capabilities of WOT and WebRTC, a multimedia server technology, this study also contributed to the advancement of distance learning by providing a virtual location for visiting and sharing various facilities. The work was mostly done in the agricultural field, but the results of the experiments could also apply to other fields. This introduced answer gives the office by which a few students and instructors could go to the field trips while different students could be worked with by a live transmission of that excursion and get the experience. The ease of use of WOT's APIs and standards, which made it possible for the various objects to communicate with one another through web language, was the main advantage. Rules from small level servers could also be used in devices. The Internet of Things (IoT), API, and Web Application Interface stages make up this framework. The simple web browser could be used to enable communication between multiple users and obtain data from devices that have already been deployed by implying this framework. Agricultural distance learning could be improved and implemented using the proposed framework. The internet, communication networks, and devices have all improved over the past few years, transforming the world into a global village and transforming everyday objects into smart objects into what is now known as the Internet of Things. A review "Brilliant Sensors from Ground to Cloud and Web Insight" was finished on Implanted Knowledge (EI) a coordinating examination field that deals with revealing the activities of everyone, things, complex shapes and furthermore figure out the secret characteristics of savvy gadgets [65]. Utilizing open-source agricultural data, the data extraction process resulted in the creation of useful ontologies and information resources for effective decision-making. The previously used agricultural data was thoughtfully analyzed in order to produce the new material for enhancement purposes. The past exploration record, properties, applications, structures, and EI research-related holes were checked on in this review and showed a clever water supply application. The primary objective was to develop intelligent management systems for agricultural processes and to simplify the threats and new directions of Intelligent Building Technologies. The semantic web advancements were utilized for the improved looking through process, distributing the information online in efficient structure and associating the gadgets for correspondence and working. The astute rural information ought to be broke down by researcher's groups to really take a look at the unwavering quality to send in genuine ranches and horticultural regions by the nations for powerful creation. For safe data availability, international trusted standards are also required. despite the fact that numerous studies suggested that WOT and other technologies would emerge and find applications in the agricultural sector to address interoperability, performance, production, and management issues. There is very little research on it, and no study provided a taxonomy to provide a clear explanation or opportunities for future research in this area.

In any case, this work introduced a deliberate writing survey of ongoing pertinent examinations that were led to give the answers for the horticultural issues. The curiosity of this study is that we have introduced a scientific categorization of WOT applications to the farming space and a wot based horticulture model. Last but not least, open issues and directions for further work discussed.

3. Research Methodology

A systematic literature review, which will be the suggested methodology, will be carried out to gather, examine, and classify all current and planned research as well as the protocols, standards, and developing techniques [66].

Detailed procedure has shown in the Figure 7 below.

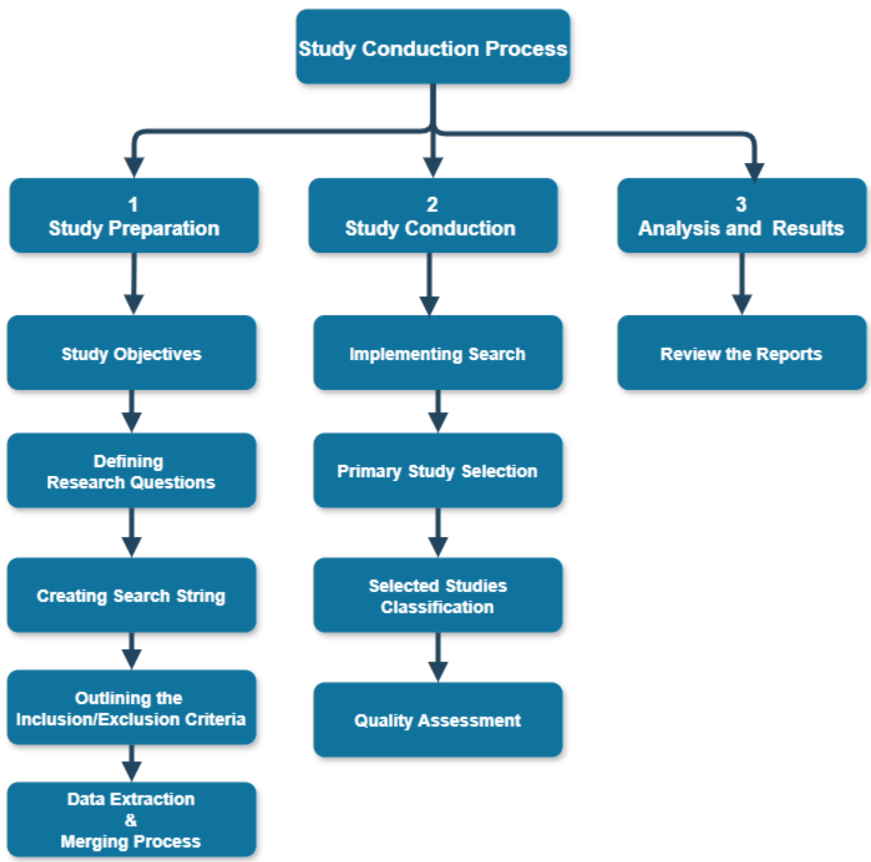

Figure 7: Systematic Literature Review Process

Three steps structure the process: preparation of the study, conducting the study, analysis, and results. The chosen papers will be categorized based on the application domains, research types, and research approaches. We will extract as well as classify studies based on their methodologies. Researchers will discuss this SLR and provide recommendations for future directions [67]. The methodology that is being used has been suggested by [66].

3.1. Research Objectives

The main objectives related to the selected study are following:

- The purpose of this paper is to give an outline to the ongoing research on WOT technologies concerning the Agricultural industry.
- To acknowledge and reveal current and future work of WOT in Agriculture applications and shortcomings of work done so far.
- To provide an overview of movements in the research discipline.
- To map out publications in the related field of the study.

3.2. Research Questions

To have the overall view of the area of the interest identified with their corresponding motivations based on the selected study. The answers to the given questions will assist in giving an idea of the existing research trends, limitations in WOT Agricultural research and its potential future directions.

All the given questions and the motivation that will lead to the provision of answers to the given questions has been presented in form of table 1 as follows. For research questions, refer to Table 1.

Table 1: Research Questions

No.	Research Question	Motivation
RQ1	What are the primary target publication channels for WOT agricultural research?	Identify reputable sources for WOT agricultural research and future study.
RQ2	How has approaches occurrence for WOT agricultural articles changed throughout time?	To categorize publications in WOT-Agriculture Research as they change over time.
RQ3	How many kinds of WOT based agricultural studies are present?	To gain insights about the research approaches regarding WOT in the study.
RQ4	What are existing researches along with gaps in WOT agriculture research?	Understanding current researches might inform future research strategies and identify unresolved questions in agricultural research.
RQ5	What alternative approaches were offered to solve challenges in WOT agricultural research?	To identify the existing approaches offered in the WOT agriculture study.

3.3. Search Scheme

A searching string has been employed in order to gather relevant work in the given research area. Figure 8 below presents the strings combination.

For the purpose of the search, we used the relevant keywords relating to research area. In light of the inquiry, many databases were used to find relevant material for this investigation. In order to get the bibliometric studies, Google Scholar was used.

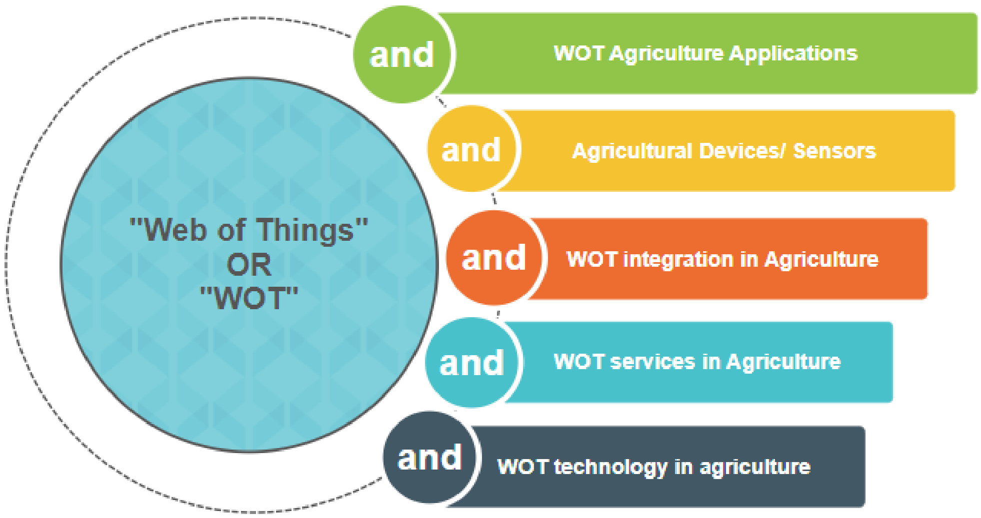

Figure 8: Search String

The search scheme is presented in the Figure 9 below.

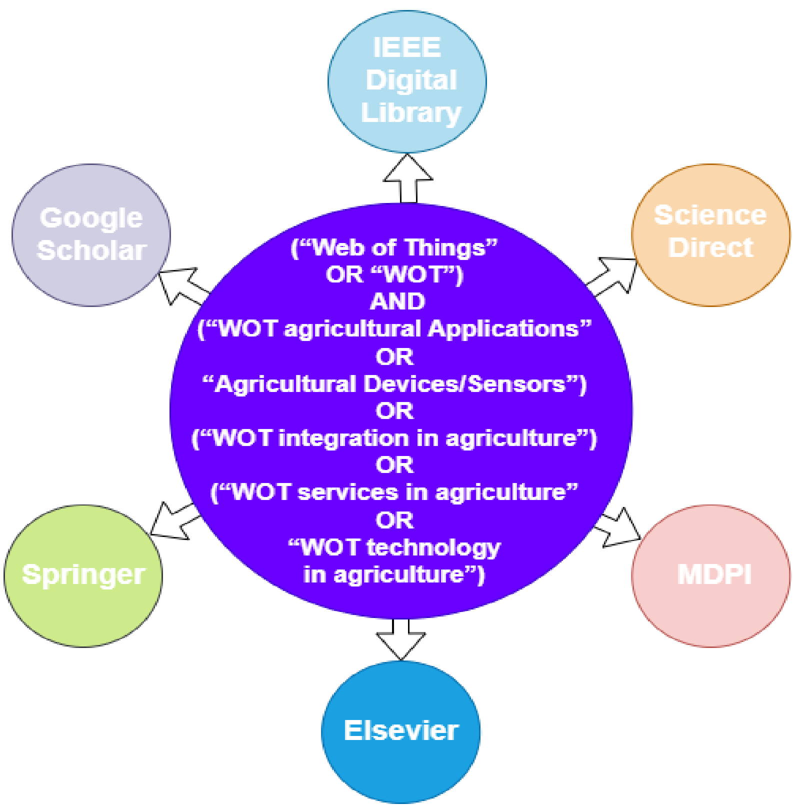

Figure 9: Searching Arrangement with Databases

3.4. Study Selection Process

In the selection criterion, an attempt was made to look for the most related work. Work published in the two different sources were counted only once the order in which the research was done. Whole material has been reviewed according to keywords. Secondly, we excluded identical and nonidentical topics. Thus, works were selected based on described conditions.

For criteria, refer to Table 2.

Table 2: Inclusion/Exclusion Criterion

Inclusion Criteria	Exclusion Criteria
IC-1 Articles presenting concepts and integration of WOT	EC-1 Articles that are not focused on WOT applications
IC-2 Articles that are focused on WOT applications and their implementation	EC-2 Articles not presenting new and emerging ideas
IC-3 Articles presenting WOT problems/goals	EC-3 Articles presenting general focus on WOT application integration-based model
IC-4 Articles presenting WOT standards/protocols/tools	EC-4 Articles not related to the search string
IC-5 Studies published in English Language	EC-5 Articles that are published before 2010

Outcomes of procedure has been explained through a diagram. For study selection process, refer to Figure 10.

3.5. Quality Assessment

One of the decisive steps in assessing goal is to raise the standard of elected papers. Commonly, the Quality Assessment (QA) is performed in Systematic Mapping Study and Systematic Literature Review. Using an SLR, an assessment was created to get level of related works that were chosen for this investigation [68].

1. Paper strengthens the agricultural sector and WOT. Potential answers: Fully (+1), Partially (+0.5), and Not (+0).
2. Paper proved an identified concern within the agricultural field through WOT: Fully (+1), Partially (+0.5), and Not (+0).
3. The study's shortcomings and potential for more research are examined: Fully (+1), Partially (+0.5), and Not (+0).
4. Study was published in a well-known platform. Below is a potential response to this query regarding Conferences and Journals Rankings.

For Conferences:

- If CORE A (+1.5),
- If CORE B (+1),
- If CORE C (+0.5),
- If not ranked CORE (+0)

For Journals:

- If Q1 (+2)
- If Q2 (+1.5)
- If Q3 or Q4 (+1)
- If not ranked (+0)

At the end, the overall score of the study is computed from the individual scores of each question which ranges from 0-5.

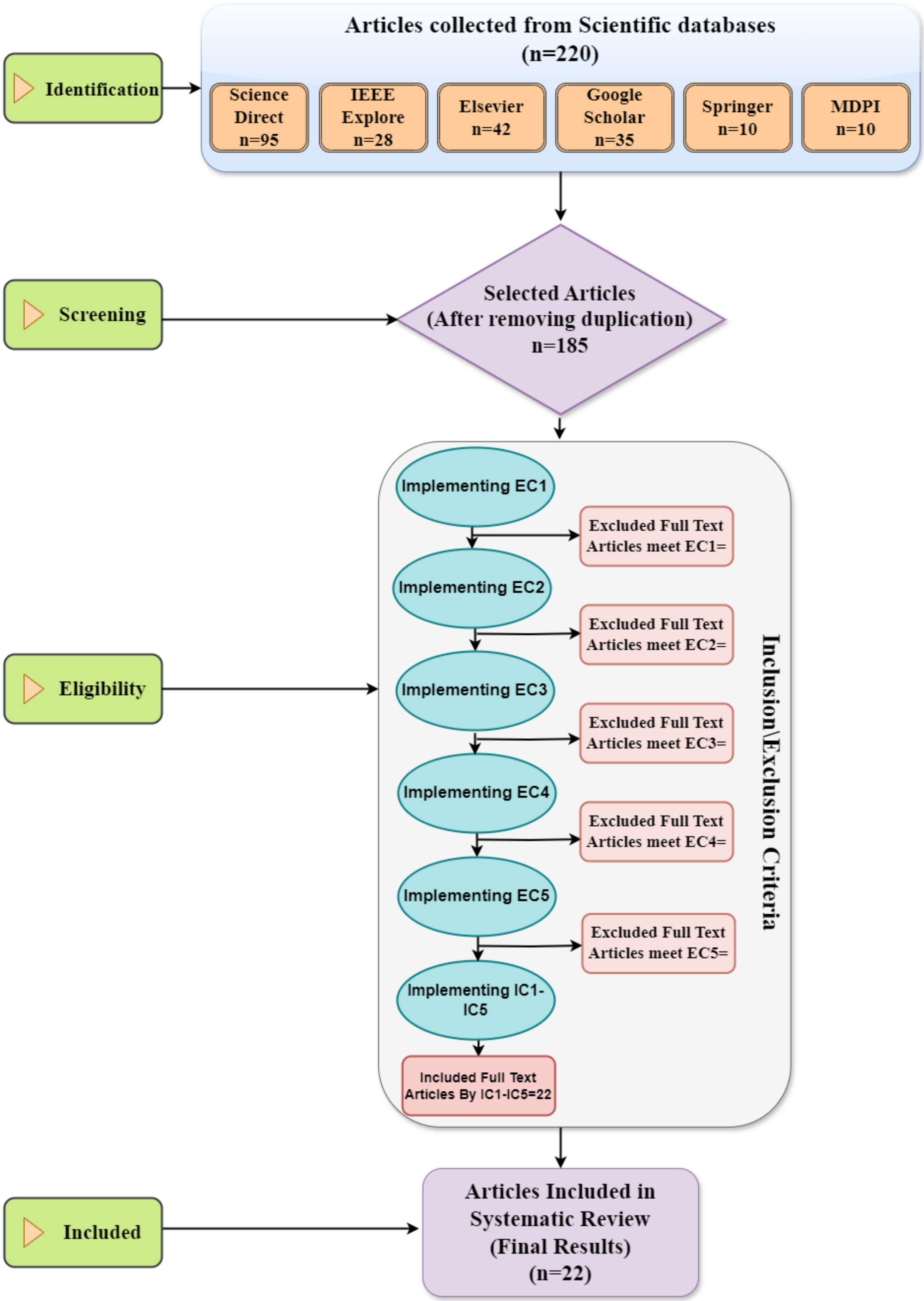

Figure 10: Study Selection Process

3.6. Data extraction and merging process

- RQ1. For answering this question (RQ), it is required to define a publishing channel.

- RQ2. Articles should be grouped by the year of their publication.
- RQ3. The categories that can be used to identify a study type [69]:

Solution proposal: Solutions to agricultural issues are provided including problem solving methods. it can be genuinely new or may be a development of an existing well-known strategy. The effectiveness and importance of the solution is illustrated through justification or by giving few examples only.

Conceptual Research: They were therefore able to simplify these concepts by seeing and examining the data that is currently available on the WOT apps There are no used.

Evaluation Research: Investigation and assessment are performed for the WOT-agriculture mechanisms as well as concerns recognizing problems in WOT-Agriculture applications.

Others: which include surveys, system, architecture, Development, experimental, reviews, performance analysis, and models.

- RQ4. Determine the current state of Web of Things (WOT) in agriculture industry is the study's main research question. Perhaps, one can possibly make sense by gathering concerned scholarly papers from different peer reviewed journal, identifying the research void, and is able to depict the trends of the research. This proposed SLR will help both new scholars and specialists to develop existing effort on WOT in agricultural resolutions
- RQ5. According to [69], a strategy can be divided into following groups:

System: It might be a suggestion that could offer solutions to monitor the agriculture, controlling and decision making using WOT.

Framework: There are particular theoretical or conceptual model developed for promulgating or achieving the interoperability and effectiveness of IoT systems in WOT.

Application: An idea that supports the function to continuously observe the agricultural processes, to administrate it and to informs the farmers or users about what is happening by utilizing web application.

Method: A structure proposed and a plan for the WOT services as a means to develop agricultural knowledge with step-by-step procedure.

Infrastructure: A managing setup must exist to track of farming via WOT services.

Architecture: Idea concerning the techniques of the agricultural sector.

Guideline: An example of a practice that can be used to find solutions for agriculture by WOT technologies is also a discussion.

Others: Platforms and analysis etc.

It is primarily involved with the ultimate studies that are grouped for each query; it recalls the important works along with ranking provides a graphic representation of the outcome of grouping.

4. Results

It gives conclusion of conducted study questions by elaborating on them. Out of them, the studies were selected by evaluation procedure and were sum up into contribution of WOT in Agriculture area.

4.1. Selected Studies Results

Initially all 220 identified research studies have been evaluated based on their titles, keywords and abstracts which resulted in the exclusion of 198 articles and inclusion of 22 articles only. The 22 papers were scrutinized effectively to respond to the research questions of this research investigation.

4.1.1. RQ1. What are the primary target publication channels for WOT agricultural research?

In the context of this Systematic Literature Review, the Publication channels are only those journals and conferences. Concerning the papers, all were published in the 12 journals (0. 54%) and in 10 conferences (0. 45%). Additionally, all studies utilized diverse publication areas.

For the publication channels, please refer to Figure 11 below.

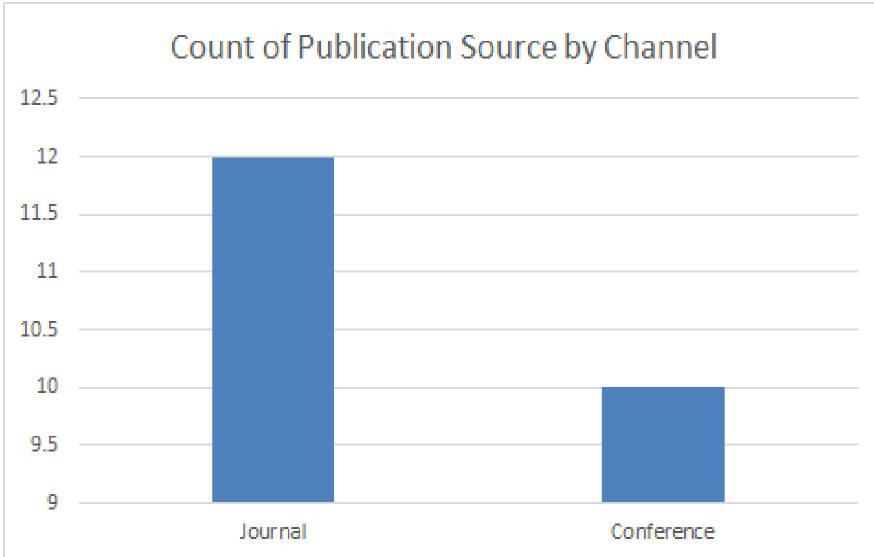

Figure 11: Publication Channels

4.1.2. RQ2. How has approaches occurrence for WOT agricultural articles changed throughout time?

In consideration of the papers selected for this study, the papers of focus were published in the period of 2010 to 2020. Over years different types of publications have exhibited the information in the figure. The figure below shows annual developments of WOT integration in agriculture. With the advent of IoT and other technologies, 2016 saw the greatest number of papers published, marking the beginning of the WOT era in all fields, including agriculture. Second busiest years are 2018 and 2019 where research was conceptual, proposals, and contributions to integrating WOT with internet of things systems and architectures.

For types of publications, please refer to Figure 12 below.

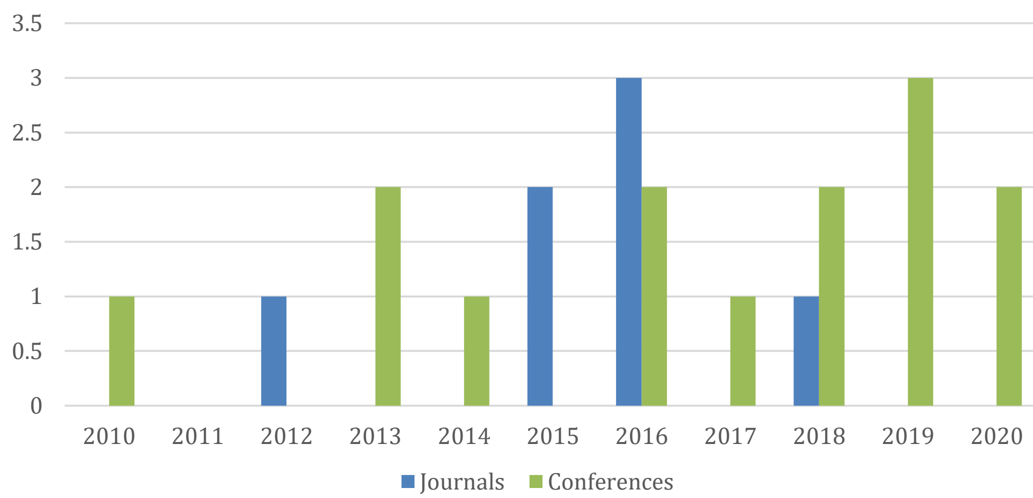

Figure 12: Publications over Years

The graph indicates that the mostly articles appeared in journals in 2011, with no paper being published during that year. In the field of agriculture, WOT was integrated in numerous ways, many of which involved web applications, systems, and frameworks. It is unlikely that this study, which was conducted in 2020, will reveal the precise number of studies that were published in that year.

For trends in the studies by years, please refer to Figure 13 below.

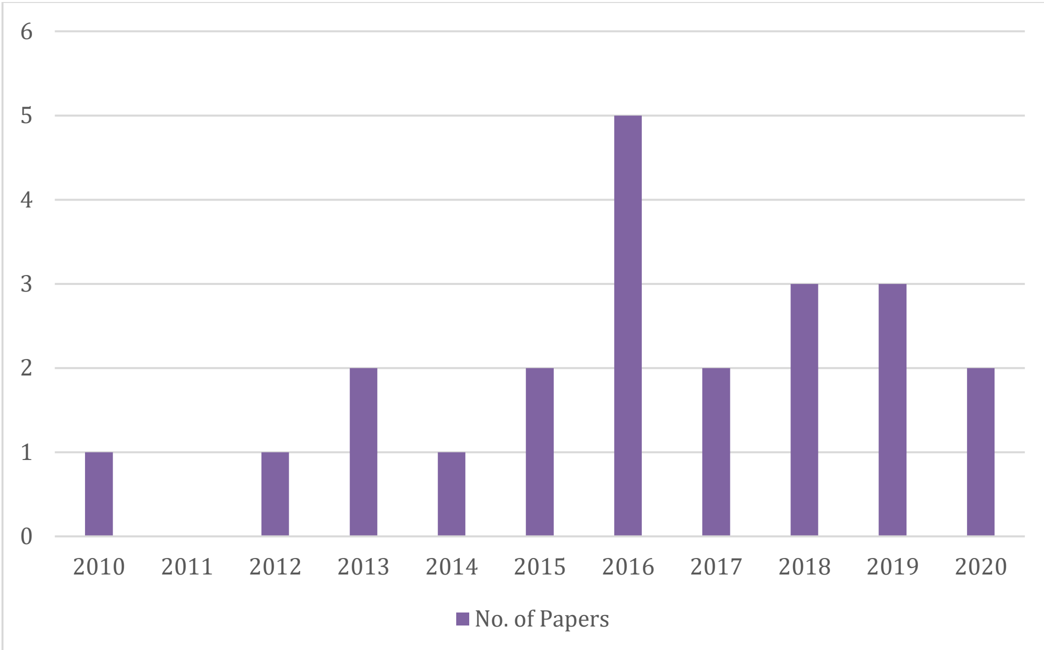

Figure 13: Trends in studies by year

4.1.3. RQ3. How many kinds of WOT based agricultural studies are present?

For presented methodical investigation, selected 22 articles were divided into nine categories of research, which included: Solution proposal (6 articles) (0.27%), Experimental research (3 articles) (0.14%), Proposed System (3 studies) (0.14%), Proposed Model (2 studies) (0.09%), Contributional Research (3 studies) (0.14%), Conceptual Research (2 studies) (0.09%) whereas only one study included survey and evaluation research, implementation and evaluation research. Figure 14 displays every type, and Figure 15 displays the outcomes of these types. The provided graphical representation demonstrates that the chosen studies (solution proposals) primarily address agricultural problems. Additionally, some experimental, practical, and assessment WOT-Agricultural solutions were presented. The author of this study [20] suggested using Service Oriented Architecture (SOA) to combine new and old infrastructure features in order to address the issue of sensor interoperability and integration into systems for monitoring and sharing. Webservices for sending, handling, and exchanging agricultural data over the Internet were included in new infrastructure, along with the concept of the sensor web. The author of this study [46] identified the challenges in obtaining and keeping track of real-time data and suggested a web enabled setup that makes MQTT protocol to track and monitor devices as well as analyze, store, and provide users with access to real-time data. An author looked at the issues with the water supply systems in terms of farmers' awareness and offered a single web enabled system where farmers could obtain up-to-date data on water quality [48]. The problems with the internet connection and data quality were also fixed by this application.

For research types, please refer to Figure 14 below.

Three tabs made up the application: the Locn tab displayed locations, the Map tab allowed users to choose their desired location, and the Data tab displayed location data. The author of this article [50] examined the problems with integrating heterogeneous platforms and devices and offered a framework for doing so by utilizing Semantic Web technologies. This framework would allow combination of multiple areas, devices, and set ups for streaming and examining actual data, identifying faults as well as coordinating various platforms and devices.

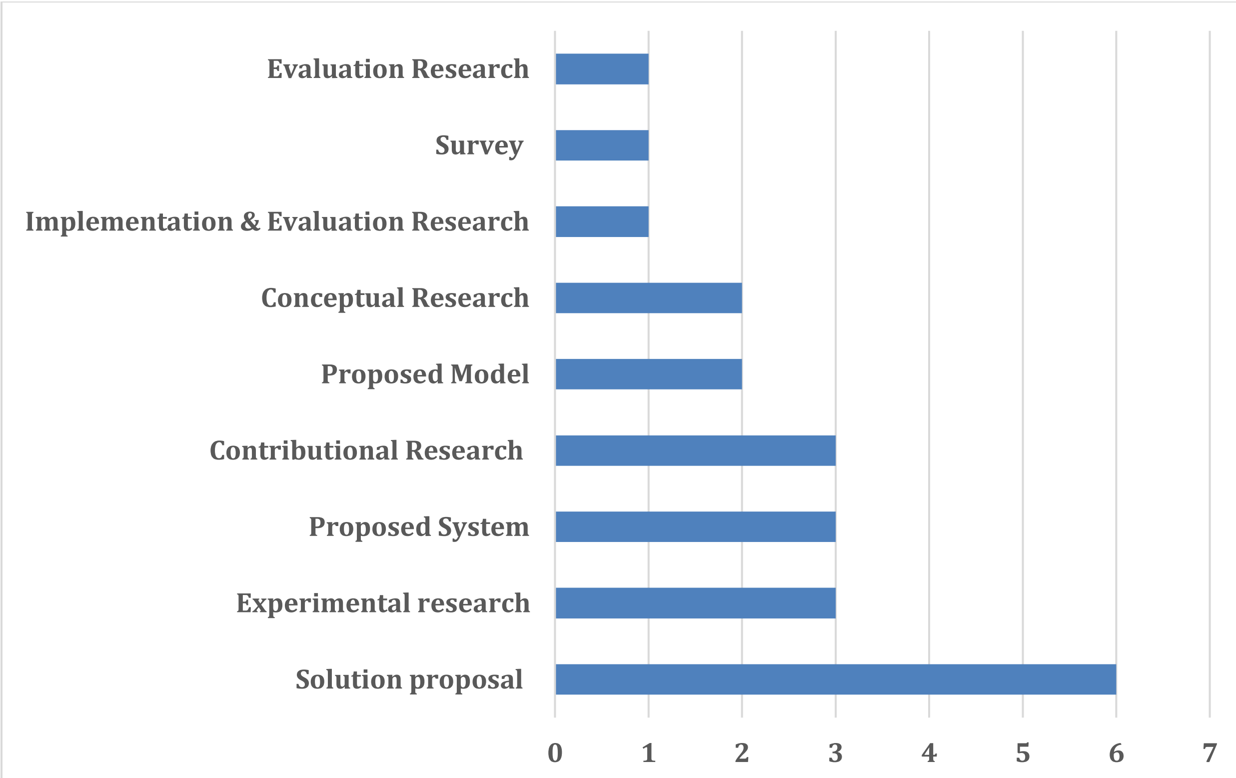

Figure 14: Research Types

For results of all research types, please refer to Figure 15 below.

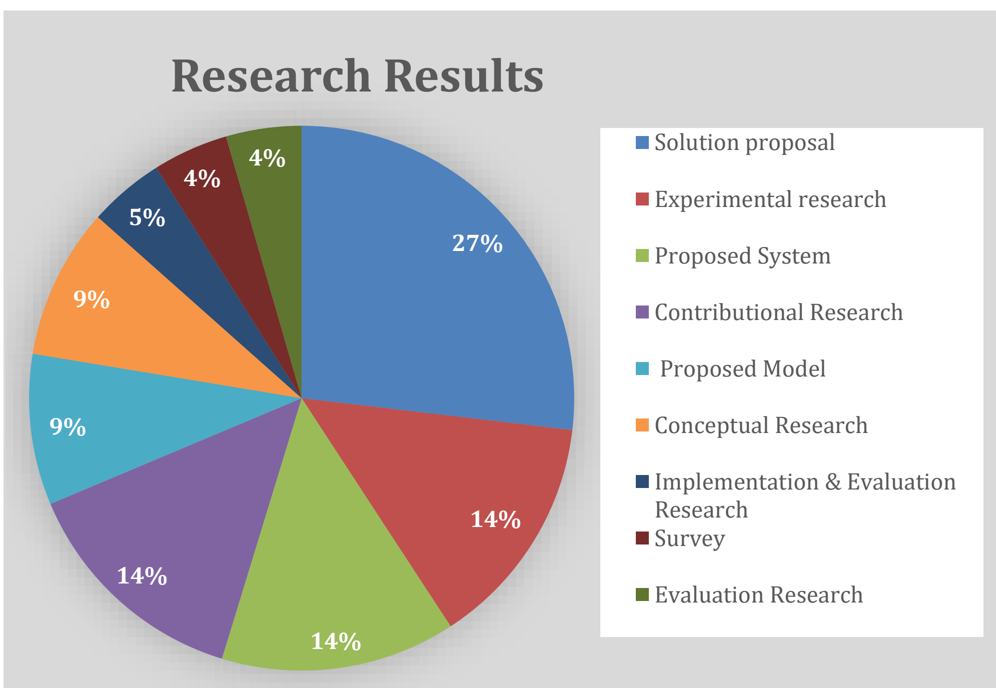

Figure 15: Research Types Results

4.1.4. RQ4. What are existing researches along with gaps in WOT agriculture research?

As displayed in the outcomes it is presumed that the vast majority of the examinations depend on the checking and the executive frameworks, Systems, and web applications for Rural area by coordinating WOT into few different innovations. Some of the cases discussed here include: In a work [53], the creator introduced a middleware design by coordinating Internet innovation in current IoT frameworks for saving information of each gadget by one-of-a-kind identifier independently and introduced the information in a graphical view. This study [45] introduced an irritation determining and data framework for indicated district bug expectation. Using WWW technologies, this software with a web interface offered functions for storing and mining data. The WebGrabber, which was used to obtain data and carry out the real-time calculation, was included in this system. Then, at that point, this framework improved the gauging and dynamic framework by making a calculation. This system was reusable, cost-effective, and virtually extensible. A technique of observation to help farmers manage and keep an eye on various crop-related states was suggested in a paper [47]. This framework created by coordinating the Remote sensors organizations, Web of Things advancements and highlights a ready framework to help constant observing of soil, water system conditions, graphical view, and dynamic in light of the yield circumstances. A review [63] presented in regards to protect verifiable culture resources. It can handle decision-making, resource management, problem detection, and problem-solving. Several managements, monitoring, control, and decision-making-related WOT-based solutions are presented. The vast majority of them coordinated the a few advances for productive execution and results yet some of them actually need accomplishing the objectives, for example, dealing with gigantic information sum, multi-space gadgets, organizations. The majority of works combine IOT involved agricultural systems and applications with WOT. To get over the shortcomings and restrictions of IoT-agriculture research, WOT technologies have arisen to provide immediate processing and agricultural activities. WOT services made it possible to collect, analyze, and make decisions based on real-time data. They also made it possible to control and manage the diverse infrastructures, sensors, and devices as well as crops. Yet, there are still a few holes that were acknowledged in this precise writing survey. The WOT made standards and infrastructures better, but secure international standards are still needed. Prior to applying the available agricultural data to real farms, it is important to examine it. A significant hole has been found in regards to instructive and research region in horticultural space that it needs far off functional stages for instructive purposes and just 1 review was tracked down on this subject. The fact that less research has been done in the WOT-Agricultural domain research area on SLR, SR, LR, and mapping studies is another gap. Along these lines, it needs further work.

The selection of articles is included in the Table along with specifics about their categorized outcomes, please refer to Table 4.

Table 4: Articles Classification

Ref.	**Quality Assessment**										
	P. year	**P. Channel**	**Research Types**	**Research Approaches**	**Application Domains**	**(1)**	**(2)**	**(3)**	**(4)**	**T. Score**
[20]	2015	Journal	Experimental Research	Infrastructure	Monitoring	1	1	1	2	5
[21]	2019	Journal	Conceptual Research	Framework	Interoperability	1	1	1	2	5
[27]	2012	Journal	Evaluation Research	Architecture	Analysis	1	1	0.5	2	4.5

[41]	2013	Conference	Solution proposal	Management system	Monitoring And Management	1	1	1 0	3
[42]	2015	Journal	Solution Proposal	Database System	Storing and Analysis	0.5	0.5	1 1	3
[45]	2013	Conference	Proposed System	Decision & Forecasting System	Storing and Analysis	1	1	1 0	3
[46]	2016	Conference	Proposed Model	Web Application	Monitoring	1	1	0.5 1.5	4
[47]	2017	Conference	Proposed Model	Monitoring System	Monitoring, Controlling and Decision making	1	1	1 0	3
[48]	2016	Journal	Proposed Solution	Web Application	Monitoring	1	1	0.5 2	4.5
[49]	2016	Journal	Implementation and Evaluation Research	Platform	Analysis	1	1	0.5 2	4.5
[50]	2016	Conference	Solution Proposal	Framework	Analysis	0.5	0.5	1 0	2
[51]	2017	Conference	Experimental Research	Platform	Storing and Analysis	1	1	1 0.5	3.5
[53]	2018	Conference	Proposed System	Architecture	Storing and Analysis	1	1	1 0	3
[54]	2019	Journal	Survey	Guideline	Analysis	1	0.5	1 2	4.5
[58]	2016	Journal	Contributional Research	Existing Aspects Analysis	Analysis	1	1	1 1	4
[59]	2010	Conference	Solution Proposal	Framework	Integration	1	1	1 0	3
[60]	2020	Journal	Conceptual Research	Guideline	Optimization	1	1	1 0	3
[61]	2019	Journal	Experimental Research	Framework	Monitoring and controlling	1	1	1 1.5	4.5
[62]	2014	Conference	Solution Proposal	Method	Publishing	1	1	0.5 0	2.5

[63]	2020	Journal	Solution Proposal	Application	Management	1			1	1.5	4.5
[64]	2018	Conference	Contributional Research	Platform	Education	1	1		1	0.5	3.5
[65]	2018	Journal	Contributional Research	Guideline	Analysis	1	1		1	1.5	4.5

4.1.5. RQ5. What alternative approaches were offered to solve challenges in WOT agricultural research?

In carefully chosen studies mostly are offered systems (4) (0.2%), Applications (4) (0.2%), Framework (4) (0.2%), guideline (3) (0.14%) and Platform (3) (0.14%). Whereas the remaining offered Architecture (2) (0.09%), Analysis (1) (0.045%), Method (1) (0.045%) and infrastructure (1) (0.045%).

These all has shown in the Figure 16 below.

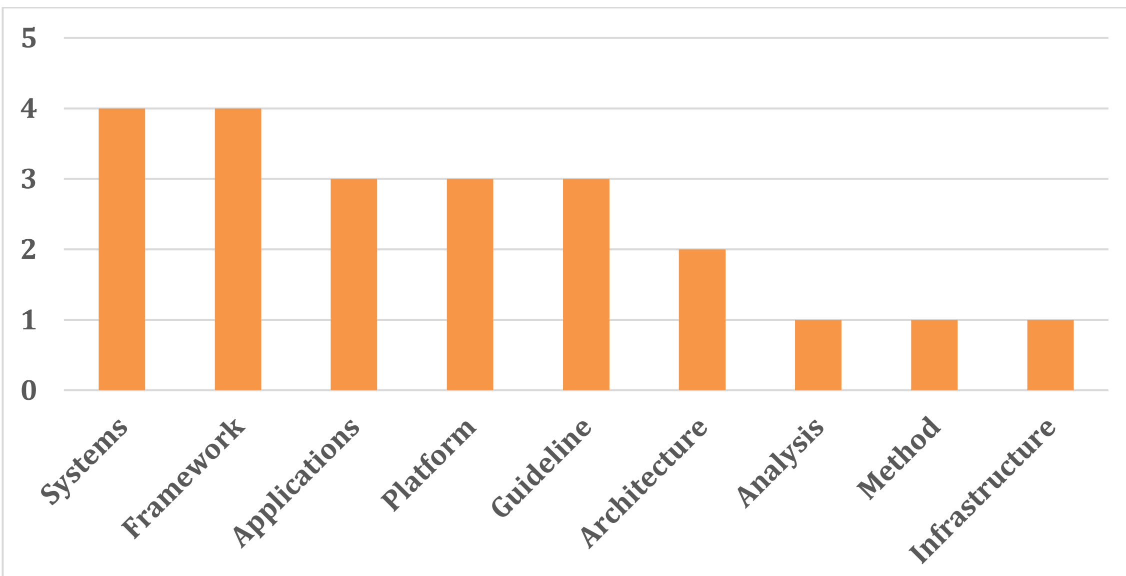

Figure 16: Research Approaches

All of the strategies were aimed at enhancing agricultural practices, equipment, and product attributes for successful farming. Some methods improved the previously offered solutions by incorporating the wot to transform traditional agriculture into smart and precision agriculture and make them affordable, dependable, and efficient agricultural applications. Also included is a table that summarizes the methods used in the chosen studies.

For the Overview of Research Approaches, please refer to the Table 5

Table 5: Detailed summary

Ref no.	Approach
[20]	In order to overcome the difficulty of interoperability, an open, geospatial web service-oriented physical infrastructure was suggested, which would be integrated with the PA monitoring systems and sensors. It gathers, organizes, and disseminates data from devices. Ten distinct sensors were placed in Wuhan, China to estimate the functionality of

	infrastructure. When the suggested infrastructure was compared to the current one, it was evident how well it could monitor processes.
[21]	Presented the integrated model with WOT into the supply chain workflow to achieve knowledge sharing and establish an effective supply chain across the networking using RFID to boost the production of agriculture. The presented research examined numerous IoT infrastructures, company projects, and IoT applications and proposed a conceptual model for integrating IoT and WOT techniques. A Web of Virtual Things (WoVT) set up was used as a Fog Layer to overcome collaboration issues, as well as a REST interface for integrating devices at the lower perceptual layer. The simulation procedure demonstrated that the combining the WOT and IoT can be quite valuable and productive.
[27]	This concept discussed the combination of Linked Open Data and Worldwide Semantic Web Technology. Multiple forms and data types resulted in data transformation and convergence of WWW under the name World Wide Semantic Web (WWSW). Methodologies opened emergence of semantic technology, which helped address numerous issues connected to the performance, efficiency, and access of multiple services on the internet.
[41]	By combining IOT and WebGIS, precision agriculture management system (PAMS) was created and implemented on the chosen farm. WebGIS processed the network geographical data efficiently, and IoT was used to improve perception accuracy. The platform for managing, spatial information infrastructure, the mobile client, and IOT infrastructure were its four stages. The data was collected, transferred, and published using Internet of Things (IoT), WebGIS and Location-Based Service (GPS), and RS methods for managing and monitoring the production.
[42]	In order to overcome the current obstacles, it investigated Agricultural Knowledge-Based Systems that employed Semantic Technologies. It was employed by scholars and people to investigate underutilized crops, offer fresh perspectives and ideas for future research, and make knowledge useful. Numerous ontologies were created to aid in the creation of semantic products. A lot of knowledge-based and expert systems, as well as web-based systems, employ "if-then" queries to get the answers to questions.
[45]	In this work, a software was utilized the World Wide Web technological advances for weather data mining and storage. The files with .txt extension were downloaded and the network stations of the NOA were connected. It was used for Actual time pest forecasting. It consists of two stages: first collects weather data by customized WebGrabber; the second stage calculates the population in real time and stores data on a local MySQL server. An algorithm was introduced for forecasting and decision-making. It was inexpensive, simple to use with an almost infinitely expandable architecture.
[46]	It was suggested to use a web-based configuration to track, observe, and evaluate the agricultural data in real time. The systems saved and shared the sensor data over the Web. Message Queue Telemetry Transport (MQTT)" protocol was used to transfer data and monitor gadgets. It had the characteristics of asynchronous communication, lower complexity, and lower power consumption.
[47]	A set up was developed for the purpose of monitoring and decision. WSNs, IoT, and WOT were employed to enhance the method of supervising and controlling crops conditions. A device by which water details can be estimated, an efficient application to handle the entire irrigation process, to identify the possible graphical view of the field and an option to monitor the real time soil conditions.

[48]	The need of water in crops was explained to the farmers and then the A web application was developed for delivering the immediate details to the agriculturalists. Such factors as restricted internet access, poor data quality, and some general problems of the organization's functioning were detected and addressed. It offers the farmers an integrated data and communication solution. It also emphasized on the need and importance of synergy and/ or ensemble of heterogenous framework and tools for Smart Agriculture.
[49]	Studies were made concerning the increase in productivity of crops and farms through determination of the precise, required, or optimum weather and environmental conditions. Thus, appearance of IoT and other technologies like, IoT devices, wireless sensors, Mobiles, Smart systems, Monitoring cameras and Weather stations were included. The world's initial platform, Smart-FarmNet globally was developed using Semantic Web Technology to auto data gathering and virtually had integrated all the various devices and sensors, and the collected data was stored so as to perform various analyses. A base API to control and incorporate massive quantities of different devices and networks to exemplify their data with the help of SWT was developed.
[50]	A framework named Agri-IoT was created with the adoption of semantic web technologies to provide expanded functionality to support different devices, detectors, and actual data transmitting for evaluation purpose. It provides one computing unit with pipeline processing enabling applications to evaluate large amounts of data, identify unknown occurrences, interconnect heterogeneous devices, sensors, and networks. This framework performed exceptionally well on small to large farms.
[51]	According to the approach, WOT applications necessitated advancements in solutions for adapting them to common models for varied aims. A multi-functional solution with reusable settings was offered. A Smart agricultural framework highlights a suggested approach for obtaining accuracy and performance in both execution and evaluation. The results confirmed the desired outcomes.
[53]	A specific Middleware design was proposed for urban agriculture, integrating real-time Web technology into current IoT devices. The major role was to save the data of each detector unit with a distinct, independent identity through an online application with a visual image display.
[54]	A study was conducted with the purpose of encouraging further research on SWT applications for agricultural problem solutions, as SWTs played an important role in tackling issues in the agricultural region as a helping domain. It provides comprehensive analysis of existing SWT resources, methodologies, data trading standards. Two techniques for developing centralized semantic facilities to support agriculture were discussed. The study also explored and considered semantic technological web applications for agriculture.
[58]	This investigation examined the impacts of the Web of Things towards the agricultural industry. The analysis was conducted in three steps. 1. expectations and assumptions for area, 2. Actions of machine manufacturers, 3. Position of existing progress of sector. It indicated that WOT and IOT are the core elements for farming's high profitability and productivity.
[59]	Semantic Web-based knowledge paradigm presented for collecting, analyzing, and bringing together data from several sources for agricultural awareness and decision-making. In order to attain the concerned data and metadata for the extraction of information, web technologies were used. This work serves as an enhancement to the existing effort of giving farmers with knowledge to help them make better decisions about large-scale productivity using less resources and machinery to meet future needs.

[60]	It Presented the integrated model with WOT into the supply chain workflow to achieve knowledge sharing and establish an effective supply chain across the networking using RFID to boost the production of agriculture.
[61]	This highlighted WOT's contribution to agriculture area. Incorporation of IoT to equipment for environmental observance improved agriculture by bringing decision-making capabilities and transforming it into automated agriculture.
[62]	The research conducted here offered a system for obtaining and processing data, as well as interacting with other databases, for the Danish government in their own language using a web platform called "RDF". The recommended approach collects data, analyzes it, cleans it, and after that incorporates them into other data resources. A testing was undertaken, which yielded positive outcomes.
[63]	A'WOT integrated application was offered to upkeep the ancient cultural items at Agli'e Castle (Turin) that render decisions, manage items, identify issues to discover solutions.
[64]	It fulfilled the need for a remote practicable option for STEM courses and contributed to promote remote learning by combining the capabilities of WOT and WebRTC, a multi model service. By implementing it, communication between multiple users might be facilitated by allowing data to be retrieved from previously implanted devices.
[65]	This concentrates on a merged research area named Embedded Intelligence (EI). This study analyzed the past research history, properties, applications, structures, and gaps in EI research, and exhibited a proactive water supply application.

4.1.6. Quality Assessment Results

The level of each elected article is indicated in the table. Most of them have a highest score of around 50%, 45.5% have an average score, and 4.5% have the lowest point, as seen in figure. The obtained evaluation may be useful to WOT-Agricultural analysts and experts when selecting associated research.

For quality assessment, please refer to the fig 17 below.

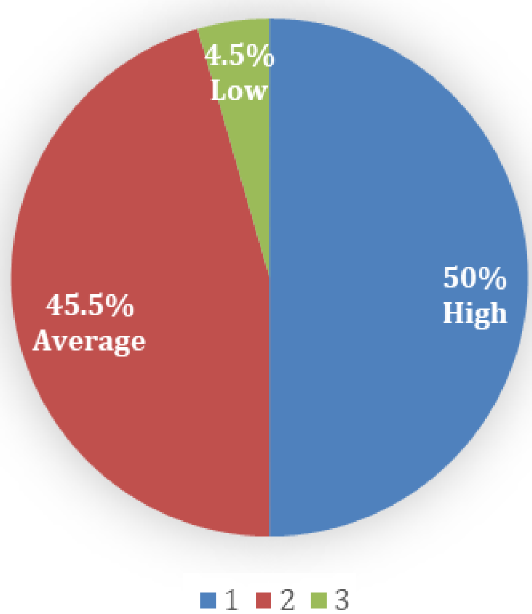

Figure 17: Article Ranking

For quality assessment score, refer to the Table 6.

Table 6: Quality assessment points

Ref.	T. Score	No.
[50]	2	1
[62]	2.5	1
[41] [42] [45] [47] [53] [59] [60]	3	7
[51] [64]	3.5	2
[46] [58]	4	2
[48] [49] [54] [27] [61] [63] [65]	4.5	7
[20] [21]	5	2

5. Discussion

This SLR extracted the works on the WOT emerged advances in agriculture research. The studies that were selected have been utilized for addressing the research questions posed in the methodology. Findings indicate that numerous studies were undertaken to identify solutions to agriculture sector difficulties.

5.1. Selected Studies Results

The principal rationale in directing this methodical writing survey was to explore the proceeding with research development of the agrarian innovation period by sifting through the 22 examinations from 220 examinations. After removing these papers in accordance with the guidelines provided. These are the most common outcomes: A number of application domains for agricultural research trends were identified through the review of selected studies on WOT involvement in agriculture. By offering improvements for complications with IoT agricultural systems, and integrated devices, the web of things paved way for smart agriculture. Web of things settled the issues of heterogeneous information, gadgets, principles, and stages. The readers are encouraged to conduct additional WOT-agricultural research by these application domains. The application areas have been grouped into eleven sorts: publishing, integration, education, interoperability, precision and decision-making, monitoring, control, management, storage, analysis, and optimization. Areas are additionally subdivided like air, water, weather gadgets, systems, monitor, controlling, managing sensors, and storing farm data, diseases, research, and environments situations, mining or analyzing agricultural data, production, and system performance and optimization as well as supply chain processes. These subdomains also include making predictions based on the data from farms and supporting decisions, combining networks, devices, and protocols for improved working, publishing datasets and experimental results, integrating the various IoT devices, networks, and sensors for efficient agriculture and providing learners with real-time information on study platforms and research implementation results. WOT and Internet of Things (IoT) combination have made it possible to break through the boundaries of previous technologies. The emergence of WOT and IOT will aid in the transition from conventional to smart agriculture. The classification table in the section devoted to the results of the research question served as the source for the application domains that are depicted in the taxonomy. The 22 selected research papers were examined in light of the WOT agricultural existing research trends in order to produce that classification table. The inclusion and exclusion criteria outlined in section 3 was used to evaluate these selected papers. This scientific classification will help in rousing for additional exploration around here.

The planned arrangement has shown in the Figure 17 below

Figure 17: Taxonomy of Application Domains

5.2. Wot Model for Agriculture

A web of things enabled sketch has been developed to demonstrate the WOT's involvement to the creation of a Smart Agricultural. It shows how WOT is used in several agricultural areas, including monitoring, controlling, and managing gadgets, machinery, yields and environment situations, and watering system by utilizing facilities of web. One of the most significant characteristics is the ability to provide real-time facilities and establish reliable connections. It provided a representation of WOT enabled advanced agriculture.

The Model has shown in the Figure 18 below.

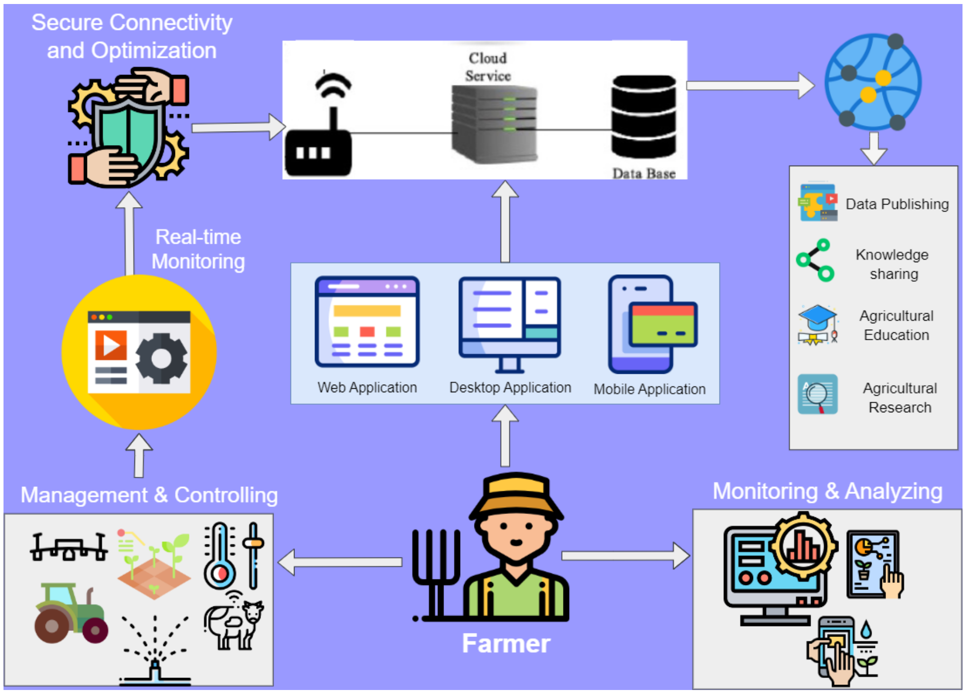

Figure 18: WOT Agricultural Model

5.3. Open Issues and Challenges

Numerous works have obtained the wot involvement and establishment of fresh approaches to the current applications and technologies issues in the agricultural area. WOT has emerged as the primary player to address the agricultural field's challenges. However, there are still unresolved obstacles and issues with WOT combination with farm applications, as indicated in the figure. The most widespread issues are security concerns related to the advent of new technologies at various layers in schemes, platforms as well physical structures, and online applications. There are still many threats to the credibility of agriculture statistics, cost concerns with adding WOT technology into hardware and software. International standards are required to provide effective security services.

The issues and challenges have shown in the Figure. 19 below.

Figure 19: Main Issues and Challenges

Farmers should be made aware of the benefits of using wot applications for more efficient farming and higher profits. There is a need of additional literature reviews, SLR, and establishment of WOT technology in agricultural industry. Farmers in remote areas have a poor understanding of technology. The refinement of WOT involvement for large-scale areas are needed. But there's a requirement for incentives to pursue additional study on existing and continuing areas of study.

5.4. Research Gap and Future Directions

The discussion was wrapped up with the presentation of numerous studies aimed at overcoming agricultural application difficulties through the use of Web of Things technologies. As a result, further comprehensive research into WOT solutions for agricultural domain challenges is still required. As previously noted, the WOT has proven to be the primary driver of agricultural progress. The majority of the studies provided existing and novel solutions in a non-systematic manner. As a result, thorough studies and literature evaluations of existing solutions research are required to aid in future research and find any flaws in the present and continuing study, as well as keys to those flaws. In addition, more emphasis should be placed on evaluation studies to assess the existing work associated to trends of WOT in agricultural industries in order give rise to smart automated agriculture.

The main research gaps and future directions are given below:

Research Gaps:

- Systematic Studies
- Literature Reviews
- Evaluation of existing approaches
- Development of new standards

5.5. Threat to Validity

This SLR may face various validity challenges, such as a poor screening of research articles, insufficient data collection, and an adequate quality evaluation of the studies that were selected.

5.5.1. Selection of Research Articles

Section III provides a detailed approach for selecting research articles. The portion provided comprehensive Inclusion/Exclusion criterion for screening research articles. Selected study years extend from 2010 to 2020 in order to determine the continual incorporation of WOT in the agricultural industry. However, it is still possible that some articles will be missing. The main cause for this possible outcome is the absence of articles published prior to 2010, as well as common interest papers. The second option might be a search string to retrieve related studies. Although the precise search string is explained in Section III, there is still the possibility that a few study publications will require additional exploring keywords. The search string mentioned in third Section has been adjusted multiple times to discover the most appropriate study articles, however a gap remains for the fresh term.

5.5.2. Insufficient Collection of Data

A different possible cause for uncertain findings is insufficient data gathering. The likelihood of this was reduced by evaluating the collected data three times.

5.5.3. Evaluation of Quality

Most important part in SLR is to test quality, as poor quality might lead to untrustworthy findings. Section III discusses a workable technique for ensuring the quality of the selected research articles.

6. Conclusion

A comprehensive literature review of previous studies in the Web of Things-based agriculture field is described in this study. Based on the well-defined methodology, 22 studies were selected for this comprehensive survey. The main works were filtered out of the review in strict accordance with the established guidelines. Each and every piece of work was thoroughly examined for effectiveness. It came to the conclusion that WOT technology offered potential improvements in area of agriculture after conducting a comprehensive review of previous studies. By providing web-enabled services, improving existing systems, and assisting in the creation of online informative databases for farmers, educational institutions, and the general public, WOT astonishingly surpasses compatibility issues of IoT in agriculture industry. Taking into account what is happening, we have introduced a scientific classification of farming application spaces where the snare of things offered the types of assistance to conquer the current mechanical difficulties in the horticulture space. It depicts the agricultural sectors in which services were utilized in a variety of ways, including techniques, both ancient and new, to minimize complications. The process of integrating the web of things in the agricultural sector was outlined in a model of what-based smart agriculture. The researchers will benefit from this taxonomy and model in terms of gaining a clear understanding of the agricultural domains in which WOT has been and is being utilized, as well as in deciding on the preferred application areas in accordance with requirements. It will show the ways for additional new areas where WOT can be valuable in dealing with the cultivating and other horticulture tasks. The governments of various nations have WOT agriculture plans of their own and promote WOT-based research in agriculture. Determining the way these application areas are participating to motivate readers is one of the promising future directions in this study. Despite the fact that a lot of research has been done on WOT-based agriculture, not much of it has been presented as SLR, SMS, or SR. Further investigation in this field must be directed around here to inspire further exploration.

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