Logistics Analytics for the Organic Farms

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Abstract. Organic farms are challenged through fresh and non-chemical. This paper aims to develop a digital platform for organic farming it focuses on information systems for the purchase and auction of organic agricultural products, as well as the internet of things (IoT). This application the customers enables traceability and real-time visibility. The adopted research methods include a neural network to predict demand and supply. The result can predict the volume of vegetables each month to achieve planning and delivery. In addition, the data analytics is automatically optimal and the supplier can react in real-time decisions based on evolving circumstances to achieve supply chain efficiency.

Keywords: Organic farms, Logistics analytics, Internet of things, Neural network, Digital platform

1. Introduction

Health and wellness have gone mainstream the healthy-living and self-care nutrition become a flourishing wellness movement in the 21st century. From reasonable for healthy is increasing and the consumer demand for food using natural substances has affected organic vegetables which have expanded in terms of farm numbers markets and price. Moreover, wellness is multidimensional such as physical mental emotional spiritual and social environments. The complementary diversification activities of nature conservation Agri-tourism on-farm sales and processing and care farming are more likely to emerge jointly on a farm. The growing trend of healthy makes farmers more interested in growing organic vegetables. The market must have more demand for environmentally friendly products and more products in the market such as organic vegetables, and vegetables non-toxic. The most significant challenges for organic farmers are related to regulations of organic production and the consumer can trust the product Organic farm creates new economic opportunities and services in rural regions that contribute to the resilience of farming systems. Farm diversification is an important aspect of agricultural and rural development. It contributes to the stabilization of farm incomes. The agriculture group is one of the target industries. There is a need to change from traditional to modern focusing on management and use of technology or smart farming.

The smart farm is the application and technology that support the production process from the farmer to consumers to improve product quality, reduce costs, as well as develop the smart product. The smart farms aim to enhance agricultural development in four key areas: (1) cost reduction in production processes (2) increasing quality of production standards and product standards (3) reducing risks in the sector of agriculture caused by pest outbreaks or natural disasters (4) management and knowledge transfer for sustainable. Therefore, if this group transforms farmers into entrepreneurs using the digital platform for organic farming it focuses on information systems for the purchase and auction of organic agricultural products, as well as the internet of things (IoT). This application the customers enables traceability visibility on a digital platform as digital marketing to help in the business sector as well as support the flow of supply chain in a real-time. IoT it has been applied and plays a huge role in agriculture nowadays. IoT is defined as technology, systems and strategies that change the economics and organization of smart farms, particularly regarding scale and location. The tendency of small-scale production at multiple locations makes logistics a feasible option for on demand production near the consumption point. The demand is currently being explored to estimate the benefits of personalized products, low quantity on demand production and local or regional economic growth [1]. Smart agriculture results in the cultivation process and production planning being more efficient which reduces production costs and labour as well as response to market demands. This study involves the management of variable demand, optimization of distribution operations, smooth in and outflow of products and minimization of operations cost.

However, for this to occur, efforts involving logistics research and data analytics with direct farmer involvement are needed to address demand challenges facing organic farmers. The objective of the research is analytics the demand and supply of organic agricultural products and to develop digital platforms and IoT for the organic farming business. Based on the study above, this research, considers the impact of consumer behaviours supply chain system equilibrium supply chain system in platform online according to this market demand function to build a network equilibrium model, in which organic vegetable enterprises can optimal decision-making.

2. Literature Review

2.1. Internet of Things (IoT)

IoT is a network model that uses sensors, global positioning systems, global geographic information systems, gas sensors, and laser scanners to monitor, interact with, and connect processes or objects in real-time, in particular by collecting a wide range of information such as light, heat, electricity, chemistry, sound, physics, location, and mechanics, and then integrating them with the Internet [2]

2.1.1 Internet of Things technology

Kevin Ashton invented the term Internet of Things in 1999 as an extension of RFID technology in which different RFID sensors connected. Which later affects many electronic devices such as Smart Devices, Smart Grid, Smart Home, Smart Intelligent Transportation, etc. These electronic devices can be connected to the network, causing Kevin to define the Internet -Like or Things, which is a replacement for calling electronic devices.

The advantage of the IoT is that it allows all objects to be connected to the network, thus making them easier to detect and manage. At this stage, the IoT divide into 3 levels [3]. First, there is the sensing layer, which forms mainly based on various sensors that can use the information to sensing devices, thus collecting the required information and then carrying out intelligent analysis, and finally enabling the connection between the device and the network. It is the network layer, which mainly includes the network management system, the cloud computing system, and the Internet system, whose main function is to sense the processing and transmission of the data obtained. Finally, there is the application layer, which can fully realize the sensing and identification between people and things, things and things, to complete the research and analysis of the data and play the intelligent function of the IoT itself [4, 5].

2.1.2 Important variables for Internet of Things technology

2.1.2.1Wireless Sensor Network (WSN) is made of multiple sensor nodes, WSN allows devices to connect and detect what is going on within the network. Such as detecting light, temperature, loudness, etc.

2.1.2.2 Access Technology is a part of technology development on the hardware side such as Processors, Radios, and Sensors collectively referred to as System on Chip (SoC). There are three types of Access Technology connectivity: Bluetooth 4.0, IEEE802.15.4e and WLAN 802.11(Wi-Fi).

2.1.2.3 Gateway Sensor Node is responsible for connecting to the Internet network. This will allow all devices in the Sensor Nodes network to enter the Internet. Gateway Sensor Node is located under Local Network, which is assigned to the Gateway under that Local Network that it can connect to the Internet. Can or not if not, it means that the device connected to the Gateway may only communicate within the same Local Network. [6]

2.2. Smart Agriculture /Smart Farming

Smart agriculture integrates the emerging mobile communication network system, Internet system, and cloud computing system, and uses various sensors and wireless sensors to achieve intelligent warning, intelligent identification, intelligent sensing, and intelligent decision-making, thus providing strong technical support for agricultural development and forming visual and refined decisions [7]. (e smart agriculture model mainly consists of several systems such as a remote monitoring system, expert system, data analysis and collection system, wireless sensor system, and data analysis and processing system, thus being able to solve different kinds of problems existing in agricultural production.

Smart Farm or a farm with precision (Precision Farm) is farming by using science and information technology as tools to achieve Convenience and ease of management, which can be processed quickly and accurately. Resource utilization that is worthwhile Increase the quantity and quality of produce, reduces costs, produce results, are safe for consumers and Environment, leading to international competition. Agricultural innovation coupled. It is very popular in foreign countries such as the United States and Australia and is now spreading to countries in the region. Europe, Japan, Malaysia and India, etc., are countries that are famous for technology systems Information technology has been applied to agriculture to increase efficiency, Higher productivity. The adoption of various forms of technology to manage more can reduce labour.in agriculture, which at present, labour in the agricultural sector will continue to decline, especially in countries where developed, it will the labour in the agricultural sector has decreased. However, such countries have become more interested in the agricultural sector.

Bringing technology in various fields to help manage resulting in the production of agricultural products with quality and quantity enough to meet the market demand, so it is important to turn to important in smart agriculture and Information technology should be applied to the sector. [8]

2.3. IoT use cases in agriculture

There are many types of IoT sensors for agriculture as well as IoT applications in agriculture in general:

Monitoring of climate conditions: Probably the most popular smart agriculture gadgets are weather stations, combining various smart farming sensors. Located across the field, they collect various data from the environment and send it to the cloud. The provided measurements can be used to map the climate conditions, choose the appropriate crops, and take the required measures to improve their capacity (i.e. precision farming)

Greenhouse automation: Typically, farmers use manual intervention to control the greenhouse environment. The use of IoT sensors enables them to get accurate real-time information on greenhouse conditions such as lighting, temperature, soil condition, and humidity. In addition to sourcing environmental data, weather stations can automatically adjust the conditions to match the given parameters. Specifically, greenhouse automation systems use a similar principle.

Crop management: One more type of IoT product in agriculture and another element of precision farming are crop management devices. Just like weather stations, they should be placed in the field to collect data specific to crop farming; from temperature and precipitation to leaf water potential and overall crop health.

Cattle monitoring and management: Just like crop monitoring, there are IoT agriculture sensors that can be attached to the animals on a farm to monitor their health and log performance. Livestock tracking and monitoring help collect data on stock health, well-being, and physical location.

Precision farming: Also known as precision agriculture, precision farming is all about efficiency and making accurate data-driven decisions. It is also one of the most widespread and effective applications of IoT in agriculture. By using IoT sensors, farmers can collect a vast array of metrics on every facet of the field microclimate and ecosystem: lighting, temperature, soil condition, humidity, CO_2 levels, and pest infections. This data enables farmers to estimate optimal amounts of water, fertilizers, and pesticides that their crops need, reduce expenses, and raise better and healthier crops.

Agricultural drones: Perhaps one of the most promising agritech advancements is the use of agricultural drones in smart farming.

Predictive analytics for smart farming: Precision agriculture and predictive data analytics go hand in hand. While IoT and smart sensor technology are a goldmine for highly relevant real-time data, the use of data analytics helps farmers make sense of it and come up with important predictions: crop-harvesting time, the risks of diseases and infestations, yield volume, etc. Data analytics tools help make farming, which is inherently highly dependent on weather conditions, more manageable, and predictable.

End-to-end farm management systems: A more complex approach to IoT products in agriculture can be represented by the so-called farm productivity management systems. They usually include several agriculture IoT devices and sensors, installed on the premises as well as a powerful dashboard with analytical capabilities and in-built accounting/reporting features. [9]

IoT solutions focused on helping farmers close the supply-demand gap, by ensuring high yields, profitability, and protection of the environment. The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprises specialized equipment, wireless connectivity, software and IT services.[10]

2.4. Information processing technology

Information processing technology the ultimate purpose of information processing is to collect and analyse the acquired data. In the process of agricultural production monitoring, much production data is collected, and they have the characteristics of being real-time, dynamic, and massive. Using IoT technology, the production data can be stored and analysed to a certain degree, and corresponding data patterns can be found. Cloud computing technology is mainly used for information processing, and it can effectively solve the problem of storage, calculation, and the related processing of massive agricultural production data. Many emerging cloud service platforms can realize the storage, searching, and analysis of massive agricultural information. Cloud computing technology includes data mining, data analysis, AI, and other technologies. Data mining technology can be used to meet the requirements of data integrity, accuracy, and standardization, and to support follow-up expert systems and users for further operations. Data mining technology can clean and extract the agricultural big data, discover the internal connections between the data, and store and manage them in different categories. Artificial intelligence technology has powerful information analysis capabilities in controlling irrigation, identifying pests and diseases, crop harvesting, and so on. Using machine vision, image recognition, and other technologies, AI can perform accurate judgment and prediction based on the obtained agricultural information, thus achieving intelligent decision-making. [11]

The current theoretical methods of AI technology include dynamic Bayesian networks, Kalman filtering, D–S evidence theory, and rough set theory. Glaroudis et al. researched IoT messaging protocols that were regarded as major options for IoT applications in smart farming [12]. They presented seven protocols, compared concerning their performance, and measured in terms of relevant key indicators. Farooq *et al*. constructed smart farming with relevant technologies (Cloud and Edge Computing, Big Data analytics and machine learning, communication networks and protocols, and robotics), and analyzed application domains, relevant smartphones, sensor-based applications, and security and privacy issues in IoT-based agriculture. [13]

Artificial neural networks and linear regression are widely used in particularly all branches of science for model and prediction. Linear regression is an old data processing tool, and artificial neural networks are a comparatively new one. The goal of the study was to determine whether artificial neural networks are more accurate than linear regression in demand prediction. The study used a dataset obtained from field experiments on the technological improvement of the customer ordering. Data processing by using the linear regression and artificial neural network methods showed that the latter is a great deal better than linear regression in agriculture prediction.[14]

The neural network can integration IoT by the wireless sensor networks' development for watering crops to optimize agriculture to design and develop the control system between node sensors in the field of crops and the data management via smartphone and web application. The three components are hardware, web application, and mobile application. The data mining technique was applied neural network the obtained data for predicting the suitable temperature, humidity, and soil moisture of crops in the future plan. The results showed the implementation to be useful in agriculture. The moisture content of the soil was maintained appropriately for vegetable growth, reducing costs, and increasing agricultural productivity.[15]

Deep learning (DL) constitutes a modern technique for image processing, with large potential. Having been successfully applied in various areas, it has recently also entered the domain of agriculture. Convolutional neural networks (CNN) are compared with other existing techniques, and the advantages and disadvantages of using CNN in agriculture are listed. The overall findings indicate that CNN constitutes a promising technique with high performance in terms of precision and classification accuracy, outperforming existing commonly used image-processing techniques. [16]

The conclusion, the development of technology, the combination of cloud computing technology, data analytics and artificial intelligence technology will be more applied to the agricultural IoT.

3. Methodology

3.1. Methods of Data Collection

This research development of a digital platform focuses on the production of network organic groups in Ubon Ratchathani Province. The main structure of the system consists of Information systems and digital platforms for organic farms for producers and consumers. The IoT can be visible as a web application and support work via mobile devices. The population divided the sampling into 2 groups the farmers who produce organic products from toxins and the consumer organic groups. Using a quantitative approach as the methodology. The survey method was conducted through a questionnaire and used a purposive sampling technique. A triangulation research methodology is used for big data analytics. This methodology includes the analysis of secondary data, observations and surveys or structured interviews. This method is based on conceptual ground instead of representative ground. Initial, 89 farming are selected based on the following set of criteria: Participatory Guarantee Systems (PGS) are locally focused quality assurance systems. They certify producers based on active participation of stakeholders and are built on a foundation of trust, social networks and knowledge exchange; Certificate of PGS a process of certifying organic products and the population are 400 customers of organics group.

Location and production

The location farms using IoT to monitor the vegetable growth and show to online market real-time visualization of big data as shown in Fig.1. The case study was carried out with a large ordering from marketing online. The transaction is more than 40 ordering per week with 44 vegetables. This research uses data science as a basis for analyzing the material and information flows of the supply chain of a farm. It provides a method for data collection, a visualization of the material and information flow between the analysis of the activities, relevant data collection involves

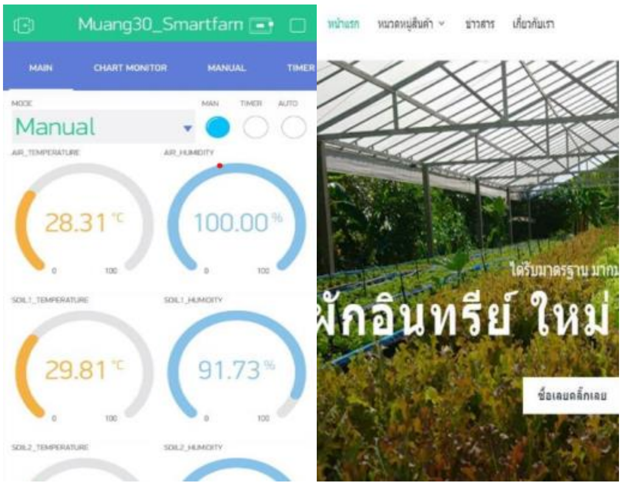

Fig. 1 Real-time visualization of Organic farms

characteristics of material flow, inbound and outbound logistics, service to market, and reliability and flexibility of the production system.

Distribution and market

The digital system consists product of 89 farms, and the transportation of approximately 5-7 tons of goods, every week between 230 pick-up and delivery stations in 18 markets place. The distribution and transportation schedule for the organic vegetable system has defined the customer need. This schedule has been adapted to the demand for goods over the years. Orders are dispatched to the nearest farm within 4 hours.

3.2. The development digital platform smart farm system

The online system develops according to the procedures for the System Development Life Cycle: SDLC as follows: In the planning phase, the term of the project interview stakeholder to define the requirement. This includes the owner of the organic farm, the process of production, packing, and transportation or delivery to door. Design and prototyping, the design shows the information on organic agricultural products and details can connect to point of sale. A website provides maps and community information.

The Operators can improve their community information, products, details, and pictures. The website can link with social networks that entrepreneurs already exist such as Facebook, Twitter, Instagram, Pinterest, etc. The System analysis and design can be illustrated in the form of a Use Case Diagram with the main system as shown in Fig.2 The overall system analysis and design in this research have designed the users into 3 parts:

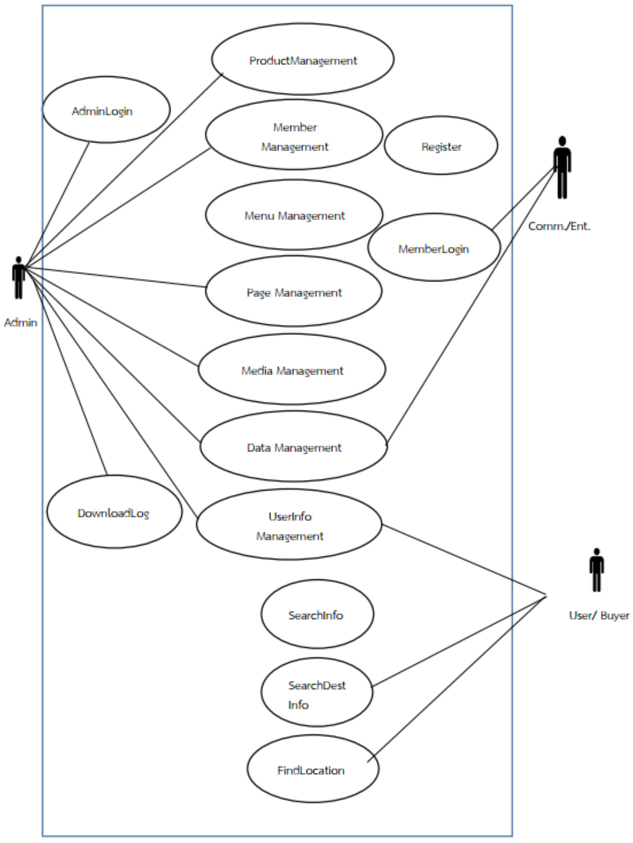

Fig. 2 Use case diagram for organic application

1) User segment or buyer segment
2) Community and entrepreneurs
3) Admin section

Development: The platform has assembled with a total of 14 sub-systems using Wix Website Editor and Mock plus design and layout. Languages used JavaScript, HTML, CSS and SQL. The database management system used MySQL. The web Server system is Apache Web Server used to simulate the system on the website Browser used is Chrome, Firefox. Geographic information web service: Google map API

3.3. Logistic Data analytic

Demand forecasts are never exact due to the fact there are always random components of the demand that cannot be predicted in advance. Forecasting models and neural network techniques are adopted for diagnosing, classifying and predicting. Prediction demand by a radial basis function (RBF). The RBF network is a feed-forward, supervised learning network with only one hidden layer. The RBF network is a function of one or more predictors that minimizes the prediction error of one or more target variables. RBF models, 70% (data sets) of the original data sets were randomly selected as the training set and the remaining 30% (datasets) were

Table 1. The model summary of prediction

Model Summary		
Training	Sum of Squares Error	129.943
	Relative Error	.955
	Training Time	0:00:00.23
Testing	Sum of Squares Error	77.656[a]
	Relative Error	.987
Dependent Variable: Demand		
a. The number of hidden units is determined by the testing data criterion: The "best" number of hidden units is the one that yields the smallest error in the testing data.		

used as the test set. The size of random is 400 data which never-before-learned. The data is close to the real value used to control the differential influences between variables and their distribution such as Softmax function, Sigmoid function, Hyperbolic Tangent, Gaussian function. For this research, the Softmax function is used for the hidden layer.The following value is assumed Eq. (1)

$$D = f\left(X_{ij}W_{ij,k} + b\right) \quad (1)$$

where D is Output, X is Input, W is Weight i to j hidden k ,b is biased

However, this study considers planning, cost, seasonal and profit. The variables include criteria of models and formal statistical tests on residuals. The parameter list is as follows; Eq. (2).

$$D = \sum_{i=0}^{n} P_{vet}, D_{mar}, Q_{vet}, Sea \quad (2)$$

P_{vet} = $Total\ price\ of\ vegetable$
D_{mar} = $Distance\ from\ market\ (i)\ to\ customer\ (j)$
Q_{vet} = $Total\ quantity\ of\ vegetable$
Sea = $Seasonal$

In this model, The data rescaling for covariates with standardized. The active function is softmax used for the hidden layer and identity for the output layer.

This research defines markets for 3 groups; Supper market, Local market and Online market. The data is operated with the nearest neighbour algorithms and is developed as a way to recognize patterns of data without requiring an exact match to any stored patterns. Nearest neighbour analysis can also be used to compute values for a continuous target. Continuous features are optionally coded using adjusted normalization. In this situation, the average or median target value of the nearest neighbours is used to obtain the predicted value for the new case.

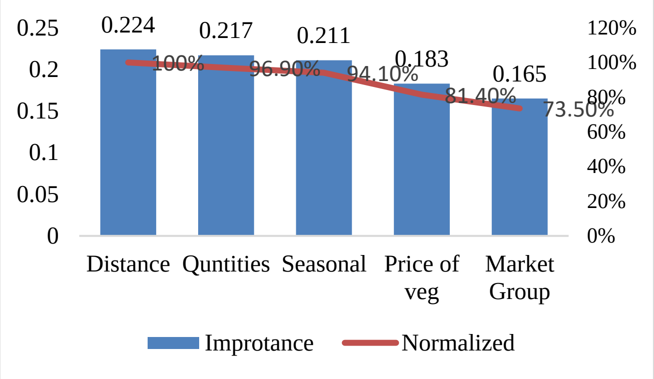

Fig.3 The independent variable

4. The Result

Demand forecasts

The model demand forecasts can predict in advance. The RBF network structure has eight hidden layers as displayed and five variables. The variables include distance, a type of market, seasonal, and vegetables. In the model summary, there were fewer errors in training and testing samples. The average per cent relative error is 0.955 and 0.987. (Table 1)

The result of the demand model is considered in Eqs. (3)

$$D = \sum_{i:j} P_{vet} w_{ij} + \sum_{i:j} D_{mar}\, w_{ij} + \sum_{i:j} Q_{vet}\, w_{ij} + \sum_{i:j} sea\, w_{ij} \quad (3)$$

$$Weight\ w_j = \begin{pmatrix} 0.759, -0.192, -0.214, -0.313, \\ 0.293, -1.871, -0.209, -0.847 \end{pmatrix}$$

The independent variable the most important is the distance from the market (0.211). The value of other are vegetable (0.217), seasonal (0.211), price (0.183), market (0.165). (Fig. 3)

Distribution planning

The distribution and transportation schedule for the organic vegetable system has defined the customer need. The product of 89 farms, can using the result from KNN for arrangement the schedule for distribution the organic product to market. The result of KNN can predict the demand for vegetables each month to achieve planning Fig.4. In addition, the data analytics classification the vegetable and the distance from 3 markets; the supper market, the local market and the online market Fig.5.The supplier can react in real-time decisions based on evolving circumstances to achieve supply chain efficiency.

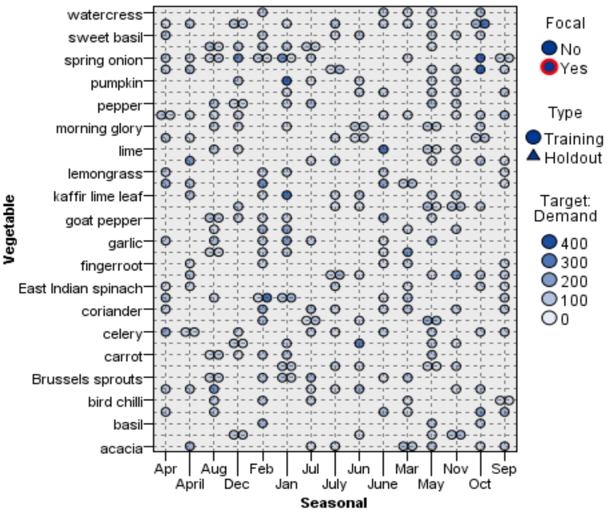

Fig.4 The Seasonal demand

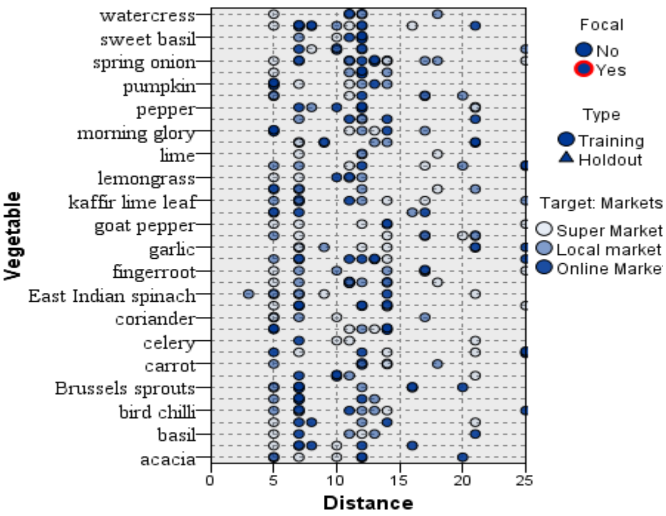

Fig.5 The Distance from market

The Smart farm and Market Place

The result of this research is a monthly quantity analysis of organic agricultural products' demand and supply to support the entrepreneurs. A prototype digital marketing system as a central market form called Market Place that combines information on selling organic products of Ubon Ratchathani province and a smart farm model that collect data for farm management. The system that divided into three main parts, which are entrepreneurs or communities involved in the production and distribution of organic products or organic vegetables. User or Buyer's Equity and the admin section by registering the domain name of the system using the name www.u-ofarm.com for easy memorization.

From the results of system distribution and trial, the satisfaction level in all aspects was at a high level. Especially in terms of presenting information on issues, Information is useful to users. Operators gave the highest-level average of satisfaction 4.52. The user satisfaction assessment of the system was satisfied with the digital marketing system in all aspects at a high level. They were satisfied in terms of system functionality, convenience and speed of use at the highest level, with a satisfaction value of 4.51 at the highest level.

5. Conclusion

The research is analytics the demand for organic and to develop digital platforms and IoT for the organic farming business. Based on the platform online according to this market demand function to build a model, in which organic vegetable enterprises have optimal decision-making. Concluded that a system is a tool that helps increase distribution channels for entrepreneurs and helps consumers to get more information on organic products in Ubon Ratchathani province and have more choices

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