A Business Model Monitoring Using Autonomous Drones in Smart Agriculture

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***Abstract*—Today, one of the biggest economic resources of our country is agriculture. We started out from this and thought about how we can improve agriculture, so we put forward this smart agriculture project where drone and mobile application work together by using agriculture with IoT technology. We aimed to improve the economy, develop in the field of agriculture, and establish a healthy and safe system for our farmers.**

***Keywords*—Business Model, Smart Agriculture, Autonomous Drones.**

I. INTRODUCTION

"Number of new digital solutions and new business models are increasing in the world. The study [1] compiles 40 sample companies and summarizes their business models."

The project team decided to focus on smart agriculture that has been developed for farmers in this start-up, and this subject needs several new digital technologies, like all samples in that study [1]. New business ideas and models are led by this new type of digital solutions. So new business ideas are enabled and enhanced through grey areas in the European regulatory framework. These activities include managing metering data for small end customers, monitoring grid and voltage related constraints as more renewable sources connect to the distribution system, infrastructure for EVs, ownership / management of meters, flexibility services - but don't inhibit market for aggregators [2]. Our start-up was established to increase the economic value in our country and to invest in the future to provide the farmer with the necessary efficiency.

Nowadays, our farmers are forced to sell poor quality products domestically by losing time while doing many of their work and ignoring the maximum yield from their grains. We enable our farmers to get this efficiency by using technologies such as Drone, IoT, Multispectral camera to both save time and provide quality products.

II. AUTONOMOUS DRONE USING IN SMART AGRICULTURE

Agriculture is the oldest production activity in human history and although agriculture is a source of life, it has great importance from past to present. The agriculture world continues to expand with the use of agriculture, which has developed so much until today, and the use of information and communication technology (ICT) increasing exponentially. Information and communication technologies (ICT) should be used in agriculture as the increasing population causes an increasing need for food [3].

Smart agriculture is focused on providing a more efficient and sustainable production while optimizing human labor by utilizing advanced technology to monitor and analyze the agricultural industry. With the rapid development of technology, the use of autonomous vehicles in smart agriculture has become very widespread and has provided farmers with many opportunities such as monitoring their crops remotely and monitoring soil health with the help of many sensors and cameras.

Autonomous vehicles developed for farming purposes are equipped with various loads such as sensors, high resolution, and multispectral cameras, tracking and positioning (GPS) [4]. The drone, which is activated by the mobile app, can access its location with the GPS used on it and can make location-oriented progress. Farmers using autonomous vehicles get better insights about the agricultural field with the help of the

images they have obtained and provide more accurate and consistent data to make better decisions.

III. MATERIALS AND METHODOLOGY

A. Drone

Using drone in smart agriculture is an increasing trend. Most of the countries started to use drone in agriculture [5]. At this stage, our autonomous drone helps farmers by providing daily reports and analysis about what is happening in their field. With autonomous drones, people do not need to control the drones manually. Drone act with commands given through an application and move towards the selected area through the application. An instruction to be given to the drone in advance is sufficient for such a flight to take place, and it is not necessary to give instructions every day to fly. When the drone flies it starts its process to imaging and area mapping. It saves the image of the whole land autonomously with the instructions coming from the mobile application. It transfers the recorded photos to the server for processing.

Drone can communicate in real time with the mobile application. If desired the drone can also be controlled manually. After completing its mission, it returns to its starting point and connects to the wireless charging station [6]. We aim to make the drone as light as possible to reduce electricity usage. Plastic and glass fiber are very durable and light materials. It is widely used in drone technology. Drone's battery will have wireless charge and will keep as light as possible. With full charge maximum flight time will approximately be 30 minutes depends on weather and such condition [7]. Gimbal is used in drone.

Gimbal is a device that helps to hold camera. It is very important that the drone and the camera are stable when shooting photos. The gimbal helps users a lot with stability. Even drone is moving the image on the camera will be sharp and decent [8].

B. Autonomous Flight System

With Industry 4.0, many autonomous systems started to be developed. Many efforts have been made to ensure that unmanned aerial vehicles developed in this process become autonomous. In this period, many researches were made to be used in the professional field. These sectors include military, transport, agriculture, real estate and construction, photogrammetry (aerial measurement), film and aerial photography.

The purpose of the autonomous flight software is to scan the agricultural area independently of the human [9]. First, the boundaries of the agricultural land are determined by the user with this software. This software creates a route based on where the drone is located. It allows the drone to move independently of the human on this route. There are many features in applications developed for autonomous drones. These applications include automatic routing, defining specific tasks and viewing terrain.

As seen on the left in Figure 1, the points marked by the software determined the route the drone will travel in an agricultural area. Drone can move around these points. The drone can photograph the agricultural area in the square areas shown on the right in Figure 1. Afterwards, these square areas photographed are processed with a special image processing program and a report is issued on the health of the land in a way that the end user can understand.

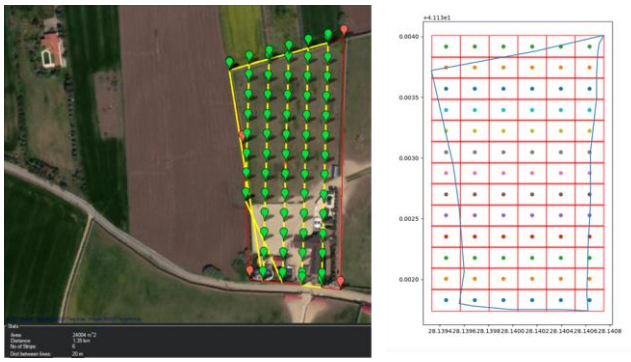

Figure 1. *Determination of drone movement path by software*

C. Multispectral Camera

Multispectral camera is a camera that is used to monitoring places invisible to the human eye with spectral bands. By integrating multispectral cameras with drones, the health status of plants can be measured instantly. The tool that enables these measurements to be made is the multispectral bands. There are thousands of wavelengths to be recorded in the electromagnetic spectrum. To deal with all these wavelengths, the imaging spectrum divides the spectrum into groups of wavelengths called bands. There are 4 most known bands and these bands are Blue, Green, Red and NIR (Near infrared) What these bands distinguish is Chlorophyll, and chlorophyll is can be defined a green-colored biological pigment that absorbs rays of various wavelengths and causes photosynthesis in the plant [10].

Chlorophyll absorbs light strongly and reflects strongly in green light, with wavelengths in the range 450-520 nm (blue) and 630-690 nm (red), so it appears as a healthy vegetation green. In the near infrared, healthy plants in the range of 700-1000 nm are observed and therefore highly reflect light [11]. This is mainly due to the healthy inner leaves of the plants. Since this internal structure varies between different plant species, near infrared wavelengths can be used to distinguish between different plant species [12]. Whether the plant is healthy is calculated using data in the red and near infrared bands and it is called NDVI (Normalized Difference Vegetation Index). NDVI is considered to be the key measure of plant biomass quantity and leaf area index value and is used for plant growth monitoring and yield forecasting throughout the growth cycle [13].

$$NDVI=(NIR-Red)/(NIR+Red) \quad (1)$$

Equation (1) shows that NDVI (Normalized Difference Vegetation Index) is calculated using NIR (reflection in the near-infrared spectrum) and Red (reflection in the red range of the spectrum) [14].

The normalized difference vegetation index is basically the ratio of wavelength reflected from healthy vegetation to wavelength reflected from all other sources and is calculated for each pixel location in the image. Simply, NDVI is found by applying the obtained red and near infrared wavelength data in the formula. The NDVI value varies between -1 and 1. it approaches 1 in areas with healthy (green) vegetation, approaches -1 in areas with arid soil and unproductive vegetation [13]. Low NDVI when agriculture-heavy regions are observed areas with values indicate areas with poor plant growth due to various reasons such as drought, disease, and pests. On the other hand, high NDVI values indicate places where plant growth is healthy [13].

As a result, by using multispectral cameras with NDVI sensors, the status of crops can be learned, the vitality of the vegetables and fruit grown or the plants in this area or whether the plants are disease (places not visible to the human eye) can be learned by analyzing NDVI images (the health of the soil and vegetation decreases as the images turn red, The health of the soil and vegetation increases as the images turn green shown in Figure 2) [15].

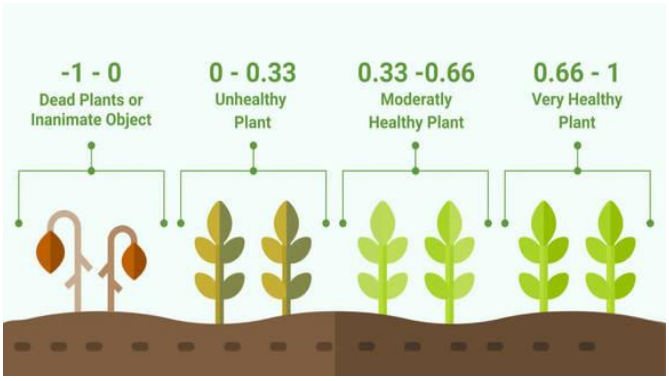

Figure 2. *The effect of NVDI's changes between -1 and 1 on plants*

D. *Server-Side*

Servers connect devices that communicate with each other via internet. The server enables the data sharing of the drone with the mobile application in the smart agriculture system and at the same time, it performs image processing, reporting and autonomous flight planning since the processing capacity of the drone is low. The mobile app creates a route for the drone to move according to the agricultural area whose location is determined by server. Server generates reports by processing the images taken by the drone along the route with the help of a special software. It ensures that these reports are sent to the mobile application. The user can access these reports via the mobile app. In this way, the user can transfer the productivity of the agricultural area from the drone to the mobile application by using the server.

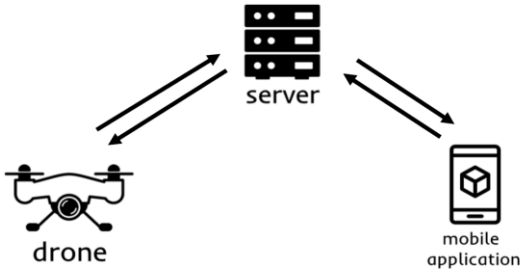

Figure 3. *Interaction between server, drone and mobile application*

E. *Mobile Application*

Mobile application provides users with daily data flow over the internet. It stores long-term data in the cloud system, thus allowing users to access their old data whenever user want. It offers users the drone's battery percentage, whether it can fly according to the weather and drone damage status. It shows the soil fertility analysis chart of your field, the chlorophyll density map of the plants and such graphics. Makes daily feedback. Informs about unexpected situations. Perform analysis flights in parts with low efficiency. It does all of this on its daily automatic flights. Mobile application is very user friendly. It was designed have simplest and most easy to use mobile interference. Drone can be controlled by using the mobile application. It can also be paused while on its mission and make a call to return home [16].

The user can view items such as drone's altitude, speed, distance to home, angle of the gimbal, signal connection percentage from mobile application [16]. User can give orders to get more detailed pictures in certain area. Drone use training and exercises were included in the mobile application. With virtual reality, users will get an experience as if they were using the drone in real life. Users will able to experience external factors such as wind effects, simulated accidents, flying birds in simulation mode [17].

IV. BUSINESS MODEL

This paper demonstrates the summary of monitoring using autonomous drones in smart agriculture business model on the business model canvas.

A. *Value Proposition*

The value proposition is the value a business offers to a customer when it agrees to buy a product. The value proposition is part of the overall marketing plan of the organization. Quality ideas include a mission statement or statement to consumers that represents the brand of the company to customers, telling them what the company is, how it operates, and why it needs it from the company. Value ideas may be delivered in the form of company or marketing statements used by firms to summarize why customers are purchasing goods or using services. This argument can add value to potential buyers if made convincingly, solve issues for some goods or services that the company provides in contrast to another similar offering. Describes the advantages of your goods and services your customers can expect [18].

Thanks to smart farming technology, the results from farming by large organizations such as corporations or the government will be clearly productive. Drones will enable more efficient use of the land with the help of a multispectral camera, and this will benefit companies and individual farmers using this product. By offering customer-specific system packages (individual farmer or large enterprise) Haki Solutions acts according to the needs of the customers and can provide services according to what the customers demand.

B. Customer Segments

Customer segments are a group of consumers or organizations that you want your goods or services to be sold to. One of the most important building blocks of the canvas business model is consumer segments. So, the secret to success is to use this building block correctly [19]. Which product will be sold to which customer is important. Different services can be provided according to the demands of the customers. Haki solutions have different customer profiles and Haki solutions have created different service packages to satisfy these customers. In the application, the services are explained clearly in a way that customers from every segment will understand and the customer can easily get the service.

C. Suppliers

A "supplier" is the business you want to deliver the product or service you want, and more than just raw materials, the supplier is. Communication with suppliers is mostly one-way and, if necessary, can be substituted easily by another supplier. The "partner" could be the main provider or downstream consumer who is most involved in your achievement. Partners are more interested in the process and assist in delivering [20]. Haki solutions are in a logical cooperation with their suppliers. Company buys multispectral cameras, drones and batteries from different suppliers and integrates the parts effectively. Haki solutions also gets the assistance of IoT service from experts in the field. And, thanks to this logical cooperation with suppliers, quality service is provided to customers.

TABLE I. BUSINESS MODEL CANVAS

<table>
<tr><th colspan="5">HAKI SOLUTION BUSINESS MODEL CANVAS</th></tr>
<tr>
<td rowspan="2">Key Partner
Drone equipment suppliers.
Multispectral camera suppliers.
IoT Software developers
Agricultural Region Management
Various manufacturers.</td>
<td>Key Activities
Drone manufacturing
Mobile application development
Server setup</td>
<td rowspan="2">Value Propositions
Chance to view the land
The chance to make productivity analysis of the land
Instant view from the field
High return on investment
Extra profit for the farmer
Autonomous use cheaply
Save time</td>
<td>Customer Relationships
Social Media
E-mail Contact
Sectoral Magazines
Agricultural Exhibitions</td>
<td rowspan="2">Customer Segments
Government
Individual Farmers
International Companies
Agricultural Companies</td>
</tr>
<tr>
<td>Key Recourses
Autonomous Drone
Multispectral Camera
Agricultural imaging analysis</td>
<td>Channels
Social Media
Sectoral Magazines
Agricultural Exhibitions
Website</td>
</tr>
<tr>
<td colspan="2">Cost Structure
Advertisement Cost
Manufacturing Cost
Logistic Cost
Office Cost
Taxes</td>
<td colspan="3">Revenue Streams
Customers
Potential Investors
Net present value
Total cost of ownership
Government incentive
Public offering</td>
</tr>
</table>

D. *Revenue Flow*

Revenue flows are several sources for firms to raise cash by selling products or delivering services. The type of revenue recorded in a business account depends on the type of operation that has been carried out by the company. Revenue flow, customers are connected, and the number of potential customers increases. Thus, Haki solutions serves many people and institutions in the sector. Thanks to the quality service it provides to these customers, the customer potential is increasing exponentially. Haki solutions also aim to collaborate with governments to meet the food needs of the growing population.

V. SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals (SDGs) are a global call for action aimed at eradicating hunger, protecting our world, and promoting stability and equality for all people. The Sustainable Development Goals, consisting of 17 goals and 169 subheadings, were adopted by the presidents of the nations that met at the United Nations Sustainable Development Summit held in New York on September 25, 2015, to eliminate poverty in all aspects and ensure the collective well-being of mankind by 2030.

A. *Goal 2*

Zero Hunger: Since we aim for everyone to reach quality products, eating food, which is a vital need, will become something everyone can easily reach. Thus, we aim to reduce hunger to zero.

B. *Goal 3*

Good health and well-being: In line with our project aiming to increase the quality of all agricultural products and reduce the use of chemicals, a healthy life awaits us, as natural and healthy products will be grown rather than chemicals.

C. *Goal 8*

Decent work and economic growth: There are many countries in the world that can grow their economy thanks to agriculture, and our project encourages agriculture. Thus, a new job area is created where the unemployed can also work.

D. *Goal 12*

Responsible consumption and production: Thanks to our systems, our products are helped to solve problems in a natural way and to grow them in the best way without chemical intervention. In other words, the use of chemicals is decreasing, and the number of organic grown products is increasing.

VI. CONCLUSION

In this age we live in, there are not so many organic products of poor quality and too many unemployed or unpaid farmers. Since there is a bad understanding of trade in the world even for those who do their job well, we wanted to turn this into an equality by removing it from a competition. The drone we use combines IoT technology and offered an easy-to-use mobile application to the user, so that the user can check the status of the product on his phone at any time and receive all kinds of assistance to keep the product's efficiency at the highest level. When these conditions are met, the number of healthy and quality products will increase everywhere, and as a result, the producer will see the value it deserves and the consumer will regain the right to access quality products at average prices.

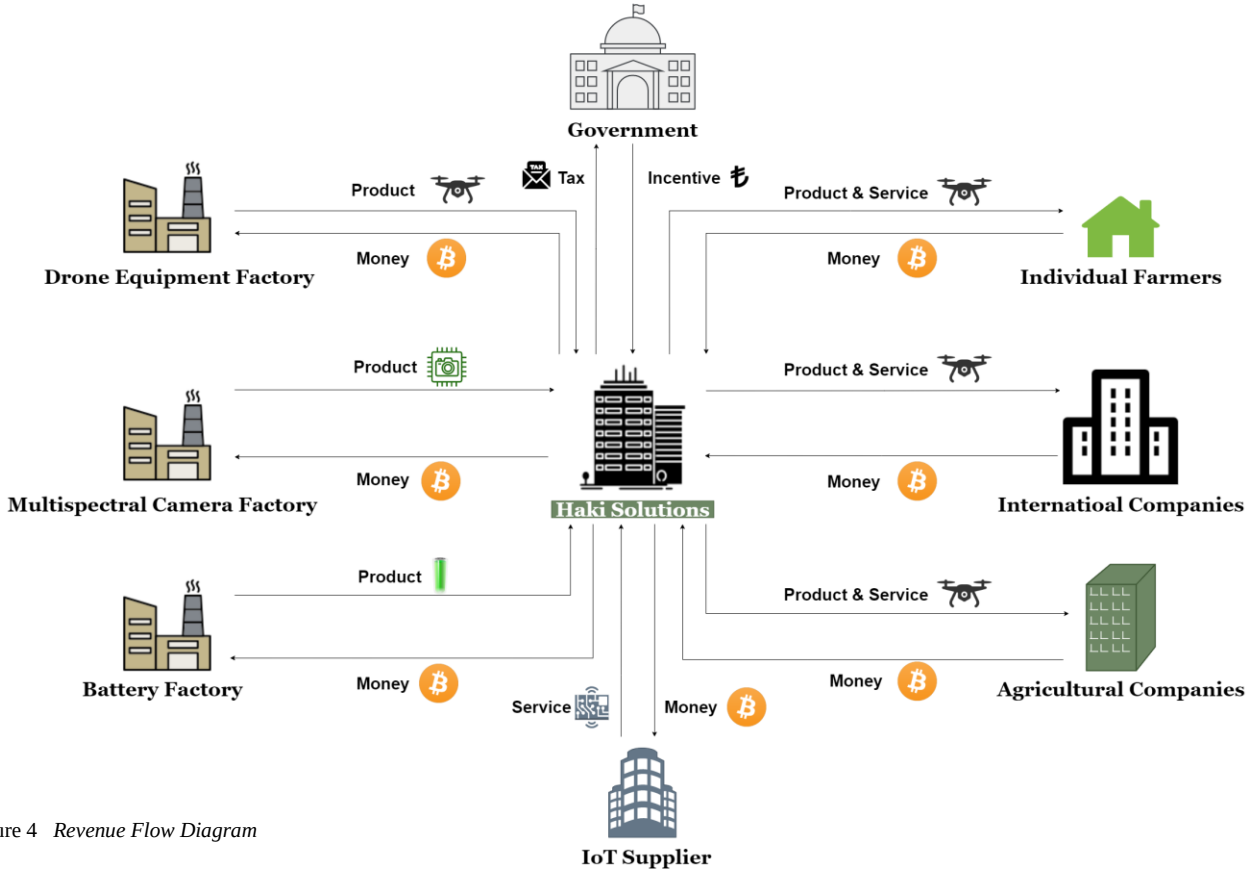

Figure 4 *Revenue Flow Diagram*

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