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The efficiency of using drones to reduce farming costs and yields

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Abstract

The purpose of the present study is to investigate the empirical relationship between drone usage (DU) and cost and time management (CTM) of the farmers. To accomplish this objective, the study collects the data from the Malaysian farmers through convenient sampling technique. Study applies partial PLS-SEM technique to acquire the empirical results. This technique comprises of two models: measurement and structural models. Outcomes of the study indicate that there exists a positive relationship between drone usage and cost and time management of Malaysian farmers. Keeping in mind the importance of drone usage, present study suggest to the government of Malaysia to provide different incentives to the rural farmers of Malaysia for the usage of advances technology like drone cameras for the monitoring of their crops.

Keywords: Drone Usage, Farmers, Cost and Time management.

1. INTRODUCTION

Recent developments in the areas of information technology and sensor-based smart devices have widened the scope of Drones to the agriculture sector other than the military operations. Usually referred to as Unmanned Aerial Vehicles (UAVs), Drones are pilotless aircraft for short-distance flights. Long-distance flying Drones are also available that are known for flying at higher altitudes (Pivoto et al. 2018). Drones are divided into two distinct categories including Rotary Motor Helicopters and Fixed Wing Airplanes. The efficient use of Drones in the agriculture sector has been on the rise after military and industrial usage. Drones have found various beneficial applications in agriculture that may include farm analysis, time-saving, higher agricultural yield, Geographic Information System (GIS) mapping integration, and imaging of crops health status (Puri, Nayyar, and Raja 2017a). Different kinds of Drones are available in the market for precision agriculture such as DJI Matrice 100, Honeycomb AgDrone System, Agras MG-1-DJI, DJI T600 Inspire, and EBEE SQ-SenseFly.

1.1 Adoption of agriculture technology

Variations in the natural environment, market consumption, and resource availability present several challenges to farmers that need to be addressed through the digitalization of the agriculture sector. Implementation of the latest technologies in the agriculture sector can provide several benefits in terms of higher yields and reduced costs. Drones are one of the IT-based smart devices to be employed for effective farming as compared to traditional methods of land scouting. Some of the benefits of using Drones technology in farming may include accurate farm analysis, cost & time saving, enhanced yields, and effective ways of spraying crops (CIMMYT 1993). According to a recent research report, the global market of

Drone usage in the agriculture sector would grow at 35.9% and will reach $5.7 billion by 2025 (TROPOGO 2022). Farmers also have to face some of the limitations in the utilization of Drones for crop surveillance due to several issues that may include:

- Connectivity issues
- Weather dependent
- Need for high skills and expertise

Figure 1: *Advantages of Drone usage in agriculture*

1.2 Drones for precision agriculture

Drones have been in use for remote surveillance in various fields. From the past few decades, the utilization of Drones has increased in the monitoring of agriculture crops. Research studies have revealed that there will be 80-90% growth in the Drone market for the agriculture sector. The utilization of Drones can provide better results as compared to satellite images that get obstruction due to clouds and other environmental issues. Drones are also cost-effective and easy to maintain through the replacement of damaged parts due to crashes (Strehr 2015). Agricultural Drones can be operated manually or pre-determined flight trajectories can be programmed through GPS. A technique of self-leveling has been programmed to adjust the Drone's flight in higher winds for stabilized images. Drones come in several attributes based on the demand of farmers ranging from basic digital cameras to still photography techniques. Near-infrared imaging technology is also in use for enhanced resolution of images obtained from Drone cameras as healthy crops reflect infrared wavelengths of light (Anderson 2014). The whole view of fields provides easier ways to pick the targeted spots through precision agriculture (PA). Drones contain a lot of potential in terms of improving sustainable farming. The agriculture drone market is expected to raise to $32.4 billion, indicating that the farming sector is going to see the many advantages of drones over the traditional approaches like ground surveying (Pinguet 2021).

Figure 2: *Two types of Drones, Rotary copter (left) and fixed-wing airplane (right) Source: (Strehr 2015)*

With the passage of time, the capabilities of Drones have been enhanced to expand their use in complex terrains of agriculture crops. Drones have become a vital part of precision agriculture using high-quality remote sensing with spectral imaging technology. Remote sensing satellite technology has been in use since the 1950s, scanning crops to measure temperature and spectral reflectance properties crucial for agriculture yield. The temperature detected through RS techniques indicates the crops' health. High-quality photos can be attained through Drones for crops analysis and spraying fields at small elevations. Agriculture Drones are equipped with high-quality cameras to capture high-resolution RGB images for thousands of acres (Kulbacki et al. 2018). Images obtained from Drones can be analyzed through software to make decisions regarding crops' health and yield. The capability to collect data regularly and map field variability enable more consistent precision agriculture methods and improved decisions. Drones are utilized in a variety of disciplines, including early soil investigation and cultivation based on exact 3D maps (Li et al. 2009).

Drones have become an important feature of large-scale precision farming operations in many places. Farmers can use the data acquired by drones recording fields to plan the crop plantation and treatments to get the best yields possible. According to the research statistics, precision farming technologies such as Drones can raise the farming yields by up to 5%, which is a significant increase in an industry with normally low profitability (Puri, Nayyar, and Raja 2017b). In addition to monitoring plant health, Drone technology can be rolled out to attain detailed color information of plants left through the Normalized Difference Vegetation Index (NDVI). This technology allows farmers to detect any variations in the plant's color to save the plants through pre-assessment (Croptracker 2022). Detailed images of Drones based on infrared technology provide RGB colored data, which can be utilized to detect crop's health with the variation of color as shown in figure 3.

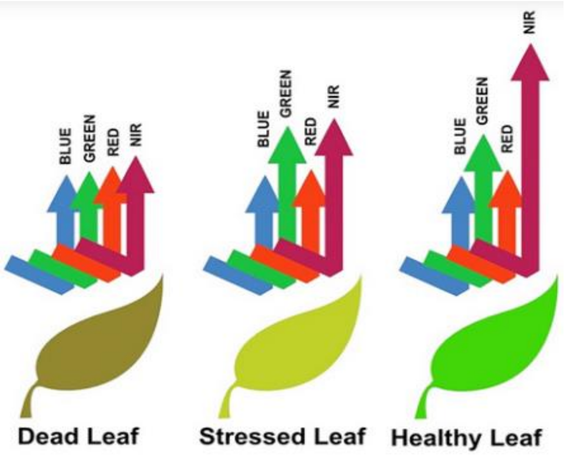

Figure 3: *Field monitoring through NDVI*

In addition, NDVI is considered to be one of the earliest and most extensively employed indices when combined with NIR imaging (near-infrared). Only near-infrared and green light is reflected by healthy plants. Plant indices show the amount of light captured across wavelengths to boost the contrast of a map. These plant indices were built with the goal of catering to a variety of camera types. As a result, a near-infrared camera is necessary (Aeromotus 2017). Drones have already altered the farming sector and seem to continuously grow in the future. Several other aspects need to be undertaken by farmers while using Drones for the surveillance and inspection of their fields including:

Zone management: The application of zones plays a vital role in Drone technology to detect health differences in crop areas.

Plant count tools: Several third-party tools are available that allow farmers to determine visibly distinct plants for their counting.

2. Literature Review

The term Drone is referred to an aerial device that is unmanned and operated through remote control technology. The research study of (Ubina and Cheng 2022) provided an overview of the capabilities of Drones in agriculture fields for managing and monitoring crop farms that enhances precision agriculture (P.A). Drones have been in use for monitoring offshore fish farms and other aquaculture farms due to the presence of high water currents, waves, and underground water environments. (Ubina and Cheng 2022) collected data on water pollutants, water quality, fish behavior, water temperature, and current velocity through unmanned technologies such as Drones. Adoption of the latest technologies such as Big Data, the Internet of things (IoT), and Artificial intelligence enhance farmers' efficiency to meet the ever-increasing food demands (Meivel et al. 2016; Kerdpitak, 2022). Drones are currently regarded as a relatively new device, and even less-developed equipment in comparison to the advanced technology being utilized in smart or precision agriculture farming. In the agricultural industry, two types of drones are in use now: medium-sized, which are primarily used for analysis applications, and larger drones used for planting and spraying of pesticides in the field (Pathak, Barzin, and C. Bora 2018).

In addition to the implementation of UAS in the agriculture sector, there is less researched data is available for aerial applications of fertilizer, water, spray, and pesticides for small-scale farmers. (Huang and Thomson 2010) proposed a method for crop spraying system that was based on the utilization of autonomous UAS. UASs can be employed for aerial spraying in insect penetrated areas, particularly to eliminate flies and mosquitos in crop areas. This research study proved that an improved spray system can be implemented through Drones that can lead to pest management in agriculture (Sadeghi, Jones, and Philpot 2015). Infrared Drones are versatile devices that can be employed for a variety of agricultural works. Research conducted by (Loon et al. 2019), investigated the utilization of Drone technology in agriculture farms. Digital technology has made farmers able to fly Drones over their crops to detect the presence of any slow-growing plants that would require some additional nutrients or water supply for improved health. Drones fitted with infrared sensors can measure certain wavelengths of light that are reflected and absorbed by plants. This process generates color-contrasted images to highlight the areas of damage in plants or crops.

(Hafeez et al. 2022) studied the efficient implementation of Drone technology to monitor agricultural farms and pesticide spray over the crops. Food demand has been on the rise that can only be met through the enhanced yield of crops. The modernization of the agriculture sector has become one of the major concerns of present times, requiring the implementation of smart devices for the surveillance and maintenance of crops. Several factors contribute to low crop output that can be addressed by utilizing drone technology in agriculture. This study report examines drone technology in the agriculture sector during the last decade, as well as its evolution through time (Ehrlich and Harte 2021). It has been discussed how drones can be used for crop monitoring and pesticide spraying in Precision Agriculture (PA). The research study of (Hafeez et al. 2022) has established the implementation of deep learning and artificial intelligence to the work done related to multiple sensor development, drone structure, and innovation in crop spraying. In addition, Drones have made the application of fertilizers for crops much easier as compared to traditional on-ground tools such as a tractor. (Zarco-Tejada, Ustin, and Whiting 2005) provided that large farms with higher profit margins use Drones for spreading fertilizers.

In addition, for pasture surveying, drone images also help ranchers to inspect the health and height of cultivated vegetation along with the monitoring of weather damages to the desired area. Drones can also be employed to direct and herd cattle to the desired location from different parts of the farmland (Zhang and Kovacs 2012). Drones at cattle ranches could also be employed to inspect or examine the quality of water containers and fences in far-flung farm locations. If a water trough breaks down, the farmer will not only be informed of the problem but will also be able to go to its site and repair it. The research report provided by (Yang et al. 2019) reviewed the usage of unmanned aerial vehicles in the agriculture sector. A comprehensive analysis was made to investigate the utilization of Drones in farming. These Drones use suitable sensors and UAVs to collect useful data for precise analysis of crop yield. In addition, the images obtained from Drones can assist farmers to identify any diseases present in plants before the detection of disease through human eyes. It also inspects plants for any pest, fungi, and weeds attack. Drones can be employed at varying altitudes and for different flight paths as per the surrounding geography through additional equipment such as LiDAR.

Monitoring of crop health is one of the important aspects of precision agriculture that includes fertilization, irrigation, pesticide spray, and timely harvest. (Subramanian et al. 2021) studied the on-site detection of issues regarding crop monitoring to implement corrective measures. Drones are gaining more popularity in the times of COVID-19 in response to the labor shortage and technical manpower availability in the context of smart agriculture. Crop pests and insects are known to generate catastrophe in food production all over the globe. Diseases and pests have damaged more crops than the predictions made by FAO. This is the need of the hour to take drastic measures for plant protection and cultivation growth. To utilize drones effectively in agriculture and related industries, operational characteristics such as flight height, speed, and liability must be improved (Guo et al. 2019). Drone-based spraying factors such as dispersion, droplet density, droplet size, homogeneity, and penetrability should also be considered when adopting drone-based measures to mitigate pests.

With the adoption of agriculture technology for crop handling and monitoring, farmers will be able to plant their crops using Drone-planting systems in near future. This will reduce the labor cost as it will be easy to directly implant the seed into the desired soil area in a field. Furthermore, automated Drones have been much researched in agricultural technology for improved farming procedures. Most of these research studies are based on crop surveying and spearing. Further research is required in this field to detect birds colliding with Drones during a flight over the crops or farmlands with the implementation of Artificial Intelligence (AI) (Dailydot 2016). ProHawk Drone equipped with a sonic bird repeller has been deployed to scare the birds away from its flight path emitting predator sound. Moreover, the Australian Research Centre for Aerospace Automation (ARCAA) has proposed the development of an AI-integrated Drone system, equipped with a thermal imaging camera that will inspect the animal presence in an area. Tests have been made in the study of (Lausch et al. 2013) where proposed Drones were able to stay for 20 minutes or longer in the air using a 1500 mAh 6s power source.

Rice is a staple food, one of the most important feed crops of this globe has been in danger due to lowered productivity with more than 20% fall (ISAAA 2016). Research showed that the brown planthopper causes a great loss in productivity of rice crops all over the globe. It causes damage at a later stage of the rice crop. In China's mountainous locations, (Qin et al. 2016) investigated the prospect of deploying a miniature UAV for pesticide spraying with great effectiveness and no damage to the rice crop. They discovered that droplet deposition and dispersal increased as rice growth progressed, which corresponded to the UAV's operational height and velocity for crop spraying. They can provide an effective delivery of pesticides through a standards delivery flying at 1.5-meter height with 5 ms-1 of speed. Water for irrigation is one of the precious commodities in the agriculture sector. The use of Drones in an irrigation system can also help to ensure the proper distribution of water without water wastage in farming lands. It will also be able to identify those areas that contribute towards water wastage (Lausch et al. 2013). For this purpose, researchers have placed special monitoring systems to test the Drones for effective irrigation that will identify the areas experiencing ‘hydric stresses or inadequate water supply. Drones equipped with thermal and infrared sensors will provide detailed snaps of farmlands to farmers for the identification of areas getting too little or too much water. Experimental studies of (Gupta, Bansal, and Husain 2018) have made farmers able to conduct vegetation index, determine health, and density of crop while the crop is still on the field. Farmers are also able to additionally assess the topography of their land through Drones having air-borne laser scanning devices that can develop 3D maps of farmlands.

Numerous researchers have attempted to investigate the role of drones on the cost and time management of the farmers. Most of the researchers highlighted their important role in saving the time and cost of the farmers. For instance, Rajput et al. (2021) conducted their research in India and stated that drone usage saves 20 times of farmers. In their study, they discussed three different types of drones, namely: Octocopter, Quadcopter and Hexacopter which are very cost effective drones to dig out the issue in the agriculture crops.

Veroustraete (2015) narrated that drones play an important role in the crops management. The study indicated that drone service providers and farmers will flesh out all of the prospective uses for drones in the coming years which will be very fruitful for the farmers as it promotes the crop intelligence of farms. Mustafi et al. (2021) stated that drones are employed for a variety of purposes, including industrial monitoring, photography, crop observation, air ambulance, and many more. In the last few years, there has been significant advancement in the field of drones of all kinds as they are aligned with a number of advantages such as: ease of usage, accurate monitoring of locations difficult to access by man, tracing criminal activities, forest fire observations, and crop yield surveillance on vast agriculture farms.

According to Tuna et al. (2017), Drones' practical applications are currently spreading in a broad range of industries and sectors. Among them, agriculture sector is the most promising one. According to a survey, drone facilities are necessary to overcome multiple obstacles faced by farmers in order to improve crop productivity. Usage of drones in the agriculture sector will not only helpful for the crop management, but also saves a lot of time and cost of farmers. Some researchers have discussed different applications of employing drones in the agriculture sector. For example, Padmapriya et al. (2021) believed that drones are high-tech gadgets that fly across the skies and can be used by farmers to assess the state of their farms at the start of any crop year. Anghelache et al. (2021) indicated that drones are very useful for the farmers to observe the diseased plants. Author specified that drones create 3-D maps for soil analysis, which farmers may utilize to ensure proper seed ploughing. Researcher regarded drones amongst one of the most suitable gadget which not only saves the time and cost of farmers but also contributes to the agriculture productivity.

Muraru et al. (2019) conducted their research on the rural farmers who make the usage of drones to analyze their crop locus and indicated the usage of drones as a time saving gadget to the farmers. Authors concluded that it is very difficult for the farmers to inspect every nook and cranny of their hundreds of hectors of land on the regular basis. Drones perform this role flawlessly, as farmers can conduct routine air surveillance of their fields to determine the status of their crops at regular intervals. Zalavadiya and Vasoya (2020) also highlighted the cost saving features of drones and indicated that drone cameras provide day-to-day overview of farm operations to notice the growth of the crops. Hence, after reviewing the above literature, it postulates that:

Hypothesis-1: There is a positive relationship between drone usage and cost and time management.

3. Methodology

3.1. Data sources and sampling procedure

The fundamental aim of the study is to investigate the role of drone usage (DU) on the cost and time management (CTM) of the farmers. To accomplish the proposed study objective, author conducted the research on the Malaysian farmers and gathered the data through a questionnaire survey. Survey was designed on 5-type Likert scale: starting from 5: strongly agree to 1: strongly disagree. The study acquires the data from 250 Malaysian farmers by using convenient sampling technique.

3.2. Data screening

After acquiring the data from the respondents, authors conducted data screening. First, authors monitor each questionnaire to observe their missing values. Those questionnaires were not considered for the empirical analyses which are having more than 30% of missing values. After the careful examination of each questionnaire, it has been found that 220 respondents filled their questionnaire properly. Thus, present study used the data of 220 respondents for the empirical investigation.

3.3. Data analysis

Present study employs extensively used multivariate technique [e.g., partial least square structural equational modeling (PLS-SEM)] to test the proposed relationship among the modeled variables. This is an extensively used estimation technique in the field of social sciences. It is having the build-in feature which automatically deals with the problem of data's normality. It also has the capacity to estimate the complex models. PLS-SEM is comprised of two models: Model 1: measurement mode, and model 2: structural model.

Measurement model is used for the pre-cautionary or preliminary analysis. For example, it tests the reliability and validity of the data. It is a well-known fact that if data is not reliable or valid then there is no benefit to perform empirical analysis on the data because the computed results will be problematic. However, after validating the measurement model, structural model is used to perform the hypotheses testing on the modeled variables. Structural model uses bootstrapping technique to test the relationship among the variable of interests. Path analysis is an interesting feature of structural model, which builds the paths and test the significance of these paths.

4. Empirical Results

4.1. Descriptive statistics

Descriptive statistics are frequently used to summarize a large pool of data into a systematic way. Results of the descriptive statistics of each variable are presented in Table 1. Table reports the mean values of the data along with maximum and minimum responses of the respondents. Values of standard deviation, along with kurtosis and skewness are also reported in this table.

Table 1: *Descriptive statistics*

Items	Mean	Min	Max	Std. Dev.	Excess Kurtosis	Skewness
DU1	3.21	1	5	1.364	-1.123	-0.234
DU2	3.115	1	5	1.192	-0.878	-0.155
DU3	3.22	1	5	1.264	-0.955	-0.249
DU4	3.127	1	5	1.281	-1.047	-0.075
DU5	3.36	1	5	1.338	-0.971	-0.407
DU6	3.092	1	5	1.348	-1.13	-0.169
CTM1	3.22	1	5	1.345	-1.08	-0.311
CTM2	3.21	1	5	1.297	-1.041	-0.176
CTM3	3.162	1	5	1.303	-1.004	-0.269
CTM4	3.127	1	5	1.315	-1.034	-0.178
CTM5	3.111	1	5	1.293	-1.004	-0.12

4.2. Measurement model

Measurement model of the study is shown in Figure 4 which is used to test the validity and reliability of the data. The empoirical findings of the measurement model are presented in the subsequent sections.

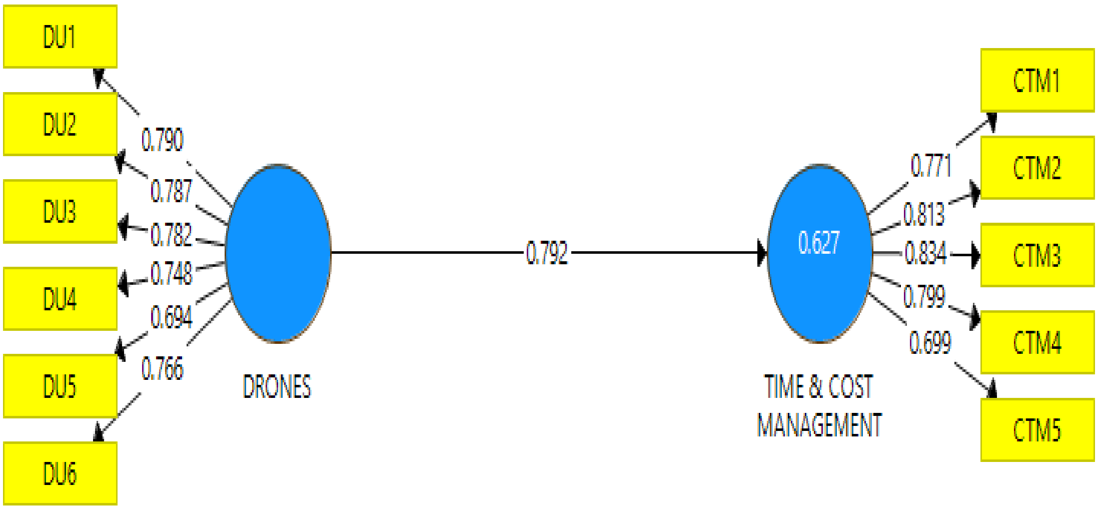

Figure 4: *Measurement model*

4.2.1 Convergent validity

Results of convergent validity are reported in Table 2. Convergent validity is normally measured with the values of factor loading. According to a rule of thumb, the loading values must exceed from 0.4 in order to satisfy the criteria of convergent validity. Table shows that the loading values of proposed items are ranging from 0.694-0.834 which clarify the presence of convergent validity in the data

Table 2: *Convergent Validity*

	CTM	DU
CTM1	0.771	
CTM2	0.813	
CTM3	0.834	
CTM4	0.799	
CTM5	0.699	
DU1		0.796
DU2		0.787
DU3		0.782
DU4		0.748
DU5		0.694
DU6		0.766

4.2.2. Discriminant validity

Testing of discriminant validity is also crucial to acquire the efficient results. Outcomes of discriminant validity are presented in Table 3. According to the criteria of Forner-Larker, the diagonal values must be greater than the remaining values. Table 3 clearly shows the fulfillment of this criterion. Hence, it is concluded that discriminate validity is present in the data.

Table 3: *Discriminant Validity: Forner Larker Criteria*

Constructs	DU	CTM
DU	**0.762**	
CTM	0.692	**0.785**

4.2.3. Construct reliability and validity

Crohn-Bach Alpha (CBa) is used to test the reliability and internal consistency of the data. According to the rule, the value of CBa must exceed from 0.5 in order to satisfy the criteria of data's reliability. However, the higher the value close to one, the higher will be the reliability of data. Outcomes of CBa are presented in Table 4 which shows that the values of CBa for both of the constructs exceeds from 0.5 which clearly indicates the reliability of data. Study used construct reliability (CR) to counter verify the results of CBa. Findings of CR also show that the data for the present study are highly reliable and ready for the empirical analysis. The coefficient of average variance extracted (AVE) is used to test the convergent validity of each item. The value of AVE, exceeding from 0.5, revels the presence of convergent validity in data.

Table 4: *Construct reliability and convergent validity*

	CBa	CR	AVE
DU	0.855	0.892	0.581
CTM	0.842	0.889	0.615

4.3. Structural model

The structural model of the study is presented in Figure 5, which tests the hypothesized relationship among modeled valuables through a bootstrapping process.

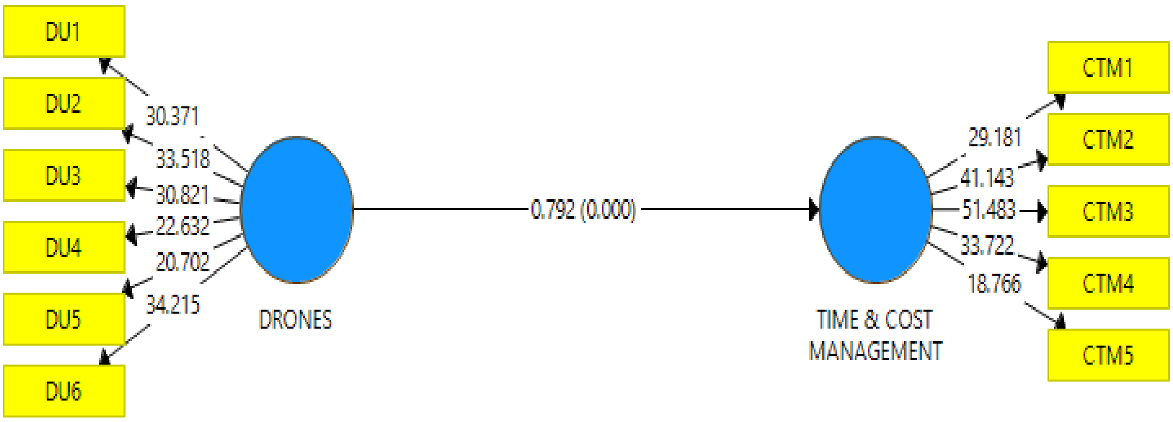

Figure 5: *Structural model*

4.3.1. Collinearity Issue

First step of structural model is to perform the diagnostic regarding the issue of collinearity. Model tests the Collinearity among each item of the construct through VIF. Results of VIF are reported in Table 5 which shows that the issue of collinearity among items does not exists in the data as the values of VIF do not exceed from 5.

Table 5: *Collinearity diagnostic*

Items	VIF
CTM1	1.779
CTM2	2.000
CTM3	2.069
CTM4	1.844
CTM5	1.484
DU1	2.033
DU2	1.916
DU3	1.903
DU4	1.695
DU5	1.499
DU6	1.664

4.3.2. Path Analysis

The final and foremost step of structural model is to conduct path analysis to obtain empirical results of the study. Results are reported in Table 6. Table shows that the coefficient of CTM (i.e., 0.792) is significant at the level of 1%. The positive sign with the coefficient indicates the positive relationship between DU and CTM. Results implies that 1-unit of increase in DU tends to increase CTM by 0.792 units. Thus, the proposed study hypothesis is accepted. Moreover, the value of R2 (0.667) shows that 66.7% variation in CTM are described by DU.

Table 6: *Path Analysis*

Path	Coefficient	Standard Deviation	T Statistics	P Values
DU➔CTM	0.792	0.022	35.412	0.000***
R^2	0.667			
Adj. R^2	0.625			
***: significant at 1%.				

5. Discussion and Conclusion

Agriculture sector is the backbone of the economy as it is having strong influences on the economic productivity (Reinecke and Prinsloo, 2017). Due to the devastating effects of environment, the agriculture productivity also suffers. Adverse climatic changes damage the crops. To observe this damage is critical, but, difficult for the farmers as it takes their huge time and energy (Virk et al., 2020). It is a well-known fact that globalization has changed everything. This global era makes the use of technology very easy for every person. "Drones usage" is highly utilized technology to observe the damage in the agriculture crops, which not only saves the time of farmers but also very cost effective (Puri et al., 2017). However, we did not find vast range of studies on the empirical relationship between drone's usage and cost and time management of farmers.

Present study is, therefore, an attempt to test the empirical linkage between drone usage (DU) and cost and time management (CTM). To accomplish the study objective, we conducted the research on the Malaysian farmers and gathered the data through a questionnaire survey. The study acquires the data from 220 Malaysian farmers by using convenient sampling technique. Study applied PLS-SEM, a second generation multivariate technique to acquire the empirical results of the study. This technique comprises of two models: measurement and structural models. Outcomes of structural model indicate that there exists a positive relationship between drone usage and cost and time management of Malaysian farmers. This relationship is justified very easily and aligned with many previous researchers (i.e., Godden, 2019; Michels et al., 2021; Fertu et al., 2021). It is believed that drones usage in the agriculture sector assists the farmers to reduce their labor cost and gather more precise data. It also reduces the number of resources that are required to grow crops, and minimizes the amount of waste generated throughout the process (Godden, 2019). In addition to this, drones are very suitable gadget for the farmers to test the irrigation level of their crops. For instance, after using the drone cameras farmers can easily get the idea that whether portions of the field require more water, less water, or more fertilizer (Michels et al., 2021). Fertu et al. (2021) believed that the usage of technology increases the productivity. Author perceived drone cameras as an advanced technology for the agriculture sector which helps the farmers to monitor their crops in a 3-D angle. Pathak et al. (2020) documented different benefits of drone cameras. According to the study, drones are time and cost saving gadgets to monitor the crops. They are the safest way to spray for pesticides which also increases the crop yields. Ipate et al. (2015) believed that proper monitoring of agri-crops is crucial to increase the agriculture productivity which increased the labor cost. For example, it is difficult for a single person to monitor all the crops. In this regards, farmers have to hire different labors to perform this task. It is an undeniable fact that when someone hires labor, he/she has to pay labor cost (i.e., wage). Nonetheless, the usage of advances technology (i.e., drone cameras) for the crop monitoring will reduce this labor cost and are aligned with a number of advantages. For example, they collect the information about plant leave culture, obtain information on soil water holding capacity, or managing irrigation systems, particularly for large agricultural producers who grow in dispersed places. Keeping in mind the importance of drone usage, present study suggests to the government of Malaysia to provide different incentives to the rural farmers of Malaysia for the usage of advanced technologies like drone cameras for the monitoring of their crops.

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