Time Series Analysis for Vegetable Price Forecasting in E-Commerce Platform: A Review

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Abstract. Vegetables industry plays an important role especially in providing the abundant fresh agricultural products. Forecasting the vegetable price is vital in agriculture sector for effective decision making. In Malaysia, the problems faced by the farmers are not only their age, but also their competitive skill where the wholesale market and the hypermarket/supermarket are prioritized by the consumers in Malaysia for the fresh vegetables and fruits. This review article helps to recognize the current problems faced by the agricultural sector of Malaysia and study the relationship between the agriculture and E-Commerce. Recent researchers have mentioned the growth of the E-Agribusiness and the authors found the potential of an Agricultural E-Commerce platform with price forecasting model in solving the current national issue. This research reviews the existing agricultural E-Commerce platforms in worldwide and try to compare with the local one. After the reviews have been done, the authors bring up an idea in constructing the time analysis model in hybrid approach for veggies price forecasting in an agricultural E-Commerce platform which can be used by the government in deriving their policies.

1. Introduction

E-Commerce refers to the use of the Internet to market, buy and sell goods and services, exchange information, and create and maintain web-based relationships between participant entities [1]. E-Commerce has changed the way of business by using internet to create and transform business relationships. It involves the application of web-based information technologies towards automating business processes, transactions and workflows, and buying and selling information, products, and services using computer networks [2]. But on the forefront real time data, direct input from customers, referrals, and buying pattern also form a part of the E-Commerce inputs.

In Malaysia, most of the farmers are ageing and not well-educated to the new agricultural technology causing Malaysia agricultural development are way behind the neighbouring country [3], [4]. The agricultural sector has the lower average monthly salary in Malaysia and its average monthly salary was below the national average. The current fisherman see themselves as the last generation and have no willingness in having their next generation to inherit their business, even the farmers do the same [3]. The problem faced by the farmers are not only their age but also their competitive skill where the wholesale market and the hypermarket/supermarket is prioritized by the consumers in Malaysia to purchase the fresh vegetables and fruits [5]. Forecasting the vegetable price is important in agriculture.
sector for effective decision making which the farmers can have a better Supply Chain Management (SCM) and inventory management when it comes to a SCM under E-Commerce environment [6].

The question of how e-commerce is integrated in the complete business cycle and its effect on overall business performance is still unexplored area. Based on available literature, the conceptual model is developed for understanding relationships between e-commerce and supply chain performance. Supply chain management (SCM) is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers [7]. Supply chain management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption.

According to the Selected Agricultural Indicators that collected by the Department of Statistic Malaysia in 2019, it summarize that the total imports and exports were both declined from 2017 to 2018 which were recorded as 2% and 9.5% respectively [8]. This circumstance affected the trade balance of the agricultural sectors to show a decrease of 32.4% overall from RM31,269 million in 2017 to RM21,138 million in 2018 [8]. It proved the fact that Malaysia relied on the imports from the other countries too much where the exports to the other countries were no longer able to cover the cost it take for the imports.

The palm oil contributes the most in the Gross Domestic Product (GDP) of agricultural sectors of Malaysia at 37.9% [8] and it accounts for 40% of the agriculture area. According to the news, it is reported that the total palm oil stocks suffered from a decline of 4.08% to 2.26 million tonnes in November 2019 from 2.35 million tonnes recorded in October, 2019 [9]. The palm oil market is volatile and its prices fluctuate considerably on global market [10]. Besides, it is reported from the statistic of Index Mundi in 2019 that the global prices of palm oil performed a downward trend since 2010 [11].

With the 60% of plantation occupied by the oil palm and rubber which is majorly managed by the global companies, the rest of the land area are managed by family households on an independent smallholdings [12], [13]. Therefore, it shown a concern to the Malaysia whether we are overly dependent on the palm oil and then whether we should start putting more effort on the other agricultures to produce sufficient food source to satisfy the basic need of the growing population of Malaysia.

The total amount of employed persons in Malaysia in 2018 surpassed those in 2017 despite the fact that the overall employed persons in the agriculture sector are declined [8]. The population of Malaysia is growing at 1.4% per annum. Nevertheless, Malaysia keep on losing people that the number of migration are getting higher day by day [12], [13]. There are only 28% of the overall population in Malaysia involve themselves into agriculture but almost 70% of them are ageing which is approximately 60 years old on average [3], [4].

In the older times, the farmers whom used to plant the food crops have stopped planting the food crops after they started to realize the easiness of maintaining the plantations than planting a food crops which are extremely lower and unstable price and they start planting oil palm [4]. According to the survey that is carried out between 2010 to 2018 in Malaysia, the publisher concludes that the average monthly salary for employees in the agricultures, forestry and fishing industry in Malaysia was around 1.87 thousand Ringgit Malaysia [14]. The agricultural sector has the lower average monthly salary in Malaysia and its average monthly salary in that year was below the national average. This is why there are no new generation in fishermen and farmers willing to get involved into inheriting their parental businesses [15], [16].

According to news reported by The Star [17], the farmers from Cameron Highland forced to dispose their tones of vegetables due to the Movement Control Order (MCO) delivery complications caused by the COVID-19 pandemic in Malaysia whereby the citizen tend to have the panic shopping to secure themselves and it will eventually causing the shortage of the food supply.

This tragedy of what faced by the Cameron Highland farmers bring up the importance of having an official and authorized E-Commerce platform to provide the agricultural products online market with proper credibility. Lazada Malaysia and Shopee Malaysia came forward to get use their platform in selling the agricultural products to help the local agricultural businesses. Lazada Malaysia has pledged its long-term support to E-Commerce entrepreneurs and small-medium enterprises (SMEs) in Malaysia.
where Lazada created a special ‘Cameron Farmers’ section, alongside its MyFishman for seafood supplies and Mymarket2u for other grocery needs [18]. Besides, the ‘Daily Super Brand Day’ which is organized by Shopee Malaysia with the slogan “Shop Safely From Home” encourage the citizen to buy the grocery needs included the vegetables and raw foods from home and even with the discount code.

Therefore, this study targeted to encourage the young generation to get involved in the agricultural development and promote Malaysia’s agro products as well as to help the small farmers to live a better life.

2. Electronic Commerce (E-Commerce)

The history of Electronic Commerce (E-Commerce) can be traced back to the late 1970s where the businesses began to conduct a greater portion of their routine buyer-seller operational processes online [19]. Throughout the few years of difficulties in using the Electronic-Data-Interchange (EDI) which it means to have significant benefits but usually hard to be achieved in the real life, the organizations have changed their way heavily into the Inter-Organizational-Systems (IOS) and E-Commerce applications over the Internet. The EDI which once tend to be cost-effective is now feasible for all organizations through online applications. With such an exponential forecast in the growth of business-to-business (B2B) E-Commerce, establishing trust among trading partners in a global virtual environment becomes crucial. E-Commerce draws on technologies such as mobile commerce, electronic funds transfer, supply chain management, internet marketing, online transaction processing, electronic data interchange (EDI), inventory management systems, and automated data collection systems.

There are basically six types of E-Commerce which included the Business-to-Business (B2B), Business-to-Consumer (B2C), Business-to-Government (B2G), Consumer-to-Consumer (C2C), Government-to-Consumer (G2C) and also Government-to-Business (G2B) [20]. According to popular E-Commerce market data, US-founded Amazon is one of the leading E-Commerce platforms worldwide. Asian competitors such as Rakuten or Alibaba are also constantly expanding their share within the B2C E-Commerce market. Online auction website eBay is the most popular example for C2C E-Commerce whilst also providing a platform for merchants to sell their goods.

2.1. Role of E-Commerce in Agricultural Marketing

The growth of the internet and E-Commerce have transformed the lives of many people especially in developing countries. It help to improve the livelihood of the poor through better communication and greater access to information. With the knowledge of Information Technology, the poor farmers with low income able to obtain the information of the market price and thus they are able to sell their crops at a better prices to reduce the risk or under-selling and of either over of under-supplying their crops in a given agricultural sector. For example, the African company Esoko, which used to be called as TradeNet, is a popular agricultural market intelligence and trading platform used in Africa and it give alerts to the user regarding the current market data [21]. There is no doubt that E-Commerce has grown rapidly since the first users started to step onto the platform and made trade. In 1991 when there are less than 3 million internet users around the world and no existence of the E-Commerce yet until 2019 which have around 4.1 billion people of the global population are using the internet [22].

Electronic Agribusiness (E-Agribusiness) referred to as application of E-Commerce in agribusiness which means those relevant parties doing the agribusiness online through internet. Technically, E-Agribusiness adopted the business transaction in which the parties interact electronically and virtually without any physical exchanges or direct physical contact and thus, basically there are no requirement of having a physical store to start an E-Agribusiness [23]. With the agricultural E-Commerce or E-Agribusiness, it brings a lot of benefits not only for the small-scale farmers but also for those SME. The advantages of the E-Commerce for SMEs included the higher profit margins and better and quicker customer service provided because the cost of running a business is markedly less that they do not need to pay for the rental fees and so on. Therefore, E-agribusiness would be more productive and hence it enable the relevant parties to yield twice the result with half the effort.
China which is now leading in the development of the E-Commerce platform among the world introduced a few of the agricultural e-business platform. Under the background of vigorous development of “Internet+” to link the entire agricultural value chain from production to marketing through internet-connected networks [24], Hubei Future Home High-Tech Agriculture Co. Ltd. has built an agricultural e-business platform, NYW, in full investment. Wuhan officially launched the Internet+ Agricultural demonstration pilot in 2015, taking Jiangxia and Dongxihu districts as the first demonstration pilot areas. NYW covers four aspects: agricultural e-business, rural tourism e-business, crowd funding of agricultural micro projects, and entrepreneurship & training in e-business [25].

In the competitiveness analysis from similar products, the promising agricultural trading sites in China now include www.cnhnb.com, www.znpcp.com, www.nongpibao.com, www.lenw.cn, and so on. Cnhnb.com as a B2B website jointly is designed to serve rural users, widening sales channels for agricultural products while Lenw.cn as a network platform rooted in China’s agricultural industry and integrating agricultural information with business services is targeted to spread agricultural information and service agricultural markets [25]. The Owlting that originated from Taiwan and also Sooretul that founded in Senegal [26] are the examples of the E-Agricultural business platform in the world.

2.2. E-Commerce in Malaysia

Over the years, the government of Malaysia aim to drive Malaysia towards Digital Economy. In 2018, there is a forum regarding the Malaysia Digital Economy has been held widely by Ministry of International Trade and Industry (MITI) and the Malaysia Digital Economy Corporation (MDEC) in 2018 in order to educate the local stakeholders especially the SMEs on the importance of digitalization and encourage them to start to work on E-Commerce business. It was reported that there are significant growth of Malaysia’s digital economy since 2016 which 58,824 online businesses has been registered with the Companies Commission of Malaysia (SSM) in 2016 [27]. Except China, Malaysia is leading in establishing a Digital Free Trade Zone (DFTZ) which comprises e-Fulfillment Hub, Satellite Services Hub and e-Service Platform to stimulate growth in electronic trade. DFTZ targeted to develop the digital economy and cross border trading activity using the E-Commerce while increasing the E-Commerce growth and contribution to GDP by RM211 billion (approximately US$47.68 billion) by 2020 [28].

In Malaysia, there are about 80% of the Malaysian population are active internet users and there is a high rate of mobile phone usage. With the total population of around 30 million, Malaysia is an appealing market for E-Commerce in Southeast Asia because of its fast-growing economy and advanced infrastructure for digital technologies. Until today, Malaysia has built around 200 industrial estates zoned and prepared for industrial development, together with specialized parks such as Technology Park Malaysia and Kulim Hi-Tech Park. Along with the ongoing development, the E-Commerce market in Malaysia has been increasing faster than ever.

According to the ranking examined by The Map of E-Commerce based on the average quarterly traffic, mobile application ranking, social media followers and number of staff, the Malaysia’s top E-Commerce players included Shopee, Lazada, Lelong, Zalora, GoShop and so on [29]. As of the fourth quarter of 2019, Shopee led the Malaysian E-Commerce market as the most clicked E-Commerce site in the country, followed by Lazada and Lelong with almost 29 million clicks. With the huge number of clicks in 2019, Shopee became the leading online shopping platform in not only Malaysia, but also across Southeast Asia. In 2017, the E-Commerce GDP contributed 6.3% to the total Digital GDP of Malaysia. In order to increase the E-Commerce growth and promote its contribution to the GDP, MDEC set out six key strategic initiatives [30] while at the same time they encourage the Malaysian to embrace E-Commerce through the Go eCommerce website.

2.3. Issues of Agriculture Sector Malaysia

The issues hurdling the agriculture sector of Malaysia includes the food production and productivity is declining in Malaysia while its food consumption is increasing, the bias on the oil palm plantation, no fair prices providing to the farmers for their crops, the ageing and unskilled farmers and fishermen, rely
on imported food, supply channel bottlenecks and lack of market understanding. When the situation get worsen, it will affect the GDP of Malaysia as well. Since Malaysia was used to be developed from being an agrarian economy to an industrialised country, the agricultural sector usually tend to be left behind. However, based on the interview with Datuk Seri Salahuddin Ayub, the Minister of Agriculture and Agro-based Industry in 2019, he stated that those recent development shows that the Prime Minister Dr Mahathir and Finance Minister Tun Daim Zainuddin are expressing greater interest in reinstating the agriculture contribution especially to learn and exchange views agriculture with China, particularly on new technologies [31]. There are many defects in the present agricultural marketing system and it is not easy to handle it immediately, thus, a new techniques and trends or even a new concepts should be adopted in order to overcome these defects. The authors seek the possibility of solving the problem from the agricultural E-Commerce or E-Agribusiness in order to eliminate the roles of middleman and increase the income of the farmers while increase the food sources of Malaysia at the same time where the aim of raising the income of farmers is also the Federal Agricultural Marketing Authority (FAMA) chairman’s agenda [32].

Moreover, the idea of development of e-agribusiness is relevant to the National Agrofood Policy 2011-2020 (NAP4) [33] by the government of Malaysia. This policy was developed in 2010/2011, with the main focus on improving the efficiency of agrofood industry in Malaysia. The objectives of the NAP4 included as follow:

- To ensure adequate food supply and food safety,
- To develop the agrofood into a competitive and sustainable industry and,
- To increase the income level of agricultural entrepreneurs.

The idea of developing the agricultural E-Commerce platform fulfil the criteria of the NAP4 because the agricultural entrepreneurs whom are interested to involve their e-agribusiness and those small-scale farmers can have proper plan for the inventory and supply chain management of their veggie in prior and thus their income could be increased which it satisfy objective No.3 of this policy which is to increase the income level of the agricultural entrepreneurs. Besides, the agricultural E-Commerce platform can promote the urban farming/home farming indirectly where it encourage everyone to plant and sell their veggie online and thus one of the main idea which is the sustainable agricultural development can be achieved.

However, there are lacking in the growth of the agricultural E-Commerce platform in Malaysia. To the best of the authors’ knowledge, there is only one agricultural E-Commerce platform in Malaysia which is the Agrobazaar Online, funded by the Government of Malaysia and founded by the FAMA Malaysia [34] to provide the E-Commerce platform to enable the user to sell and buy the agro-product. In the user experience of the authors, the Agrobazaar online tend to lack of the online intelligent chatbot which it is quite challenging when the user faces a problem in using the platform. For the seller, they need to have the physical store in prior to start their business in the Agrobazaar Online platform. Then, it is not that user-friendly for those entreprenuers whom wants to focus on the online business.

### 3. Types of Forecasting Method

In term of the forecasting methods, it can be differentiated into two types which are qualitative and quantitative as shown in Figure 1 [35].
Qualitative forecasting methods, often called judgmental methods, are methods in which the forecast is made subjectively by the forecaster. In contrast, quantitative forecasting methods are based on mathematical modelling. Since they are mathematical, these methods are consistent [35]. Although quantitative methods are objective and consistent, they require data in quantifiable form in order to generate a forecast where it is hardly to find for example if we are making a strategic forecast or if we are forecasting sales of a new product. Furthermore, quantitative methods are only as good as the data on which they are biased whereas qualitative methods have the advantage of being able to incorporate last minute “inside information” in the forecast.

In differentiation of qualitative methods, there are the example such as executive opinion in which a group of managers collectively develop a forecast, market research that relies on surveys and interview in determining the customer preferences and also the Delphi method in which a forecast is the product of a consensus among a group of experts while maintaining their anonymity. On the other hand, the time series models and causal models are both the quantitative methods. The time series models are based on the assumption that a forecast can be generated from the information contained in a time series of data where the time series can be defined as a series of observations taken over time whereas the causal models which can also be called as associative models are based on the assumption that the variable being forecast is related to other variables in the environment.

While the above traditional forecasting methods are being used and tested for decades, they are now comforted and improved by modern forecasting methods using Machine Learning (ML) and Artificial Intelligence (AI) [36]. ML forecasting can be used by big retailers, supply chain, and logistics experts to aid to improve the customer engagement and produce more precise demand forecasts better than traditional forecasting techniques. Besides, ML forecasting is also used to expand into new sales channels, improve customer service, reduce inventory and improve productivity.

ML forecasting is certainly the method to achieve high forecast accuracy and way forward. With ML forecasting, processors learn from mining loads of big data without human interference to deliver unparalleled customer demand insights. Extrapolative analytics and algorithms, like Neural Networks (NN), Recurrent Neural Networks (RNN), and Support Vector Machines (SVM) have developed as the latest discussion amongst senior managerial sides. ML forecasting is self-correcting and powerful if compared with traditional forecasting techniques like average, moving average, trend, multiple linear regression.

For years, ML forecasting models have been rejected due to the absence of storing and processing abilities essential to engaging them. Nowadays, with cloud computing, dynamic regression, and unnoticed machinery, models are turning into the catalyst for “Machine Learning Forecasting.” With the use of pattern recognition, there will be a swing from vigorous engagement to automatic engagement. As part of this shift, ML forecasting takes over tasks from info gathering to real implementation. Compared to traditional forecasting techniques, ML forecasting aids supply chain and logistics experts recognize and forecast consumer demand that, in most scenarios, would be otherwise impossible.
4. Time Series Forecasting
The time series price data contain both linear and nonlinear patterns. Therefore, neither a current linear forecasting nor a neural network can be adequate for modelling and predicting the time series data. The linear forecasting model cannot deal with nonlinear relationships, while the neural network model alone is not able to handle both linear and nonlinear patterns at the same time. There are a few of statistical method in forecasting time series data which can be explained in the Table 1.

Table 1. The Example of Time Series Forecasting Method [37]

| Model                                      | Pros                                      | Cons                                      |
|--------------------------------------------|-------------------------------------------|-------------------------------------------|
| Linear Regression (LR)                     | - Ability to handle different time series components and features.  
- High interpretability.                  | - Sensitive to outliers.                  |
| Exponential Smoothing                      | - Ability to handle variable level, trend, and seasonality components.  
- Automated optimization.                 | - Sensitive to outliers.                  |
| Autoregressive Integrated Moving Average (ARIMA) | - High interpretability.  
- Realistic confidence intervals.  
- Unbiased forecasts.                     | - Requires more data.                     |
| Seasonal Autoregressive Integrated Moving Average (SARIMA) | - Solid underlying theory.  
- Stable estimation of time-varying trends and seasonal patterns.  
- Relatively few parameters.               | - No explicit seasonal indices.           |
| Dynamic Linear Model (DLM)                 | - High interpretability.  
- More transparent than other models.  
- Deals well with uncertainty.  
- Control the variance of the components. | - Higher holdout error.                   |
| Neural Network (NN)                        | - Less restriction and assumptions.  
- Ability to handle complex nonlinear patterns.  
- High predictive power.  
- Can be easily automated.                | - Low interpretability.                   |

5. Related Works of Time Series Forecasting
Linear Regression (LR) is one of the causal models, but still there are researchers using it for the time series data. Its problem in time series analysis would be its ability to do extrapolation which it might be useful in predicting the future. The suitability of applying time series regression (TSR) in doing the forecasting has been proved with the high forecasting accuracy [38], [39]. There are the other proposed model included the hybrid LR and Deep Belief Network (DBN) [40], adoption of multiple linear regression (MLR) with the lagged predictor variables [41], distribution enhanced LR [42] and so on. Anyhow it is unsuitable in doing the vegetable price forecasting because it only looks at linear relationship between the dependent variable and independent variable along a straight line graph.

Holt-Winters’ seasonal method is one of the Exponential Smoothing method where Holt and Winters extended the Holt’s method in order to capture seasonality [43]. In forecasting the economic data, the Holt-Winters method is conservative in the construction of forecast intervals and resampling methods might needed in the future work [44]. The Double Seasonal Holt-Winters’ performed the best in short-
term traffic [45] and the Holt-Winters’ seasonal method can be extended by employing Artificial Bee Colony [46].

In term of time series data, Autoregressive Integrated Moving Average (ARIMA) forecasting model is established in few studies in different field included the economic [47], agriculture [48]–[52], production [53], social security [54] and etc. The problem with ARIMA is that it does not capture the seasonal component of the time series and hence it is extended which is Seasonal ARIMA (SARIMA). SARIMA is popular in forecasting the vegetable price [55]–[59] because its ability in handling the seasonality. However, it is appropriate only for a stationary time series and often consume huge historical database in development [60]. It is unable to extract the non-linear component [61] and hence a proper input of seasonality need to be provided for SARIMA to work correctly with good results where the Wavelet or Fourier transform is possible to solve this problem [62].

There are the lack of research papers explained the use of Dynamic Linear Model (DLM) in forecasting the price of agricultural products which mostly it is applied in predicting the data flow [63], energy consumption [64], food security [65] and the rest. DLM as one of the state space method has state explosion problem where a large state space is hard to be fully constructed [66]. Besides, pre-calculation is required before the apparent physical interpretation for a state space techniques [67] and it is restricted to Single-Input, Single Output (SISO) system only [68].

Neural Network is often used for a better decision making with few referred studies in predicting the price of agricultural products by the authors [69]–[71]. Combination Forecasting is one of the prediction method that is varied from traditional perspective which it utilizes the combination of mathematics, operation research, econometrics, computer science and other related methods for carrying out the economic forecasting [72]. There are few authors combined the use of ML technique with linear forecasting model in doing the forecasting model not only for the vegetable prices [73]–[75] but also for the other aspects [76], [77] to handle both linearity and non-linearity.

From the author’s perspective, the vegetable price might fluctuated seasonally since some of the vegetable species would have the abundant production during specified rich phase and hence those abundant supply of veggies tend to have the lower prices. Therefore, the seasonality have to be taken into account in doing the time series forecasting model. After few reviews done by the authors on the comparison between those two seasonal time series forecasting models which are Exponential Smoothing and SARIMA. SARIMA model outperformed Exponential Smoothing model especially in term of the price forecasting for vegetable [78]–[80]. Besides, the combination forecasting models achieve outstanding accomplishment compared to the single forecasting model [77].

Hence, GANN model which outperformed the other ML methods [74] will be combined with SARIMA model and also employing the wavelet transform as well for the data segmentation to construct a seasonal time series vegetable forecasting model.

6. Conclusion
In conclusion, the outcome of this research is that the food shortage can be handled by means of technology ideally where we can encourage everyone to take part in the agriculture and even have their own agro-businesses online without any physical store. By having the E-Commerce platform, the small-scale farmers whom used to be left behind able to increase their income by involved into the E-Commerce and the platform with the price forecasting model can assist those who are interested in selling their agro-products to have proper management plan in prior to avoid any losses.

The current problem available in agricultural sector of Malaysia inspired the authors about the importance of having an E-Commerce platform with the vegetable price forecasting model. A forecasting model will be constructed and utilized by using the new hybrid approach combining both linear model and neural network model and the accuracy of the price forecasting and prediction should be at least 80% for the local vegetable data. The forecasting model should be functioned well with the accurate forecasting and the data will be illustrated and displayed on the E-Commerce platform to ease the user to trace the future price trend where this design and construction will help in achieving the
policy which derived by the Government while helping the life of the farmers and even the citizen in any possible situation of the food shortage.

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