Periodicals of Engineering and Natural Sciences ISSN 2303-4521
Vol. 7, No. 1, June 2019, pp.302-310
Available online at: http://pen.ius.edu.ba

Implementing E-Commerce model for Agricultural Produce: A Research Roadmap

Tumpa Banerjee [1], Monalisa Mishra [2], Narayan C. Debnath[3], Prasenjit Choudhury[4]
[1] Departement of Computer Application, Siliguri Institute of Technology,Siliguri, India
[2]Department of Computer Science & Engineering, C.V Raman College of Engineering, Odisha, india
[3]Department of Software Engineering, Eastern International University, Vietnam
[4]Department of Computer Science & Engineering, National Institute of Technology, Durgapur, India

Article Info

Received Dec 31th, 2018

Keyword:

Agricultural produce
E-Commerce
Static pricing
Supply
Demand
Perishable nature
Dynamic pricing

ABSTRACT

The advancement in technology and the increase in usage of Internet access has revolutionized the landscape of agriculture using E-Commerce. Several E-Commerce websites are operative in India to promote uniformity in agricultural marketing across the integrated markets by removing information asymmetry between buyers and sellers. Stakeholders are reluctant to utilize this new technology for trading agricultural produces in spite of close opportunities. Pricing mechanism of the online trading portals neither generates maximum revenue during high demand and less supply nor ensures minimum loss due to the decay or down selling of the products. Static pricing mechanism prevents the sellers from joining this online system, as it does not provide many benefits to an online customer. A continuous adjustable dynamic pricing mechanism that can adapt the market condition and quality degradation is crucial for maintaining the seller revenue and customer interest. This paper explains several existing dynamic pricing mechanisms and analyzes their relevance in the field of agro-marketing. In this paper, several research challenges on dynamic pricing approach of E-Commerce have been summarized. The factors like demand, supply, and freshness of the agri-products must be considered for the development of a pricing mechanism in the dynamic environment of E-Commerce.

Corresponding Author:

Tumpa Banerjee,
Departement of Computer Application,
Siliguri Institute of Technology,
Hill Cart Road, Siliguri,West Bengal,India.
Email: tmp.manna@gmail.com

1. Introduction

The internet has led to the miraculous change in society and across the world. The internet has changed the definition of communication, marketing, education, healthcare, etc. Usage of the internet in the agricultural sector may bring revolution in the economy and improvise the livelihood of the farmers. Agricultural E-Commerce facilitates the possibilities of new types of business models by providing farmer to consumer, consumer to farmer, farmer to business and business to consumer services. The implementation of E-Commerce is expected to be more profitable, transparent and competitive[1]. The objectives of E-Commerce include removal of intermediaries benefitting growers and consumers, cross-boundary selling, easy delivery, and price transparency. Agricultural E-Commerce benefits the growers to present their yield in a wider market irrespective of the physical distance and reach the consumer directly. Successful implementation of E-Commerce for agricultural products will help to improve the financial status of the growers and economic growth of the country.

Constituting an E-Commerce portal for trading agricultural products is a demanding task, but operating the system with prosperity is more challenging. The government has been taking several initiatives to promote the e-trading of agricultural produces. Several private organizations are also working on this to ease the transaction over the internet. Many E-Commerce portals are operational and varieties of products are being traded, but vegetables are yet to get success. Stakeholders are reluctant to utilize this online system for selling and purchasing of agri-products. Very few people are using this new marketing system for which the achievement of success is taking time. The pricing mechanism of the existing E-Commerce portal neither maximizes revenue nor minimizes loss for the grower. The consumers are not taking interest in online shopping because they are not getting any advantage in product price. E-Commerce of agri-product is not profitable for both the buyers and sellers. Because of the relatively new form of E-Commerce in agri-market, many features of traditional E-Commerce is yet to deploy. Improvement in the pricing is required for the successful execution of the system. Dynamic pricing mechanism is important to adapt the real-time supply, demand, and freshness of the product.

2. Background

At present, many agricultural E-Commerce websites are operative in India but are still in its inception. Various features of E-Commerce are not yet implemented and many strategies are not considered in agricultural products. This paper discusses the operations and limitations of some agricultural E-Commerce websites active in India.

Indian government initiated the Electronic National Market (e-NAM) and AgMarket to promote the uniformity in agricultural marketing across the integrated markets by removing information asymmetry between buyers and sellers. The farmers are able to discover the real-time price of any product based on actual supply and demand and trade electronically with the APMC mandis. Presently, 585 Agricultural Produce Market Committees(APMCs) are connected to the e-NAM network from 16 states and 2 Union Territories. The portal has been launched in 2016 but has not been fully functional in any state, only ten percent of total mandis are doing online trading [2]. Agents have monopolized the conventional APMC forcing the desperate farmer to sell his yield at a lower price, they are not allowing electronic trading using e-NAM.

kisanpoint.com is a trading platform active in Chittor in Andhra Pradesh, India, which sell products like pesticides, fertilizer and seeds etc for farming. Business area of this platform is limited, and the customer has to purchase a minimum of Rs. 2000 to avail this online shopping. This E-Commerce website provides business to farmer service, aimed to link the businessman with the farmer. It simplifies the purchase of a farming product of the farmer but cannot ease the marketing of their yields.

Another E-Commerce portal Mandi5.com has been started by Strawberry Technologies to simplify the supply chain for agri-products. It aims to provide a better rate to the farmer thus reducing the cost of fresh products to the buyers. This portal also connects the farmer to the business and has not been fully functional.

Agrozones.com is another E-Commerce platform for selling agricultural produce all over India. It envisages for selling a wide variety of agri-products like fruits, vegetables, seeds, cereal, pulses etc, but only a few dry fruits and seeds are trading now.

BigBasket is one popular online supermarket operating in 26 cities in India deliver high standard goods at lower prices, including spices, fruits, and vegetables. They buy products from leading suppliers and farmer, store in warehouse and serve the order to the customer from the warehouse. For perishable products like vegetables, they link with the local farmer and purchase the product based on order since the handling of a perishable product is the most complex task in supply chain management.

Several issues cause the failure of e-trading of agricultural produces. The issues in general, which affect the objective of implementing e-trading in the field of agri-products are as follows:

(i) Price determination: Seller in the conventional market meets with other sellers and set price of the product based on supply, demand, competitors' price, quality and freshness of the products. In electronic marketing sellers are unaware of total supply, competitors' price and cannot estimate the demand for the product, the seller gets difficulty in determining the selling price. The E-Commerce portal should determine the selling price on behalf of the seller by taking into consideration the above mentioned factors.

(ii) Wastage due to unsold: Consumer postpones his purchase decision if the selling price is greater than the reference price and the leftover products become black-legged in the next period. Agricultural products will not be in marketable condition and get wasted after a certain time. The seller will suffer from the loss incurred from unsold due to huge supply. Demand and pricing are co-related to each other. The demand for the product can increase by reducing the selling price of the less fresh product. The current E-Commerce websites do not secure their returns on investment in situations where supply is more than demand.

(iii) Revenue generation for the seller: In the conventional market, the seller takes advantage when the supply of the product is lower than the demand of the product. He tries to maximize his revenue by setting a higher price of the product, which can compensate for his loss owing to unsold and decomposition. In the electronic environment, sellers are unable to tune the price of the product depending on real-time supply and demand. The operational websites use static pricing mechanism and fail to generate maximum revenue for the seller.

(iv) Fair Price for the consumer: E-Commerce reduces the transaction cost by removing the middlemen between farmer to consumer and benefits pass to the grower and buyer. E-Commerce is expected to reduce the product price for the buyer. But the price of the product does not attract consumers. It is required to raise the consumer interest towards online shopping of agri-product to make the e-trading fully operational. Price of the existing E-Commerce portals does not attract the consumer.

3. Effect of Existing Pricing Mechanism in Agricultural E-Commerce

The primary objective of implementing electronic trading in agricultural produce is to provide a better price to both the grower and the consumer by removing the middlemen. Better pricing means the selling price is high enough to generate revenue for the grower and low enough to attract the consumer. The present pricing mechanisms are not customer responsive which causes failure of agricultural E-Commerce. The effects of the existing pricing mechanism are as follows:

(i) Inept auction mechanism: E-NAM uses an auction mechanism to set the price of the product based on the real-time supply and demand. An online auction is a logical space where sellers and buyers meet and conduct transactions. Millions of auctions take place online every day for divers' goods ranges from antique to collectibles. But the existing auction strategy used by e-NAM is not appropriate for the perishable items because the participants submit their bids for the same product throughout the duration and the result is declared after the completion of the time period. The quality of the item may not be the same for this entire time period. The quality of few items may reduce and bid value may not increase, even decline. So, the time-variant auction mechanism will be worthwhile for marketing the agro-products. The current mechanisms are unable to function in the worst situation. No clear strategy has been mentioned what the seller needs to do with the remaining resources left with them when the buyers' willingness to pay does not match with the seller's price. It is again painful for them to sell the remaining product physically.

(ii) Uncertainty in cost recovery: The static pricing mechanism sets a static selling price of the product for the entire life in the virtual market until the seller himself change the price. Selling price may be high enough to attract consumer and the static mechanism does not allow changes in the price as well as demand. Perishable product lost its freshness over time, which should reflect in the price of the product to maintain the demand. Because of huge supply, it is often required to reduce the price lower than the base rate to increase the sell and return on investment. The static pricing puts the seller at higher risk of loss due to unsold or decomposition.

(iii) Inadequate revenue: In the conventional market, the seller charges more for a product when they realize the supply of the said product is comparatively low. Thus, they generate revenue because sometimes they are bound to sell their product at a lower price or unable to sell their entire product

due to huge supply. Sellers are unaware of supply and demand in the online system, therefore they cannot set the price accordingly. Pricing mechanism does not ensure maximum revenue in case of low supply and high demand.

(iv) Customers' apathy: Removal of middlemen benefits the growers as well as customers, but the price of the present system does not indicate this. The price should be decided by the seller and the customer at the time of the transaction. In static pricing mechanism, the seller himself sets the price of the product without considering the customer's willingness to pay. The consumer does not get an advantage in terms of price from this online system. Consequently, customers are not forwarding the evolution of agricultural E-Commerce.

Setting the optimal price of the product based on price influencing parameters is crucial to the successful execution of e-trading. The dynamic pricing system will be helpful to solve the above-mentioned problems in this regard.

4. Dynamic Pricing Mechanisms: Context of E-Trading of Agri-Product

A continuously adjustable dynamic pricing mechanism is required which can adapt the changing market conditions constantly, consider the perishable nature of the product and maintains the seller's revenue and customers' interest. The dynamic pricing mechanism provides the right price of the right product at right time to the right person. Implementation of dynamic pricing in the field of agriculture is crucial to sell out all the agri-products by their lifetime and to ensure profit to the seller. Enormous researches have been done in dynamic pricing of perishable product but are not relevant to this study of agri-product.

Author Chunlin Luo. et al proposed a dynamic pricing policy [3][4]in a market of monopolist sellers and a fixed number of perishable products was sold during a finite time horizon. It is considered that the valuation of the product is zero once the sales time over. In this case, the authors assumed that product value is decreasing over time and the price of the product is determined based on the time only. This model did not consider the demand for the product and the amount of leftover items. This model is suitable for electronic products, fashion apparels and seasonal goods where the lifetime of the product is long, but not for vegetables whose lifetime is a few days to weeks only.

In dynamic pricing mechanism, the prices of the product vary with the real-time supply and the demand is regulated by the selling price and consumer preference price. A price has to set considering that the demand of the product will meet expected demand. The future demand can be predicted, but hardly satisfy. Most researchers deal with the problem by extending the single distribution, to a set of distribution to which the real demand distribution belongs. LI Gen-dao. et al studied the dynamic pricing problem in random fuzzy environment[5]. But the model didn't acquire the dynamic attribute of the system completely and can be resolved at the beginning of each period.

In [6], Piril Tekin focussed on ANN design using PSO algorithm and it has been shown that the performance of the proposed model is more efficient than the normal model. In this case, the author considers that the price of the product is based on shelf life and freshness of the product. This model is not suitable for the vegetable market because the price of the vegetable does not only depend on the freshness of the product but also on supply and demand of the product.

In the context of online trading, Xing Wang. in [7] classified the consumer in two categories: strategic consumer and conventional consumer and two linear functions consider as demand functions for advance selling stage and normal sales. A two-stage pricing model has been proposed which can help the companies to maximize their profit. But the proposed model does not consider the quality degradation of the product over time, which is the utmost factor to determine the price of the perishable product.

The authors Xu Lie. et al proposed a dynamic production and pricing model [8] of perishable product in supply chain management. The buyer takes the purchase decision after compiling the selling price with reference price. If the buyer postpones his purchase decision, the leftover buyer and the products blacklegged into the next period. The production decision for the next period will be taken based on demand and price in the previous period. This paper takes into account the manufacture of electronic products involving a finite period lifetime. Vegetable marketing is different from the electronic product marketing; production of the vegetables cannot regulate within its finite period life cycle.

In [9], Takeshi formulated a pricing problem focusing on discount sales at a certain time of the day for daily perishable products. The model analyzed the reference effect and the amount of inventory.
The authors Jaekwon Chung. et al in [10], studied a dynamic pricing model by taking predefine shelf life, remaining shelf life and discount rate into consideration and prices of the products always decreases over time. The less fresh product may be sold at a higher price in vegetable market when the demand for a product is very high compared to supply.
Dynamic Pricing problem is a nonlinear optimization problem. In [11], Alexander stated that the price will have to be tuned in a sophisticated way to obtain the benefit of dynamic pricing and the demand of the product should not reduce as the result of price changes. So any dynamic pricing model requires establishing how demand responds to the changes in the price. He used Kuhn Tucker condition for solving nonlinear optimization to solve this and it steers to utmost expected profit by time. In 2010, he proposed a deterministic as well as a stochastic model for a time dated items and a stochastic model for items with salvage value where price is directly related to the inventory level. But the author admitted that aforesaid mathematical models faintly represents the real-life situation, only characterize the relationship between price and customer purchase behavior.
Many researchers use reinforcement learning to model this dynamic pricing model. Raju et al in [12] investigated the use of reinforcement learning techniques to the problem of determining dynamic prices in an electronic retail market. They considered a single seller market and model the problem as MDP, two seller market problem as a stochastic game following RL based adaptive behavior. Authors demanded that the models can be generalized to the case of more than two sellers.
The authors Rupal Rana. et al, have proposed a model free approach considering the demand behavior of the customer by a particular distribution [13] . The seller can determine the selling price without knowing the structural form of the demand function and competitors' prices. This model may also help to determine the current demand level, which is useful to optimize the pricing strategies. This solution of the dynamic pricing problem is suitable for the industry like airlines, hotels, and fashion where there is a fixed deadline for selling a given inventory in an attempt to maximize revenue.
In [14], Narahari classified customers into two segments: captives and shoppers, according to their purchase behavior. A single seller retail store has been considered, which sells a selected product and provides a discount on the shopping of more than one unit of product. They set up a Markov decision process model and RL framework for dynamic pricing problem and use Q-learning to learn the dynamics. They have demonstrated that reinforcement learning strategy can also be used to determine optimum order amount, reward point and volume of discount to be offered to maximize seller's revenue.
Y Narahari. et al in [15] have used reinforcement learning (RL)to study price dynamics in multi sellers electronic retail market. The customers are classified in two categories; price sensitive customers and lead time sensitive customers. They consider two cases: (i) no information case: sellers are unaware of the customer queue level, inventory level and the price of the competitors (ii) partial information case: the seller is acquinted with the said parameters. Q-Learning algorithm is used to implement a pricebot or automated pricing agent and compare the performance with that of other running pricebots for no information case. The partial information case modeled as Markovian game and formulated it in the RL framework.
Kavyashri and Nitin in 2016 considered a neural network model for dynamically adjusting prices of the product [16][17]. Neural network processes the information just like a human brain. In [16], it considered five attributes, product stock, delivery time, discount, rating and competitor's price to determine the selling price of the product in order to maximize seller's revenue. These five factors and production cost consider as the inputs of the neural network and backpropagation algorithm is the widely used method for calculating the error derivative of the weights. The research paper [18] present an optimization technique of price using neural networks with reduced time complexity and it also helps to know the product that is in demand.
The research work in [19] proposed PSO trained neural network to adjust price over time based on the quantity demanded. The author assumed that PSO-trained neural network can simplify the calculations of the least variable cost function that is the main factor in dynamic pricing.
The paper [20] is devoted to predicting the customer's offer price which could result in securing orders in the electronic business environments and introduce a number of neural network based models for performing time series forecasts of customer's offer price.
Anusha et al in 2017 studied the pricing structures based on the number of the same item in an order and search for the best bundle/price niche [21]. They proposed several models based on neural network and hill climbing with different parameters to determine optimal bundle/price and also analyzes their complexity.

Research works in [18][19][21][22],have proposed dynamic pricing models by taking several factors of price determination into account excluding remaining lifetime of the product.
The present literature on dynamic pricing aims towards revenue generation considering various prices influencing factors such as supply, demand, competitors' price, freshness, etc. Most of the studies focused on maximizing revenue and cost reduction with time did not focus on the return on investment. In the case of agricultural produce, the valuation of the product is zero after spoilage, therefore, the amount of perishable product spoilage is required to curtail by raising the demand [6]. The selling price reduction is the only option for raising the demand for a less fresh product. This price reduction due to perishability is also not uniform throughout the product's life. Raising the selling price of a low supplied product may initiate some extra profit without affecting the demand. The effects of all factors such as supply, demand, and age-sensitivity have to be considered for pricing of agri-product on dynamic environments. Table-1 depicts how the dynamic pricing mechanisms of present literature use the price influencing parameters of agricultural produce. The pricing mechanism that considers the supply, demand and age profile of the agri-product of dynamic environment is imperative to attain the awaited success in the field of agricultural E-Commerce.

Table 1: Price influencing parameters of different dynamic pricing mechanisms.

	Supply	Demand	Quality	Freshness	Amount of left overitems	Considered Parameter
Chunlin [3, 4]	Y		Y	Y		
LI [5]	Y	Y				
Piril [6]			Y	Y		
Xing [7]	Y	Y				
Xu [8]	Y	Y	Y	Y		
Takeshi [9]	Y		Y	Y		
Jaekwon [10]			Y	Y	Y	
Alexandre [11]				Y		
Raju [12]						Customer Behavior
Rupal [13]				Y	Y	
Narahari [14]		Y				
Narahari [15]		Y				Customer Behavior
Kavyashri [16]	Y					Delivery Time, Ratings
Nitin [17]			Y			Production Cost
Topu [18]						Competitors price, Production Cost
Lian [19]				Y		Quantity Demanded
Yevgeniya [20]		Y				Competitors Price
Anusha [21]						Number of same item in a order

5. Challenges in Dynamic Pricing

A plethora of research has been done on dynamic pricing mechanism in the field of E-Commerce but none considers all the price influencing parameters of the agricultural product. Developing a dynamic pricing approach considering all these parameters is nontrivial and there are several challenges in the development of dynamic pricing mechanism in agricultural produces.

(i) Supply prediction: The market price is determined by demand and supply. Price of the agricultural produce changes with the amount of production. Agricultural produces cannot be stored for long period. Sellers have to dispose of their entire amount of yields within the lifetime of the products. The seller is compelled to sell his entire yields at any price when the products are going to perish. Supply has maximum control over the price of the perishable product. Government estimates the production in respect of major food grains, oilseed, fiber etc based on amount rainfall and previous year productions. Statistical data need to be released from the authorized organization to predict the supply of the product otherwise it is very hard to estimate the total supply of a product in a market in advance. The supply model can also be helpful to estimate the supply of product from the past data.

(ii) Demand prediction: Demand represents the willingness to purchase a product. Marketers use to estimate the total demand for the product to determine the selling price. The accuracy of the demand forecasting of agricultural products logistic is beneficial for the seller to control the selling price [22]. Effective match of supply and demand can help the seller to reduce the uncertainty of demand and wastage of the products because of unsold. The difficulty of demand prediction of agri-products lies in the accuracy and investigation. Historical data of demand amount is required to model the demand estimation of the agricultural product but the official statistics have not been released, researchers have to investigate for that. Maximum people purchase their daily vegetables from the local retailers and the local retailers have little concept of statistical data which creates complicacy in getting accurate sales data. But the supermarket has a definite amount of historical data, which will be precise data. In [23], the authors provided an ARIMA based forecasting model for accurately forecasting the demand of the agricultural product and claimed that the accuracy of their prediction is 89%. The model can forecast the future from the past value which is unknown. A probability distribution is required to determine the demand for the product based on the price of the product and the probability of purchasing the product by a customer.

(iii) Price changing with attrition: Perishable nature of agricultural produce affect the pricing of the produce. Sellers are bound to sell their produce at a lower price to create demand for the less fresh product. Seller is forced to charge a high price at the beginning to compensate for this anticipated loss. The attrition rate of all the agricultural products is not the same. It is also unpredictable to decide the reduced price with deterioration. The less fresh product can get a high price when there is a huge demand compared to supply. Amount of remaining product to sell within the stipulated time is also one important factor inclusion of perishable nature. Measuring the price reduction with the age of the product is very hard.

6. Conclusion

The rapid growth of internet use over the last five years has given the opportunity to adopt the new technology and experience the service of the cloud. Agricultural E-Commerce can ameliorate the financial condition by remarkably reducing middlemen costs from the supply chain and can build a hearty relationship between farmers and consumers. The existing online trading portals are unable to accomplish the objectives of agricultural E-Commerce. Participants are afraid of loss that may incur from unsold or decomposition. Implementation of dynamic pricing is imperative since product price varies with real time supply, demand, the freshness of the product. Plenty of research has been done on dynamic pricing model, but inconsequential to vegetable marketing.

By studying the existing work we have seen that there is a gap between the dynamic pricing model for trading agricultural produces over the internet and other perishable products. The major part of the existing researches did not consider all the price influencing factors like supply, demand, lifetime, and remaining lifetime etc. There is still space for studies on pricing model for agri-products on dynamic environment. We have also discussed the various benefits of dynamic pricing and concluded that it is difficult to achieve a higher degree of success without this in the field of electronic trading. As future work, our aim is to propose a suitable dynamic pricing model for e-trading of agri-product.

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BIBLIOGRAPHY OF AUTHORS

Tumpa Banerjee received her MCA degree from National Institute of technology, durgapur in 2007. She is currently Ph.D. student of National Institute of technology, Durgapur and working as Assistant Professor in Siliguri Institute of Technology, Durgapur. Her research interest include data analysis, data mining and soft computing.

Monalisa Mishra} {received her M.Tech degree from KIIT University, BBSR in 2011. She is currently Ph.D. student of National Institute of technology, Durgapur and working as Assistant Professor in C.V Raman College of Engg., BBSR, Odisha, India. She has published more than ten papers in international and national journal and conference proceedings. Her research interest includes Wireless Sensor Networks, IoT, Image Processing, Neural Networks.

Narayan C. Debnath has been a Full Professor of Computer Science since 1989 and currently the Chairman of Computer Science at Department of Software Engineering, Eastern International University, Vietnam. He is also serving as the Director and Past-President of the International Society for Computers and Their Applications (ISCA). Dr. Debnath is a recipient of a Doctorate degree in Computer Science and a Doctorate degree in Applied Physics (Electrical Engineering). In the past, he served as the President, Vice President, and Conference Coordinator of the International Society for Computers and Their Applications (ISCA), and has been a member of the ISCA Board of Directors since 2001. He served as the Acting Chairman of the Department of Computer Science at Winona State University and received numerous Honors and Awards. During 1986-1989, Dr. Debnath was a faculty of Computer Science at the University of Wisconsin-River Falls, USA, where he was nominated for the National Science Foundation Presidential Young Investigator Award in 1989.

Prasenjit Choudhury has been working as an Assistant professor in Computer Science and Engineering department in National Institute of Technology, Durgapur, India, since 2000. He has received his Ph.D. degree in Computer Science and Engineering from National Institute of Technology, Durgapur in 2014. He received his M.Tech and MCA degree from National Institute of Technology, Durgapur in 2008, and Jorhat Engineering College, India in 1995, respectively. Focusing on data analysis and security, he has published more than fifty papers in international and national journal and conference proceedings. His research interest includes Big data Analytics, Data Mining, and Security and Service management in Mobile Ad-hoc Network.