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RESEARCH PAPER

Providing a System Dynamics Model to Evaluate Time, Cost, and Customer Satisfaction in Omni-Channel Distribution: A Case Study

Ahad Hosseinzadeh[1], Hamid Esmaili[1*], Roya Soltani[2]

1. Department of Industrial Engineering, North Tehran Branch, Islamic Azad University, Tehran, Iran
2. Department of Industrial Engineering, KHATAM University, Tehran, Iran

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Abstract
The shopping experience in Omni-channel distributions is influenced by the physical environment of the buyer, delivery time, and the cost of production to distribution of the goods which have a significant impact on customer loyalty and customer satisfaction. This study presents a system dynamics approach to identify the variables affecting the three aspects of customer satisfaction, cost, and delivery time, as well as the relationships among these variables in omni-channel distribution. By reviewing previous studies and expert opinions identifying important variables, followed by generating different scenarios in the Vensim software, the optimal values of the important variables are estimated. It is observed that by approaching the values of the fourth scenario – increase in the amount of market competitiveness indices, customer referral rate, marketing costs, technology etc. and decrease in the maintenance costs – the highest customer satisfaction and the lowest cost and delivery time can be achieved.

Keywords: Omni-channel distribution, System dynamics, Customer satisfaction, Cost and delivery time.

Introduction

Nowadays, there are many channels for people to search and purchase the products in light of the growing influence of mobile apps and digital contact points on the people purchasing behavior. It means that sellers have nowadays more opportunities to connect with these customers. However, it makes the implementing of the marketing operations difficult (Cummins & Peltier, 2016; Hendalianpour et al., 2020). A customer's journey may begin by searching a product's information and continue on social sites or emails. The ideas on the product can be also exchanged and discussed in cyberspace or social and friendly environments. The final purchase takes place in a store or online. Communications after the purchase can also be directed towards the customers through different channels (Bala & Arshad, 2017). Customers are constantly changing omni-channel experiences. They want to transfer the interactions on one channel (or device) to the next interactive channel.

New communication channels define new factors affecting the sales and decisions of the consumer. In multi-channel methods, channels operate separately and often compete with each other. In this approach, there is a high variety in various channels in terms of product information, price, consumer experience, and service level. Omni-channel manages, predicts, and supports all customer purchasing experiences on all channels (such as physical presence in store, print media, and on phone) and online (such as websites, weblogs, emails, mobile

* Corresponding Author, Email: h_esmaili@iau-tnb.ac.ir

apps, social networks, etc.), in a way that the transition from one channel to another is performed properly and efficiently for the customer in the purchasing process, without a change in his or her purchasing (Lim et al., 2018; Hendalianpour 2020).

This paper presents a system dynamic approach to identify the variables affecting the three aspects of customer satisfaction, cost, and delivery time, as well as the relationships among these variables in the Omni-channels. First by reviewing previous studies and expert opinions, the important variables are identified. Then, by generating different scenarios in the Vensim software, the optimal values of the important variables are estimated.

Review Literature

Omni-channel commerce involves mixing traditional commerce with online commerce by integrating the processes across the organizational and information technology chain. A study by Irani et al. (2011) sought to examine how a company can select the best intermediary for its marketing channels with the minimum criteria and time. The purpose of Hendalianpour et al. (2019) paper was to design a practical scale for measuring structure through the perspective of retailers and store retailers. It also involved external logistic partners in these processes. In a study conducted by Verhoef et al. (2015), it was shown that omni-channel retailing aims to know how the purchasers are influenced by their searching and purchasing process and these channels. Architecture integration and data adjustment with active relational technologies have been developed in the paper written by Li et al. (2015). Beck and Rygl (2015) classified the retailing into multi-channel, cross-channel, and omni-channel retailing by reviewing the literature. Then, they proposed multiple retailing classifications. The aim of the study conducted by Hübner and wollenburg (2016) was to show how retailers are developed from independent multi-channel to an integrated omni-channel. Ishaq et al. (2016) identified the process of store-based retailer physical distribution to integrate the online channel into the business model. Picot et al. (2016) followed two objectives in their research. First, they evaluated the challenges of online retailing by coordinating the bricks strategy and the Omni-Channel outlook. Second, they identified the possible methods of overcoming these challenges in order to succeed in implementing the Omni-Channel strategy.

Mena and Bourlakis (2016) reviewed 27 articles on the Omni-channel. The aim of Hagberg et al. (2016) paper is to analyze the phenomenon of digitizing the Omni-channel retailing by creating a conceptual framework that can be used for further defining of current changes in the retailing and consumer interface. Saghiri et al. (2017) stated that Omni-channel systems can be built on a three-dimensional framework. These three dimensions, which should be considered for the Omni-channel system, are the channel stage, type, and agent. The study conducted by Huré et al. (2017) aimed to investigate the Omni-channel purchase value by empirical studying and testing the Omni-channel model based on the purchase value literature and reviewing the Omni-channel literature to identify the key characteristics. The study conducted by Manser et al. (2017) presented an integrated marketing communication framework to know how distinct customer communication points influence customer interaction and profitability in a multi-channel environment and indicated that the emergence of Omni-channel marketing destroys the silos. Ailawadi and Farris (2017) developed a basic framework for distribution management and explained the criteria relevant to each element of the framework. Murfield et al. (2017) examined the effect of the quality of logistics services on consumer satisfaction and loyalty in the omni-channel retail environment.

Park and Lee (2017) evaluated customer channel selective behavior from the perspective of customer behavior, sociology, and collaborative communication strategies. In a study conducted by Bloom et al. (2017), the effects of using consumers' digital information tracking

in the in-store advertising design on purchasing behavior and brand image were investigated. The purpose of the study conducted by Galipoglu et al. (2018) was to identify, evaluate, and determine the structure of studies carried out on omni-channel retailing and to show the intellectual basis of omni-channel retailing studies from a supply chain management perspective. Marchet et al. (2018) examined how companies have included the logistic variables into their omni-channel management strategy and business logistics models that have been adopted recently. Jensen (2018) followed two goals in his work, including developing a deeper understanding of the business channel management and its structure and a better understanding of what consumers expect from the retail industry and its reason. Wollenburg et al. (2018) stated that the realization of customer orders played a major role in omni-channel retailing. The aim of the study conducted by Kembro et al. (2018) was to enhance the understanding of how design and warehouse operations are influenced by the move to integrated omni-channel.

Wollenburg et al. (2018) analyzed the internal logistics networks used to provide service for customers across the channels using an exploratory study with retailers of different backgrounds. Focusing on support and competition criteria, Kim and Chun (2018) analyzed their effects on retail strategies of manufacturers when a new online channel is added to the company via the Internet or mobile device. Zhang et al. (2018) evaluated the customer behavior and reaction in the new Omni-channel environment and emphasized consumer empowerment. Hosseini et al. (2018) presented an economic decision model based on the Markov chain, which considers offline and online channels, open and closed channels, non-repetitive customer journeys, and customer channel preferences. The aim of the study conducted by Gawor and Hoberg (2018) was to find monetary and management metrics for implementing B2C-type retailers' omni-channel strategies by examining contracts between the due date, time of delivery, the convenience of delivery, and overall price. Daugherty et al. (2018) aimed to investigate the logistics customer service (LCS) published in leading logistics journals from 1990 to 2017 in order to develop weapons for supply chain researchers to address the emerging problems related to customer service in the omni-channel and retail e-commerce.

Von Briel (2018) conducted a four-stage Delphi study on the future of omni-channel retailing with 18 retailers. Tao et al. (2018) evaluated the effect of an omni-channel strategy, using a dynamic system model based on the performances of X retailing Company in China. A study was conducted by Kang (2019) to evaluate the relationship between the lifestyle of socio-local consumers as individual characteristics and to recognize the value of physical and online exhibition and sales in the omni-channel. Pakdel and Seifi (2019) examined pricing in a two-channel sales network, including selling products through a traditional retailer, physical goods, and a direct Internet channel. The aim of a study conducted by Sankaranarayanan and Lalchandani (2019) was to provide an omni-channel architecture for air travel plans that make it possible to access integrated and up-to-date travel information across the channels. In his study, Akter (2019) aimed to conceptualize the virtual, physical, and integration quality. Ryu et al. (2019) examined the retail companies in the domains of cloth selling or fashion items. Paul et al. (2019) described a new capacity-sharing strategy in Omni-channel retail distribution. Hendalianpour et al. (2020) have optimized a multichannel distribution network, multi-level Omni, and the flow of intra-network product delivery under unknown conditions through a multi-objective mathematical model.

As can be seen from previous studies, studies such as Hübner et al. (2016), Bloom et al. (2016), Murfield et al. (2017), Marchet et al. (2018), Paul et al. (2019) and many others have been explored. Meanwhile, limited researches such as Hosseini et al. (2018), have utilized the Markov chain for the first time; Abdulkader et al. (2018) have used a two-step hysterical

approach and multiple ant colony algorithms; Gawor and Hoberg (2018), have used Dynamic Systems; Sankaranarayanan and Lalchandani (2019), have utilized the log-log; Tao et al. (2018) have used regression model, with the help of machine learning algorithms, and a limited number of other researchers have provided models using other techniques. This information shows that limited research has been done in applied fields using system dynamics. However, in this article, system dynamics method was used to provide a model to achieve optimal time, cost, and level of customer satisfaction in omni channel distribution systems. Moreover, a small number of previous studies have addressed the comprehensive view of a business in this area. Therefore, in this study, the impact of different variables on each other and the target variables of the problem have been examined comprehensively and seamlessly. On the other hand, by examining the literature on the subject, it was shown that there were a small number of articles on the distribution network of a supply chain in general and a handful of authoritative articles on the new omni-channel's method of distribution or retailing. On the other hand, despite the various fluctuations and uncertainties ahead, the distribution network was assumed to be stable in almost all previous studies, which reduced the accuracy of the results of the research. Therefore, this study aimed to determine the important and influential indicators in the Omni-Channel distribution system to establish a connection between communication strategies and measurement criteria, and to plan a set of goals, set an innovative strategy, and optimize time, cost, and satisfaction. Customer satisfaction in the distribution network was done by designing a system dynamics model.

Attention: we do not mention the name of the companies due to the competitiveness and the commitment of the researcher not to disclose the company information.

Methodology

System dynamics is a management tool for making a decision on dynamic systems to simulate and understand complex systems using mathematical modeling. In other words, the dynamic system is a way of understanding the dynamic and continuous behavior in complex systems (Sosnowska et al., 2019). As the dynamical system approach considers the effect of each of these factors on each other in addition to the factors affecting the research resilience, the results have good validity (Nguyen et al., 2017). This study aims to reduce the costs and time, and enhance customer satisfaction by considering uncertainties in the distribution and retail network, especially uncertainty in demand (Figure 1).

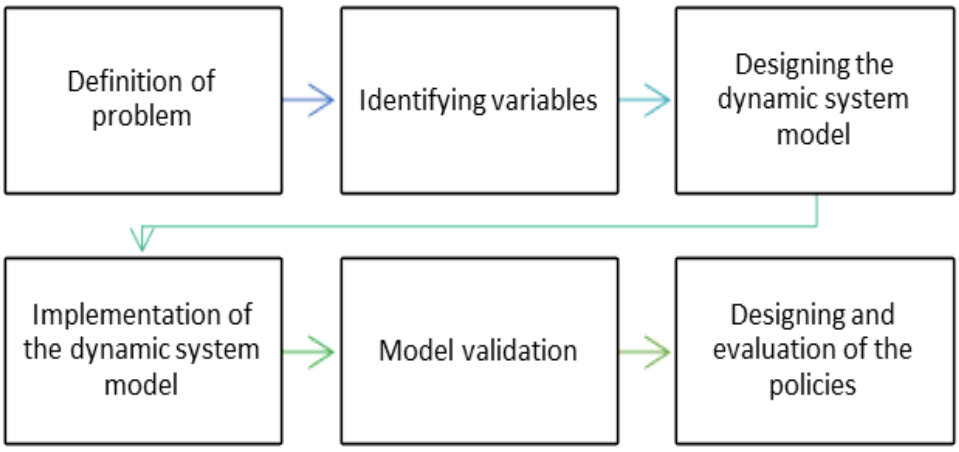

Figure 1. Research Steps

Modeling and Data Analysis

Defining the Problem by Review of the Literature

The correct definition of the problem, assumptions, goals, and the results expected to be derived from the problem will help to obtain the correct results (Bloom et al., 2017). We experience significant growth in online sales in the world with the expansion of the Internet use and the developments in the area of designing the apps. The evidence of this issue is an increase in sales on the available online channels (Hübner and kuhn, 2016). The retail digitizing process has had a large impact on the distribution and retailing of the supply chain and has changed the retailing structure. Although online commerce is expanding increasingly and mobile devices play a major role in this regard, physical stores are still the key retail space. Customers who have access to digital tools have more information and capability to purchase.

The omni-channel purchaser is always connected to the internet through communicative tools such as mobile or computer and is aware of market changes and new products, finds the best deal, and receives each purchase at the desired time and place. The omni-channel approach is the logical evolutionary step following the multi-channel approach and includes all ways of purchasing. In this approach, the consumers' experience in each channel is the same and switching from one channel to another will not lead to receiving new or different information. This coordination in presenting the information shows the omni-channel as more complicated than traditional multi-channel approach. The omni-channel retailing has activated many businesses and has enabled them to invest in new opportunities. There are many different selling channels in the business process, but the term omni suggests that customers can purchase through all channels, and all information on the purchasing process is ideally available in real-time across all channels (Li et al., 2015).

Given what was stated above, increasing trends in distribution costs, restricted access to financial resources and liquidity, the complexities governing the financing methods, and the difficulty in managing the accounts payable and receivable across the chain and so on have led into supply chain management. Supply chain financial management, especially in the distribution sector, helps companies focus on the whole chain beyond their enterprise in order to optimize these financial processes. This holistic approach focuses on cooperation with other members of the supply chain. It has been generalized as an appropriate approach to manage the financial flows in order to protect the strategic components of the supply chain. Therefore, new considerations arise in creating coordination between the financial management and the logistics management and distribution channels that create new business areas, especially for banks and financial services organizations (MC Crory, 2011). Optimizing the cash flow in the distribution system operating processes not only satisfies the chain stakeholders but also enhances the efficiency of the distribution system and leads into a win-win approach for both financing institutions and distribution companies.

Identifying the Research Variables

Based on the available data and the existing documents as well as previous studies and interviews with the experts, the data needed for this research were identified and shown in Table 1.

Table 1. Key Variables Affecting Customer Satisfaction, Delivery Time and Cost

Indicator	Auxiliary* / Rate variable●	Corresponding state variable	Input* / Output●	Index explanation
1.Consumer geographical density	*	Delivery time	* ●	Population measurement per unit area or unit of volume
2.Consumer physical convenience	*	Customer satisfaction/cost	* ●	Easy access to the channel by consumers
3.Consumer time convenience	*	Customer satisfaction/cost	* ●	Fast access to the channel by consumers
Demand volume.4	*	Delivery time	* ●	Demand per unit of time
5.Order response time	*	Delivery time	* ●	Demand response time
Order visibility.6	*	Delivery time	* ●	Track the order path
7.Product availability	*	Customer satisfaction	* ●	Product access rate in the chain
Product variety.8	*	Customer satisfaction	* ●	The variety of products offered on the channel
9.Product customizability	*	Customer satisfaction/ cost	* ●	The level of customization of the products offered in the channel
10.Product returnability	*	Customer satisfaction	* ●	Ability to return the product to the channel, such as returning a defective product
Service capacity.11 1-11 (Lim et al., 2018)	*	Cost	*	Sufficient capacity at all times to meet agreed needs
12.Amount of customers that place the order	*	Cost	* ●	Location density of customers in each region
13.Attractiveness increment rate	●	Customer satisfaction	* ●	Increasing the rate of attracts of target audience
14.Annual order income of each Customer	●	Customer satisfaction	* ●	
15.Average order rate	●	Cost	* ●	The average order in the units of time
16.Application of Technology	*	Customer satisfaction	* ●	How to use different types of technology in the channel
17.APP active users scale	*	Customer satisfaction	* ●	Users use different applications
Value creation.18	*	Customer satisfaction	* ●	Relatively valuable value that is mentally targeted by the user or the buyer understands
19.The ability to meet customers' demand	*	Delivery time/cost	* ●	Ability to respond to customer orders
20.Brand attractiveness	*	Customer satisfaction	* ●	An individual's inner feeling about a product, service, or company
21.Commodity income	*	Customer satisfaction	* ●	The amount of income from the sale of goods and services
22.The capacity of the supply chain	*	Customer satisfaction/ cost/ delivery time	* ●	Ability to generate output at a specific time
23.Demand adjustment	*	Delivery time	* ●	Natural demand process with existing capacities
24.The gross profit	*	Customer satisfaction	* ●	The difference between income and production costs of a product or service, before deducting costs; Salaries, taxes, and interest
25.Active users	*	Customer satisfaction	* ●	Number of active users in channel applications per unit of time
26.Industry competition coefficient	*	Customer satisfaction	* ●	The ability to increase market share or profitability and stay competitive
27.Impact factor of retail enterprises	*	Customer satisfaction	* ●	The extent of their effects on satisfaction and customer orientation, coct, ETC.
28.Improvement of service quality	*	Customer satisfaction	* ●	Improved overall service efficiency
29.Product selling price	*	Cost	* ●	It is the amount that is demanded from the customer for each product or service

Table 1. Key Variables Affecting Customer Satisfaction, Delivery Time and Cost

Indicator	**Auxiliary*** / **Rate variable●**	**Corresponding state variable**	**Input*** / **Output●**	**Index explanation**
30.Order growth rate	●	Customer satisfaction	*	Increase the order per unit time
31.Total order cost	●	Cost	●	Costs to obtain additional inventory such as communication costs for ordering, transportation costs, etc.
Users' experience.32	*	Customer satisfaction	*	Interactions with customers
33.Users' retention rate	●	Customer satisfaction	●	Customer retention rate over a period of time
Reliability.34 11-34 (Tao et al., 2018)	*	Customer satisfaction	* ●	The ability of the set to be continuously repeatable with similar results
35.Warranty	*	Customer satisfaction	* ●	More than the Guarantee period to cover the cost of repairing and replacing parts
Responsibility.36	*	Customer satisfaction	* ●	Commitment for doing one or more things
37.Customer Relationship 35-37 (Mangipudi, & Manivannan, 2016	*	Customer satisfaction	* ●	It describes ways in which a company can connect with its customers to gain a good product and service experience.
38.Fixed and Operating Cost of Distributor Installation	*	Cost	*	Fixed and current costs of a distributor to start a business or system
39.Cost per unit shipping per product based on distance	*	Cost	* ●	Rent a product for one kilometre of transportation
40.Cost of the delivery process for each product	*	Cost	* ●	Total cost of product delivery to the customer from production time to the delivery
41.Cost of product maintenance at the distribution center	*	Cost	* ●	Maintenance costs such as insurance costs, warehouse rent, fuel, lighting, taxes as well as damages such as theft, fire, spoilage, damage and injury, etc.
Service Rate.42 38-42 (Badhotiya et al. ,2019)	●	Delivery time	* ●	The amount of services provided per unit of time

Development of Dynamic System Model

In this step, Vensim software was used to determine the effect applied from one concept to another one was positive (increasing) or negative (decreasing). Each concept was formulated based on the concepts affecting it and implemented in the software.

Therefore, using the list of variables affecting the system, the dynamic system model was designed and the effect of the defined criteria on each other was determined. Figure 2 illustrates the improved form of functional basic state. The optimal conditions were achieved when the customer satisfaction was in its maximum level and the cost and delivery time were in their minimum level. It took place with the changes in the values of the effective variables in the next stages.

In this study, the opinions of experts and literature, a time horizon of 36 months to evaluate the performance of the feedback has been considered.

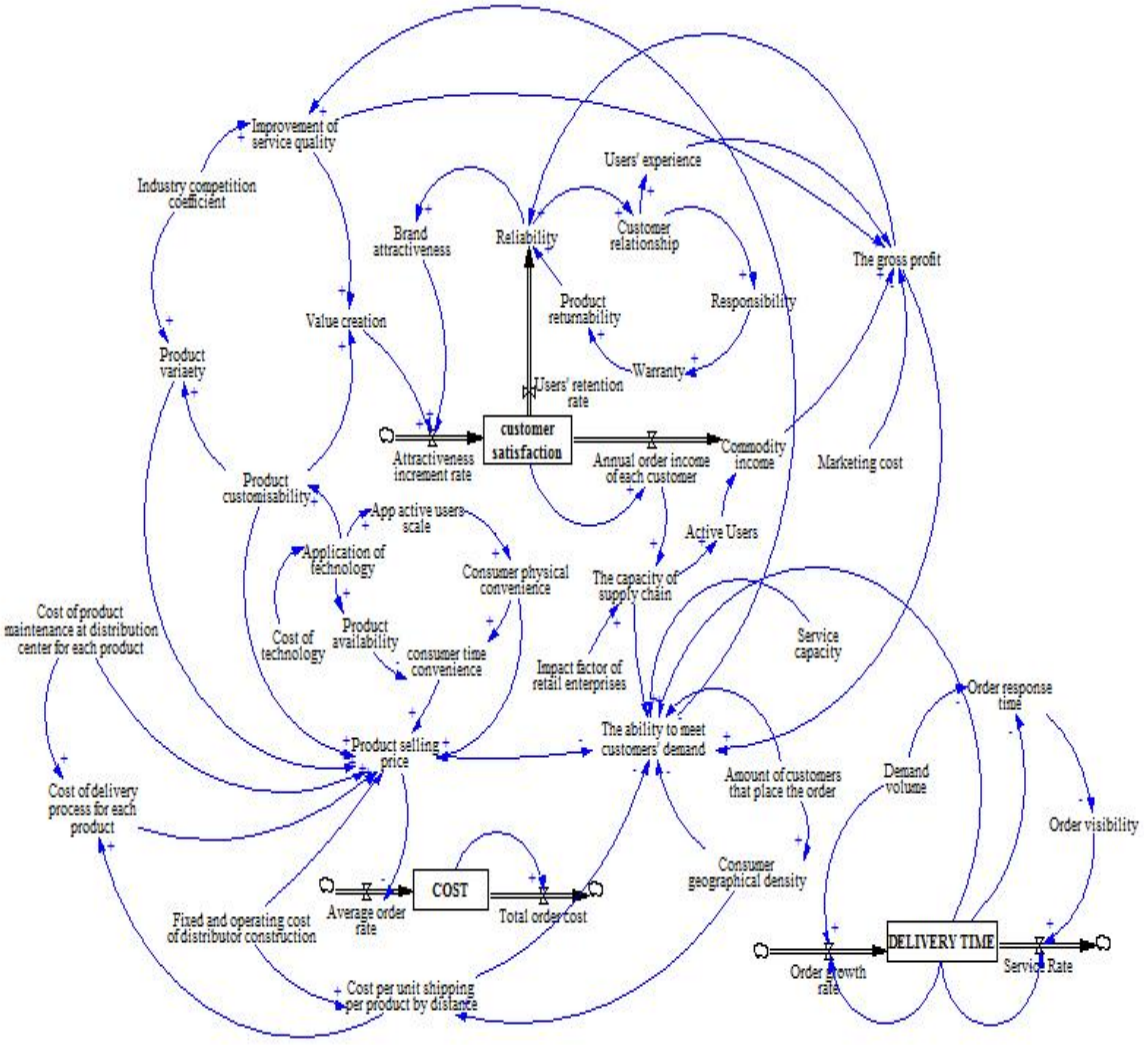

Figure 2. The Research Model

Formulating of Dynamic Hypotheses

The dynamic hypothesis explains the behavior of the reference state that should be consistent with the objective of the model. Having a good dynamic hypothesis and a well-known essential mechanism means that it provides the rate and level equations with sufficient information for initiating the system (Pruyt, 2013). After interviewing the experts and reviewing the research literature, it was found that some of the criteria were more effective, while some others were removed due to the similar effects in order to simplify the model.

Determining the Model Boundary and Research Loops

All-important members of the system communicating with each other should be considered as the internal variable, all elements that affect the system but are not affected by the system are considered as the external variable, and other variables should be removed (Table 1).

In this research, causal method and its ultimate conversion to flow chart were used for modeling the relationships among the effective factors (Figures 3 and 4).

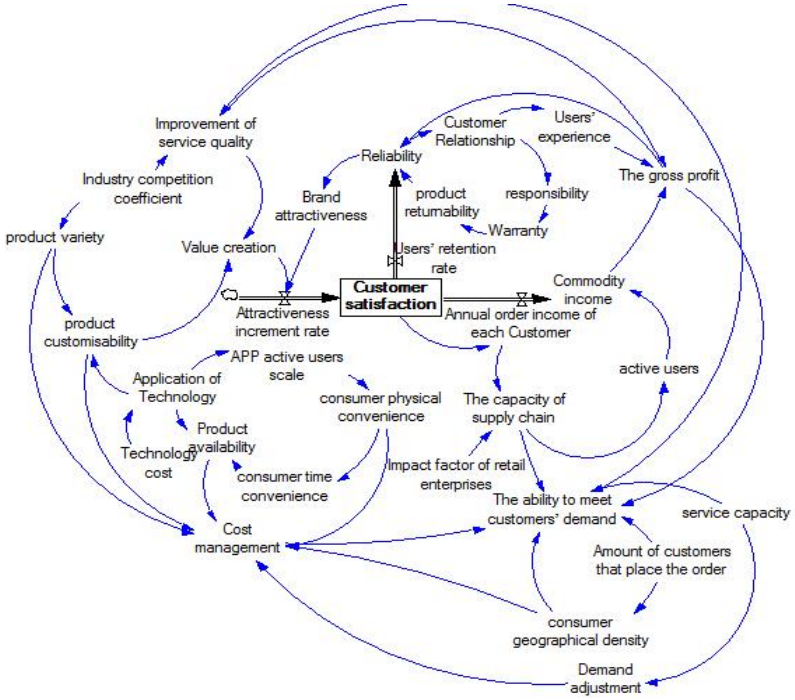

Figure 3. The Flow Chart of the State Variable of Customer Satisfaction

According to Lim et al. (2018), the consumer physical convenience (availability convenience) affects the consumer's convenience in terms of time, and these two factors affect the product availability. On the other hand, according to Tao et al. (2018), modern technologies such as web and apps affect the product availability. For example, online selling has caused customers not to pass through various paths to reach their desired products. Therefore, it increases the product availability in addition to physical and time availability. On the other hand, availability applies its impact on the selling price of the products through reducing the shipping costs and time cost. It can be also stated that the scale of active users in these applications increases due to application of the technologies such as apps and an increase in the order time and physical convenience.

Lim et al. (2018) also emphasize the customizability of the products through its variety and improving its service quality, which is one of the requirements of the success in the competitive market. They also argue that the value creation can be enhanced by creating this space, and this value besides the brand attractiveness increases the satisfaction of the customers through influencing the population increase rate.

Mangipudi and Manivannan (2016) argue that some variables including relationship with customer, responsibility, warranty, product returnability, and reliability directly or indirectly affect the customer satisfaction. A strong relationship between an organization and its customers indicates that customer demands are important for the organization, and when customer demands are important for the organization, it will be responsible for the customer and its reliability by providing services such as warranty and product returnability when the customer is unsatisfied.

Increasing the reliability will make the customer to have a pleasant communication with the organization. It finally leads to increased customer retention, repeated purchases, and increased gross income of the organization. Tao also showed that the customer purchase increases with the increase in the customer satisfaction, leading to increased income related to annual orders of the customer and increased average income. Moreover, the increased income related to annual orders of the customer increases the supply chain capacity by increasing the

volume of available financial resources and re-investment in supply chain. It also leads into increased active users and increased responsibility to customers' demands given the effect of retailers as an external factor.

However, according to results obtained by Tao et al. (2018) and Lim et al. (2018) and given the opinions of the experts, it can be stated that other factors such as service capacity, the number of customers that place an order, the geographical density of the consumer, and the selling price of the product affect meeting the customer demands. That is to say, by increasing the service capacity, the facilities to provide the service will also increase. Additionally, by increasing the amount of customers that place an order and reducing the consumer geographical density, the consumers' demand will be met less due to an increase in the volume of service to them. The selling price of the product also affects the ability to meet the customers' demand. For example, the number of clients increases with reducing the selling price and due to this increase, it will be harder to meet the demands of all customers .

Figure 4 illustrates the flow chart of the state, auxiliary, and rate variables for the state variables of delivery time and cost (simultaneously). Badhotiya et al. (2019) reported that the operating and fixed costs of distributor installation, product maintenance cost at distribution center, and delivery process cost for each product affect the product price, in a way that each of them affects the product total price and finally the product-selling price.

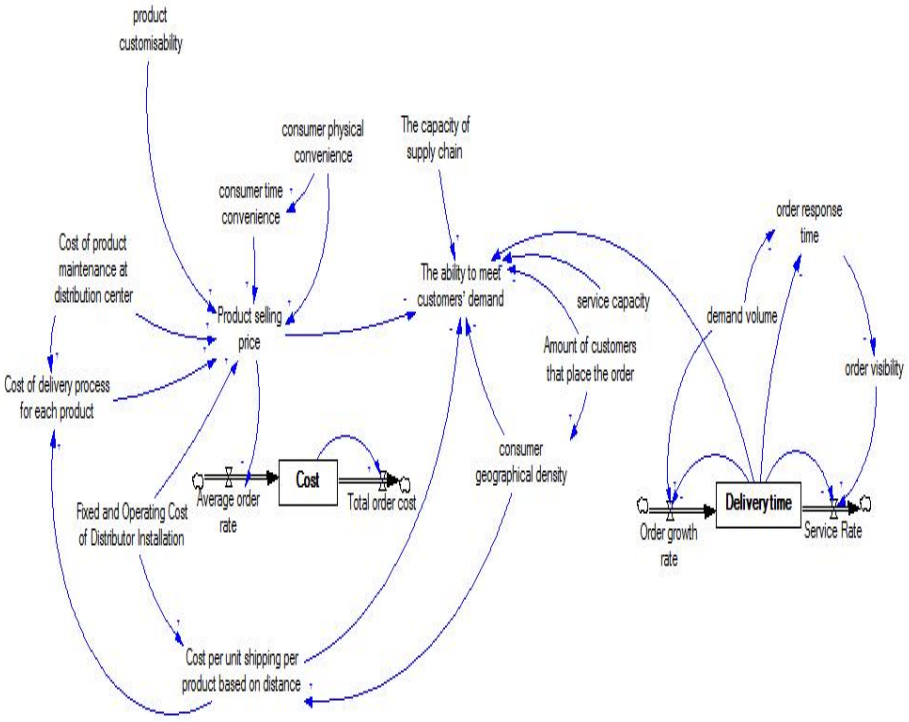

Figure 4. The Flow Chart for the State Variables of Delivery Time and Cost (Simultaneously)

On the one hand, based on the experts' opinions and also based on the logical perspective, it is clear that the customization of the product increases the total price and selling price due to imposing cost on the private sector given the change in construction pattern, need for diverse raw materials, increased construction time, and increased use of human resources and equipment. On the other hand, the costs paid to invest in order to increase the consumer convenience also affect this process in terms of both physical availability and time availability improvement.

Badhotiya et al. (2019) – as it seems logical – showed that the cost per unit shipping of a product based on distance (as one of the elements of order delivery process) affects the

process of delivery for each product; therefore, it indirectly affects the selling price of the product. It can also be shown that the external variable of consumer geographical density affects the cost per unit shipping of a product based on distance due to the change in the shipping path. That is to say, when the geographical density is reduced and the consumers are more scattered, longer path will be needed to deliver the product for them, and this increase in the path will result in an increase in cost per unit of the product shipping.

Finally, it was shown that the selling price of the product affects the demand, and an increase in the demand affects the two factors of responsibility and average order. Accordingly, as stated before, by reducing the selling price, demand increases and the ability to respond to it gets difficult. Moreover, with the product selling price reduction, the average order increases and vice versa. By increasing the average order, the state variable of cost increases due to an increase in the need for facilities to meet the customers' demand and this increase leads to increased total order cost.

According to Lim et al. (2018), delivery time and service capacity affect the ability to meet the customer demand, in a way that by reducing the delivery time, the space to meet the demand increases and the service capacity affects accordingly. These researchers also stated that order rate and order volume that affect this variable also influence the delivery time, in a way that order volume in a given time interval specifies the delivery rate and as this rate increases, the delivery time also increases, since it is time-consuming to meet the demand of the large volume of customers. It was also reported that delivery time and the ability to track the order affect the service rate. By reducing the delivery time, the empty time space also increases and this space provides more conditions for the delivery of service, leading to an increase in service rate. The ability to track the order also decreases the delivery error, leading to decreased delivery time.

Implementing the Dynamic System Model and Validation

Sweeney & Sterman (2000) presented a set of tests for validation. In this research, the validity of the proposed model has been tested and assessed based on these tests.

Boundary Adequacy Test

In the boundary adequacy test, the status of the variables has been examined in the infinity state (the maximum and minimum values). As shown in Chart 1, removing the factor of the cost of product maintenance at distribution center has a higher impact on the cost factor. It reflects the effect of the variables on each other.

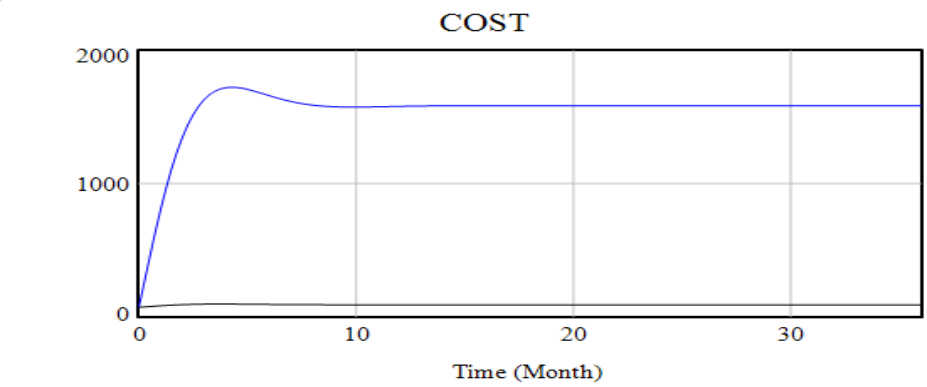

Chart 1. The Effect of Removing the Factor of Cost of Product Maintenance at the Distribution Center

Chart 2 illustrates the effect of removing the factor of brand attractiveness on the variable of customer satisfaction so that ignoring this factor in the long term can not only decrease the customer satisfaction but also create a negative attitude towards the product.

Chart 2. The Effect of Removing the Factor of Brand Attractiveness on the Variable of Customer Satisfaction

Chart 3 shows the effect of removing the factor of demand volume on increasing the delivery time.

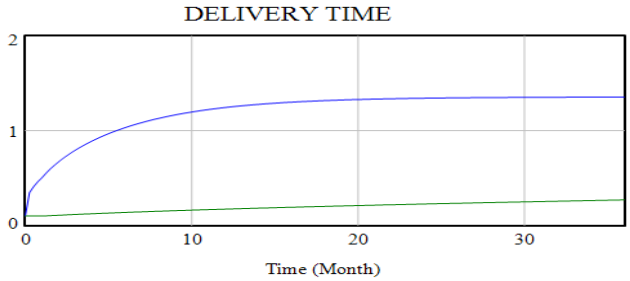

Chart 3. The Effect of Demand Volume on Delivery Time

Structure Evaluation Test

As the equations of the model have been written in the Vensim software in this study, based on Figure 5, the accuracy of the equations structure has been proven by the software.

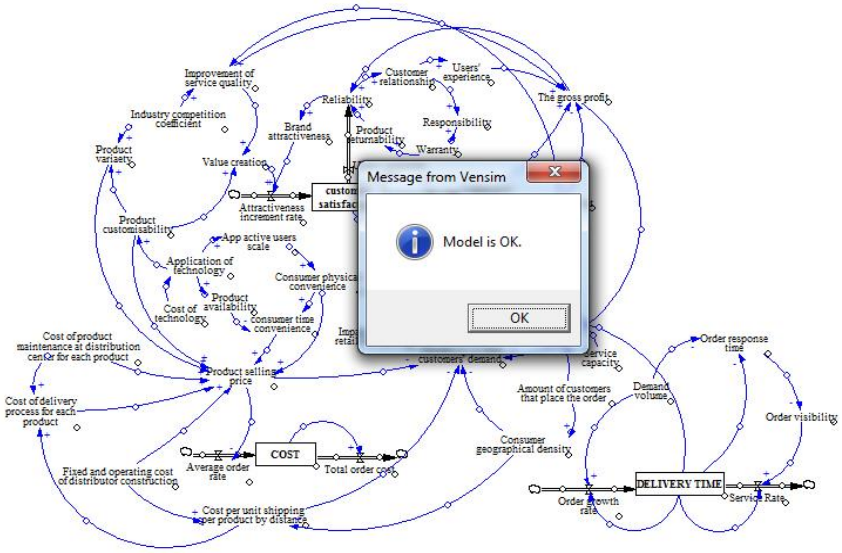

Figure 5. The Accuracy of the Equations Structure in Vensim Software

Parameter Evaluation Test

The model parameters and factors in this study have been selected using the comparative evaluation with the reference model and through reviewing the research literature. They were finally confirmed by the opinions of the experts.

Boundary Conditions Test

*The First Situation***:** *Increasing the Average Order Rate Towards One*

An increase in the average order rate will increase the volume of cost to size. In other words, by increasing this rate, the order volume also increases and all costs such as production, storage, and distribution costs increase to meet it.

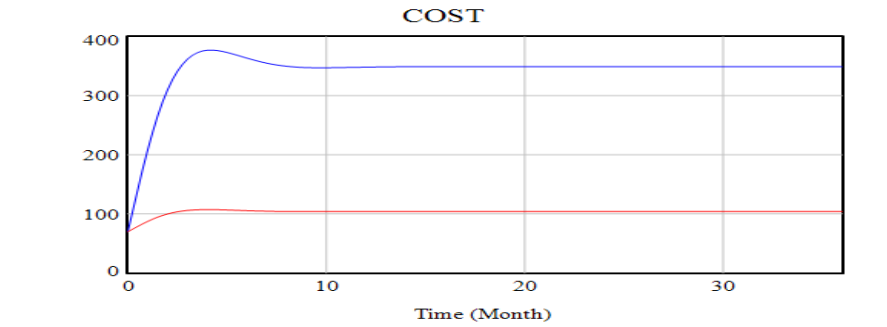

Chart 4. The Model Behavior When the Average Order Rate Moves Towards One

*The Second Situation***:** *Attractiveness Increment Rate is at its Lowest Level*

If the attractiveness increment rate decreases, according to Chart 5, the customer satisfaction also decreases.

Chart 5. The Model Behavior in the Boundary States of Attractiveness Increment Rate

The Third Situation: Order Growth Rate in its Best State

Based on Chart 6, when the attractiveness increment rate reaches its maximum level, the delivery time will increase significantly, since the volume of responsibility to order increases.

Chart 6. The Model Behavior in Boundary States of the Attractiveness Increment Rate

Integrity Error Test

This test shows the sensitivity of the model results to selecting time interval. To perform this test, 36-month time interval was converted to 60-month time interval. According to Chart 6, 36-month and 60-month time intervals suggest that with a change in the model time interval, no change is seen in the model behavior, and the factors affecting the performance, even controlled, will improve the performance (Chart 7).

Chart 7. The Model Outputs in 36-Month and 60-Month Time Intervals

Behavior Reproduction Test

Charts 8 to 10 show that with control of the order growth rate, the average order rate and attractiveness increment rate, and delivery time and cost will decrease and customer satisfaction will increase. However, several factors are involved in improving the performance the coordination of which requires much time.

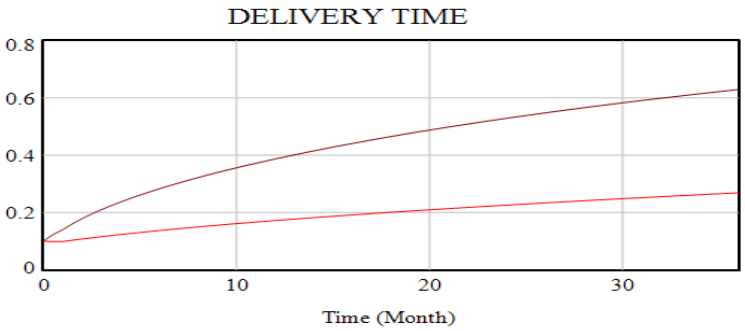

Chart 8. Reduction in Delivery Time

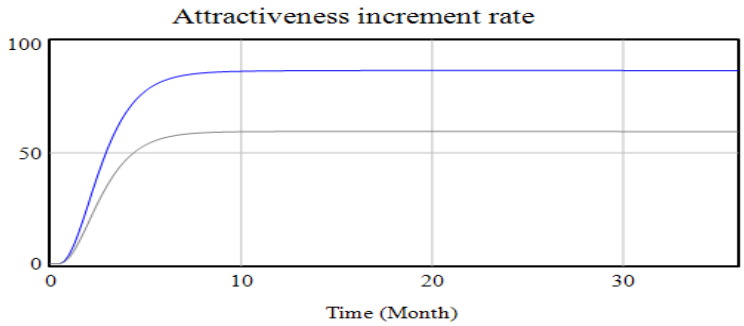

Chart 9. Reduction in Cost

Chart 10. Increase in Customer Satisfaction

Analysis of the Results and Presenting the Scenario

Once the model structure and behavior are ensured, the model can be used to design and evaluate the improvement policies. By considering the opinion of the experts and the values defined in the official articles, different values were considered for the desired variables and accordingly, five different scenarios were defined (Table 2). It should be noted that these five scenarios were designed by considering the controllable variables of the organization.

Table 2. The Research Scenarios

Variable / Scenario	s1	s2	s3	s4	s5
Market competition coefficient	20	10	8	12	15
Users' retention rate	14	10	15	10	16
Marketing costs	15	20	13	17	21
Product maintenance cost	12	9	18	16	20
Technology cost	10	15	10	12	20
Retailor effect factors	10	10	13	15	15
Service capacity	12	17	9	15	10
Demand volume	10	11	18	13	20
Amount of customers that place the order	7	10	9	11	17
Operational and fixed costs of construction of distributor installation	20	15	10	20	15

By considering these scenarios, the model was re-implemented. The results of the changes for the state variables of consumer satisfaction, delivery time, and cost are shown in the Charts 11 to 13.

Chart 11. Different Scenarios in the State Variable of Consumer Satisfaction

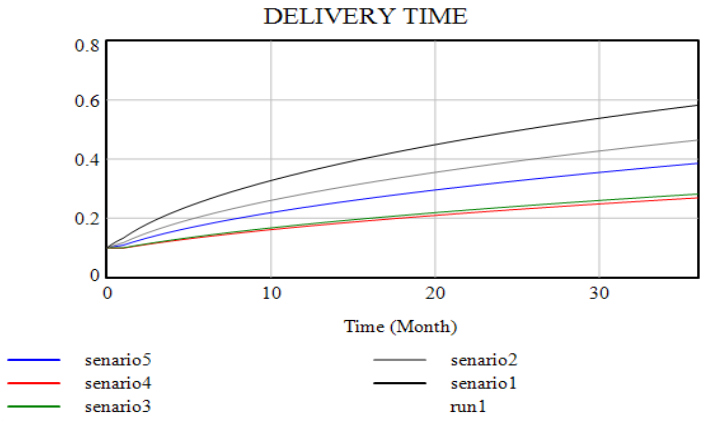

Chart 12. Different Scenarios in the State Variable of Delivery Time

As shown, the fourth scenario showed the best performance. In this scenario, the value of coefficient indices of market competition, users' retention rate, marketing costs, technology cost, the factors of retailer effect, service capacity, demand volume, amount of customers that place the order, and operating and fixed cost of distributor installation showed an increase by 12%, 10%, 17%, 12%, 15%, 15%, 13%, 11% and 20%, respectively. On the contrary, the cost of product maintenance at the distribution center showed a reduction by 16%. It showed the best performance for the state variables of the customer satisfaction, delivery time, and cost.

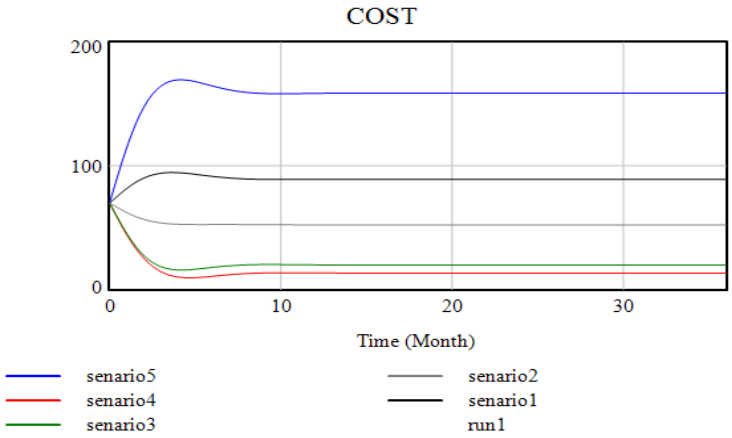

Chart 13. Different Scenarios in the State Variable of Cost

Conclusions

Nowadays, online consumers rely on interactive technology and social media for doing a research, re-planning, and sharing new experiences with regard to purchases. The today consumer is an omni-channel creature that considers a significant difference between on-line shopping and shopping from stores. Innovation in retailing causes a change in consumers' expectation of the purchase experience. In this regard, cases such as the cost spent for purchase, product delivery time, and customers' satisfaction with this experience are vital to achieve desirable profitability and survival in this competitive market. In line with achieving the desirable point in cost, customer satisfaction, and delivery time in omni-channel, the dynamic system method not only considers the factors affecting the supply chain but also considers the effect of each of these factors on each other.

In this study, a dynamic system model was designed to examine the time, cost, and customer satisfaction in omni-channel distribution channels. To achieve this model, first the influential variables were identified. Then, it was designed by creating a causal model. Finally, it was converted to the flow model diagram. In the next stage, the relationships between the variables and the equations of that model were implemented. All the important tests were done for validation. In conclusion, by designing different scenarios, it was shown how the three variables aimed at customer satisfaction, delivery time, and cost can be satisfied and optimized through designing appropriate strategies and achieving optimal values of variables. After designing different scenarios, it was observed that as the values of the variables shown in Table 2 approached the values of scenario 4, the state variable of customer satisfaction showed an increasing trend, which was positive over the 5 years. The delivery time was in its lowest value.

In other words, by changing the values of the defined variables to the levels stated in Scenario 4, the purchased commodity was delivered to the customer at the shortest possible time, which affected customer satisfaction. The cost paid by the customers, despite these changes, reached its lowest level; this led into intensified competition in this competitive market, profit, and finally customer satisfaction. According to the results of this study, users can achieve their desired goals by considering different solutions, a specified planning, and approaching Scenario 4. Moreover, when the external and uncontrollable variables approached the states defined in these scenarios, the users could be able to respond to these changes by changing the strategy. In future studies, researchers can design some strategies and solutions to reach these values in each of these variables and present management strategies to realize this model. Additionally, the crisis management strategies can be examined when the imposed and unmanageable variables are changed by the organization.

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