Simulation Analysis of Omni-channel Strategy Based on System Dynamics: A Case Study of Company X

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Abstract. To investigate the effect of omni-channel strategy, this studyformulates a system dynamics model based on omni-channel retailing practice of company X in China. The model validation and simulations under basic scenario illustrate the applicability of the system dynamics methodology in this problem. In particular, we conduct a sensitivity analysis on users’ retention rate (URR). The results show that omni-channel strategy of company X will be practical and enhancing URR can promote the performance of the company. This paper creates a new paradigm to study omni-channel strategy using system dynamics. In addition, intuitively sound insights for both company X and traditional retailers are also provided.

1. Introduction
With the rapid development of e-commerce in China, retail business is facing the dilemma of transformation. Meanwhile, the shortcomings of traditional e-commerce in meeting the consumers’ experience are increasingly prominent. Thus the omni-channel strategy has been considered by large online or offline retailers, such as Alibaba and Suning, to fulfill the extraordinary purchasing from online and bricks-and-mortar stores.

The advent of omni-channel strategy attracted a myriad of research interests. The omni-channel strategy aims at a seamless and unique experience regardless of which purchase phase the consumer is in or the channel the consumer uses [1]. As a combination of the physical and online channels, omni-channel retailing enables the physical channel in serving frequent and predictable needs, as well as being a showroom and/or a pickup location for the online channel. On the other hand, the online channel can be used for complementary strengths by providing variety and serving sporadic needs [2]. The impacts of channel integration or omni-channel strategy for retailers are examined in many researches. Namely, it may lead to a competitive advantage and channel synergies [3, 4], change consumers’ behavior towards shopping process [5] and have the benefit of a larger service scale [6].

Recently, many researches on omni-channel strategy are discussing the definition of this strategy and its impacts on retailers. As the complexity in reality and technological advancement increase, traditional static model in most researches cannot provide accurate analysis. Therefore, we examine the omni-channel strategy from a system perspective and also link it to the value creation process of a company.

The purpose of this paper is to investigate the effect of omni-channel strategy using system dynamics. At the same time, a new paradigm is created to promote the performance of the company X which adopted the omni-channel strategy in China.
2. Methodological approach
The system dynamics (SD) methodology, which performs well in long-term, chronic and dynamic management problems [7], is adopted in this study. As a valid description of the real processes, SD creates the dynamics of the variables of interest and also enables to analyze various scenarios. The purposes of this SD study are to understand how omni-channel strategy influences the company’s profits and the customers’ behavior, and how the company can further improve the system performance.

2.1. Model variables
In this study, we define the value creation process of the company as a series of activities including value proposition, creation and transmission and value acquisition. Relevant variables in value creation process and the abbreviations are shown in table 1.

| Definition | Abbreviation | Definition | Abbreviation |
|------------|--------------|------------|--------------|
| Amount of customers that place the order | AOCPO | Income growth rate | IGR |
| Attractiveness increment rate | AIR | Increase of attractiveness | IOA |
| The ability of cost controlling | AOCC | Improvement of service quality | IOSQ |
| Annual order income of each customer | AOIIEC | Land leasing costs | LLC |
| Average order rate | AOR | Marketing cost | MC |
| Application of Technology | AOT | Management expenses | ME |
| APP active users scale | APPAUS | Manual labour and logistics costs | MLALC |
| Average revenue per customer | ARPC | New active users | NCU |
| The ability to meet customers’ demand | ATMCD | New order increase rate | NOIR |
| Brand attractiveness | BA | The number of physical stores | NOPS |
| Business coverage | BC | Operational capacity | OC |
| Brand influence | BI | Operating expenses | OE |
| Commodity income | CI | Order growth rate | OGR |
| The cost of food deterioration | COFD | Order quantity | OQ |
| The capacity of supply chain | COSC | Other revenues | OR |
| Channel preference coefficient | CPC | Profitability of the enterprise | POE |
| Demand adjustment | DA | Policy support coefficient | PSC |
| External accreditation | EA | Risk factor of product supply | RFOPS |
| Enterprise capacity | EC | Scale growth | SG |
| Enterprise profit | EP | Service quality | SQ |
| Environmental protection input | EPI | Total cost | TC |
| Enterprise revenues | ER | Total order cost | TOC |
| Financing capacity | FC | Users’ demand | UD |
| Growth ability of the enterprise | GAOE | Users’ experience | UE |
| The gross profit rate | GPR | User growth rate | UGR |
| Growth rate of active users | GROAU | Unit order income | UOI |
| Industry competition coefficient | ICC | Users’ retention rate | URR |
| Impact factor of retail enterprises | IFORE | Value creation rate | VCR |

Stock (state) variables and flow (rate) variables are important elements of a SD model. Stock variables are the accumulations within the system and flow variables represent the flows in the system. We employ amount of customers that place the order (AOCPO), brand attractiveness (BA), business cov-
average (BC), order quantity (OQ) and service quality (SQ) as stock variables, because they are vital components of omni-channel strategy. A customer is free to choose any channel opened by company X, but he or she may take BA and SQ into account to make a better decision for himself/herself. So the quantity of orders on different channels vary from individuals. As a result, AOCPO will be influenced by user retention rate (URR). Specially, if URR is determined, the changes in the company’s revenue reflect the performance of omni-channel strategy. On the other hand, by examining the behavior of URR, we can understand how the system reacts to the change of URR in reality.

In a system, many factors come from the external environment and have positive impacts on decision-making process. For instance, the increase of attractiveness (IOA), improvement of service quality (IOSQ), new active users (NCU), new order increase rate (NOIR) and scale growth (SG). To examine how these factors work, we set them as flow variables in the following sections.

2.2. Causal loop diagram
To describe the structure of a system in SD methodology, causal loop diagrams are often utilized. This kind of diagram represents the major feedback mechanisms of a system, including both negative feedback and positive feedback loops. During model development stage, these loops can serve as preliminary sketches of causal hypotheses and also simplify the system model. After having a clear grasp of the relationship of the variables shown in table 1, we can draw the causal loop diagram of the omni-channel strategy as figure 1 shows.

![Figure 1. Causal loop diagram of the omni-channel strategy.](image)

2.3. Flow diagram of system dynamics
Based on the casual loop diagram, we can construct the flow diagram of system dynamics in Vensim PLE software as figure 2. In this study, the company X is adopted as the experimental case. Company X is a forerunner of omni-channel strategy in China, which integrates fresh supermarkets, dining experience and online business warehousing. Consumers can go to the physical stores for shopping or place an order on the company’s mobile phone application (APP). The company has established a good brand image in the industry.

Note that data sources of the parameters include research reports of retailing industry and public data declared on Chinese government’s websites. Additionally, several parameters are determined through interviews with staff of company X. And we also use statistical forecasting method, nonlinear regression equation method and literature reference method to determine the equations of the system dynamics model. The simulation time is set from 2016 to 2026.
3. Model validation
Structure validity is the most important for a SD model, which reflects proximity of the set of relations used in the model and the actual system. To detect the potential structural flaws in the system dynamics model, several structure tests should be conducted including extreme-condition test, behavior sensitivity test and compare the model performance with the real system. Once there exist any hidden structural flaws or inconsistencies in the model, they would be revealed by such tests. However, omni-channel strategy is still new in China and the practice of company X is in premature phase. Thus, long-term data compatible with the time horizon of the model are unavailable. Unfortunately, it is impossible to collect such long term field data within the scope of this research. So we conduct structural validation tests to confirm that the model structure yields acceptable behavior under extreme parameter values and conditions. Furthermore, the model behavior exhibits meaningful sensitivity to parameters APPAUS, AOCPO, CI, NOPS and OQ. These behaviors are consistent with the empirical and theoretical evidence, because reasonable variations (less than 10%) of these parameters are observed in the tests. Figure 3 and 4 of the next section further validate the model’s behavior. Meanwhile, the results shown in figure 5 and 6 are reasonable. In this context, we consider the model to be effective.

4. Simulation output
The SD model is designed to provide insights to possible future scenarios. In this section, we present simulation results of the basic scenario and in particular, we conduct a sensitivity analysis of user retention rate (URR). As discussed in subsection 2.1, URR is the core element of the company’s corporate value acquisition, it also indicates the effects of omni-channel strategy. To complete the users’ orders, company X must rely on a strong logistics distribution system and physical store services. In return, potential users are attracted and the company builds its sustainable competitiveness. Specifically, the company can enhance its operational capabilities and brand influence. In another way, the company can attract other dominant brands or capitals. Therefore, we focus on URR and examine its impact on the company.

4.1. Simulation of basic scenario
The simulation depicted in figure 3 shows the total costs (TC), enterprise revenues (ER) and enterprise profit (EP) from 2016 to 2026. It is clear that the revenue and total cost of company X increase since the adoption of omni-channel strategy. The initial growths of EP and ER are not obvious, which is identical to the actual operation of the company. After 2019, the TC, EP and ER will increase rapidly. These results are in line with the expected results, for the company is expanding its scale. Consequently, many funds are invested on physical stores though they are not so profitable at early stages.

The user scale simulation under the basic scenario is shown in figure 4. According to figure 4, the active APP user scale (APPAUS) will continue to increase and maintain a relatively stable growth trend. If company X does not change the management strategies of the online and offline channels, the active users’ growth may be slightly insufficient and make it hard for the company in opening up the market. It is estimated that the APPAUS will exceed 9 million by 2026.

From the perspective of company revenue and user scale, we can see that the SD model’s behavior can rebuild the realistic system and visually show the development trend of specific variables, which is in accordance with the validation in section 3. In another word, omni-channel strategy of company X will be practical in the future.

4.2. Sensitivity analysis of URR
In this study, we set the URR as 0.6 under the basic scenario (simulation 1). In order to understand how URR influences the company, we conduct a sensitivity analysis on URR by setting it to 0.7 (simulation2) and 0.8 (simulation3). The impact of URR on enterprise profit (EP) is depicted in figure 5 whilst the relationship between URR and enterprise capacity (EC) is shown in figure 6.
According to figure 5, when URR increases, the EP will increase simultaneously. This is because when the company creates good shopping experiences for customers, the users’ stickiness begin to appear. Therefore, both the amount of orders and corporate merchandise revenue increase. When the URR increases to 0.8 (simulation 3), the EP increases by 40% than that of URR is 0.6. Also, 17% growth is observed when URR equals 0.7 in comparison with the basic scenario. Interestingly, we can see that it is of benefit for the company to identify the consumers’ demands and behaviors accurately. And making some adjustments to omni-channel strategy are also necessary for the company to maximize the value of customers in its development.

The increase of URR also has a positive effect on enterprise capacity (EC) as depicted in figure 6. Similar to URR increases the profits of the company, higher URR brings more active users and orders, which implies that management and operation capacities of the enterprise are more required. Therefore, when omni-channel strategy is implemented, a company should focus on both online and offline service quality. For instance, improve operation efficiency of its supply chain, create superior categories and develop new categories continuously.

To our best knowledge, the discussions on URR are consistent with the empirical and theoretical evidence and they can also be evidences of the model validation.

5. Discussion and conclusions
This study developed a system dynamics model to investigate the effect of omni-channel strategy. The model is based on the knowledge of all the influential factors concerning with the company X, which practices omni-channel retailing in China. The comprehensive description and analysis of the SD simulation demonstrate that users are of value for omni-channel strategy. To fulfill the strengths of omni-channel strategy and promote the transformation of the traditional retail industry, a few insights are outlined as follows.

As China’s omni-channel retailing is still in exploration, enterprises like company X should take advantages of external platforms, such as Alibaba and Tencent that have freed up the traditional retail industry. Given that the integration of online channel and physical stores are not so deep, we suggest the companies take integration measures including setting up a new brand membership system and promoting the sharing of customers’ feedbacks in the channels. Additionally, omni-channel strategy is more difficult to implement in domestic market. So these companies need to keep learning from the other countries. Finally, revisiting strategic continually and adjusting their goals according to the market are also significant.

For traditional retailing industry, the retailers should understand the impact of the companies that adopted omni-channel strategy and grasp its own resources and capabilities. Transformation of these stores could be sensible. For instance, they can keep on improving their service quality and try to satis-
fy comprehensive needs of consumers. More importantly, leading a competitive differentiation with omni-channel retailing companies can result in better performances for traditional retailers.

Acknowledgments
This work is supported by the Ministry of Education of Humanities and Social Science Project (Grant No.17YJC630230).

References
[1] Verhoef P C, Kannan P K and Inman J J 2015 J. Retailing. 91 174  
[2] Chopra S 2016 Decision. 43 135  
[3] Hu W and Li Y 2012 Ann. Oper. Res. 192 151  
[4] Herhausen D, Binder J, Schoegel M and Herrmann A 2015 J. Retailing. 91 309  
[5] Juaneda-Ayensa E, Mosquera A and Sierra Murillo Y 2016 Front. Psychol. 7 125  
[6] Ishfaq R, Defee C C, Gibson B J and Raja U 2016 INT. J. Phys. Distr. Log. 46 543  
[7] Barlas Y 2002 System. 1 1131