13th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2009, Hammamet, Tunisia, 16-21 October 2009

IMPACT OF INFORMATION DISTORTION UNDER SERVICE SUPPLY CHAIN MANAGEMENT

Ayşe Nur Koç, Erkan Bayraktar, Ekrem Tatoğlu
University of Bahçeşehir
Department of Industrial Engineering,
Beşiktaş 34100, İstanbul
Turkey

ABSTRACT
Although there are a number of academic studies about supply chain management, the subject of service supply chain has still waited to receive much more attention to be searched and explained as supply chain. It is generally believed that supply chain management is one of the most vital issues in manufacturing industry. Nowadays, with the development of service industry, some of research papers have showed us that the supply chain theory can be considered and applied in service industry. Although there are several evidences on the impact of information distortion – bullwhip effect – on supply chain management, there are limited studies about bullwhip effect on service supply chains. According to these scarce studies, capacity planning is one of the main causes of the bullwhip effect. Purpose of this study is to analyze the bullwhip effect for a four-stage service supply chain by simulating Mortgage Service Game with Microsoft Excel.
Keywords: Services, Supply Chain, Information Distortion, Mortgage Service Game

1. INTRODUCTION
Over the last decade, supply chain management has been one of the highly researched topics by the academicians, and has gained quite bit popularity among the manufacturing companies. Recently, service companies which want to increase or preserve their market share have also founded out the importance of their suppliers. In order to manage service businesses successfully and achieve sustainable competitive advantage, it is even more important to understand the information technology, global marketing, and the nature of services in contrast to manufacturing. Information distortion is one of the issues raised in supply chains whether it is in manufacturing or service industries.
In this study, information distortion problem within service industries is analyzed under the framework of Mortgage Service Game. Several parameters controlled by the service companies are discussed with respect to information distortion. A simulation model is constructed, then verified and validated to justify the simulation outputs. After a detailed analysis and discussion of the result, the study concludes with the limitations and further research areas.

2. INFORMATION DISTORTION ON SERVICE SUPPLY CHAINS
While service sector grows, employment opportunities are shifting from manufacturing to services where supply chain for services has gained a significant attention recently. However, it is generally a well known fact that services are one of the understudied areas in the field of operations management. Service Supply Chain Management is concerned with the planning and management of activities from support functions to the delivery of end-user services [1]. The discernments between manufacturing and services industries are not always clear, and many industries are mixture of both manufacturing and service. In order to link these sectors an effective supply chain is always crucial [2]. Service

supply chain is a complete consumer services network, which organizes the services related to all aspects of the manner according to an organic form on the basis of the modern information technology, logistics technology, systems engineering, and so modern science and technology to meet consumer demand maximum [3]. Service Supply Chain *(SSC)* is a service-network that reorganizes different service entities in order to satisfy customers' require by using modem management technology to break down and rebuild a system which considers customers' demands as starting point and takes a complex service or an Integrated Service Package as a series of process in service when the service-industries are developed to some extent [4]. Following the definitions of Service Supply Chain in these studies, yet the definition of SSC is still not clear and unique. Similarly, there are several studies in manufacturing industries in order to show evidences on the impact of amplification or bullwhip effects on supply chain management. The bullwhip effect, also known as Forrester or whiplash effect is one of the key areas of research in supply chain management applications. It represents the phenomenon where orders to supplier tend to have larger variance than sales to the buyer and customer demand is distorted [5]. But unfortunately, there have not been enough studies to provide bullwhip effect on service supply chain management. There is very interestingly one study on the amplification phenomenon in service supply chains, so far. Anderson and Morrice (2000) developed a four-stage service game (which is called as mortgage service game) in order to find out if there is any impact of "bullwhip effect" in "Service-Oriented Supply Chain" with managing entity product in the service industry. Their study is on the amplification phenomenon in service settings on the Mortgage Service Game. This game was developed to study decision-making in service-oriented supply chains which consists four process steps: initial processing, credit checking, surveying and title checking. The survey section is only explained in order to show each stage's processing, because automatically all stages operate in the same manner. As each application is checked for the credit worthiness of its applicant, the application flows from the backlog of credit checks to join the backlog of surveys [6].

3. SIMULATING MORTGAGE SERVICE GAME

Mortgage Service Game was applied to simulate service supply chain in order to show information distortion and amplification on capacity planning as logic of the study of Anderson and Morrice (2000). The aim of this study is analyzing the impact of capacity adjustment time, service delay time, the proportion of information sharing (application start rate) and also variability on application start rate on the bullwhip effect for a four-stage service supply chain. The number of levels of these four factors with their respective values is listed in Table 1. Here, with three different levels for each of the four parameters, $3^4 = 81$ different scenarios were produced totally. Once a simulation model was constructed, then it was verified and validated to justify the simulation outputs.

Table 1. Independent factors of the experimental design

Independent factors	**Levels**		
	1	**2**	**3**
Adjustment capacity time (τ)	15 day	20 day	25 day
Service Delay Time (λ)	5 day	10 day	15 day
Proportion of information sharing (α)	0	0,5	1
Variability on application start rate	U[19-21]	U[18-22]	U[15-25]

The bullwhip ratio is denoted as the dependent variable of the design of experiment. Bullwhip ratio is calculated as in Equation 1. It indicates the ratio of variance of the completion rate at stage i to the variance of the application start rate in order to calculate bullwhip ratio at stage i as in Equation 1.

$$\text{Bullwhip Ratio(i)} = \frac{\text{Var(Application Processing Rate (i))}}{\text{Var(Application Start Rate)}} \quad (1)$$

4. RESULTS

Unsurprisingly, the results of simulation show that the bullwhip ratio is dramatically increasing while flowing from one stage to the next stage. In Figure 2, it is clearly seen that in the bullwhip ratio is so high, especially in situations where there is no information sharing. The four parameters, adjustment capacity time, service delay time, proportion of information sharing and variability on application start rate are indicated as tau, lambda, alpha and variability, respectively. Based on the simulation analysis, this study noted a highly significant finding that low levels of capacity adjustment time and high levels of service delay time, proportion of information sharing and variability on application start rate have a positive impact on reducing the bullwhip ratio for all stages except initial stage. For instance, Figure 1 shows us how these four parameters impact on bullwhip ratio at stage 4. Similarly, Figure 2 shows us how two by two their interactions impact on bullwhip ratio at stage 4. However, as an initial stage cannot respond the variability of these four parameters immediately, it has different impacts on bullwhip ratio. Also, medium levels of information sharing and variability and high levels of capacity adjustment time and service delay time have slightly positive impact on reducing the bullwhip ratio.

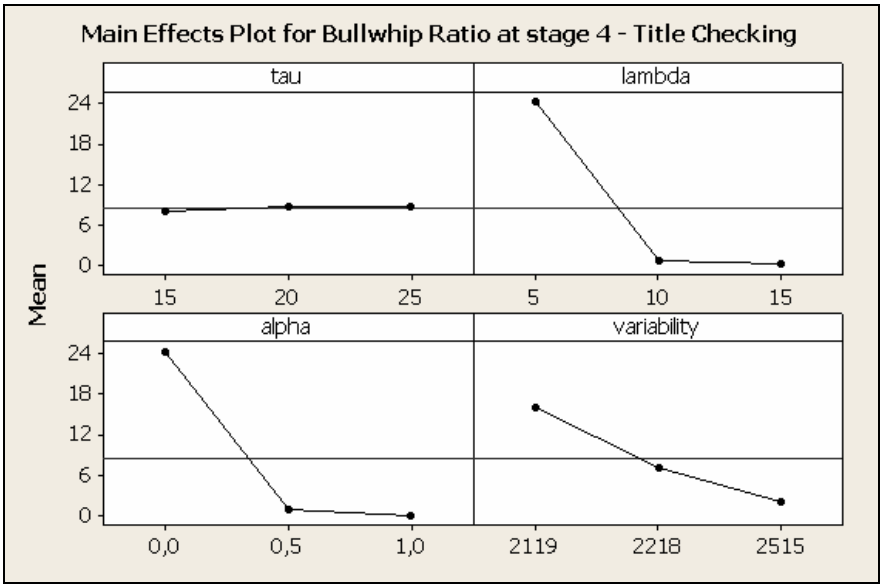

Figure 1. Main effects of four parameters on bullwhip ratio at stage 4

5. CONCLUSION AND FURTHER RESEARCH

The simulation analysis indicates the importance of information sharing in order to mitigate information distortion under service supply chain management. Also this study may further be extended to evaluate the impact of bullwhip effect on the performance measures of a four-stage service supply chain (e.g., backlog cost of the stages, total chain backlog cost, total cost of the stages, total chain cost) and to make information sharing through all stages and to use capacity information in order to calculate target capacity. Our calculations on target capacity are limited only to use backlogs and/or information of the application start rate. Examination of different equations on calculations of target capacity in a four-stage service supply chain would also be applied for future research (e.g., using capacity information of predecessor stages and/or successor stages). The most crucial implication of this study lies in the need to share information across all stages to mitigate information distortion aka the bullwhip effect.

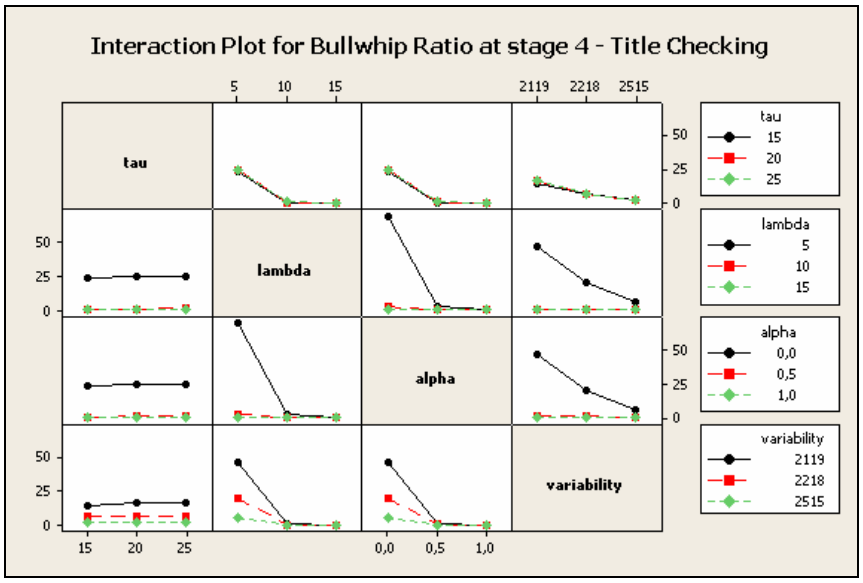

Figure 2. Interaction effects of four parameters on bullwhip ratio at stage 4

6. REFERENCES

[1] Fitzsimmons, J., Morrice, D., Tirupati, D., Powell E., Rice W., January 15, 1999. Service Chain Management Optimizing Service Delivery, CRM Project, 1, http://www.crmproject.com/authors.asp?a_id=622.

[2] Cook, J.S., DeBree, K. and Feroleto, A., Autumn 2001. From raw materials to customers: supply chain management in the service industry. SAM Advanced Management Journal, 66 (4), pp.14-21.

[3] Zhenghua, H., 2003. The concept model and applying of service supply chain, Commercial Research, pp.111.

[4] Liu, Y., Li, C., Cheng, J., 2008. The research on service supply chain. IEEE/SOLI Service Operations and Logistics, and Informatics.12-15 Oct. 2008 and Beijing. China, 2, pp.2263-2268.

[5] Bayraktar, E., Koh S.C.L., Sari K. and Tatoglu, E., 2008. The role of forecasting on the bullwhip effect for e-scm applications. International Journal of Production Economics, 113 (1), pp.193-204.

[6] Anderson, E.G. and Morrice. D.J., 2000. A simulation game for service-oriented supply chain management. Journal Production and Operations Management, 9 (1), pp.40-55.