Study of Bullwhip Effect in Small and Medium Entreprises Through Industrial Engineering Methods

CH.Bhanu Sri[1], P.Aknadh[2], Ronanki Ravi Kumar[3]

[1]*Assistant Professor, Dept. of Mechanical, Sanketika Vidya Parishad Engineering College, Vizag, A.P, India*
[2]*Assistant Professor, Dept. of Mechanical, Sanketika Vidya Parishad Engineering College, Vizag, A.P, India*
[3]*M.TECH (final year),Dept. of Mechanical, Sanketika Vidya Parishad Engineering College, Vizag, A.P, India*

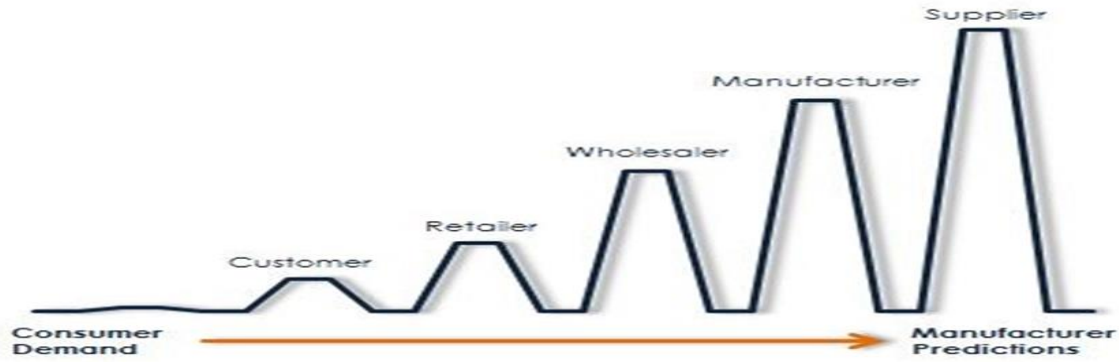
Abstract –
Effective supply chain management is critical for mitigating the Bullwhip Effect (BWE) in SME's. Thus, this study examines how order batching, lead time, rationing, demand forecasting errors, information sharing and sale promotions affect the Bullwhip effect. Primary data was collected through questionnaires from 180 respondents belonging to business organizations operating in Andhra Pradesh, INDIA. From the literature, the constructs namely: Demand forecasting, Order batching, Rationing, Lead-time, sales promotions and information sharing are considered to know the influence on Bullwhip effect. It is proposed to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists and to postulates the relationship pattern and then tests the hypothesis statistically. Correlation analysis is proposed to conduct to measure distinctiveness and uniqueness of the adopted construct and to check the issue of multi-co-linearity. Multiple regression analysis is also proposed to conduct to examine the relationship between the independent variables.Tabu Search's capabilities illustrate its scalability and replicability. A quadratic multi-regression analysis interprets the input parameters (iterations, neighbors, and tabu list size) association with total supply chain cost and run time. The analysis shows iterations and neighbors to minimize total supply chain cost, while the interaction between iterations x neighbours increases the run time exponentially. Therefore, increasing the number of iterations and neighbours will increase run time but provide a more optimal result for total supply chain cost.

1. INTRODUCTION

Supply chain management includes four main flows, i.e. information, material, payment and ownership. In order to have an efficient supply chain system, adequate planning, managing and controlling are necessary for creating value for consumers (Christopher, 1998; Lambert, Cooper, & Pagh, 1998).
This requires close coordination between organizations within the value chain. The members within the supply chain are required to have an appropriate understanding of the network. In addition, all members must strive for creating value for customers.
A problem created by one member of the supply chain will affect the efficiency of the whole supply chain.

Bullwhip Effect (BWE)

Through the numerous stages of a supply chain; key factors such as time and supply of order decisions, demand for the supply, lack of communication and disorganization can result in one of the most common problems in supply chain management. This common problem is known as the bullwhip effect. The bullwhip effect figure as shown



Order Batching:

Order Batching

Order batching is one of the main causes of the bullwhip effect. It refers to the art of placing orders at upstream levels in batches.

Batching of different lot sizes directly relates to the inventory holding cost so it is important to find optimum order batching or lot sizes.

Lead Time:

It refers to the time delay or time required for fulfilling customer order. A longer lead-time will create a higher demand forecasting errors, which will also give incorrect data for successive periods.

OBJECTIVE OF STUDY:

To measure the impact of variables like information sharing, operational efficiency which influence the intensity and scope of bullwhip effect in Indian market

To explore major causes responsible for Bullwhip Effect.

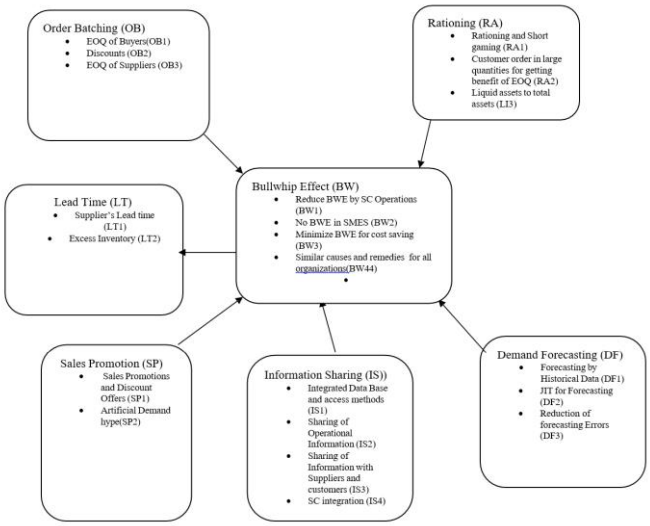
To suggest the strategies reduce the Bullwhip Effect.

Understand the data collection planning process

Appreciate human factors of data collection

2. METHODOLOGY:

Conceptual Model of Bullwhip Effect And Their Enablers:



Confirmatory Factor Analysis (CFA):

Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) are powerful statistical techniques. Exploratory factor analysis could be described as orderly simplification of interrelated measures.

Confirmatory factor analysis is a useful statistical technique to verify the factor structure of a set of observed variables.

CFA allows the researcher to test the hypothesis that a relationship between observed variables and their underlying latent constructs exists.

The researcher uses knowledge of the theory, empirical research, or both, to postulate the relationship pattern and then tests the hypothesis statistically.

The threshold values of propriety indicators

3.CASE STUDY:

Survey questionnaire is developed from an extensive literature review which examined a number of streams of research, including lean and agile supply chains, supply chain strategies, design requirements for various supply chains, confirmatory factory analysis.

Twenty questions on the constructs such as product development (PD); (ii) sourcing (SOU), (iii) Manufacturing (MFG), (iv) Demand management (DM) (v) Information Technology (IT) (vi) Supply chain Network Design (SCN) (vii) Inventory Management (INV) are developed.

The survey was addressed to personnel involving purchasing, production, marketing& sales, logistic providers with mailing and personal contacts. A total of 160 out of 250 usable surveys were received. This resulted in an effective response rate of 64.0 percent.

Descriptive Statistics

A summary of the demographic characteristics of the sample. Of the 160 responses received from three types of medium and small scale industries, namely

(i)Apparel manufacturing

(ii)Automotive spare parts

(iii)Electronic components.

Responses indicate that people from important business are involved. Customer types namely Retailer, Bulk Manufacturer,Distributor and Customer direct are involved in the study.

The research population for this study includes the key members of supply chain located in Visakhapatnam. We contacted different retailers, wholesalers, distributors, manufacturers and raw material suppliers through email and face-to-face discussions to obtain appropriate and accurate data.

Since Visakhapatnam is the main hub of business in Andhra Pradesh it was the selected for this research. The study had a sample size of 160 respondents.

Scale and Measures

The constructs used in this study have been adapted from earlier studies. The questionnaire in this study was based on the five point Likert scale (1- Strongly disagree; 2- Disagree; 3- Undecided; 4- Agree; 5-Strongly agree).

Confirmatory factor Analysis, Correlation Analysis, Multiple regression analysis was carried out to examine the Bullwhip Effect in respect of Small and Medium Enterprises.

4.RESULTS AND DISCUSSION:

Reliability Assessment

Establishing construct reliability involves testing each of the multiple indicators of a construct.

Since the data for this research was generated using scaled responses, it was deemed necessary to test for reliability. Based on the coefficient values, the items tested were deemed reliable as they were greater than 0.70. Average Variance Extracted (AVE) of Squared Multiple Correlation (SMC), Composite Reliability (CR) of latent variables are presented in table 3.

Composite Reliability (CR) and Average Variance Extracted (AVE) was more than 0.6 and 0.5 respectively, indicating good construct reliability and adequate convergent validity. Also, standardized factor loadings (>0.50) respective performance dimension.

Performance dimension	Item	Standardized Factor Loadings	SMC	Composite Reliability (CR)	AVE
BW	BW1	0.70	0.49	0.91	0.73
	BW2	0.91	0.83		
	BW3	0.85	0.71		
	BW4	0.94	0.88		
DF	DF1	0.79	0.63	0.94	0.85
	DF2	0.97	0.94		
	DF3	0.99	0.98		
LT	LT1	0.71	0.50	0.63	0.56
	LT2	0.64	0.42		
IS	IS1	0.70	0.50	0.83	0.56
	IS2	0.87	0.75		
	IS3	0.85	0.72		
	IS4	0.51	0.26		
SP	SP1	0.64	0.41	0.77	0.64
	SP2	0.93	0.87		
OB	OB1	0.74	0.55	0.69	0.53
	OB2	0.60	0.36		
	OB3	0.61	0.37		
RA	RA1	0.91	0.83	0.78	0.55
	RA2	0.74	0.55		
	RA3	0.53	0.29		

Correlation Analysis:

Correlation analysis was carried out to measure distinctiveness and uniqueness of the adopted construct and to check the issue of multi-collinearity. Summarized results are presented.

Construct	Order Batching	Lead Time	Rationing	Demand Forecasting	Information Sharing	Sales Promotion	Bullwhip Effect
Order Batching	**1.00**						
Lead Time	**0.647**	**1.00**					
Rationing	**0.624**	**0.634**	**1.00**				
Demand Forecasting	**0.734**	**0.865**	**0.681**	**1.00**			

Regression Analysis:

The hypothesis that all six predictor variables (i.e. order batching, lead-time, rationing, demand forecasting, information sharing and sales promotion) will aggregately affect BWE was tested through multiple regression. The results are presented in Table 5.4. Regression analysis can be very helpful for analyzing large amounts of data and making forecasts and predictions. To run regression analysis in Microsoft Excel.

Results of regression analysis overall model

Construct	beta	S.E	p-value
Order Batching	0.0892	0.0503	0.078
Lead Time	0.2908	0.0523	0.000
Rationing	-0.1390	0.0447	0.002
Demand Forecasting	0.0023	0.0576	0.968
Information Sharing	0.3602	0.0573	0.000
Sales Promotion	0.2280	0.0478	0.000
Constant	-0.514	0.120	0.000

The results of the regression analysis for the overall model indicates that the predictors variables (i.e. order batching, lead-time, rationing, demand forecasting, information sharing and sales promotion) explain 89.09% of the variance in the dependent variable (R^2=0.8908, p<.05).

Hypothesis 1A

The hypothesis that order batching will affect BWE was tested. The results presented in Table 5.4 shows that order batching is not statistically significant impact on BW.

Hypothesis 1B

The hypothesis that lead-time will affect BWE was tested. The results presented in Table

5.4 shows that lead time has a statistically significant positive impact on BWE (p<.05).

Hypothesis 1C

The hypothesis that rationing will affect BWE was tested. The results presented in Table

5.4 shows that rationing has a statistically significant positive impact on BWE (p<.05).

Hypothesis 1D

The hypothesis that demand forecasting will affect BWE was tested. The results presented in Table 5.4 shows that demand forecasting has a statistically no significant impact on BWE (β=.283, p<.05).

Hypothesis 1E

The hypothesis that information sharing will affect BWE was tested. The results presented in Table 5.4 shows that information sharing has a statistically significant positive impact on BWE (p<.05).

Hypothesis 1F

The hypothesis that sale promotion will affect BWE was tested. The results presented in Table 5.4 shows that sales promotion has a statistically significant positive impact on BWE (p<.05).

5.CONCLUSION

Conclusion

This study finds that demand forecasting, order batching, rationing, lead-time, sales promotions and information sharing are the major factors affecting the bullwhip effect. These factors lead to longer lead-time, forecasting errors, heavy inventories, excess of safety stock and financial losses. Moreover, they can directly lead to supply chain inefficiency. The study also confirms that the BWE can be managed effectively through sharing of real time information and a centralized supply chain network.

6.Future Scope

Since BWE has a great influence on the supply chain system, further researches are required to eradicate BWE. There are some issues for further researches:

- It may be investigated the ways that minimizes the complexity of the supply chain.
- Finding out the ways that improve the collaboration among the stages of the supply chain.
- It may be surveyed that how many manufacturers are concern about all the causes of BWE.
- Bullwhip can be observed at the industry-, firm-, and product-level, in various types of supply chains.
- More accurate forecasts, smaller batch sizes and shorter lead-time help to reduce bullwhip.

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