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A Review on Amplification of Order Quantities– Bullwhip Effect

John Rajan A, Arun Prasad N S, Aswin Shankharan, Vignesh T and Vincent H Wilson
Professor, Department of Manufacturing Engineering, School of Mechanical Engineering (SMEC), VIT, Vellore, India
UG Student, Department of Manufacturing Engineering, School of Mechanical Engineering (SMEC), VIT, Vellore, India
UG Student, Department of Manufacturing Engineering, School of Mechanical Engineering (SMEC), VIT, Vellore, India
UG Student, Department of Manufacturing Engineering, School of Mechanical Engineering (SMEC), VIT, Vellore, India
Professor, Department of Technology Management, School of Mechanical Engineering (SMEC), VIT, Vellore, India

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Abstract:
The most important problem of the future that should be addressed today is the guarantee of effective goods transfer without any amplification of the order quantities. We are addressing this paper from the analytic approach of the knowledge gained by referring over 150 papers of different publications on Bullwhip effect and the problem faced by people in the Logistic and Supply Chain Arena. Bullwhip Effect is nothing but the variation in the demand and supply over a multi layered supply chain system. This is caused due to human errors at various stages of the process, including Forecasting and Survey. Now that technology has advanced and the evolution of Industry 4.0 has given bloom to so many sophisticated ways of handling goods, we still are not able to achieve the minimum loss on the side of Bullwhip effect.

Keywords: *Supply Chain, Bullwhip, Information Sharing, Batch order, Demand, Lead Times, Safety Stock.*

I. INTRODUCTION

An important supply chain and enterprise risk management problem that has got considerably more attention is the concept known as Bullwhip Effect. In a two stage single item supply chain, it means that demand is far less than order which is received by the supplier. It could be found out that there are 2 major causes of Bullwhip Effect, i.e, demand forecasting and order policies. As we go through further studies we could know that Bullwhip effect could be witnessed under various forecasting methods and varying demand patterns. In his paper of "A human experiment on inventory decisions." A. Ancarani adopted controlled human experiments to estimate buyer's inventory decisions when there are uncertainties in supply chain [1]. As now it seems epoch making to mention that on his experiments with single stage inventory system gave light to the fact that inventory behaves differently in case of non-stationary demand as compared to a stationary demand. As the pivotal theme in the evolution of inventory theory is to make more practical assumptions about demand of product into inventory model. Moreover decoding the origin of Bullwhip is very unlikely as the growth is Metastasis development, thereby we could not cover a particular part of the supply chain as the cause of Bullwhip. TQM policies like Poke Yoke cannot be applied here because the decisions are based on human experience and mostly theoretical and technical human mistake proofing won't be successful in a situation like Bullwhip Effect.

1.1 Beer Distribution Game

It is a simulation game designed by Jay Wright Forrester to demonstrate the importance of communication, management, and collaboration at various stages of a supply chain. The game consists of 24 rounds and four groups. The groups being manufacturers, distributors, wholesalers, and retailers. The task of the game is to meet customer demand with less expenditure on orders and inventories. Figure 1. Shows the model of a typical mock-up of the Beer Distribution Game. The motivation behind the game is to establish that variation in the frequency of ordering by each group can lead to issues like Bullwhip Effect

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Figure 1

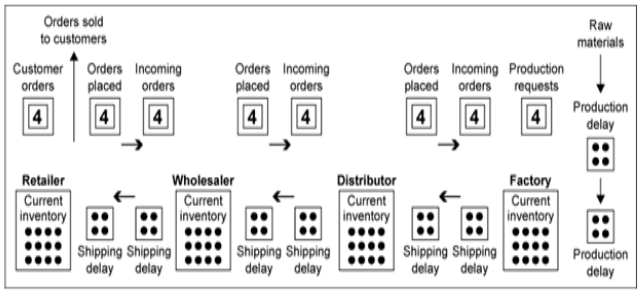

Figure 1: Mock-Up of Beer Distribution Game
(Source: https://www.isixsigma.com/wpcontent/uploads/2019/08/Mock-up-of-the-Game-Board.gif)

II. Literature Review

A concise note of the best practices followed in the supply chain flow history is mentioned in Table 1. It starts from the introduction of Literature work on Logistics till the new practices followed used at the wake of the 19 th century.

TABLE 1: History of Emergence of Bullwhip Effect

1898	Literature work on Logistics
1919	Start of Supply-chain as an education
1927	Mass production by Ford
1950	Concept of Postponement
1952	Introduction of Bar Coding
1961	Forrester Effect
1963	Foundation of Council of Logistics Management
1971	Introduction of Reverse Logistics
1984	Theory of Constraints in book called “The Goal”
1985	First Time full scale analysis of Supply Chain
1988	Introduction of Lean manufacturing concepts
1993	Introduction Concept of Re-Engineering
1997	Bullwhip Effect
2001	Green Supply Chain
2012	Global Supply Chain Security

It is understood from all the previous research works that all these best practices have made less effort on the Bullwhip Effect. The Bullwhip Effect is considered in all sectors, consisting of the Service sector, where the components of the supply chain are regularly now not liner, as in the traditional product grant chain. On the other hand, we have to seem to be at the human behaviours that have brought on the Bullwhip Effect, as the analysis explores how the retailer's constrained functionality to forecast end-customer demand and their sub-optimal replenishment insurance policies distort provider demand indicators. The problems on stock and collaboration are mentioned down in many papers over a It is understood from all the previous research works that all these best practices have made less effort on the Bullwhip Effect. The Bullwhip Effect is considered in all sectors, consisting of the Service sector, where the components of the supply chain are regularly now not liner, as in the traditional product grant chain. On the other hand, we have to seem to be at the human behaviours that have brought on the Bullwhip Effect, as the analysis explores how the retailer's constrained functionality to forecast end-customer demand and their sub-optimal replenishment insurance policies distort provider demand indicators. The problems on stock and collaboration are mentioned down in many papers over a range of sectors to understand the vivid problems underlying an effect. The main essence of the troubles to bullwhip effect could be Erratic Human behaviours, Parameters correcting inventory, security inventory policy, Delivery time delays (lead time), Demand Forecasting techniques, order batching policy, information sharing, lack of synchrony, Price policies, operation potential constraints and the range of hyperlinks in the chain. In Table 2, you can see the issues addressed in each paper, and that would provide us a thought about the Bullwhip Effect.

TABLE 2: Issues addressed in each paper

Reference No	Parameters correcting inventory	Safety stock policy	Lead time	Demand Forecasting Techniques	Order Batching Policy	Information sharing	Lack of Synchrony	Price Policy and Operations constraints
[11]							✔	
[22]								✔

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[33]		✔						
[44]					✔			
[55]			✔					
[58]	✔							
[59]								✔
[60]					✔			
[1]	✔							
[2]						✔		
[3]						✔		
[4]			✔					
[5]		✔						
[6]					✔			
[7]						✔		
[8]		✔				✔		
[9]		✔						
[10]			✔					
[12]								✔
[13]	✔							
[14]								✔
[15]								✔
[16]						✔	✔	
[17]			✔			✔		
[18]						✔		
[19]							✔	
[20]					✔			
[21]		✔						
[23]								✔
[24]				✔				
[25]						✔		
[26]				✔				
[27]							✔	
[28]		✔						
[29]							✔	
[30]						✔		
[31]	✔							

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[32]	✔							
[34]		✔						
[35]		✔						
[36]								✔
[37]								✔
[38]				✔				
[39]	✔							
[40]								✔
[41]						✔		
[42]				✔				
[43]						✔		
[45]			✔					
[46]		✔			✔			
[47]				✔	✔			
[48]	✔							
[49]				✔				
[50]				✔				
[51]					✔			
[52]								✔
[53]				✔				
[54]					✔			
[56]					✔			
[57]								✔

III. BULLWHIP EFFECT

The bullwhip effect is a phenomenon we can observe in our everyday life, starting from the extra orders for the food we make for a gathering, the seasonal manufacturing like Umbrellas during the rainy season, sweaters and Jackets during the winter season, etc. It is a common phenomenon that is observed in the process of life, and this, when happens in the industry, especially in a Supply Chain, leads to a massive loss in money, workforce, material, and many other damages that incur in a production. Bullwhip Effect is the amplification of order quantities in the trend of Supply Chain of industries with variation in the demand and supply due to factors like change in market trends, discounts in pricing, or any other external factor that changes the demand goes upstream with the supply [27].

Fluctuations in demand lead to a rise or fall in order quantities in a supply chain. Forecasting being an approximate calculation of quantities, this change in the market leads to variations in demand graph of a supply chain, which may lead to excess or sometimes lesser quantities than the required amount leading to a loss in money, material, and time. The bullwhip effect is a practical constraint that has been dealt only using experiences of the past as the underlying factor of the Bullwhip Effect in a supply chain is the improper flow of information or misinterpretation of demand quantities.

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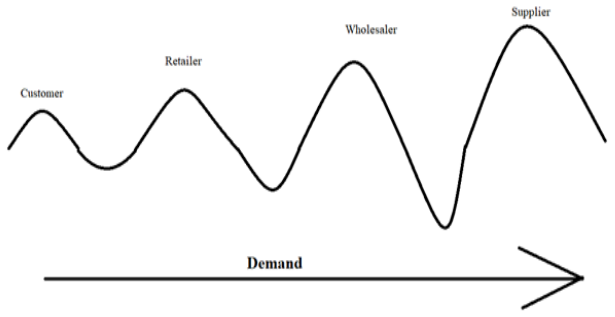
This varies with the type of product and industry though the reason underlying Bullwhip effect is the same across all the sectors and markets. Many types of research that have taken place in a Lean industrialization perspective have not created a big difference in the reduction of the Bullwhip effect as such. Various industries like Proctor & Gamble, HP, ITC have shown in their case studies that only change in customer demands does not lead to the Bullwhip effect, but many other factors are responsible for the same that aligns with the industrial work.

Since products differ in kind in demand forecast as Elastic and Non-Elastic products, a general answer can't be derived that would cater to all merchandise and production. The distortions in the furnish chain due to Bullwhip impact is because of wrong verbal exchange between the contributors of the supply chain like the retailer, supplier and manufacturer .These information's include scheduling, transport time, order batching, demand, etc. Also, false statistics is exceeded for private benefits of one man or woman in a furnish chain and when this false statistics is shared for income with the aid of absolutely everyone in the provide chain like the amount of stock required, the amount of stability inventory, the real demand, etc [18]

Figure 2: Basic Illustration of Bullwhip Effect



3.1Consequences of Bullwhip Effect:

Bullwhip Effect creates a negative impact on a supply chain. A supply chain forms the backbone of the whole production process, when this skeleton is not shaped for its function; the whole unit of production gets disrupted [23]. The process relies on supply chain and the data that flows in it. When this data goes through amplification, it affects the uniformity in the flow of money, materials and manpower in the supply chain and the production process. Relying on the data obtained between two stages of a supply chain believing it to be right, the functionality of the whole production process is affected when this Bullwhip effect arises due to human errors on predictions, order batching and carelessness in analyzing the market. An article of HBR has stated that Bullwhip effect may lead to a disruption in the economy of China and for a few months in 2016, the Shanghai Stock exchange started going down due to the increase in Bullwhip effect in the industries of the country [34].

A lot of interlinked networks leading to a huge foundation of economy form a supply chain and this when affected by Bullwhip effect, shakes the whole network which affects the interdependent networks forming a large economic loss. The major disadvantage with Bullwhip effect in Supply Chain is there is no abstract solution to it [47]. No mathematical solution could be derived for reduction in Bullwhip effect as it is a practical on ground situation of an industry that varies across products, markets and locations.

Though tightened lean principles can control it to an extent and fairness in data sharing could make a reasonable amount of reduction, Bullwhip effect can never become Zero and it is a hypothetical scenario [7]. When changes in demands are drastically increasing, Bullwhip effect is proportionally increasing with the same. Olden day manufacturing techniques cannot withhold Bullwhip effect or even three decades of experience in a same industry cannot predict the demand for the next day. With this scenario that exists in the real world, Bullwhip effect is all around the corner. The competitors and the markets have expanded along with the increasing demands for products with increasing population, rising economy and demands. In an economic point of view, a rise in economy leads to a rise in demand which fluctuates the demand graph in a supply chain leading to Bullwhip effect which again someday would be responsible for affecting the growth in economy.

3.2 Effect on Economy:

The effect of Bullwhip on economy is one which has been overlooked by a lot of people. In it is one of the important areas of interest to economists. The Figure 3 shows the effect of Bullwhip on economy.

The Kondratieff Wave shown in the following Figure

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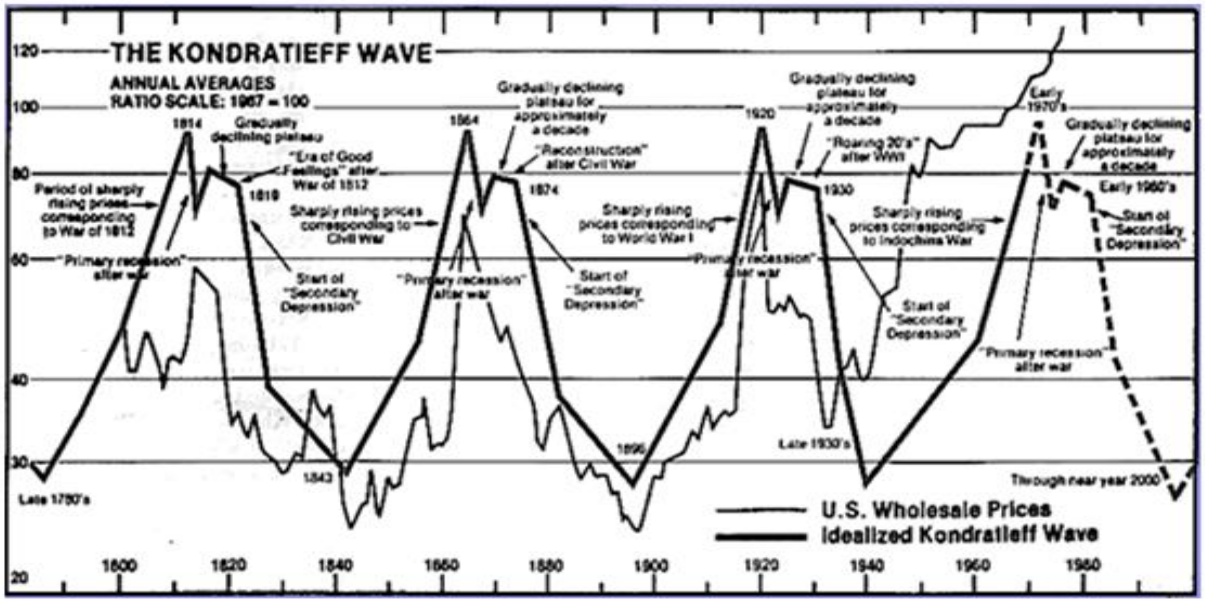
3 is a demonstration of the cyclic effect of the Bullwhip Effect in the economy as inequity is the most essential factor contributing to the Kondratieff Wave. As it is observed in the wave, there are typically 3 phases in one amplification namely the Expansion phase, the Stable phase and the Decline phase.

These periodicities are a result of technology innovations which bloomed after the World War II. As each amplification is caused during the break through of an innovation leading to separate economy phases of their own

Figure 3
Figure 3. Periodicity in the economy—an example of a Kondratieff Wave (Source: Kondratieff (1984) http://www.angelfire.com/or/truthfinder/index22.html)



From Figure 3 it could be observed that the actual Wholesale Prices is less than the Idealized Kondratieff wave due to the over-expansion of the economy than the predicted values. The reason for the over-expansion is that the order quantity increases due to the Bullwhip Effect, resulting in more order than the demand resulting in lesser prices.

IV. Causes of Bullwhip Effect

The major cause for bullwhip effect is due to the flow of the false or improper information between various players in the supply chain.

We observe bullwhip effect when supply chain channel partners work on false information there by providing wrong signals.

4.1 Inaccurate Information

It is one of the major causes for the Bullwhip effect. Because of lack of the correct information, every supply chain channel player makes self-assumption of the demand and supply and places larger orders to be

able to supply keeping in mind if there is an increase in demand .

4.2 Discounts and Offers

Seasonal discounts make up and down cycle for the products which make supply chain channel partners to place higher orders upstream. This makes everyone to stock higher keeping in mind the previous sales.

When Discount period ends it causes a huge fluctuation in inventory and it leads to the bullwhip effect [37]. We can partially reduce it by keeping track of previous sales during discount period and immediate fluctuation in demand after that discount period and use this data to forecast.

4.3 Shortage Gaming

This happens due to wrong prediction, when customers order same product in different companies and cancel some, this leads to false assumption of demand increase which leads to increase in inventory.

Another reason for shortage gaming is retailer assumes a particular product has more demand but due to some unforeseen changes more than others. This leads to

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shortage gaming which causes increase in inventory which in turn leads to the bullwhip effects.

4.4 Delay

Due to the delays made in receiving orders by previous supply chain partners some time supply chain channel players place larger order to safeguard themselves which lead to increased inventory. These delays are generally due to technical errors and some unavoidable reasons

4.5 Communication Gap

Due to no proper communication between the supply chain players there will be error in estimating the inventory which leads to Bullwhip effect [41]. The communication gap is caused due to no proper supply chain infrastructure and when there is no proper relation among the supply chain players

4.6 Returns Policy

Free returns policy can make way to the wrong demand and false information flow causing upstream activities which disrupts the flow of the supply chain and leads to the Bullwhip effect.

4.7 Market Fluctuation

This is nothing but the price fluctuation happening in the market or even the change in the preference of the customer. The whole sellers try to sell out the material down the stream with many discounts, but the demand by the time material reaches down is gone . This causes distortion in the inventory management which in turn causes Bullwhip effect.

4.8 Order Batching

Generally companies make orders in batches; they do this because when companies order frequently they may cause them more operation cost and transportation cost, so to avoid these companies generally make orders in batches. But when demand gets decreases, there are inventory gets stocked which leads to Bullwhip effect in the supply chain.

4.9 Rationing

This happens due to wrong prediction, when customers order same product in different companies and cancel some, this leads to false assumption of demand increase which leads to increase in inventory. This causes Bullwhip effect.

V. Solutions for Reducing Bullwhip Effect

As we have come to know about Bullwhip Effect, we realize that it is hard to make the Bullwhip Effect to Zero. Though we cannot make it to zero, we can try out ways to reduce Bullwhip Effect so that we have a minimal effect of Bullwhip over the Supply-chain.

Focus on the Customer:

A strategic design of customer centric network design should be fixed so that the demand fluctuation does go too high. The whole supply chain should be segregated based on the value on which they contribute to the customer.

Set the Push-Pull strategy:

Allot the inventory based on the demand certainty. If the demand is stable then push strategy can be used. If the demand is uncertain then pull strategy can be used.

Sharing of Information:

The lack of information sharing results in the direct rise of prices. The links between two partners should be well built and a good information sharing practice should be encouraged. Moreover the lead time should be calculated and the information correlation should be analyzed.

Break Order batching:

Use proper transport models so that we get minimized prices with right time of delivery. The valuation of each supplier should be assessed prior and proper goals of lead time should be fixed.

Stabilize the prices:

To attract the customers and to gain their loyalty the prices should stable. The customer gets disoriented when the prices fluctuate. Leading to misinformation of demand.

Avoid Gaming/ Rationing during Shortage:

Allocate products based on past sales figures and avoid rationing during uncertain times of sales. Cancel the return policies, as it forbids the customer to return the product.

VI. Conclusion

As we have gone through papers on supply chain and have focused are work and analysis on papers covering

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Bullwhip effect we have come across a lot of real time problems and how Bullwhip effect plays a major role on the economy of our country. I guess the recent fluctuation in the prices of FMCA goods has a part played by Bullwhip effect of supply chains in the particular sector. We have to take into account of all factors from human behavior to machine forecasting errors for the Bullwhip effect. Never can we make the Bullwhip Effect as Zero but yet from the study of over 100 papers we have strong and reliable evidences that minimizing that to a near zero is possible and we have to work on it. The future is full of uncertainty and many new practices are introduced into the field of production and distribution which could diminish the effects of Bullwhip to a larger extend. From the journals and interviews from pioneers in the industry of supply chain we could understand the fundamental system which we are following makes the changes. An accepted overall standard all over the global is the most important aspect which the present economist are concerned with [52]. For example, USA has a credit based economy whereas India has a savings based economy. When we do global supply chain distribution we have to overcome these fundamental regional problems too. As a concluding note it is very clear that the future perspective to approach Bullwhip effect will change as we could see Industrial Internet of Things, Cloud Networking, Data Mining and Artificial Intelligence coming around to solve these old problems.

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VIII. REFERENCES

1. Y. F. Chen and S. M. Disney, “The myopic order-up-to policy with a proportional feedback controller,” Int. J. Prod. Res., vol. 45, no. 2, pp. 351–368, 2007.
2. R. Croson and K. Donohue, “Upstream versus downstream information and its impact on the bullwhip effect,” Syst. Dyn. Rev., vol. 21, no. 3, pp. 249–260, 2005.
3. R. Croson and K. Donohue, “Behavioral causes of the bullwhip effect and the observed value of inventory information,” Manage. Sci., vol. 52, no. 3, pp. 323–336, 2006.
4. Hau L Lee, Kut C So, and Christopher S Tang, “The Value of Information Sharing in a Two-Level Supply Chain,” Manage. Sci., vol. 46, no. 5, p. 626, 2000.
5. M. S. Sodhi and C. S. Tang, “The incremental bullwhip effect of operational deviations in an arborescent supply chain with requirements planning,” Eur. J. Oper. Res., vol. 215, no. 2, pp. 374–382, 2011.
6. C. I. Papanagnou and G. D. Halikias, “Supply-chain modelling and control under proportional inventory- replenishment policies,” Int. J. Syst. Sci., vol. 39, no. 7, pp. 699–711, 2008.
7. M. Hussain, A. Shome, and D. M. Lee, “Impact of forecasting methods on variance ratio in order-up-to level policy,” Int. J. Adv. Manuf. Technol., vol. 59, no. 1–4, pp. 413–420, 2012.
8. H. L. Lee, V. Padmanabhan, and S. Whang, “Information distortion in a supply chain: The bullwhip effect,” Manage. Sci., vol. 50, no. 12 SUPPL., pp. 1875–1886, 2004.
9. T. Hosoda, S. M. Disney, and S. Gavirneni, “The impact of information sharing, random yield, correlation, and lead times in closed loop supply chains,” Eur. J. Oper. Res., vol. 246, no. 3, pp. 827–836, 2015.
10. M. Jakšič and B. Rusjan, “The effect of replenishment policies on the bullwhip effect: A transfer function approach,” Eur. J. Oper. Res., vol. 184, no. 3, pp. 946–961, 2008.
11. H. Akkermans and C. Voss, “The service bullwhip effect,” Int. J. Oper. Prod. Manag., vol. 33, no. 6, pp. 765–788, 2013.
12. J. G. Kim, D. Chatfield, T. P. Harrison, and J. C. Hayya, “Quantifying the bullwhip effect in a supply chain with stochastic lead time,”

May – June 2020
ISSN: 0193-4120 Page No. 2813 - 2823

Eur. J. Oper. Res., vol. 173, no. 2, pp. 617–636, 2006.

13. J. Shan, S. Yang, S. Yang, and J. Zhang, "An empirical study of the bullwhip effect in China," Prod. Oper. Manag., vol. 23, no. 4, pp. 537–551, 2014.
14. E. Sucky, "The bullwhip effect in supply chains-An overestimated problem?," Int. J. Prod. Econ., vol. 118, no. 1, pp. 311–322, 2009.
15. R. Tangsucheeva and V. Prabhu, "Modeling and analysis of cash-flow bullwhip in supply chain," Int. J. Prod. Econ., vol. 145, no. 1, pp. 431–447, 2013.
16. P. Wangphanich, S. Kara, and B. Kayis, "Analysis of the bullwhip effect in multi-product, multi-stage supply chain systems-a simulation approach," Int. J. Prod. Res., vol. 48, no. 15, pp. 4501–4517, 2010.
17. B. Adenso-Díaz, P. Moreno, E. Gutiérrez, and S. Lozano, "An analysis of the main factors affecting bullwhip in reverse supply chains," Int. J. Prod. Econ., vol. 135, no. 2, pp. 917–928, 2012.
18. S. Agrawal, R. N. Sengupta, and K. Shanker, "Impact of information sharing and lead time on bullwhip effect and on-hand inventory," Eur. J. Oper. Res., vol. 192, no. 2, pp. 576–593, 2009.
19. R. L. Bray and H. Mendelson, "Information transmission and the bullwhip effect: An empirical investigation," Manage. Sci., vol. 58, no. 5, pp. 860–875, 2012.
20. R. L. Bray and H. Mendelson, "Production smoothing and the bullwhip effect," Manuf. Serv. Oper. Manag., vol. 17, no. 2, pp. 208–220, 2015.
21. M. Hussain and P. R. Drake, "Analysis of the bullwhip effect with order batching in multi-echelon supply chains," Int. J. Phys. Distrib. Logist. Manag., vol. 41, no. 10, pp. 972–990, 2011.
22. M. A. Haughton, "Distortional Bullwhip Effects on carriers," Transp. Res. Part E Logist. Transp. Rev., vol. 45, no. 1, pp. 172–185, 2009.
23. A. Ancarani, C. Di Mauro, and D. D'Urso, "A human experiment on inventory decisions under supply uncertainty," Int. J. Prod. Econ., vol. 142, no. 1, pp. 61–73, 2013.
24. J. Dejonckheere, S. M. Disney, M. R. Lambrecht, and D. R. Towill, "Measuring and avoiding the bullwhip effect: A control theoretic approach," Eur. J. Oper. Res., vol. 147, no. 3, pp. 567–590, 2003.
25. D. E. Cantor and E. Katok, "Production smoothing in a serial supply chain: A laboratory investigation," Transp. Res. Part E Logist. Transp. Rev., vol. 48, no. 4, pp. 781–794, 2012.
26. S. M. Disney and D. R. Towill, "The effect of vendor managed inventory (VMI) dynamics on the Bullwhip Effect in supply chains," Int. J. Prod. Econ., vol. 85, no. 2, pp. 199–215, 2003.
27. P. T. Xu, K., Dong, Y. and Evers, "Towards better coordination of the supply chain", Transportation Research Part E," Transp. Res. Part E Logist. Transp. Rev., vol. 37, no. 1, pp. 35–54, 2001.
28. L. C. Alwan, J. J. Liu, and D. Q. Yao, "Stochastic characterization of upstream demand processes in a supply chain," IIE Trans. (Institute Ind. Eng., vol. 35, no. 3, pp. 207–219, 2003.
29. E. G. Anderson, D. J. Morrice, and G. Lundeen, "The 'physics' of capacity and backlog management in service and custom manufacturing supply chains," Syst. Dyn. Rev., vol. 21, no. 3, pp. 217–247, 2005.
30. T. K. Chen, H. H. Liao, and H. J. Kuo, "Internal liquidity risk, financial bullwhip effects, and corporate bond yield spreads: Supply chain perspectives," J. Bank. Financ., vol. 37, no. 7, pp. 2434–2456, 2013.
31. R. Croson, K. Donohue, E. Katok, and J. Sterman, "Order stability in supply chains: Coordination risk and the role of coordination stock," Prod. Oper. Manag., vol. 23, no. 2, pp. 176–196, 2014.
32. J. Dejonckheere, S. M. Disney, M. R. Lambrecht, and D. R. Towill, "The impact of information enrichment on the Bullwhip effect in supply chains: A control engineering perspective," Eur. J. Oper. Res., vol. 153, no. 3 SPEC. ISS., pp. 727–750, 2003.

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ISSN: 0193-4120 Page No. 2813 - 2823

33. S. Cannella and E. Ciancimino, “On the bullwhip avoidance phase: Supply chain collaboration and order smoothing,” Int. J. Prod. Res., vol. 48, no. 22, pp. 6739–6776, 2010.
34. S. Delhoum and B. Scholz-Reiter, “The influence of decision patterns of inventory control on the bullwhip effect based on a simulation game of a production network,” Prod. Plan. Control, vol. 20, no. 8, pp. 666–677, 2009.
35. X. Wang, S. M. Disney, and J. Wang, “Stability analysis of constrained inventory systems with transportation delay,” Eur. J. Oper. Res., vol. 223, no. 1, pp. 86–95, 2012.
36. G. Gaalman and S. M. Disney, “State space investigation of the bullwhip problem with ARMA (1,1) demand processes,” Int. J. Prod. Econ., vol. 104, no. 2, pp. 327–339, 2006.
37. G. Gaalman and S. M. Disney, “On bullwhip in a family of order-up-to policies with ARMA(2,2) demand and arbitrary lead-times,” Int. J. Prod. Econ., vol. 121, no. 2, pp. 454–463, 2009.
38. S. Geary, S. M. Disney, and D. R. Towill, “On bullwhip in supply chains - Historical review, present practice and expected future impact,” Int. J. Prod. Econ., vol. 101, no. 1 SPEC. ISS., pp. 2–18, 2006.
39. V. Giard and M. Sali, “The bullwhip effect in supply chains: A study of contingent and incomplete literature,” Int. J. Prod. Res., vol. 51, no. 13, pp. 3880–3893, 2013.
40. S. M. Disney, D. R. Towill, and W. Van De Velde, “Variance amplification and the golden ratio in production and inventory control,” Int. J. Prod. Econ., vol. 90, no. 3, pp. 295–309, 2004.
41. S. C. Graves, “Addendum to ‘A Single-Item Inventory Model for a Nonstationary Demand Process,’” Manuf. Serv. Oper. Manag., vol. 1, no. 2, pp. 174–174, 1999.
42. S. M. Disney, M. Lambrecht, D. R. Towill, and W. Van de Velde, “The value of coordination in a two-echelon supply chain,” IIE Trans. (Institute Ind. Eng., vol. 40, no. 3, pp. 341–355, 2008.
43. Y. Dong, M. Dresner, and Y. Yao, “Beyond information sharing: An empirical analysis of vendor-managed inventory,” Prod. Oper. Manag., vol. 23, no. 5, pp. 817–828, 2014.
44. L. Chen and H. L. Lee, “Bullwhip effect measurement and its implications,” Oper. Res., vol. 60, no. 4, pp. 771–784, 2012.
45. T. T. H. Duc, H. T. Luong, and Y. D. Kim, “A measure of bullwhip effect in supply chains with a mixed autoregressive-moving average demand process,” Eur. J. Oper. Res., vol. 187, no. 1, pp. 243–256, 2008.
46. G. Gaalman, “Bullwhip reduction for ARMA demand: The proportional order-up-to policy versus the full-state-feedback policy,” Automatica, vol. 42, no. 8, pp. 1283–1290, 2006.
47. T. T. H. Duc, H. T. Luong, and Y. D. Kim, “A measure of the bullwhip effect in supply chains with stochastic lead time,” Int. J. Adv. Manuf. Technol., vol. 38, no. 11–12, pp. 1201–1212, 2008.
48. S. Y. Lee, R. D. Klassen, A. Furlan, and A. Vinelli, “The green bullwhip effect: Transferring environmental requirements along a supply chain,” Int. J. Prod. Econ., vol. 156, pp. 39–51, 2014.
49. Q. Li, S. M. Disney, and G. Gaalman, “Avoiding the bullwhip effect using Damped Trend forecasting and the Order-Up-To replenishment policy,” Int. J. Prod. Econ., vol. 149, pp. 3–16, 2014.
50. P. H. Lin, D. S. H. Wong, S. S. Jang, S. S. Shieh, and J. Z. Chu, “Controller design and reduction of bullwhip for a model supply chain system using z -transform analysis,” J. Process Control, vol. 14, no. 5, pp. 487–499, 2004.
51. H. T. Luong, “Measure of bullwhip effect in supply chains with autoregressive demand process,” Eur. J. Oper. Res., vol. 180, no. 3, pp. 1086–1097, 2007.
52. H. T. Luong and N. H. Phien, “Measure of bullwhip effect in supply chains: The case of high order autoregressive demand process,” Eur. J. Oper. Res., vol. 183, no. 1, pp. 197–209, 2007.
53. W. Holland and M. S. Sodhi, “Quantifying the effect of batch size and order errors on

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ISSN: 0193-4120 Page No. 2813 - 2823

the bullwhip effect using simulation," Int. J. Logist. Res. Appl., vol. 7, no. 3, pp. 251–261, 2004.
54. J. W. Hamister and N. C. Suresh, "The impact of pricing policy on sales variability in a supermarket retail context," Int. J. Prod. Econ., vol. 111, no. 2, pp. 441–455, 2008.
55. F. Chen, Z. Drezner, J. K. Ryan, and D. Simchi-Levi, "Quantifying the bullwhip effect in a simple supply chain: the impact of forecasting, lead times, and information," Manage. Sci., vol. 46, no. 3, pp. 436–443, 2000.
56. T. Hosoda and S. M. Disney, "On variance amplification in a three-echelon supply chain with minimum mean square error forecasting," Omega, vol. 34, no. 4, pp. 344–358, 2006.
57. P. Kelle and A. Milne, "Effect of (s, S) ordering policy on the supply chain," Int. J. Prod. Econ., vol. 59, no. 1, pp. 113–122, 1999.
58. F. Chen and R. Samroengraja, "Order volatility and supply chain costs," Oper. Res., vol. 52, no. 5, 2004.
59. G. P. Cachon, T. Randall, and G. M. Schmidt, "In search of the bullwhip effect," Manuf. Serv. Oper. Manag., vol. 9, no. 4, pp. 457–479, 2007.
60. F. Chen, J. K. Ryan, and D. Simchi-Levi, "The Impact of Exponential Smoothing Forecasts on the Bullwhip Effect," Nav. Res. Logist., vol. 47, no. 4, pp. 269–286, 2000.
61. Chandak, Amit, and Anshul Gangele. "Conceptual and statistical Modeling for identifying linkages among supply chain strategy, flexibility and performance." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 9.3 (2019):993-1002
62. Sangode, Pallawi B., and Sujit G. Metre. "Green supply chain practices for environmental sustainability: a proposed framework for manufacturing firms." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 9.2 (2019):287-298
63. Equbal, A., and R. A. J. K. U. M. A. R. Ohdar. "A Comprehensive Supply Chain Performance Measurement and Evaluation (CSPME) Methodology." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 7.2 (2017): 1-18.
64. Kandi, Shrishail, Antriksh Mutha, And Abhay Kulkarni. "Centralization and Decentralization in Supply Chain Management." International Journal of Industrial Engineering & Technology (IJIET) 7.3 (2017): 5-10.
65. Akrofi, Thomas, and Ernest Ansah. "Impact of multimodal choice on any organisation's sustainable supply chain strategies." International Journal of Business Management & Research (IJBMR) 7.6 (2017):11-20
66. Sathish, T., and J. Jayaprakash. "Optimizing supply chain in reverse logistics." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 7.6 (2017): 551-560
67. Ratna, Sanatan, and B. Kumar. "Evaluating the green supply chain management barriers in a sme: an ahp approach." International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) 9.2 (2019):271-276
68. Nartey, Emelia Dede, and Theophilus Kofi Anyanful. "Integration into supply chain networks in manufacturing firms in Ghana: the effect of challenges." International Journal of Business Management & Research (IJBMR) 5.1 (2015):23-32