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Bullwhip Effect Can Be Mitigated by Using Data Base Management System

Komal Preet Kaur

Professor, Metis degree college

Abstract

Purpose: The risk of uncertainty in demand or spurious demand will lead to generation of bullwhip effect. In this research paper biasness of information and actual order of stock will be investigated through the employment of computerized system.

Design: This study is conducted to address the gap systematic literature review of 40 articles is concluded from the year 2017 to 2024. The source of article is web of science and Scopus, using PRISMA protocol with the help of TCCM framework.

Finding: The result under this research is information is amplified while reaching from end consumer to manufacture the main cause find in various studies is lead time. The factors related to the bullwhip effect also found in it.

Original value: Under this research provide insight to manufactures, suppliers, investors, managers in the replenishment policy making and also efficient utilization of resources. Mainly significance of this research to provide insight to the new startups how to maintain inventory.

Keywords: Supply Chain, Entrepreneurs, Database.

Introduction

Numerous actions should be undertaken for the purpose for the best possible supply chain performance. However, those choices occasionally conflict with the goals of all those involved in the same supply chain (Cannella, S., Dominguez, R., Ponte, B., & Framinan, J. M. (2018). The main objective of supply chain stakeholders consists of achieving their own aims, but this self-serving focus can result inadequate execution.

According to the Schisgall, O. (1981) the proctor and gamble is the first company who describe about the bullwhip effect. It is based on the traditional method of capacity restrictions (Cannella, S., Dominguez, R., Ponte, B., & Framinan, J. M. (2018). The most of the researches has shown the bullwhip effect from the distorted information they received from the retailers, wholesalers, change in fashion, product life cycle differently(Cannella et al., 2018);(Cuong et al., 2023); (Ponte et al., 2021); (Dominguez et al., 2020). But the problem is that all the components should be analysed using the data base management system simultaneously.

To fill this gap, the study provides comprehensive view of the variables influencing the production level which is being related to the bullwhip effect using the systematic literature review methodology. This study seeks to achieve the following objectives: (1) systematically review the existing literature review of the of bullwhip effect on the inventory cost, production level and customer satisfaction, (2) to identify, analysed and summarize the variables of the bullwhip effect. The PRISMA protocol with the help of

TCCM framework. The main focus of this study is to provide insight to industry that how to reduce the bullwhip effect for new entrepreneurs

The article has division of eight sections: (1) the first section is introduction, (2) this section presents the existing research on bullwhip effect, (3) the PRISMA protocol used in the methodology section,(4) the result section, TCCM framework (5) the discussion section analysed the variables and findings.(6) in this section research gap and limitations are reviewed which will be developed in future recommendations,(7) the practical implications,(8) this section highlight the conclusion and importance of findings in systematic literature review.

Theoretical background

Bullwhip effect

The effect of variance information travelled from lowest of the chain to top most level is the bullwhip effect (Forrester, J. W. (1958). Although the information is not accurate or not received on time which create trouble for the manufacturer (Forrester, J. W. (1958). Due to bullwhip effect mentioned conditions will occur firstly talk about the storage cost due to excessive information of demand, secondly the manufacturing cost due to production of goods raw material required, labour cost and lastly the transportation cost for the replenishment of stock (Beer, A. (2014); (Chopra, S., & Meindl, P. (2007). The mitigation of bullwhip effect will also have positive effect as it will reduce the investment and inventory cost (Chopra, S., & Meindl, P. (2007).

Data base management system

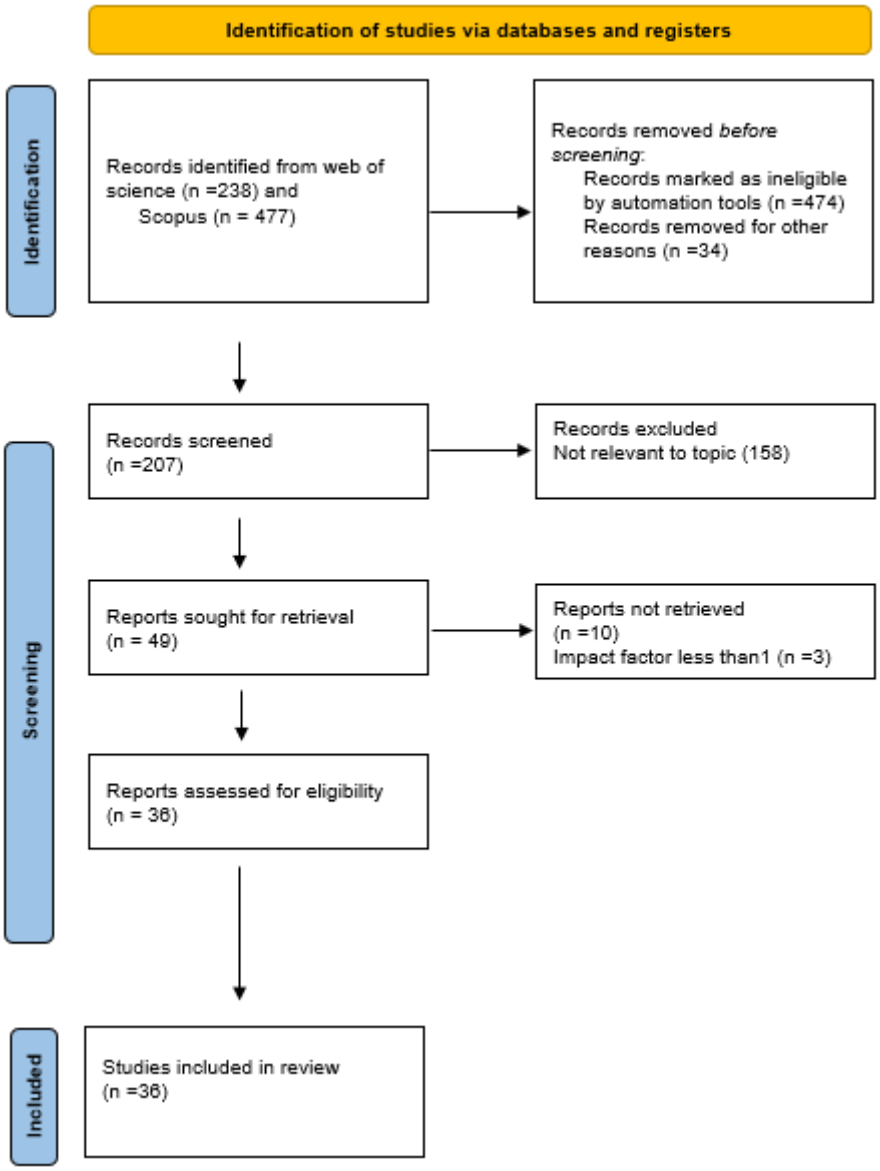
This allowed to measure, gather, record, confirm, arrange, preserve, combine update, collect, and defend data(Mapanga & Kadebu, 2013).earlier the data base management system used is flat file database but it has some limitations that are no structured relation, no security and data is in simple binary formation (Mapanga & Kadebu, 2013). Now the need that to develop new database which remove all these drawbacks then the era come of SQL database (structured query language) with the passage of time it was not able to handle the modern workload because of rigid schema system (Mapanga & Kadebu, 2013). Now the system used are NO SQL database management system which provide flexibility to the entrepreneurs (Mapanga & Kadebu, 2013).

Review approach and structure

The study carries out a thorough literature assessment that identifies research gaps, offers prospective research directions, and provides a current grasp of the underlying research stream. The study uses sequential methods to conduct a systematic literature review and organize the topic of bullwhip effect minimization using advanced computerized tools. The Prisma Protocol is addressed in the first stage (Moher et al.,2009), and the TCCM framework was used in this study in the second (Paul & Benito.,2018). Using it the figure 1 describes the following stages. At the introduction stage: the source of relevant database is web of science and Scopus and the impact factor is greater than 1and some journal has impact factor 12, the journal reviewed in this related to the bullwhip effect on the supply chain. The study articles that were taken from Scopus and the Web of Science are 238 and 477 respectively after the exclusion because of automation tool and other reason, remaining journals are 207

The screening stage: this stage records excluded 158 due to irrelevant topic. When sought for retrieval records were 49, because of not availability of full text the records left for eligibility are 36.

The inclusion stage after all of the screening records finally we have 36.



Inclusion criteria

The research paper searched from the combination of "bullwhip effect" and "supply chain". The year considered for selection is 2017 to 2024 and the language preferred is English. The disciplines included are supply chain management and business management.

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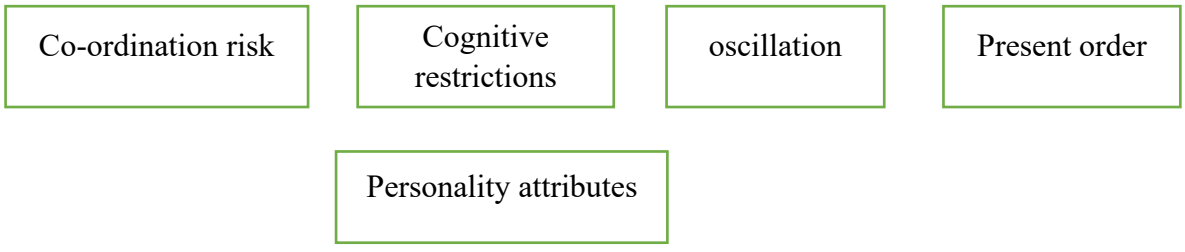
Factors of bullwhip effect



1. **Co-ordination risk:** There is lack of trust on the information provided by the suppliers and customers in that case they drop their decision and make their own choice of production (croson, R., et al (2014).
2. **Cognitive restrictions:** Participants do not believe the other behaviour and does not change according to the market situation. this situation will exaggerate the bullwhip effect (croson, R., Donohue, K., Katok, E., & Sterman, J. (2014).
3. **Oscillation:** When there is a gap between the order arrived and (backlogs Sterman, J. D. (1989); (Croson, R., & Donohue, K. (2006).
4. **Present order:** The bullwhip effect come in force when the demand is stable and ordering policy is efficient but still making variations in the stock level of the products. The participants thought the supply line is underweight so kept up pilling the stock (Croson, R., & Donohue, K. (2006); (Kovacevic, I., Panic, B., Vujosevic, M., & Kuzmanovic, M. (2013).
5. **Personality attributes:** The personality traits like risk taker, risk averse or risk neutral, clarity or confusion of the market situation, efficient and have locus of control all this effect decision which will further contribute to bullwhip effect (Ruël, G., van Donk, D. P., & van der Vaart, T. (2006).

Table 1 This table show the author citation, title, theoretical approach, context and journal.

s.no.	article title	Journal	author citation	context	theoretical
1	The implications of batching in the bullwhip effect and customer service of closed-loop supply chains	INT J PROD ECON	Ponte, B et al.	Customer service	Mathematical model
2	Capacity restrictions and supply chain performance: Modelling and analysing load-dependent lead times	COMPUT IND ENG	Cannella, Salvatore et al.	Customer satisfaction	Time queuing model, little law
3	Modelling and optimizing of variance amplification in supply chain using response surface methodology	INT J PROD ECON	Shaban, Ahmed et al.	Inventory management	Forecasting, simulation
4	When bullwhip increases in the lead time: An eigenvalue analysis of ARMA demand	INT J PROD ECON	Gaalman, Gerard et al.	Companies	Mental model, tyekins squared impulse
5	Modelling the operation of synchronized supply chains under a collaborative structure	ACAD-REV LATINOAM AD	Lopez-Campos, Monica et al.	Partners and customers	***
6	Quality grading of returns and the dynamics of remanufacturing	INT J PROD ECON	Ponte, Borja et al.	Manufacturer	Pout model, control

					theoretic model
7	The Impact of Cooperativeness Supply Chain Performances	INT J ENG EDUC	Panic, Biljana et al.	Management	Transaction cost theory and the resource-based view theory
8	Analysis of Variance Amplification and Service Level in a Supply Chain with Correlated Demand	SUSTAINABILITY-BASEL	Shaban, Ahmed et al.	Cost reduction	Control theory modelling
9	Decision support system for managing multi-echelon supply chain networks against disruptions using adaptive fractional order control algorithm	RAIRO-OPER RES	Cuong, Truong Ngoc et al.	Manufacturers, retailers, Distributors, and end customers	**
10	Bullwhip severity in conditions of uncertainty: regional vs global supply chain strategies	INT J EMERG MARK	Alvarado-Vargas, Marcelo J et al.	Firm, supplier	Internationatio nal theory
11	The implications of COVID-19: Bullwhip and ripple effects in global supply chains	INT J PROD ECON	Scarping, Marcia Regina Santiago et al.	Investors and manufacturing firm	CAPM
12	On the dynamics of closed-loop supply chains under remanufacturing lead time variability	OMEGA-INT J MANAGE S	Dominguez, R et al.	Innovative recommendati ons for companies	
13	Holistic versus analytic thinking orientation and its relationship to the bullwhip effect	SYST DYNAM REV	Branch, M; Grosser, A	Wholesaler, retailer	Theory of holistic thinking
14	Robust Control of Bullwhip Effect for Supply Chain System with Time-Varying Delay on Basis of Discrete-Time Approach	IEEE ACCESS	Chen, D et al.	Customers stream retailer and distributors	***
15	Two-stage supply chain inventory management	ANN OPER RES	Zhou, YL et al.	Management	SD THEORY

	based on system dynamics model for reducing bullwhip effect of sulphur product				
16	An Interaction Investigation of the Contributing Factors of the Bullwhip Effect Using a Bi-Level Social Network Analysis Approach	J THEOR APPL EL COMM	Zhou, HT et al.	Manufactures, retailers, wholesaler	Bi-modal theory
17	An improved forecasting approach to reduce inventory levels in decentralized supply chains	IEEE ACCESS	Tliche, Y et al.	Manufactures	Retailer use SMA method, newton method
18	Sensitivity analysis of the bullwhip effect in supply chains with time delay	INT J SYST SCI-OPER	Khiavi, SA et al.	Producers	Discrete mathematical model
19	Decision Bias and Bullwhip Effect in Mult echelon Supply Chains: Risk Preference Models	IEEE T ENG MANAGE	Pournader, M et al.	provide managers with useful new ideas for improving performance.	Ordering policy
20	System Performance Implications of Capacity and Flexibility Constraints on Bullwhip Effect in Supply Chains	DECISION SCI	Narayanan, A et al.		
21	Two-part tariffs, inventory stockpiling, and the bullwhip effect	EUR J OPER RES	Qu, Z; Raff, H	Production, manufacturing transportation	Game theoretic approach
22	Analysing the behaviour of the bullwhip effect considering different distribution systems	APPL MATH MODEL	Kadivar, M et al.	Manufacturer; distributers, suppliers	ARMA
23	The impact of demand parameter uncertainty on the bullwhip effect	EUR J OPER RES	Pastore, E et al.	Firm, manufacturer	ARMA
24	Incorporating demand, orders, lead time, and pricing decisions for	SCI IRAN	Gamasaee, R et al.		Game theory

	reducing bullwhip effect in supply chains				
25	How to measure bullwhip effect by network data envelopment analysis?	COMPUT IND ENG	Goodarzi, M et al.	Manufacturer	WPF-DEA network
26	Quantifying the Bullwhip Effect in closed-loop supply chains: The interplay of information transparencies, return rates, and lead times	INT J PROD ECON	Ponte, B et al.	Ecosystem	Four archetype
27	The bullwhip effect in rule-based supply chain planning system-a case-based simulation at hard good retailer	Omega (United Kingdom)	Nguyen D.T et al.	Supply chain players	Optimization model
28	Regulating the bullwhip effect in supply chain hybrid recycling channels using linear quadratic gaussian controller	International journal of industrial engineering and production research	"Khiavi S.A et al.	Suppliers, manufacturers, distributors, and retailers, w	Discrete time state
29	Preceding the impact of operational and financial variables on bullwhip effect using threshold regression	Journal of global operations and strategic sourcing	Gupta S at al.	Manufacturer	Regression model
30	Supply chain cash flow bullwhip effect: an empirical investigation	International journal of production economics	Patil C et al.	Firm, industry government policy	Analytical space model
31	The moderating role of vendor managed inventory on the bullwhip effect in covid 19	Cogent business and management	"Mukucha P et al.	Vendor	Bonferroni
32	Can non audit services from shared auditors in supply chain mitigate the impact of the bullwhip effect on investment efficiency	Management accounting research	"Chen J. et al.	Reduce bullwhip effect	Fuzzy perceptual mapping

33	Reducing the bullwhip effect in supply chain with factors affecting the customer demand forecasting	International journal of services operations and informatics	"Rezaeefard M. at al.	Manufacturing firm, supplier	Fuzzy consignment model
34	The bullwhip effect, demand uncertainty and cost structure	Contemporary accounting research	"Chen C.X et al.	Buyer and seller	Control theoretical modelling
35	Meta prediction models for bullwhip effect prediction of a supply chain using regression analysis	International journal of information systems and supply chain management	"Chiadamrong N et al..	Auto industry	Meta prediction model
36	An empirical investigation of bullwhip effect: practices perspective	International journal of public sector management	"Gupta S. et al		Empirical model

SD theory: system dynamic theory
ARMA: auto regressive moving average
CAPM: capital asset pricing model
WPF- DEA: Window presentation foundation- data envelopment analysis
The above table shows the selected 36 SLR related to the bullwhip effect. It is evident from the table that the benefited parties are the manufacturers, suppliers, customer, investors. Main focus drawn towards the inventory management. The theories used in this are CAPM, ARMA, holistic thinking theory, game theory. The main author citation is Ponte, B et al., Gupta S. et al. The data taken from 2017 to 2024. Main sources are web science and scopus.

Tabel 2 The above table shows the geographical location in which researches related to bullwhip effect conducted.

Geographical location	Number
United Kingdom	4
China	5
India	2
Iran	5
The United States	2

The most collaboration countries are Iran, United Kingdom and then China. The main articles of bullwhip effect come from these countries contributed significant knowledge. Every entrepreneur needs solution for reducing cost for inventory. And also, India shows effect of bullwhip effect on the overall cost of supply chain participants.

Table 3 The table 3 shows the impactor factor of journal which is not less than 1.

Impact factor	Impact factor
INJ J PROD ECO	12
COMPUT IND ENG	7.9
Omega INJ J MANAGE	6.9
J THEOR APPL EL COMM	5.6
Omega (United Kingdom)	8.673
contemporary accounting research	6.2

The impact factor shows which journal is most authentic research paper are efficiently reviewed. The most authentic journal in the supply chain management fined from impact factor are international journal of production economics has impact factor of 12 and the other journal is computer industrial and engineering is 7.9 and the other journal mentioned above are omega, contemporary accounting research.

Table 4 By following the TCCM framework following table show the independent variable, mediating variable and dependent variable.

	Characteristics		
	Independent variable	**Mediating variable**	**Dependent variable**
1) 1	Batch size	Customer service	Closed loop supply
2)	Capacity restrictions, responsive factor, customer demand, safety stock,	Market and firm	Order rate variance, inventory variance, full rate
3)	Variance amplification	Response surface	Supply chain
4)	Customer demand	Transportation, production	Bullwhip effect, lead time
5)	Operations	Collaboration and information	Supply chain performance
6)	quality grading scheme	Returned products	Closed loop supply
7)	Cooperative relationship	Knowledge	Performance
8)	Lead time, forecasting parameter	Ordering policy	OVR, NSA.AFR
9)	Time period, demand	Transport risk, quality risk	Quantity of product
10)	Actual sales	Wholesaler, factory, supplier, inventory	Stock out
11)	Bullwhip effect and ripple effect	***	Buyer and supplier, global airline industry
12)	Remanufacturing lead time	Information transparency	Return rate
13)	Overall thinking orientation	Attitude towards contradiction	Bullwhip effect
14)	Time	****	Inventory state
15)	End customer demand	Information sharing	Retailer, wholesaler and manufacturing inventory

16)	Demand forecasting	Decentralized or centralized system	Price fluctuation
17)	DDI	Lead time	Inventory level
18)	Customer orders, manufacturing time delay.	Raw materials	Retailers, distributers suppliers.
19)	Information	***	inventory in hand or stock out
20)	System performance	Capacity and flexibility	Bullwhip effect
21)	Wholesale price	Transport cost	Demand
22)	Customer demand	Replenishment policy	Select distribution channel
23)	Demand	***	Bullwhip effect
24)	Price	Profitability	Bullwhip effect
25)	Network data development analysis	***	Bullwhip effect
26)	Yield manufacturer, customer demand	Waste collected	Demand recyclable items, variance amplification
27)	Demand	Order lot size	Production
28)	Operational variable	lead time	Bullwhip effect, time invariant
29)	Operational variable		Financial variable
30)	Working capital	Mismanagement and management	Cash flow bullwhip effect
31)	Bullwhip effect	Overstocking, Obsolescence, Stockholding cost	Vendor management inventory, form postponement
32)	Supply chain performance	Management performance	Sales and operation planning
33)	Fixed cost	Inventory, assets	Cogs, sales revenue
34)	Demand uncertain	Cost structure	Bullwhip effect
35)	Demand	Replenishment	Bullwhip effect

The above shows the independent variable, moderating variable and dependent variable. This shows the relationship between various variables operational variables, customer demand, fixed cost, supply chain performance. The mediating variable are marketing firm, ordering policy, transportation, waste collected and lead time. The dependent variable shows the production, cost of goods sold, bullwhip effect.

Table 5 The methodology used in the SLR are shown below whether it is quantitative, qualitative or mixed.

Methodology	**Serial no.**
Quantitative	2,4,5,7,8,10,12,16,17,22,25,26,31,33,35.
Quantitative	9,11,13,14,18,21,28,29.

Mixed	27

Every researcher has choice which method to choose according to the study conducted. The empirical study or theoretical or mixed. Here in this study the main focus is towards the quantitative method and the use of qualitative method and one study used the abductive method.

Result

Theory development

This section lists every article that was examined and included in the review of the literature from 2017 to 2024. Journal titles, theories, and author citations are shown in table 1 and most of researches are empirical and other theoretical. Most of the research articles include supply chain (8), bullwhip effect (11), demand uncertainty (4) ……

Context

The bullwhip effect was the primary environment in which the research was done mainly manufacturers (11) suppliers (4) firm (3) customers (5) companies (2) shown in table 1. The geographical indication is (UK), (USA), (Iran), (China), (India) shown in table 2.

Characteristics

Most of the articles using independent variable and outcomes. This is listed in table 1independent variable are customer demand, wholesale price, operational variable, supply chain performance and dependent variable are bullwhip effect, revenue, cost.

Methodology

Types of the quantitative research (15), qualitative research (8), mixed research (1) in the tile of bullwhip effect

Discussion

This section discusses the previous finding TCCM framework. Under the review of extant literature on bullwhip effect. The theory used are mathematical model, ARMA and game theory. The utility analysis is used for suppliers, firm, customers. The content used in the customer demand, supply chain performance and dependent variable are bullwhip effect, revenue and cost. The methodology used are quantitative, qualitative and mixed.

Theory

The comprehensive study of systematic literature review the following theories are revealed:

System dynamic theory (SD theory)

Utilizing system thinking, SD is a type of computer simulation technology that analyses inventory management, production management, and other organizational problems (Ekanayake, E. M. A. C.et al (2021); (Luo, J., Ding, Y.et al (2023); (Zhang, Z., Zargham, M., & Preciado, V. M. (2020). In the area of supply chain inventory management, it has been extensively utilized, and researchers have produced useful findings (Forrester, J. W. (1997). The outcome demonstrated that prepayment financing improves supply chain performance and offered solid theoretical backing and a basis for comparison for later research projects (Zhou, Y., Li, H., Hu, S., & Yu, X. (2022).

Auto regressive moving average (ARMA model)

ARMA model is a more real model for the demand process, thus more accurate for real-world (Duc, T. T. H., Luong, H. T., & Kim, Y. D. (2010). This model suitable for the time series of demand process as compared to the AR model because it has a combined characteristics of MA model and autoregressive process (Pindyck, R. S., & Rubinfeld, D. L. (1988).

Game theory

A retailer fixes the prices against the supplier selling prices, and the supplier mention prices based on the manufacturer's selling prices (Gamasaee, R., & Fazel Zarandi, M. H. (2018). the game theory model with the use of time series model used for finding the optimal prices in an SC. However, the optimal prices are put into the time series model for predicting elasticity of demands in supply chain. Through this theory the bullwhip effect will drastically (Gamasaee, R., & Fazel Zarandi, M. H. (2018).

Characteristics

Lead time

Lead time is when the order is placed and receiving delivery time gap through which the replenishment policy will be decided (Gaalman, G., Disney, S. M., & Wang, X. (2022). This variable used for the reduction un bullwhip effect if lead time is reduced and companies' motto is also focus on it (Gaalman, G., Disney, S. M., & Wang, X. (2022).

Inventory level

The main aim is to efficient utilisation of resources according to the product life cycle. information is collected of used products and new innovation is when required (Ponte, B., Cannella, S.et al (2021). The inventory level helps in lowering the investment cost and bullwhip effect (Guide and van Wassenhove, 2009; Abbey and Guide, 2018; Pazoki and Samarghandi, 2020).

Distorted information

The amplifying effect of customer demand due to distorted information (Panić, B., Kovačević, I., Vujošević, M., & Kuzmanović, M. (2020). The information delivered from retailer to manufacturer will go up according to their position of demanded products. This will not only increase inventory cost but also backlogs (Panić, B., Kovačević, I., Vujošević, M., & Kuzmanović, M. (2020).

Context

The cooperativeness will increase in the supply chain if the participants of supply chain want to reduce bullwhip effect. The main benefit received by the society resources used efficiently, manufacturer cost of production reduces, no issue of overstocking by wholesaler and retailer. The fear of obsolesce will be reduced.

Methodology

Most of researches are quantitative and some are qualitative. The sample method used by them are mainly

- **Experimental**
- **Simulation method**
- **Observation**
- **Questionnaire**
- **Structure and semi-structure interview**

Gaps addressed in the reviewed systematic literature for future agenda

Theory	• SC-wide integrated DRP logic. • Newly available theory to show ratio b/w bullwhip effect and cost structure • Comprehensive supply chain system model and evaluation system • Function of the WMA/Newton approach.
characteristics	• Forecasting and ordering policy parameters • Forecasting and ordering policy parameters under correlated demand • Re-evaluate the relationship between the length of the lead time and the magnitude of the BWE • Analysing the impact of compound causes of BWE
Context	• Organizational structure change and production adjustment. • Problem will be greater when supply chains are more global than regional due to volatility in consumer demand.
methodology	• Quantifying the bullwhip effect in a CLSC system • LQG optimal controller • Analytical formula is an approximation search of an exact (or less approximate) formulation

Conclusion

The aim of study is to go through systematic literature review of the bullwhip effect reduced by data base management system. To develop rigorous framework PRISMA framework is used. The research article on this topic searched 715 and after all the screening article included 36. The results produced by using the TCCM framework. The main characteristics are lead time, distorted information, inventory level. Through the help of database management system information will be recorded, new innovation will be introduced when needed, consumer grievances will be solved and many more.

From the theoretical point of view, the game theory, SD theory are used which drastically reduce the bullwhip effect which is the major concern for every businessman. The result of this study is studying every variable simultaneously and mitigation by opting data base management system which other researches does not perform. The future researches can show the different types of bullwhip effect variables and why they occur. This study especially useful for the new entrepreneurs who do not well about the demand and orders accurately.

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