THE BULLWHIP EFFECT PHENOMENON IN AUTOMOTIVE SUPPLY CHAINS IN SOUTH AFRICA

M.J. Naude: University of KwaZulu-Natal
J.A. Badenhorst-Weiss: University of South Africa

Purpose: The purpose of the article is to report on research that was completed to explore the concept of the bullwhip effect in supply chains and to illustrate empirically the presence of the bullwhip effect in automotive supply chains in South Africa.

Problem Investigated: This article investigates the presence of the bullwhip effect – which was identified through an empirical study – and its causes and implications for supply chain management in the South African automotive component industry.

Methodology: A literature study was conducted on the causes and implications of the bullwhip effect phenomenon. This was followed by an empirical study in the form of a survey among South African automotive component manufacturers. Descriptive and inferential statistics were used to determine the significant supply chain problems relating to the bullwhip effect in automotive supply chains.

Findings and Implications: The results indicate that automotive component manufacturers are dependent on demand-forecasting information from their customers. They experience long lead times, fluctuating orders, cancellation of orders, excess and slow moving inventory and a lack of integration with suppliers and customers. There are also signs of relationship problems and a possible silo mentality. The mentioned results indicate the presence of the bullwhip effect in South African automotive supply chains. Since the bullwhip effect can have a major impact on organisations' costs, knowing where to invest effort and resources should be a high priority for supply chain managers.

Value of the Research: Since the field of supply chain management is extremely dynamic, this article contributes to the body of knowledge and provides new insight into the bullwhip effect phenomenon. The results included in this article could assist parties in automotive supply chains to focus their attention on problems that might be within their control and if solved could lead to improved competitiveness. Furthermore, there is little empirical research on this topic in the South African automotive component industry.

Conclusion: It is possible that the bullwhip effect is responsible for inefficiencies in automotive supply chains. Knowledge of the indicators of the bullwhip effect can enable supply chain managers to identify it at an early stage and thus be proactive in preventing its costly influence on the efficiency of the supply chain. The bullwhip effect can be experienced by any industry. This is possibly the case in the automotive component industry in South Africa.

Key words: Bullwhip effect; supply chain management; automotive component manufacturers; original equipment manufacturers; automotive industry.

INTRODUCTION

The very nature of competition has changed. Companies no longer compete against companies. Supply chains compete against other supply chains for supremacy. For example, Fawcett, Ellram & Ogden (2007) point out that "Toyota and its suppliers will clash with Ford and its suppliers for global competitive advantage". However, there is a hidden inhibitor in all competing supply chains. A phenomenon called the 'bullwhip effect' is regarded as one of the forces that paralyse supply chains (Lee, Padmanabhan & Whang 2004a). In some supply chains, the bullwhip effect can drive 13 – 25% of operating costs. Thus the bullwhip effect can have a major impact on organisations' costs. Knowing where to invest effort and resources for this purpose should therefore be a high priority for supply chain managers (Lee, Padmanabhan & Whang 2004b; Torres & Maltz 2010). The bullwhip effect has

been observed in many industries in many other countries, including the automotive industry (Lee et al. 2004b; Jacobs, Chase & Acquilano 2009).

The question is: Is the bullwhip effect present in the South African automotive industry, possibly adding to inefficiencies in the industry? Since the South African automotive industry competes poorly against those of China, India and Western Europe (Venter 2009) there is the possibility of the presence of the bullwhip effect as a possible cause of a number of inefficiencies. If supply chain managers are aware of the characteristics of the bullwhip effect they can know where to focus their attention and resources.

The bullwhip effect can be defined as the uncertainty caused by information flowing upstream and downstream in the supply chain. Forecasts of demand become less reliable as they move up the supply chain from users or retailers to wholesalers, to manufacturers, to suppliers (Lysons & Farrington 2006).

This article consists of a literature study on the bullwhip effect. Descriptions of the bullwhip effect, its causes and implications for supply chains will be discussed from the viewpoint and experiences of different authors and researchers. The article also reports on an empirical study that was conducted in the South African automotive component industry, to determine the significant supply chain problems it experiences. By identifying the problems in the supply chains it is possible to detect the presence of the bullwhip effect. The quantitative study was explorative and descriptive in nature.

The results of the study indicate the presence of the bullwhip effect in the South African automotive supply chains.

LITERATURE STUDY

Introduction

Supply chains consist of vertical structures (stages) with many different owners. In the automotive industry, the supply chain structure consists of original equipment manufacturers (OEMs), original equipment suppliers (OESs), automotive component manufacturers (ACMs) and the automotive retail and aftermarket (Naude 2009:30). For example Ford Motor Company has thousands of suppliers from Goodyear to Motorola; each of these suppliers has many suppliers in turn. Information is distorted as it moves across the supply chain because complete information is not shared between stages. This distortion is aggravated by the fact that supply chains today produce a large amount of product variability. For example, Ford produces many different models with several options for each model. The increased variety makes it difficult for Ford to coordinate information exchange with thousands of suppliers and dealers. The fundamental challenge nowadays is for supply chains to achieve coordination in spite of multiple ownership and increased product variety. (Chopra & Meindl 2007:497-498). The bullwhip effect is caused by a lack of coordination between organisations and their suppliers (Ravichandran 2008:88).

A supply chain lacks coordination if each manufacturer in the chain observes it own objective, without taking into account the impact on the entire chain (Chopra & Meindl 2007:49). Therefore, synchronous supply cannot be achieved without high levels of coordination across the supply network. A lack of coordination across the supply network will result in the bullwhip effect (Christopher 2005:199). The bullwhip effect is also known as the 'Forester Effect' after Jay Forester, who identified that small disturbances in one part of the supply chain can very quickly become magnified as the effects spread through the pipeline (Christopher 2005:196).

The Bullwhip Effect Defined

According to Jacobs et al. (2009:361) the bullwhip effect is the phenomenon of variable magnification as we move from the customer to the producer in the supply chain. Even a slight change in consumer sales ripples backwards in the form of magnified oscillations upstream, resembling the result of a flick

of a bullwhip handle. Because the supply patterns do not match the demand patterns, inventory accumulates at various stages and shortages and delays occur at others. Swink, Melnyk, Cooper and Hartley (2011:225-226) describe the bullwhip effect as "a small disturbance in the flow of orders generated by customers that produces successively larger disturbances at each upstream stage in the supply chain". Small variations in demand at the customer end of the supply chain can therefore produce massive variations in orders upstream. Burt, Petcavage and Pinkerton (2010:532) view the bullwhip effect as "… a problem of fictional demand or phantom demand". Fawcett et al. (2007: 515) define the bullwhip effect as 'exaggerations of fluctuating demand' through the supply chain as suppliers overcompensate to avoid stock outages, and then under-anticipate future demand.

The observed variability in the customer demand increases the further the supplier is from the customer (Webster 2008:85). For example demand variation will increase from retailers to wholesalers, manufacturers and their suppliers (Dooley, Yan & Gopalakrishnan 2010:13). The bullwhip effect is therefore more severe in larger supply chains with more suppliers and customers (Wisner, Tan & Leong 2008:10).

In conclusion, the bullwhip effect can be described as the phenomenon where a small change in the demand is translated into a large change in the next replenishment order in the supply chain, in the absence of unexplained demand changes.

Causes of the Bullwhip Effect

Lee, Padmanabhan & Whang (1997 and 2004b:1876) were the first researchers who published extensively on the bullwhip effect. According to them the bullwhip effect is a consequence of one or a combination of the following four important aspects related to supply chain management. They are: demand forecast updating by supply chain partners; order batching to take advantage of transportation economics; price fluctuation (leading to distorted consumption pattern); and rationing.

Demand forecast updating

Lee et al. (2004a:1889) are of the opinion that the bullwhip effect is a natural consequence of the use of statistical forecasting methods in supply chains. The bullwhip effect appears when ordering is based on forecasting – not on real customer demand (Chopra & Meindl 2007: 501). The term 'demand forecast updating' refers to how an increase or decrease in a demand forecast by an organisation tends to become amplified in an order to a supplier. Failure to estimate demand accurately (wrong forecasting) and poor information sharing among supply chain entities can result in bloated inventory levels caused by a cumulative effect of poor information cascading up through a supply chain. Poor demand data forces the supplying organisation to carry additional inventory or increase lead times to account for the uncertainty. The lead-time increases when suppliers decide not to carry the additional inventory but to order it higher up in the supply chain when orders are received from customers. Either way the inventory levels in the supply chain as a whole are increased. If the lead time increases, the buyer will increase order quantities (based on conventional reorder point calculations). The supplier will interpret the increase in the order quantity as increased customer demand, and will also give this information through to the suppliers. The suppliers at the different levels will consequently need to take action to increase capacity to meet the fictional trend. Just as the suppliers have added capacity to meet the increased demand, demand falls off because the retailer realised the mistaken over-estimation of market demand. As a result of excessive stock available, orders will be reduced. The supplier will then need to reduce its capacity through taking drastic steps such as for example retrenching employees and selling assets (Fawcett et al. 2007:10; Simchi-Levy, Kaminski & Simchi-Levy 2009:153-154; Burt et al. 2010:532).

According to Webster (2008:85), forecasts that are manually developed are susceptible to the 'recency' effect – an effect that further amplifies volatility when forecasts are updated. Recency refers to the phenomenon that occurs when people tend to overreact to recent events. In the context of demand forecasting, the 'recency' effect is the human tendency to over-adjust a forecast in response to a signal of changing market conditions.

Order batching

Order batching refers to the practice of placing periodic large orders. Organisations order more than what is needed for the immediate future. As a result, relatively steady demand observed by an organisation is translated into sporadic demand on a supplier. For example, a retailer may sell a particular product every day, but replenishment orders may be placed once every several weeks (the orders for requirements over time are batched), in order to save money on transportation (i.e. a full-truck load) and ordering costs (Lee et al. 2004b:1881-1882; Webster 2008:86; Simchi-Levy et al. 2009:156). Freight incentives, such as transportation discounts on volume orders may cause customers to accumulate orders and order in bulk (Lysons & Farrington 2006:334). Care should be taken with the practice of order batching. The bullwhip effect might cancel any advantage obtained in bulk transport rates. According to Webster (2008:137) research has found that with order batching transportation costs were saved, but there was an irregular, disruptive flow, even though demand was relatively smooth. When the requirement of order batching was stopped, flow became smooth and out-of-stocks decreased.

Price fluctuations

Price fluctuations contribute to the bullwhip effect because large orders tend to appear before price increases go into effect, or in response to promotions. A distorted demand pattern may be observed at higher levels in the supply chain. Unforeseen sales promotions or sales incentive plans often result in sales distortions (Simchi-Levy et al. 2009:156).The supplier observes a spike in demand followed by a lull as the buyer sells off excess inventory (Lee et al. 2004b:1882; Lysons & Farrington 2006: 334; Webster 2008:86; Simchi-Levy et al. 2009:156).

Rationing and shortage gaming

Rationing and shortage gaming refers to the practice of allocating supply to customers in proportion to order quantities during periods of shortages. Shortage gaming is self-interest behaviour directed at 'beating the system' during shortages. For example, a retailer may order twice as much as needed, reckoning that only 50% of the order will be filled in the near future, and believing that the rest of the order can be cancelled once a partial shipment is received. Shortage gaming is a consequence of misalignment of objectives that can exist among organisations in the supply chain (Lee et al. 2004b:1879-1881; Lysons & Farrington 2006:334; Webster 2008:86; Simchi-Levy et al. 2009:156).

In addition to the four causes of the bullwhip effect identified by Lee (2004b) and others – demand forecast updating; order batching; price fluctuation; rationing – other causes have been identified in literature. These include lead time, relationships and coordination and push inventory strategy.

Lead time

In the early 1990s lags in supply chain execution and long cycle times were identified as potential drivers of the bullwhip effect and increased inventory (Torres & Maltz 2010:25). With longer lead times, demand information distortion occurs and a small change in the estimate of demand variability implies a significant change in safety stock and base-stock levels, leading to a significant change in order quantities. This causes an increase in variability (Simchi-Levy et al. 2009:156; Lysons & Farrington 2006:334). Actual cycle time is the result of both innate characteristics of the supply chain, such as distance and manufacturing time, and human aspects of the supply chain, which encompasses information lags, production planning rules and labour availability (Torres & Maltz 2010:25).

Relationships and coordination

A lack of coordination and weaknesses in supplier/ buyer relationships can lead to the bullwhip effect. Supply chains facing such challenges are characterised by conflicting goals such as: a focus on local optimisation at one stage of the supply chain (the silo-approach); a lack of customer confidence in the ability of suppliers to deliver orders on time; and a lack of information sharing. Other behavioural characteristics include perceptions such as: "they are only interested in their own advantage without considering their actions on others"; "reacting on their own situation and not on the supply chain" and

"supply chain members (at different stages) blaming each other for fluctuations" (Lysons & Farrington 2006:334; Chopra & Meindl 2007:501-508). This kind of behaviour creates various problems such as antagonism among parties in the supply chain; not receiving any feedback on the consequences of one's own reaction on other parties in the supply chain; a lack of trust between the parties; and duplication of effort (Lysons & Farrington 2006:334; Chopra & Meindl 2007:501-508).

Push inventory strategy

The push inventory strategy is a major cause of the bullwhip effect. A push strategy is used when products are manufactured in anticipation of demand and production is based on long-term forecasting. The real demand is therefore, uncertain. Push-based supply chains are associated with high inventory levels and high manufacturing and transportation costs, due to the need (or expectation of it) to respond quickly to changes in demand (Lysons & Farrington 2006:335).

Lack of supply chain visibility

A lack of supply chain visibility leads to the bullwhip effect. This means there is an inability to share easily or retrieve trading partner information in real time, as desired by supply chain participants (Wisner et al. 2008).

Consequences of the Bullwhip Effect

The consequences and implications of the bullwhip effect have already become clear in the abovementioned discussion of the phenomenon and its causes.

Ravichandran (2008:77) indicates that the bullwhip effect has implications for efficiency on various levels. At the macro level, the bullwhip effect induces poor service levels (Webster 2008:85), inefficiencies in production and production costs, scheduling (capacity utilisation), sourcing, distribution, revenue generation and revenue realisation. At the operational level, it generates more (additional) inventory and keeps it in the most inappropriate place to meet a specified service level. At a performance level it can reduce the velocity of cash, destroy potential revenue, and significantly erode revenue realisation through price discounts. It can potentially dilute competitive strategy and position and therefore can be a 'strategy buster'.

The distortion of demand information implies that the manufacturer who observes only its own immediate order data will be misled by the amplified demand patterns. This has serious cost implications. For example, the manufacturer could incur excess raw materials cost due to unplanned purchases of supplies, additional manufacturing expenses created by excess capacity, inefficient utilisation and overtime, excess warehouse expenses and additional transportation costs due to inefficient scheduling and premium shipping rates (Lee et al. 2004b:1875). The bullwhip effect contributes to high cost and poor service in supply chains (Webster 2008:85). In some supply chains, the bullwhip effect can drive 13 – 25% of operating costs (Fawcett et al. 2007:515). Thus, the bullwhip effect could have a major impact on organisations' costs. Therefore, knowing where to invest effort and resources for this purpose should be a high priority for supply chain managers (Lee et al. 2004b:1875; Fawcett et al. 2007:515; Torres & Maltz 2010:23). It is important to understand the causes of the bullwhip effect to limit the effect (Webster 2008:85).

In conclusion, Lysons and Farrington (2006:335) and Wisner et al. (2008:141) list the possible implications of the bullwhip effect as: excessive inventory quantities; poor responsiveness to market dynamics and poor customer service; cash flow problems; stock-outs or material shortages; lost sales; obsolescence; high material costs; overtime expense; high transport costs; poor profitability; and longer cycle times.

PROBLEM STATEMENT

In South Africa the recent negative economic conditions contributed to the realisation that the automotive industry needs to become more efficient. The recession led to the reduction and even

closing down of operations to the extent that many employees in the industry were retrenched. In December 2008, 36 000 people were employed by original equipment manufacturers (OEMs), such as Toyota and Ford and 81 500 were employed by first tier suppliers - the automotive component manufacturers (ACMs) (NAACAM 2009:1). In December 2010, 28 100 people were employed by (OEMs) and 65 000 were employed by ACMs. (South Africa Automotive Yearbook 2011: Secs 9:1 & 9.2). This means that since the global downturn of economic conditions worldwide the number of employees in the South African automotive component manufacturing sector has declined, with 16 500 job losses (± 20%).

A study of the automotive industry and inefficiency in automotive supply chains is therefore particularly important and necessary at this time. The competitiveness and the survival capacity of the automotive industry, particularly the competitiveness of ACMs, have never been as prominent as at present. South Africa exports a large portion of final product outputs to foreign markets and competes locally against cheap imported parts and automobiles. On average South Africa is 20% more expensive as a vehicle manufacturing base than Western Europe, with China 12% less expensive than Western Europe. That means that South Africa is 30 – 40% more expensive than China and India. The average local content (parts provided by local ACMs) on vehicles produced in South Africa is at 35%, but it needs to grow to 70 – 75% in order to negate the costs of importing components using large component supply chains and weathering a fluctuating currency (Venter 2009). Therefore, it is important that local ACMs become more competitive.

In addition to competing globally, South African automotive supply chains also compete with a hidden hindrance within supply chains. The hidden hindrance is inefficiency caused by the bullwhip effect phenomenon which threatens competitiveness. However, supply chain managers do not always know how to recognise and counter the bullwhip effect.

RESEARCH METHODOLOGY

The empirical study which forms the basis of this article is descriptive and exploratory. The nature of the problem statement, the purpose of the research study and the proposed methodology pointed the research strategy in the direction of quantitative research. The study consisted of a survey that was done among ACMs. A questionnaire was mailed to ACMs. The purpose of the questionnaire was to determine the supply chain problems in automotive supply chains and the significance of these problems. Only National Association of Automotive Component and Allied Manufacturers (NAACAM) members were included in this study as it is accepted that the largest and most important ACMs in South Africa are members of this association. A total of 173 questionnaires were sent to respondents and a response rate of 30.6% was achieved.

ANALYSIS AND FINDINGS

The questionnaire consisted of 75 questions relating to supply chain problems. A seven-point Likert response format (ordinal scale), varying from 1 (to a lesser extent) to 7 (to a greater extent), was used. Descriptive and inferential statistics were used to determine the significance of the supply chain management problems. A binomial test was used to test if the proportion of the respondents in two groups differed statistically significantly from 0.5. Two groups were formed by grouping responses ‘to a lesser extent’ together, coded as a 1 (category 1), and the response ‘to a greater extent’ together, coded as a 2 (category 2). In this way it was possible to determine whether a problem was perceived as being significant (the proportion of “greater extent” responses) or not. As shown in Table 1, only those elements or problems that tested statistically significant (excluding public infrastructure problems) were ranked from a greater to a lesser extent.

Table 1: Significant supply chain management problems

	Problem	Mean	Median	Quartiles		No. of valid cases	% of valid cases
				25	75		
	Supplier-side problems						
1.	Price of materials	4.38	4.50	3.00	6.00	50	94.34
2.	BBBEE – achieving and verifying BEE scorecards (in respect of OEMs' target)	4.29	4.00	3.00	6.00	41	77.36
3.	Financial stability of suppliers (after the onset of the recent economic crisis)	4.09	4.00	3.00	5.00	43	81.13
4.	Material lead times too long, resulting in obsolescence*	4.02	4.50	2.00	6.00	46	86.79
5.	Trust between you and your "worst 10%" of suppliers*	3.73	4.00	3.00	5.00	44	83.02
	Operations process problems						
6.	Cost of replacing outdated technology	4.79	5.00	4.00	6.00	39	73.58
7.	Capacity limitations due to capital funding*	4.21	4.00	3.00	6.00	28	52.83
8.	Output based on customer's forecast to plan*	4.20	4.00	3.00	5.00	41	77.36
9.	Labour problems – availability of skills	4.16	4.00	3.00	6.00	43	81.13
10.	Labour problems – time-consuming to resolve	4.08	4.00	3.00	5.00	37	69.81
11.	Capacity limitations due to customer order fluctuation*	4.05	4.00	3.00	5.25	40	75.47
12.	Reducing cycle time*	3.97	4.00	3.00	5.00	34	64.15
13.	Balancing inventory levels*	3.91	4.00	3.00	5.00	43	81.13
14.	Integrating information systems internally*	3.88	4.00	3.00	5.00	40	75.47
15.	Capacity limitations due to availability of skilled labour	3.75	4.00	2.00	5.00	36	67.92
16.	Integrating technology with suppliers and customers*	3.67	3.00	2.5	5.00	39	73.58
	Customer-side problems						
17.	Pressure by OEMs to reduce prices*	5.51	6.00	4.00	7.00	49	92.45
18.	Cancellation of orders*	5.02	5.00	4.00	6.00	49	92.45
19.	Excessive and slow-moving inventory due to cancellation of orders*	4.83	5.00	3.50	6.00	47	88.68
20.	Rapid changes in demand (in terms of quantity patterns)*	4.18	4.00	3.00	5.00	44	83.02
21.	Advance communication about market demand*	4.15	4.00	3.00	5.00	41	77.36
22.	Too dependent on business of a	4.15	4.00	2.00	6.00	41	77.36

	particular customer						
23.	Trust between you and your "worst" customers*	4.13	4.00	3.00	6.00	39	73.58
24.	Relationship with "worst 10%" customers*	4.12	4.00	3.00	6.00	34	64.15
25.	Little or no assistance from customers in complying with their requirements*	3.79	4.00	2.50	5.00	43	81.13

***Bullwhip-related symptoms**

Seventeen out of twenty-five significant supply chain problems identified from the empirical study and listed in Table 1 are bullwhip-related symptoms. The presence of the bullwhip effect in the automotive industry is therefore clear.

Lead time

Long lead time is a potential driver of the bullwhip effect (Torres & Maltz 2010:25). The ACMs experience lead time problems with deliveries from their suppliers, many of whom are in foreign countries (problem 4 in Table 1). It is possible that long lead times add to the other significant problems – that of struggling to reduce cycle time (problem 12) and that of balancing inventory levels (problem 13).

Demand forecasting

The bullwhip effect appears when ordering is based on forecasting and not on real customer demand (Lee et al. 2004b:1889). Being dependent on forecasting is another significant problem for ACMs (problem 8). As a possible consequence of demand forecasting, customer orders fluctuate (problems 11 and 20) to update according to real market demand. Fluctuating orders put ACMs' capacity under pressure and they battle to balance their inventory (problem 13). 'Order cancellations' from customers (OEMs), particularly since the economic downturn (problem 18), is a significant problem for ACMs. As a result of cancellations of orders ACMs have excessive and slow-moving inventory (problem 19).

Visibility

A lack of supply chain visibility leads to the bullwhip effect (Wisner et al. 2008). Integration of internal information systems (problem 14) is indicated as a significant problem. This is in line with the acknowledgement of the problem of dated technology (problem 6). Linked to this is the problem of integrating technology with suppliers and customers (OEMs) (problem 16).

Relationships and coordination

Good relationships and coordination are important for efficiency in supply chain and a lack thereof can lead to the bullwhip effect (Lysons & Farrington 2006:334). Problems with trusting some suppliers (problem 5) and customers (problem 23) are indicated as significant problems. The relationship with certain customers is also a problem (problem 24). However, these last-mentioned three problems are experienced only with a fraction of the suppliers and customers. The final significant problems – 'advanced communication about market demand' (problem 21), 'too dependent on the business of a particular customer' (problem 22) and 'little or no assistance from customers in complying with their customers' requirements' (problem 25) – could be interpreted as showing that all is not well among supply chain participants. Price is also indicated as a significant problem. On the supply-side ACMs experience high and fixed prices of raw materials (problem 1) and on the customer-side they experience pressure from OEMs to reduce selling prices (problem 17). These problems tend to point towards signs of a silo mind-set in automotive supply chains, where the different parties are mainly interested in their own interests and the benefits they stand to gain. This kind of behaviour creates various problems such as antagonism among parties in the supply chain; not receiving any feedback on the consequences of one's own reaction on other parties in the supply chain; a lack of trust between the parties; and duplication of effort (Lysons & Farrington 2006:334; Chopra & Meindl

2007:501-508). This lack of coordination and weaknesses in the relationship can lead to the bullwhip effect.

Conclusion

The above findings indicate that the bullwhip effect prevails in South African automotive supply chains.

SUMMARY AND CONCLUSIONS

The fundamental challenge today is for supply chains to achieve coordination in spite of multiple ownership and increased product variety. The bullwhip effect is the consequence of a lack of coordination among organisations and suppliers in supply chains. The bullwhip effect can be summarised as small variations in demand at the customer end of the supply chain which produce massive variations in orders upstream due to demand information distortion. The distortion of demand information implies that the manufacturer who observes only its immediate order data will be misled by the amplified demand patterns. This has serious cost implications. Since the bullwhip effect can have a major impact on organisations' costs, knowing where to invest effort and resources should be a high priority for supply chain managers. The main causes of the bullwhip effect are dependence on demand forecasting information and updating of demand information from customers, a lack of supply chain visibility, a lack of coordination and ineffective management of relationships. This leads to order fluctuations, cancellation of orders, long lead time and price fluctuations.

As it is obvious that the South African automotive industry competes poorly against other countries, it seemed to be crucial that an investigation into the supply chain problems be done. This article reported on an empirical study that was conducted in the South African automotive industry, to determine the significant supply chain problems it experiences. The results indicated that automotive component manufacturers (ACMs) are dependent on demand forecasting information from their customers (OEMs). ACMs experience long lead times, fluctuating orders, cancellation of orders, excess and slow-moving inventory and a lack of integration with suppliers and customers. There are also indications of relationship problems and a possible silo mentality. The abovementioned results indicate the presence of the bullwhip effect in South African automotive supply chains.

It is recommended that automotive supply chains pay attention to supply chain visibility, and that supply chains follow a pull strategy, which necessitates an integrated information system. Automotive supply chains should become less dependent on demand forecasting. They should also re-establish relationships and plan together, taking care not to focus on self-interest to the detriment of other parties in the supply chain.

The purpose of the article was to explore the concept of the bullwhip effect in supply chains and to determine if the bullwhip effect exists in automotive supply chains in South Africa. The results included in the article can assist the parties in the automotive supply chains to focus their attention on problems that might be within their control and if solved could lead to better competitiveness.

The study had certain limitations. It indicated only the presence of the bullwhip effect in the automotive industry in terms of symptoms and did not determine the exact causes of the bullwhip effect. The limitations of this study open up opportunities for future research, such as the following: to determine the exact causes of the bullwhip effect in the automotive industry; to quantify the bullwhip effect and thereby determine whether an investment in a supply chain-wide, state of the art system will be feasible for automotive supply chains; and to simulate different strategies to counter the bullwhip effect and determine the best strategy for automotive supply chains in South Africa. As indicated earlier in this article, the bullwhip effect can be experienced by any industry and this appears to be the case in the automotive component industry in South Africa.

REFERENCES

Burt, D.N., Petcavage, S. & Pinkerton, R. (2010). Supply management. 8th edition. Boston: Irwin McGraw-Hill.

Chopra, S. & Meindl, P. (2007). Supply chain management: strategy, planning & operations. 3rd edition. Upper Saddle River, NJ: Pearson Prentice-Hall.

Christopher, M. (2005). Logistics and supply chain management. Creating value-adding networks. 3rd edition. Harlow: Financial Times Prentice Hall.

Dooley, K.J., Yan, T & Gopalakrishnan, M. (2010). Inventory management and the bullwhip effect during the 2007-2009 recession. Journal of supply chain management, 46(1), pp. 12-18.

Fawcett, S.E., Ellram, L.M. & Ogden, J. (2007). Supply chain management: from vision to implementation. Upper Saddle River, NJ: Pearson Prentice-Hall.

Jacobs, F.R., Chase, R.B. & Acquilano, N.J. (2009). Operations and supply management. New York: McGraw-Hill.

Lee, H.L., Padmanabhan, V. & Whang, S. (1997). Information distortion in supply chain: the bullwhip effect. Management Sciences, 43(4), pp. 546-558.

Lee, H.L., Padmanabhan, V. & Whang, S. (2004a). Comments on information distortion in supply chain: the bullwhip effect. Management Science, 50(12), pp1887-1893.

Lee, H.L., Padmanabhan, V. & Whang, S. (2004b). Information distortion in a supply chain: the bullwhip effect. Management Science, 50(12), pp1875-1886.

Lysons, K. & Farrington, B. (2006). Purchasing and supply chain management. 7th edition. Essex, England: Pearson Education.

NAACAM, (2009). NAACAM Newsletter: Issue No. 9, March 2009. www.naacam.co.za (Accessed 8 August 2009).

Naude, M.J.A (2009). Supply chain management problems experienced by South African automotive manufacturers. Unpublished report (Doctoral thesis): University of South Africa.

Ravichandran, N. (2008). Managing the bullwhip effect: two case studies. Journal of Advances in Management Research, 5(II), pp. 77-87.

Simchi-Levi, D., Kaminsky, P. & Simchi-Levi, E. (2009). Designing and managing the supply chain: concepts, strategies and case studies. 3rd edition. New York: McGraw-Hill.

South African Automotive Yearbook. (2011). Definitive reference, statistics and data on the SA motor industry. 14th edition. NAACAM, section 9: human resources. Section 9.1 Table: Industry employment figures: 1997 – June 2008. Section 9.2: 100 Levels – average monthly figures. Section 9.2 Table:

Employment statistics – South African motor vehicle manufacturing industry: 1988 – 2010.
Swink, M., Melnyk, S.A., Cooper, M.B. & Hartley, J.L. (2011). Managing operations across the supply chain. New York: McGraw-Hill.

Torres, O.C. & Maltz, A.B. (2010). Understanding the financial consequences of the bullwhip effect in a multi-echelon supply chain. Journal of Business Logistics, 31(1), pp 23-43.

Venter, I. (2009). Auto bosses wring their hands over SA's declining competitiveness. Can the situation be salvaged? Engineering News, 30 October. http://www.engineeringnews.co.za/article/auto-bosses-wring-their-hands [Accessed 20 July 2010].

Webster, S. (2008). Principles and tools for supply chain management. New York: McGraw-Hill.

Wisner, J., Tan, K. & Keong Leong, G. (2008) Principles of supply chain management. 2nd edition. Ohio: South-Western Cengage Learning.