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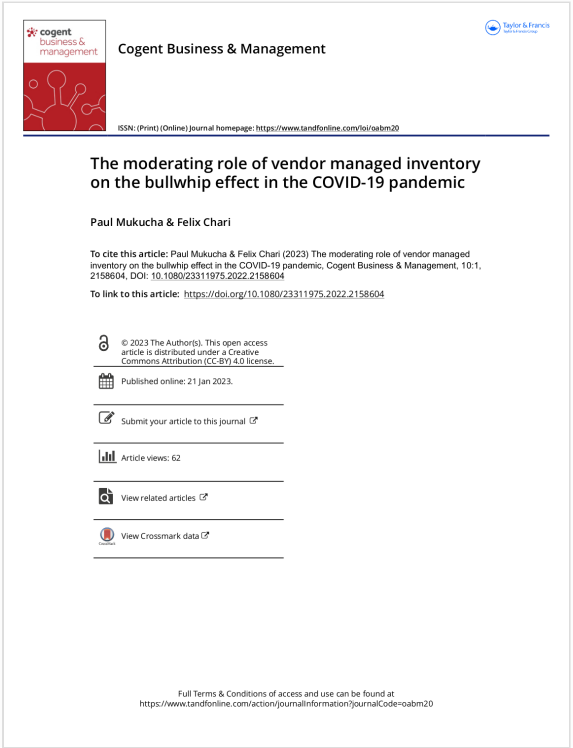

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The moderating role of vendor managed inventory on the bullwhip effect in the COVID-19 pandemic

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Abstract: The study sought to determine the role of vendor-managed inventory and form postponement in mitigating against the bullwhip effect in the bakery industry. The bullwhip effect is referred to as demand distortions along the upstream supply chain that is caused by variances between supply and demand. The bullwhip effect was conceptualized by its indicators that are overstocking, obsolescence, and inventory holding costs. A survey of conveniently chosen 100 bakeries was conducted in the city of Harare, the capital city of Zimbabwe. The informants for individual bakeries were competent bookkeepers or qualified accountants. A factorial MANOVA and follow-up ANOVAs using the Bonferroni method were conducted. The study indicated statistically significant main effects and interaction effects for all the factors and concluded that all the indicators of the bullwhip effect can be mitigated if bakery businesses pursued either or both of the vendor-management inventory and the form postponement strategies. The managerial implications of this study were that bakery businesses can avoid the consequences of the bullwhip effect through investing in plant and equipment that enables form postponement, and strengthen the widely practiced vendor-management strategy.

Subjects: ICT; Economics; Industry & Industrial Studies

Keywords: Bullwhip effect; vendor-managed inventory; form postponement

1. Introduction

The onset of COVID-19 pandemic led to a spike in demand for various food items, leading several food manufacturers into making frantic efforts to replenish retail outlets dotted around the country and expanding their production capacity (Mukucha & Chari, 2022). Then suddenly there was an introduction of COVID-19 vaccines which brought normalcy to ordinary lifestyles in generally, and demand patterns in specific. The return of demand patterns to pre-pandemic levels left many supply chains with accumulated excess inventory which had no immediate demand in phenomenon which is termed the bullwhip effect. The bullwhip effect which is also known as the Forrester effect is referred to as demand distortions along the upstream supply chain that is caused by variances between supply and demand (Forrester, 1961). Usually a small change in consumer demand translates into huge order quantities and stock levels (Lysons & Farrington, 2020). The bullwhip in supply chains is caused by updated demand forecasting, batching of orders, price fluctuations, and gaming (Lee et al., 1997a). The bullwhip effect leads to excessive investments in inventory, and accumulation of excess inventory which does not have immediate demand (Pozzi et al., 2018). The bullwhip can be mitigated through having reduced lead times,

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controlling price fluctuations, implementing better forecasting methods, and integrating planning and performance assessments (Lysons & Farrington, 2020; Sterman & Dogan, 2015).

The bullwhip effect phenomenon is one of the key features in economies that are market driven & Ma, 2017; Saab & Correa, 2005), and prevalence is ubiquitous (Wang & Disney, 2016). A study by Shan et al. (2014) on the effect of the bullwhip effect in China after analyzing data from approximately 1200 firms revealed that almost two thirds of the studied firms grapple with the bullwhip effect. A study by Isaksson and Seifert (2016) on the demand amplification in the US firms replicated a similar study by Shan et al. (2014) on Chinese firms, and they also confirmed a high prevalence of the bullwhip effect. Moreover, various aspects of the bullwhip effect have been studied in the extant literature such as the bullwhip intensity using the Fuzzy Inference System (FIS; Rahman et al., 2020), the Horizon Simulation Approach (Campuzano-Bolarín et al., 2020), the behavioural approach (Khan et al., 2019), optimal control theory (Sabbaghnia et al. (2018), and the stochastic demand situation (Michna et al., 2018).

Extant literature has proposed a raft of measures to reduce the bullwhip effect such as streamlining the supply chain, minimizing discounts and sales promotions, optimizing inventory management, and maintaining consistent and smaller orders (Lee et al., 1997a). While these mitigating measures are undoubtedly effective, they are nonetheless inadequate in minimizing the bullwhip effect to the levels that do not raise practical concerns. Therefore, the vendor-managed inventory (VMI) and the form postponement (FP) are proposed as additional measures that can be implemented to ameliorate the disastrous consequences of the bullwhip effect, and indeed these supply chain strategies are implemented by the majority of businesses in Zimbabwe. More specifically, most bakeries have got VMI arrangements with several retail outlets around the country, and practice form postponement especially on bread slicing. The needs of the bread market vary more prominently on sliced and unsliced bread, leading most bakeries to practice form postponement.

The bullwhip effect has been found to be a function of lack of end-to-end supply chain visibility emanating in delayed and biased information sharing, and poor logistic function (N. Wang et al., 2016). This study proposes that VMI can mitigate against the adverse effects of the bullwhip effect. Previous researches had already made a similar proposal, but were made in a different context and industry (e.g., Cetinkaya & Lee, 2000; Kristianto et al., 2012). A combination of the bullwhip effect and VMI has never been studied in the context of the ongoing COVID-19 pandemic and within the bakery industry. VMI is one of the collaborative initiatives in supply chain management (Chopra et al., 2018). It is proposed in this study that information sharing which is touted to lead to the reduction of the bullwhip effect (Cao et al., 2017) thrives under the VMI and FP strategies. The effect of these two supply chain management strategies on the dimensions of the bullwhip effect remains an empirical question upon which our research hypotheses are based. Therefore, this study proposes that these two supply chain management strategies are the antecedents to the reduction in the bullwhip effect.

2. Literature review

One of the major goals of supply chain management is to ensure uninterrupted flow of materials across all the nodes in the supply chain (Chang et al., 2018; Christopher, 2016), since any instability at any of the stages may result in the bullwhip effect phenomenon (Chang et al., 2018; Pastore et al., 2017; Sterman & Dogan, 2015). In the bullwhip effect phenomenon variability of orders placed and actual final demand increase as one edges closer to the production source (Forrester, 1961), due to the forecasting errors along the supply chain layers (Hugos, 2011; Wang & Disney, 2016; D. Wang et al., 2018).

There are generally four causes of the bullwhip effect in the extant literature: demand variation, price fluctuations, order batching, and gaming (Cao et al., 2017; Lee et al., 1997b; Michna et al., 2018). Demand variation relates to the accumulation of excess inventory in the pipeline due to the

large orders that accommodate safety stock (Lysons & Farrington, 2020). The addition of safety stock at each layer in the supply chain due to supply uncertainty leads to a bullwhip effect (Paik & Bagchi, 2007). The other cause of the bullwhip effect is order batching. Order batching refers to a situation whereby entities place combined orders instead of individual orders as they become due (Lysons & Farrington, 2020), since the placement of large aggregated orders leads to the attainment of the economies of scale and reduction of fixed order costs. Price changes are another trigger of the bullwhip effect. Price variations through sales promotions triggers surges in short-term demand that may send wrong demand signals to the suppliers (Chopra et al., 2018). At the end of a promotional campaign prices may revert to their original levels, thereby negatively impacting on the demand patterns (Lysons & Farrington, 2020). Gaming is the other cause of the bullwhip effect. Gaming relates to a situation whereby buyers do not trust suppliers to meet their orders and hence they order more than what they require as a way of hedging against the anticipated shortages (Lee et al., 1997a). Gaming results in information distortion in the supply chain (Lee et al., 1997b). The anticipation of supply shortages triggers an abrupt changes in order placement behaviours by institutional customers (D. Wang et al., 2018). This may result in inventory buildup.

It is believed that the bullwhip effect causes backlogs, stock outs, and excess inventory in the pipeline (Dai et al., 2017; Lysons & Farrington, 2020). Even where robust stock management software such as the enterprise resource planning (ERP) is used discrepancies are bound to happen (Bech et al., 2018; Lysons & Farrington, 2020). However, extant literature suggested that the bullwhip effect can be mitigated by having vendor-management inventory (Chopra et al., 2018). What is missing in the extant literature is how form postponement, which is another supply management strategy, can be used to mitigate the bullwhip effect. Moreover, empirical evidence on how the VIM interact with the form postponement strategy in order to minimize the impact of the bullwhip effect is missing in the extant literature.

2.1. *Vendor-managed inventory and bullwhip effect*

VMI is a system whereby a vendor manages inventory at the facilities of a customer (Chopra et al., 2018). A VMI system portrays a symbiotic relationship that allows an upstream supplier to be in charge of the management at the downstream buyer's facilities (Chopra et al., 2018). The tenets of VMI are the transfer of inventory management responsibility from a manufacturer to a supplier (D. Wang et al., 2018). The ownership of the inventory remains with the suppliers, with invoices produced only once consumption of the supplied products has been done (Lysons & Farrington, 2020). A vendor is responsible for inventory replenishments (Lysons & Farrington, 2020). In most cases a vendor deploys one of its employees to manage inventory at the customers' premises (Christopher, 2016). VMI arrangements are characterized by collaborative planning by upstream and downstream supply chain participants (De Maio & Lagana, 2020), and high precision forecasting systems (Chopra et al., 2018). The VMI is beneficial to both the vendor and the manufacturer in that the system is associated with open lines of communication, long-term relationships, and demand smoothing (Lysons & Farrington, 2020).

The VMI arrangement enhances end-to-end supply chain visibility (Ivanov et al., 2019). The visibility that is attained from VMI arrangements creates a conducive environment for reducing the bullwhip effect and the indicators of the bullwhip effect such as high inventory costs (De Maio & Lagana, 2020). Through visibility both parties have access to information such as stock at hand and the accurate consumption rate (Chopra et al., 2018). The information visible to the supplier includes, but is not limited to, sales data, production schedules, inventory withdrawals, and back orders (N. Wang et al., 2016). Moreover, the fact that the vendor will be in charge of inventory at the premises of the buyer implies that the inventory will be kept using a manufacturer's recommended material handling procedures that ensure less incidences of obsolescence (Chopra et al., 2018). The VMI strategy results in a reduction in inventory in the supply chain, leading to lower warehousing space and costs (Lysons & Farrington, 2020). The fact that VMI is associated with

demand smoothing and high precision demand forecasting the incidences of bullwhip effect is reduced (Christopher, 2016), and therefore it is logical to predict that:

H1a. VMI leads to a statistically significant reduction in overstocking

H1b. VMI leads to a statistically significant reduction in obsolescence

H1c. VMI leads to a statistically significant reduction in stockholding costs

2.2. Form postponement and bullwhip effect

Traditionally firms operated under the make-to-stock concept that relied on demand speculation and forecasting (Krajewski et al., 2005; Lysons & Farrington, 2020). However, this type of production system has been associated with the bullwhip effect (Chopra et al., 2018). As a result, Alderson (1950) proposed the postponement strategy. Postponement in supply chain management literature is also known as delayed product differentiation, late customization, or mass customization (Chiou et al., 2002; Pillar, 2004). Mass customization enables the fulfilment of customers' specific needs at a high speed and volume, but with minimum cost (Bech et al., 2018). There are three generic postponement strategies that are namely form postponement, place postponement, and time postponement. It is the former version of postponement that is of interest in this study. Form postponement relates to the delay in final manufacturing till the actual customer order is placed (Lysons & Farrington, 2020). Production systems that are good candidates for postponement have a number of configurations, short product life-cycles, high holding costs, and higher levels of demand uncertainty (Chopra et al., 2018). The uncertainty element in demand has a potential to lead to the bullwhip effect manifesting in the form of stock-outs or holding of excess inventory (Dai et al., 2017). The fact that postponement strategy thrives in the production system with short life-cycle production output (Prataviera et al., 2020) the potential for obsolescence is high if demand forecasting misses the reality in the market (Rau et al., 2021).

The hallmark of FP is delayment. The delay is meant to reduce uncertainty and get customer commitment to the acquisition of a product (Bech et al., 2018). This strategy is associated with a pull strategy where inventory moves along the supply chain on the basis of a confirmed demand from the consumption point (Jafari et al., 2021). In this case the movement of inventory along the supply chain implies that there is no buildup of inventory at any node of the supply chain structure (Lysons & Farrington, 2020). The strategy holds products in a semi-finished state, with the finalization of the production process taking place upon receiving information from the market (Jafari et al., 2021). The manufacturer simply has to choose the decoupling point (Chopra et al., 2018). It is on the basis of pull demand that the incidences of the bullwhip effect are minimized. The discussion above therefore leads to the prediction that:

H2a. Form postponement leads to a statistically significant reduction in overstocking

H2b. Form postponement leads to a statistically significant reduction in obsolescence

H2c. Form postponement leads to a statistically significant reduction in stockholding costs

2.3. VMI and FP interaction effect on bullwhip effect

The precision in demand forecasting that is the key to reduction in the bullwhip effect is anticipated to thrive under the conditions of VMI arrangement and the FP strategy. In general both VMI and FP strategies are associated with improved order fill rates, reduced supply chain costs, and reduced pipeline inventory (Bech et al., 2018; Chopra et al., 2018; Min, 2015).

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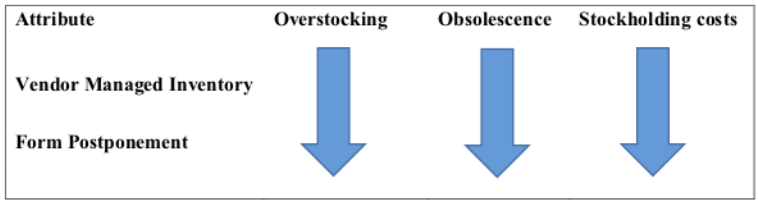
Figure 1. Conceptual model.



If these two strategies can individually lead to the attainment of the aforementioned benefits, then logically in cases where they are jointly implemented they are expected to yield the same benefits in greater levels. This leverages on the fact that there would be compatible information and accurate demand forecasts (Min, 2015). Therefore, demand forecasting is even anticipated to thrive more when there is an interaction between VMI and FP. This is based on the fact that the interaction between VMI and FP reduces the distortion of demand information. Moreover, FP favors a low buildup of inventories (Rabinovich & Evers, 2003), leading to a reduced bullwhip effect. It is therefore anticipated that the strength of the influence of VMI on the bullwhip effect (overstocking, obsolescence, and stockholding costs) varies across the levels of FP. This leads to the hypotheses that:

H3a. VMI and FP interaction leads to a statistically significant reduction in overstocking

H3b. VMI and FP interaction leads to a statistically significant reduction in obsolescence

H3c. VMI and FP interaction leads to a statistically significant reduction in stockholding costs

The reviewed literature leads to the conceptualization of the model shown in Figure 1.

The model in figure1 suggests that the VMI and the FP strategies lead to a decrease in the indicators of the bullwhip effect that have been identified as overstocking, obsolescence, and stockholding costs.

3. Methodology

3.1. Population and sampling

This study assessed firms at the same tier in the supply chain as the unit of analysis. The population for this study comprised all bakeries in the Zimbabwe. Bread is one of the staple foods in Zimbabwe consumed by almost an entire 16 million population size of Zimbabwe (Mukucha et al., 2022). However, just like most developing countries there are no updated official records of the exact number of bakeries operating in Zimbabwe. The failure to obtain a sampling frame for the target population led the researchers into making use of convenience sampling (Struwig & Stead, 2013). Convenience sampling has low cost and easy access to data (Saunders et al., 2016). The use of convenience sampling in studies focused on the food industries is not without precedence. Other studies that have used convenience sampling include but not limited to Mukucha, Manyika, Madhuku & Chari (2020)).

3.2. Data collection procedures

Data was collected from all the consenting bakeries who met the specified criteria put in place by the researchers. The participating bakeries were supposed to have updated financial records and had a competent bookkeeper or qualified accountant who could determine and provide accurate figures related to the percentages of overstocking, obsolescence, and stockholding costs related to overstocking. Many of the bakeries did not have proper records related to the bullwhip information,

thereby limiting the sample to a population of only 100 bakeries that the researcher deemed to have approximately accurate and adequate records.

3.3. Measures

The two independent variables of VMI and FP were measured in a binary format where 1 represents pursuing of the strategy and 0 meant not pursuing the strategy. The study measured three variables related to the bullwhip effect that are overstocking, obsolescence, and inventory holding costs. Overstocking was measured as the percentage of the number of stock units kept over and above the usual stockholding levels. Obsolescence was measured as the quantity of the units that were written off as a result of expiring during the studied period. Stockholding costs were measured as percentage increase in stockholding costs over and above the usual stock-holding costs. These three bullwhip effect related variables were measured under the VMI and FP conditions.

4. Results

The results in this study cover the sampling characteristics followed by hypotheses testing which is accompanied by testing the statistical assumptions of the statistical tool chosen for hypotheses testing.

4.1. Sample characteristics

The characteristics of the sample surveyed are presented in Table 1.

The respondents for this study were mainly males (73%), of the age group between 30 and 39 years (40%), with at least 11–20 years' experience (45%). Most of the respondents had a degree certificate (40%). The studied bakeries were mostly located in the industrial area (80%), and have

Table 1. Sample characteristics

Respondent characteristics	N	%
Gender		
Male	73	73
Female	27	27
Age		
18–29	25	25
30-39	40	40
40–49	15	15
50-59	10	10
60–65	10	10
Experience		
0–10	35	35
11-20	45	45
21–30	10	10
30+	10	10
Educational level		
Diploma certificate	35	35
Degree certificate	40	40
Degree + diploma certificate	25	25
Firm characteristics		
Location		
CBD area	10	10
Residential area	10	10
Industrial area	80	80
Years in operation		
0–10	30	30
11-20	60	60
20+	10	10

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Table 2. Descriptives

Variable	VMI strategy	Postponement strategy	Mean	Std. Deviation	N
Overstocking	No VMI	No FP	29.7027	13.43475	37
		FP	8.5000	1.04319	18
		Total	22.7636	14.88221	55
	VMI	No FP	12.4286	9.92056	14
		FP	2.9355	1.38890	31
		Total	5.8889	7.08142	45
Obsolescence	No VMI	No FP	14.8649	4.06313	37
		FP	4.8889	.75840	18
		Total	11.6000	5.78824	55
	VMI	No FP	7.6429	1.15073	14
		FP	2.7742	1.28348	31
		Total	4.2889	2.59039	45
Stockholding costs	No VMI	No FP	13.1622	2.90128	37
		FP	6.4444	.70479	18
		Total	10.9636	3.98592	55
	VMI	No FP	5.0714	2.05555	14
		FP	1.4516	1.31247	31
		Total	2.5778	2.30108	45

been operating for a period between 11 and 20 years (60%). Descriptive results are presented in Table 2.

4.2. Hypotheses testing

A two-way Multivariate Analysis of Variance (MANOVA) was conducted to determine the effects of VMI and FP strategies on three dependent variables conceptualized as the dimensions of the bullwhip effect: overstocking, obsolescence, and holding costs. Considering that the study has two dependent variable that are continuous and categorical independent variables, a MANOVA statistical tool was chosen since it simultaneously assesses multiple dependent variables (Field, 2018).

In order to produce the results that are generalizable the statistical assumptions were assessed (Saunders et al., 2016). Multicollinearity and singularity did not raise concerns since the highest correlation coefficient was .8 and the lowest was .574 all significant at >.001. The assumption of homogeneity of variance-covariance was not tenable, Box's test M = 289.689, F(18, 12,029.795) = 14.986, p < .001, and the Levine's test of equality of variance also did not provide evidence of the assumption of homogeneity of variance across groups for all the dependent variables: overstocking, F(3, 96) = 23.313, p < .001, obsolescence, F(3, 96) = 11.956, p < .001, save for inventory holding costs, F(3, 96) = 1.836, p = .146. The lack of homogeneity of variance as indicated by the results were deemed inconsequential since the cases for larger groups did not exceed one and half times the smaller groups. Multivariate normality was assessed indirectly through univariate normality tests using the Shapiro-Wilk test and multivariate outliers using the Mahalanobis distance. The Shapiro-Wilk tests produced statistically significant results implying that all the dependent variables were not approximately normally distributed. The Mahalanobis distance value was also above the critical value implying the absence of multivariate normality. Considering that there were a number of violations of MANOVA assumptions, Pillai's Trace which is robust to most of these violations was used for interpreting the results. Furthermore, for degrees of freedom more than one, and small and unequal sample sizes, Pillai's criterion is more robust (Field, 2018; Hair et al., 2014; Tabachnick & Fidell, 2013).

The null hypothesis that the sample population means on a set of the bullwhip effect related to dependent variables do not vary across different levels of VMI and FP was not supported. MANOVA results shown in Table 3 indicate that VMI strategy, Pillai's Trace V = .794, F (2, 672) = 8.14, p > .001, partial η^2 = .737, observed power = 1.000, and FP strategy, Pillai's Trace V = .841, F (2, 672) = 8.14, p > .001, partial η^2 = .737, observed power = 1.000 significantly affect the combined dependent variables of overstocking, obsolescence, and holding costs. The multivariate effect sizes were very big.

Follow-up tests are supposed to be conducted after a significant MANOVA result since MANOVA is an omnibus test which does not indicate the exact groups that have got some statistical differences (Field, 2018). Univariate Analysis of Variance (ANOVA) were conducted as follow-up tests. The bullwhip effects (overstocking, obsolescence, stockholding costs) were subjected to a two-way analysis of variance having two levels of vendor management inventory strategy (VMI, non-VMI), and two levels of form postponement strategy (FP, non-FP). All the effects were statistically significant at the .05 significance level.

The main effect for VMI strategy, presented in Table 4, was significant, F (1, 96) = 32.124, P < .001, partial η^2 = .251, observed power = 1.000, indicating that the average levels of overstocking were lower for VMI category (M = 5.8%, SD = 7.08) than for the non-VMI category (22.76%, 14.88). The main effect for FP strategy was significant, F (1, 96) = 59.362, P < .001, partial η^2 = .382, observed power = 1.000, indicating that the average levels of overstocking were lower for FP category (M = 5.1%, SD = 3.08) than for the non-FP category (25.24%, SD = 14.71). The observed power indicated that there was a 100% chance that the results could have come out significant for both analyses. The interaction effect was as well significant, F (1, 96) = 8.932, p < .05, partial

Table 3. Multivariate tests

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Observed Power
Intercept	Pillai's Trace	.961	764.966	3.000	94.000	.000	.961	1.000
VMI strategy	Pillai's Trace	.794	120.784	3.000	94.000	.000	.794	1.000
Postponement strategy	Pillai's Trace	.841	165.589	3.000	94.000	.000	.841	1.000
VMI strategy * Postponement strategy	Pillai's Trace	.402	21.040	3.000	94.000	.000	.402	1.000

Table 4. Univariate tests

Source	Dependent Variable	df	F	Sig.	Partial Eta Squared	Observed Power
VMI strategy	Overstocking	1	32.125	.000	.251	1.000
	Obsolescence	1	61.120	.000	.389	1.000
	Stockholding costs	1	196.673	.000	.672	1.000
Postponement strategy	Overstocking	1	59.362	.000	.382	1.000
	Obsolescence	1	155.036	.000	.618	1.000
	Stockholding costs	1	122.458	.000	.561	1.000
VMI strategy * Postponement strategy	Overstocking	1	8.932	.004	.085	.841
	Obsolescence	1	20.266	.000	.174	.994
	Stockholding costs	1	12.002	.001	.111	.929

η^2 = .085, observed power = .841, indicating that the VIM effect was greater in the FP condition than in the non-FP condition. The observed power indicated that there was an 84% chance that the results could have come out significant for both analyses.

The main effect for VMI strategy was significant, F (1, 96) = 61.120, P < .001, partial η^2 = .389, observed power = 1.000, indicating that the average levels of obsolescence were lower for VMI category (M = 5.3%, SD = 6.18) than for the non-VMI category (23.3%). The main effect for FP strategy was significant, F (1, 96) = 155.036, P < .001, partial η^2 = .618, observed power = 1.000, indicating that the average levels of obsolescence were lower for FP category (M = 3.64%, SD = 1.63) than for the non-FP category (M = 11.6%, SD = 5.79). The observed power indicated that there was a 100% chance that the results could have come out significant for both analyses. The interaction effect was as well significant, F (1, 96) = 20.266, p < .05, partial η^2 = .174, observed power = .994, indicating that the VMI effect was greater in the FP condition than in the non-FP condition. The observed power indicated that there was a 99.4% chance that the results could have come out significant for both analyses.

The main effect for VMI strategy was significant, F (1, 24) = 196.673, P < .001, partial η^2 = .672, observed power = 1.000, indicating that the average levels of inventory holding costs were lower for VMI category (M = 5.3%, SD = 6.18) than for the non-VMI category (23.3%). The main effect for FP strategy was significant, F (1, 24) = 122.458, P < .001, partial η^2 = .561, observed power = 1.000, indicating that the average levels of inventory holding costs were lower for FP category (M = 3.32%, SD = 2.66) than for the non-FP category (M = 11.06, SD = 4.49). The observed power indicated that there was a 100% chance that the results could have come out significant for both analyses. The interaction effect was as well significant, F (1, 96) = 12.002, p < .05, partial η^2 = .111, observed power = .929, indicating that the VMI effect was greater in the FP condition than in the non-FP condition. The observed power indicated that there was a 92.9% chance that the results could have come out significant for both analyses.

5. Discussion

Ordinarily when the interaction effects are statistically significant there won't be any need to interpret the individual main effects. However, in this study both the interaction effects and the main effects were interpreted on the bases that there are some operators who may be pursuing only one of the antecedents for reducing the bullwhip effect. These operators would not be interested in the interaction effects since they rely on one of the independent variables. Therefore, for the purpose of such operators both the main effects and the interaction effects were interpreted and subsequently discussed in this section.

The study demonstrated that VMI strategy reduces the impact of the bullwhip effect. The reduction in the bullwhip effect is achieved in VMI through avoiding bath ordering (Lysons & Farrington, 2020). In VMI, batch ordering is unnecessary since suppliers can send small frequent orders to the buyer leveraging on the visibility associated with VMI schemes. VMI programs leverage on electronic data interchange (EDI). EDI enables the placement of orders in smaller lots, thereby eliminating the need for the batch ordering system which has been attributed to the bullwhip effect (Lysons & Farrington, 2020). Under the VMI arrangements, the supplier is linked to the customer's Point of Sale (POS) system so as to avoid information distortion. The supplier monitors the sales within the businesses of customers if the customers are retail outlets (Chopra et al., 2018).

Most members in the supply chain individually place orders based on demand forecasting. Members update their demand forecasting based on the orders they have received (Paik & Bagchi, 2007). The end customers' demand tend to be less accurate as more supply chain tiers increase. Literature has identified reducing the supplier and customer tiers as the solution to the oscillation in in inaccurate demand forecasting (Chopra et al., 2018). The VMI arrangement studied in this survey showed that the incidences of the bullwhip effect are reduced as the layers in the

supply chain are reduced. The VMI arrangement has got very few supply chain layers that reduces the inaccuracies associated with demand forecasting (Chopra et al., 2018; Van den Bogaert & van Jaarsveld, 2022).

The VMI programs are associated with a collaborative relationship between a vendor and buyer (Chopra et al., 2018). In such relationships there is transparency in the mechanisms that support the relationship to the extent that some of the trade conditions such as price changes are discussed and communicated in advance. Communicating prices changes in advance reduces unexpected price fluctuations which are associated with the bullwhip effect (Durán Peña et al., 2021; Feitzinger & Lee, 1997). The VMI is associated with real-time communication between trading partners updating on demand patterns. The VMI leverage on electronic data interchanges to improve information sharing which extant literature has agreed that it mitigates the bullwhip effect (Lysons & Farrington, 2020).

Postponement proved to be a mitigating strategy for the bullwhip effect. Postponement as an adaptive supply chain strategy is associated with a dramatic reduction in inventory. This reduction emanates from full end-to-end supply chain visibility that brings most of the necessary demand information (Lysons & Farrington, 2020). It is this reduction in inventory that eliminate incidences of overstocking which subsequently avoids having sock obsolescence, and high inventory carrying costs (Chopra et al., 2018; Lysons & Farrington, 2020). Form postponement leverages on any product characteristics in order to elicit different variants of the value chain in the form of function, shape, colour, or performance (Jafari et al., 2021).

6. Managerial implications

It was proven in this study that vendor-managed inventory and form postponement reduces the effects of the bullwhip effect. The VMI already has a wide application in the retail business by renowned retail outlets such as Walmart. The implications of these findings suggest that restaurant businesses can protect themselves from the effects of the bullwhip effect through, firstly, engaging their suppliers into entering into VMI arrangements. This has the effect of reducing market information asymmetry. The fact that the VMI programs are associated with less consequences of the bullwhip effect, business leaders are advised to pursue such initiatives. However, VMI programs are best suited for inventory with higher levels of stock turnover. Some industry experts recommend a rate of stock turnover of 4 and above. This rate of stock turn conveniently suits the bakery industry where stock the shelf life of bread is expected not to last more than a week. Moreover, history is replete with disputes on the quantities and value of inventory at the buyer's premises. It is therefore advisable to clearly spell out in a binding contract on how the stock will be accounted for and how ownership is transferred from vendor to the buyer. Furthermore, the financial burden of looking after the stock is borne by the suppliers (Min, 2015) who in this case are the bakeries.

Secondly, restaurants need to engage in form postponement. Form postponement has already been described as the art of delaying the final form of a product on offer until a concrete customer order has been received. This enhances the customization of the bakery's value package to the market. Through form postponement accurate information is received from the market. When definite information about the required raw materials has been received restaurants can in turn place orders for raw materials without ending up with hoards of unused raw materials. The bakeries that are not yet pursuing the form postponement strategy are encouraged to pursue that strategy and extending it to various form postponement dimensions beyond that of sliced bread such as mass customization of the bread beyond the standard loaf. This can perhaps be extended to half and quarter bread. However, the implications are that bakery businesses must invest in flexible machinery which in most cases may entail large initial capital outlay. Furthermore, the invested machinery that would enable the pursuing the postponement strategy should be reconfigurable, scalable, flexible, and have interface standardization (Berch et al., 2018). Furthermore, Berch et al. (2018) advised that in evaluating capital investment for enabling form

postponement the acquired machinery should have high changeover and rump speed, and should be able to accommodate new product variants. Moreover, bakeries must ensure that their production systems are in the modular format. A module is a component of a product that provides a unique function that enables a product to function properly and can be removed or substituted from a product non-destructively (Gershenson et al., 2003). Modules are self-contained units that can be configured to produce different types of products.

Lastly, whilst this study has confirmed what is already extensively documented in the extant literature that the bullwhip effect is mitigated by the VMI strategy, further insights were revealed on how the postponement strategy interact the VMI system to reduce the consequences of the bullwhip effect. Most of the bakeries that operate under the VMI system are larger in size, leaving out the smaller bakeries to operate under the traditional systems. Therefore, the smaller bakeries are encouraged to enter into the VMI and form postponement strategies in order to reduce the consequences of the bullwhip effect.

7. Limitations and future research directions

This study relied on the figures related to overstocking, obsolescence, and inventory holding costs. Ordinarily these figures are best ascertained from inspecting the participating firms' records. However, most business people are not comfortable with opening up their business records to researchers who in most cases are strangers or agents of the competitors or worse still government agents who might be investigating issues such as tax evasion. Therefore, the researchers had to rely on the figures supplied by the firms. However, the researchers firmly believe that the information provided was accurately computed as the firms surveyed employed qualified accountants or competent book-keepers. Furthermore, the studied sample was closer to the final node of the supply chain where the bullwhip effect is theoretically at the minimum level (Forrester, 1961). This is a great limitation of this study because the demand amplification was not studied at its potentially peak levels. However, since the main focus this study was to determine the moderating effect of form postponement the interaction could only be measured closer to the final phases of the supply chain where form postponement takes place. Therefore, future researches should endeavor to source information from random samples in order to produce results that are generalizable, and collect data from samples at the nodes of the initial phases of the supply chain.

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