

AN ASSESSMENT OF SUPPLY CHAIN VULNERABILITIES TO DYNAMIC DISRUPTIONS IN THE PHARMACEUTICAL SUPPLY CHAIN

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Abstract

Objective: The adverse impact of supply chain disruptions on the operational performance of supply chains have been suggested to emanate from its existing vulnerabilities. However, empirical studies regarding this proposition remain limited. This study provides empirical evidence of vulnerabilities in the face of dynamic disruptions in the pharmaceutical supply chain. This is geared at developing resilience strategies capable of curbing these forms of disruptions.

Research Approach: In seeking to achieve the objective of this study, the mixed method research design in a longitudinal framework was adopted. It involved a two-step procedure where the study began by conducting semi-structured interviews with the downstream stakeholders of the pharmaceutical supply chain. Here the sampling method adopted was both purposive and snowballing. Data collected from this process was analysed using thematic analysis where key variables were coded for further analysis. Findings from the interviews were employed to construct close ended questionnaires. The questionnaires were administered online, approximately nine months after the first data collection process ended and analysed using various statistical techniques.

Findings: The themes that emerged from the first phase of the data generation process were classified into five main pillars which include: supply chain characteristics, regulatory framework (schemas), imbalance of market power, managerial decisions and supply chain structures. These themes were further confirmed by the findings from the survey. The study finds that imbalance of market power generates negative welfare such as time consumption and stress on the downstream stakeholders of the pharmaceutical supply chain. In the same vein, dependence on suppliers and consumers in designing the supply chain exacerbates the impact of a dynamic disruption. The findings from the survey complement these pillars by identifying other vulnerabilities: price manipulation, inadequate policies, inefficient manufacturing processes as well as available training in handling these vulnerabilities.

Originality/Value: By providing empirical evidence of the vulnerabilities within the pharmaceutical supply chain in the face of a dynamic disruption, this study extends operations management literature by highlighting vulnerability benchmarks against which resilience strategies can be employed in dynamic disruptive scenarios. The innovative aspect of this research is the ability to identify the vulnerabilities peculiar to the pharmaceutical supply chain which is required in order to successfully develop strategies that are resilient to dynamic disruptions.

Research Impact: This study extends existing debates on supply chain vulnerabilities as well as supply chain disruptions.

Practical Impact: This study contributes to practical managerial decisions, as the identifications of vulnerabilities to dynamic disruptions will aid pharmaceutical and or operations managers in assessing supplier selection and design.

Introduction

Supply chain disruptions impede the flow of products, hamper firms' abilities to produce their goods as well as adversely impact on the financial performance of a supply chain (Juttner and Maklan, 2011; Thekdi and Sarvos, 2016; Hendricks et al. 2017). Some studies have identified the existence of vulnerabilities within supply chains as pertinent to the ability of firms in withstanding the impact of these disruptions (Juttner and Maklan, 2011; Thun and Hoenig, 2011; Purvis et al., 2016). The argument for the inclusion of supply chain vulnerability stems from the underlying idea that supply chain weaknesses expose them to diverse impacts of disruptive activities (Juttner and Maklan, 2011; Pettit et al. 2013; Christopher and Holweg, 2017). This therefore calls for the need to qualify as well as quantify the vulnerabilities the supply chain is exposed to in an attempt to evaluate the need for costly strategies for resisting disruptions that may rarely occur (Wagner and Neshat, 2010). This is line with the accepted adage which states that 'you can't manage, what you don't measure'.

More specifically, there is the need to understand supply chain vulnerabilities within the pharmaceutical supply chain. Shah, (2004) explains that the complexity of the PSC burden it bears in trying to ensure that the right drugs, reach the right people at the right time and in the right condition to fight against ailments. Furthermore, high regulations require collection of variety of information that may be difficult to decipher (Zhang et al., 2009). Pharmaceutical supply chains are also encumbered with diverse forms of disruptions which to are large extent are termed as dynamic. In view of the foregoing, the aim of this study is to assess the vulnerabilities of the pharmaceutical supply chain in the face of a dynamic disruption like drug shortage. This section introduces the paper. The next section provides a brief overview of the main concepts under study. Following this, the methodology and findings are presented. The paper is concluded in the final section.

Review of Literature

Supply chain vulnerability as a concept within supply chain risk management literature remains inconclusive as it varies with regards to its research contexts, definition and framework (Liu et al., 2018). Most studies, present supply chain vulnerability as an elusive concept that occurs through certain traits of a supply chain, such as its design and the environment in which the supply chain exists. The concept and or definition of supply chain vulnerability may however differ with regards to supply chains, modes of occurrences or in the face of a disruptive event like drug shortages or counterfeiting. This study, therefore views supply chain vulnerability as the points at which the supply chain is exposed to varying degrees of attacks, damages, and adverse impacts which emanate from disruptions such as natural hazards, strikes, global warming, thefts and counterfeiting. The fact that not all supply chain risks can be controlled means that every supply chain has some degree of vulnerability – and this is the premise on

which SCRES is built (Christopher and Holweg, 2011; Hohenstein et al. 2015; Elleuch et al. 2016). However, the underlying assumptions that supply chain vulnerability is as a result of a supply chain's lack of resilience to varying forms of threats remain inconclusive (Jüttner and Maklan, 2011).

For instance, while Sheffi and Rice (2005) argued that reducing vulnerability implies reducing the likelihood of a disruption and thereby enhancing resilience. Jüttner and Maklan (2011) claim that a highly vulnerable supply chain may either have a high or low resilience based on their ability to plan and recover from a disruption. The contention here is that there are some strategies which may reduce supply chain vulnerability without necessarily improving the resilience of the supply chain. For instance, some risk strategies are adopted to mitigate geographical risk thereby reducing vulnerability, this does not necessarily translate to resilience (Pettit et al. 2013). Also, the decisions of a supply chain manager to stop outsourcing production and or packaging may reduce the supply chain vulnerability as it shortens the supply chain. This strategy does not imply resilience, as the reaction and response in the face of a disruption is classified as supply chain resilience (Tukamuhabwa et al., 2015). Therefore, appreciation of supply chain vulnerability aids in developing effective capabilities required to cope with disruptions.

Existing literature suggests various factors that may contribute to exposing the supply chain to various degrees of disruptive impact. These include; supply chain complexity, managerial practices (Blackhurst et al. 2011), supply chain structure, supply chain characteristics and supply chain density. Some researchers contend that managerial practices, for instance the application of JIT principles, reduces the firms shock absorbers through low inventories and as such a supply chain may not be able to withstand the impact of a disruption (Thun and Hoenig, 2011).

In the same vein, outsourcing and global sourcing have been credited as essential in propelling firms operations'. However, these practices reduce a supply chains visibility thereby making it difficult to pinpoint the source or cause of a disruption for quicker resolutions (Steecke and Kumar, 2009). Also outsourcing increases the length of the supply chain as longer supply and multiple layered chains have been suggested to reduce the transparency of the supply chain thereby heightening vulnerabilities (Craighead et al. 2007; Wagner and Neshat 2010). Further, supply chain characteristics which identify the degree of dependence on suppliers or consumers for the manufacture and or distribution of products may expose a supply chains' susceptibility to disruptions (Bode and Wagner, 2006; Blackhurst et al., 2017). These characteristics may increase loss of power, offer less advantageous contracts and put at stake continuous replenishment.

Although the arguments for supply chain vulnerabilities are emerging in theoretical supply chain management literature, empirical evidence supporting these assertions remains scanty (Wagner and Neshat, 2012). More specifically, examining these vulnerabilities in the face of a disruption bearing in mind the features of the supply chain is also limited. For instance, is it possible to conclude that the complexities, structure or managerial decisions of the pharmaceutical supply chain may be the leading cause of the impact of a disruption like drug shortages? Sousa et al (2011) even go so far as to question whether there are other underlying intricacies unexplored in literature? This therefore calls for the need to explore the vulnerabilities of the pharmaceutical supply chain in the face of a disruptive event

as it will aid in understanding the degree of the impact and the necessary strategies to be employed. Also, in order to effectively manage supply chain vulnerabilities, it is necessary to have empirically validated methods at hand that support managers in measuring and tracking vulnerabilities, as such; understanding why supply chains are vulnerable to disruptions is of import (Peck, 2005; Wagner and Bode, 2006; Wagner and Neshat, 2012).

Methods

In order to achieve the research objective, data was collected using mixed methods strategy which involves the integration of qualitative and quantitative research approaches in a single study (Teddlie and Tashakkori, 2009; Golic and Davis, 2012). The first stage of data collection in this study was the qualitative method which involved conducting semi-structured interviews with the downstream sector of the supply chain where five community, online and hospital pharmacists were recruited for participation. This approach was based on the idea that the phenomenon (dynamic disruptions as well as pharmaceutical supply chain vulnerabilities) is under-explored and the variables were difficult to identify (Creswell, 2013). This stage also provides a framework for comprehending detailed description by providing high level data. The interview questions therefore included questions such as: 'Could you describe a time your firm faced any form of disruptive activities?' 'Do you know what caused these disruptions and why they persisted?' The formulated key question emanated from theoretical literature, while thematic analysis was used for analysing the generated data through a reductionists approach.

The second phase of the data collection process was the administering of questionnaires to a wider audience. The questionnaire was kept simple and ensured a good flow, thus keeping users engaged as well as facilitating clearer outcomes. There were a range of question which were multiple choice questions close ended responses. The anonymised questions reduced the potential for bias, and the online nature of the questionnaire meant that it was easily available through a number electronic devices. The nature of the questionnaire meant that it was relatively easy and fast to answer it, and it was hoped that this would have increased participation. Branches across the UK were used to increase the generalizability of the results. The link to the online survey was sent to the three community pharmacy chains and requested that it be distributed to each individual branch. CPWY invitation letters were also handed out, and a direct email was sent to the Bradford School of Pharmacy staff to reach out to as many liaising participants as possible. The link was also distributed through the social media platforms 'Twitter' and 'LinkedIn'. Data here was analysed using simple statistical techniques.

Analysis of the Data and Discussions

Five downstream actors of the pharmaceutical supply chain were recruited for this research. They were chosen specifically because of their activities, experience and position within the pharmaceutical supply chain. A number of clear themes developed from this phase of the data generation process. When asked about 'forms of disruptions' that had been encountered in their firms. The participants did not refer to static forms of disruptions like earthquakes, fire, labour strikes or general nomenclatures employed by researchers such as accidents or intentional disruptions (Peck, 2005). Instead, they referred to drug shortages as disruptions and explained the various forms in which these drug shortages

impeded the flow of goods to their consumers. The participants also identified characteristics of the pharmaceutical supply chain, regulations, and imbalance of market power, price manipulation as well as managerial decisions as reasons why the supply chain was weak and as such increased the constant incidences of drug shortages.

The next stage of the data generation process involved the administering of questionnaires to first tier consumers on a national level. 22 responses were received and the findings further confirmed the themes that emerged from the interviews. For instance in table 1 below, the highest response rate for the causes of disruptions were price manipulations. This finding indicates that first tier consumers attribute price manipulations as a major cause of disruptions of goods to their patients with a 515 response rate. This implies that price manipulation which entails the distortion of prices for profit hampers the integrity of the supply chain and as such exposes the supply chain to diverse impacts of disruptions (Berg, 2017).

Similarly, managerial decisions such as bulk buying were also identified as vulnerability in the pharmaceutical supply chain with a response rate of 31.8%. These decisions stem from managers of pharmacists who engage in panic buying when they are forewarned about a disruptive activity and in some cases may sell to their counterparts who failed to take up that decisive action. This finding is also in consonance with existing literature that suggests managerial decisions as a major vulnerability within a supply chain (Craig et al., 2007).

Table 1: ***Online survey responses causes of disruption***

Causes of Disruptions	% Response Rate
Pharmacies buying bulk stock and selling it to other parties	(31.8)
Inefficiencies and ineffectiveness of the manufacturing process	(31.8)
Lack of active pharmaceutical ingredients	(18.2)
Natural disasters and uncontrollable events	(0)
Ever increasing competition within the pharmaceutical supply chain	(18.2)
Monopoly within the pharmaceutical supply chain	(36.4)
Price manipulations	(59.1)

The analysis also indicated that the impact of the existing vulnerabilities extends beyond the operations of the pharmaceutical supply chain to also have adverse impact on its stakeholders. The results suggested that employee's engagement in the firms operations during these dynamic disruptions were often stressed as a result of having to deal with consumers as well as the process of sourcing alternative product. Only 59.1% of the respondents felt that they had been trained to manage disruptions effectively, to recover from these in order to offer a high quality and uninterrupted service. This highlights the technicalities involved in dealing with drug shortages as a disruptive event and as such

requires skills and development in certain capacity. There were some participants who did not identify drug shortages as a pertinent problem within their pharmacy. This may be attributed to the fact that they had developed coping mechanisms that aided in assuaging the impact of this disruptive activity. These findings are in consonance with previous surveys conducted by GPs in 2014 (Drugs.com, 2017).

The analyses at both phases of the study reveal that lack of trust was a major weakness within the supply chain which exacerbated the impact of the disruption. The severance of trust may be between the patients and the pharmacists and or between pharmacists and their first tier suppliers. Losing distressed patients, or having to deal with confused and frightened patients due to delayed treatment, results in pharmacy staff passing the blame and frustration onto the supply chains. This then leads to fractured relationships. A lack of trust within a supply chain can hinder the ability of members of the chain to prepare for the future and make calculated decisions (Christopher, 2016). The resultant effect is an increased complexity of the supply chain. If medicine shortages were reduced, pharmacy workers would have more time to focus on and improve their services, enhancing patient treatment. The continuous shortages can expose the supply chain to greater financial security as well as counterfeiting risk.

With regards to policies, the study found that there were no laid down rules to facilitate operational recovery within the supply chain when disruptions occurred. For instance, the survey showed that 72.7% of the participants felt that there was a lack of guidance offered by the governing agencies e.g. the Medicines and Healthcare products Regulatory Agency (MHRA) and the General Pharmaceutical Council (GPHC).

Inefficient or inadequate information sharing can, therefore, lead to reduced efficiency and drug shortages (Riley, et al., 2016). A fragile chain is unreliable and so consumers (patients) may look elsewhere to source their desired medicines. This can put patients at significant risks as they may be, either knowingly or unknowingly, sold counterfeit medicines. Previous literature suggested that pharmacists are often pressed into prescribing second choice medicines, providing suboptimal treatment for patients. This can lead to an increase in adverse effects and complications. It is also possible that continuous patient use of alternative medicines can lead to shortages of these as well. The results also mention that drug shortages lead to treatment delays, something which can be undesirable and potentially dangerous for patients. Patients being sent to alternative pharmacies can also delay treatment and there is no guarantee that patients go to the other pharmacy immediately, or even at all. Patients are recipients and consumers of medication, and so they are understandably anxious when their desired medications are no longer available. Previous literature such as (Fox et al., 2009) and (Yarosan et al., 2017) showed a lack of information sharing and price manipulations for profit to be key reasons for supply chain shortages.

These findings concurred with our results, as 81% of respondents mentioned that they received no alerts prior to drug shortages, and 12 respondents blamed price manipulations (at least partly) for drug shortages. Tackling price manipulations was suggested when respondents were asked about potential improvements to the supply chain. The respondents also advocated that drug prices be fixed and not fluctuate thus preventing the NHS from being overcharged. This would in turn eliminate supplier

selection issues as suppliers are mainly chosen based on best value for money. It would also stop pharmacies stock piling in the fear prices would be raised again in the near future with drug tariffs being so temperamental (Chopra and Meindl, 2007).

Conclusion

The aim of this study was to explore the vulnerabilities of the pharmaceutical supply chain in the event of a dynamic disruptive activity. This is geared towards developing resilience strategies that will aid in reducing these vulnerabilities thereby mitigating the impact of supply chain disruptions that may occur. The finding from the survey complements the interviews which indicate that dynamic disruptions (medicines shortages) in the UK are the result of: a lack of active ingredients, manufacturing inabilities, monopolistic wholesaler markets, offshore trading, strict regulatory frameworks, lack of information sharing as well as price manipulations for financial gain. The impact of these shortages on patients is significant and it can continue long after the shortage expires. The study also identified the need to develop recovery mechanisms in order to overcome the impact of these disruptive activities.

Reducing bureaucracy, preventing monopolisation of pharmaceutical markets, and training staff to cope with shortages have been recommended as strategies which can curb the impact of these disruptive activities. External associations and governing bodies e.g. MHRA, Department of Health and the Association of the British Pharmaceutical Industry (ABPI), have a key role in developing staff and supply chain resilience in the face of disruptions.

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