



The role of power-based behaviours on pharmaceutical supply chain resilience

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The role of power-based behaviours in pharmaceutical supply chain resilience

Abstract

Purpose

This study explored the effect of power-based behaviours on pharmaceutical supply chain (PSC) resilience.

Design/methodology/approach

This study used a mixed-method approach to explore the role of power-based behaviours in PSC resilience. Qualitative interviews from 23 key PSC stakeholders, followed by thematic analysis, revealed the underlying perceptions regarding PSC resilience. Quantitative propositions were then developed based on the themes adopted from PSC resilience literature and the qualitative findings. These were tested via a survey questionnaire administered to 106 key stakeholders across the various levels in the PSC. Structural equation modelling with partial least squares was used to analyse the data.

Findings

The data analysed identified proactive and reactive strategies as resilience strategies in the PSC. However, power-based behaviours represented by quota systems, information and price control influenced these resilience strategies. From a complex adaptive system (CAS) perspective, we found that when power-based behaviours were exhibited, the interactions between PSC actors were mixed. There was a negative influence on reactive strategies and a positive influence on proactive strategies. Our analysis also showed that PSC complexities measured by (stringent regulations, long lead times and complex production) moderated the effect of power-based behaviour on reactive strategies. Thus, the negative impact of power-based behaviours on reactive strategies stemmed from PSC complexities.

Research implications

Our research particularly reveals the role of power-based behaviours in building PSC resilience. By evaluating the nexus from a CAS perspective, the analysis considered power-based behaviours and the moderating role of PSC complexities in developing resilience strategies. The study considers the interactions of PSC actors. It shows that power asymmetry is a relational concept that inhibits the efficacy of reactive strategies. This study thus advocates the importance of power in achieving a more resilient PSC from a holistic perspective by highlighting the importance of the decision-making process among supply chain partners. Our findings are particularly relevant if PSC resilience is viewed as a complex adaptive system (CAS). All the interactions and decision-making processes affect outcomes due to their inherent complexities. Although this study focused on the PSC, its implications could be extended to other SCs (supply chains).

Practical implications

We identified that power-based behaviours influenced resilience strategies. It was detrimental to reactive strategies due to the complexities of the PSC but beneficial to proactive strategies through resource-sharing. PSC actors are therefore encouraged to pursue proactive strategies

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3 as this may aid in mitigating the impact of disruptions. However, power-based behaviours bred
4 partner dissatisfaction. This dissatisfaction may occur even within strategic alliances indicating
5 that power could be detrimental to proactive strategies. Therefore, it is pertinent to identify
6 conditions that lead to dissatisfaction when pursuing strategic partnerships. This study provides
7 insight into actual behaviours influencing resilience and quantifies their effects on the PSC.
8 These insights will be valuable for all supply chain partners wanting to improve their resilience
9 strategies.
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11 12 **Originality/value**

13 Previous PSC management and resilience studies have not examined the role of power in
14 building resilience in the PSC. This paper thus provides a unique contribution by identifying
15 the role of power in PSC resilience, offers empirical evidence and a novel theoretical
16 perspective for future practice and research in building PSC resilience strategies.
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19 **Keywords:** Collaboration, Power, Trust, Pharmaceutical Supply Chain, Mixed Method,
20 Complex Adaptive Systems, Supply Chain Resilience
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25 **1. Introduction**

26 The value of the global pharmaceutical industry has grown remarkably over the last decade
27 with increased demand for the product's efficacy (Dixit et al., 2019). However, issues such as
28 medicines shortages (Vogler and Fischer, 2020), counterfeiting (de Lima et al., 2018),
29 inaccessibility, antimicrobial resistance (World Health Organisation, 2019), and
30 pharmaceutical fraud (Flynn, 2021) increase its vulnerability. For instance, in 2020, the
31 estimated loss in sales due to counterfeit medicine infiltration was over \$200 billion in US
32 dollars (OECD, 2021). The Covid19 pandemic further aggravated the global surge in illegal
33 market sales, including the Covid-vaccines (Ardal et al., 2021). The Covid-19 pandemic also
34 exacerbated the fragility of the PSC. An example is vaccine development which requires
35 significant investment, SC restrictions, limited responsiveness and new partnership
36 development (coopetition) (Campling et al., 2022). In such environments, developing a
37 resilient PSC is imperative (Stevenson and Busby, 2015; Machado et al., 2018).
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40 SC resilience entails incorporating event readiness capabilities to plan for, adapt to, resist
41 and/or recover from the impact of a disruption in a timely and cost-effective manner (Pettit et
42 al., 2019; Baz and Ruel, 2021). There are, however, arguments as to what constitutes SC
43 resilience. Some studies identify SC resilience as the balance between proactive and reactive
44 capabilities (Melnik et al., 2014; Hohenstein et al., 2015). Other studies extend SC resilience
45 to preparedness, recovery, resistance, and growth (Chowdhury and Quaddus, 2017; Ali et al.,
46 2018). SC resilience encompasses many elements, including integrating flexible operations,
47 adopting collaborative practices, and increasing visibility through information technology
48 (Scholten and Schilder, 2015; Dubey et al., 2021).
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51 Resilience strategies may differ in the PSC as it is considered unique due to the precision, safety
52 and stringent regulations required in delivering healthcare products (Narayana et al., 2014;
53 Chen et al., 2020). The PSC also consists of multidimensional processes coupled with the cost
54 of production, lead times, and complexity in demand forecasting (Mehralian et al., 2015;
55 Kochan et al., 2018). For instance, proponents of resilience strategies suggest the entrenchment
56 of flexibility where idle capacity (products and suppliers) is selected deliberately against
57 disruptions (Behzadi et al., 2020). However, the limited number of manufacturers in the PSC
58 may challenge flexible operations (Iyengar et al., 2016; Heiskanen et al., 2017). Despite their
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practical value, studies examining PSC resilience remain scarce. Many of these studies are either anecdotal, case study based or do not consider the systemic approach (Sabouhi et al., 2018; Tucker et al., 2020). Therefore, it is pertinent to identify the forms of resilience strategies required in the PSC from a systemic view where actors' interactions are under consideration.

Our contribution is highlighted here as we approach the study of PSC resilience from a systemic perspective. Here, PSC actors' interactions and decision-making processes are examined holistically rather than in parts. A systemic PSC resilience is a complex adaptive system (CAS) that demonstrates complex interactions between agents, non-linearity, feedback, self-organisations, and schemas (Choi et al., 2001; Day, 2014). A systemic approach to PSC resilience in the presence of stringent regulations and limited agents may have complex feedback (Weiland and Wallenburg, 2013). For example, influential PSC actors may control the PSC, thereby creating some stability, or they may leverage the power advantage at the cost of the weaker members (Nyaga et al., 2013). Thus, we examine resilience strategies adopted in the PSC and the contributions of power and partner (dis)satisfaction to developing these strategies.

Power-based behaviours may influence PSC resilience when viewed through a CAS lens. For example, in the PSC, its inherent attributes may yield complex and non-linear outcomes when actors interact and make decisions in response to disruptions. Similarly, each actor's decision to exhibit power-based behaviours may affect the desired results of the interactions, including SC resilience and partner (dis)satisfaction. Hence, the interplay of actions, exchanges, and reactions between actors in the presence of power-based behaviours primarily affect resilience strategies. Research on this theoretical dimension is limited (Cowan et al., 2015; Huo et al., 2017). Scholars who have acknowledged power asymmetry in SCs have focused on relational forms and performance (Benton and Maloni, 2005). To this end, it is pertinent to identify how power-based behaviours influence resilience building in the PSC. The findings of this study are relevant as they may help PSC managers determine how to manage power asymmetry when building resilience capabilities. We assess the impact of power-based behaviours on decision-making since SC actors' interactions and strategies affect other SC actors' resilience capabilities (Nair and Reed-Tsochas, 2019).

Motivated by this objective, we proposed the following research questions:

RQ1. What resilience strategies do PSC managers employ in mitigating disruptive activities

RQ2. What role do power-based behaviours play in PSC resilience?

To answer the questions posed in this study, we use the complex adaptive system theory (Day, 2014; Kim et al., 2015) as a framework to explore the contributions of power-based behaviours in SC resilience. We contribute to the literature on SC resilience by demonstrating the non-linear interaction between power-based behaviours and SC resilience. These interactions explored from a holistic perspective have not been previously addressed to the best of our knowledge. Thus, our findings are pertinent as they may help PSC managers determine how to manage power asymmetry when building resilience capabilities and in new/existing partnerships. Answering these research questions will also provide valuable insights into how power dynamics affect PSC resilience.

The following section provides a literature review to scrutinise the relationship between power-based behaviours and PSC resilience, followed by a methodology, findings, and a discussion

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3 section. The paper's final section provides the concluding arguments with implications for
4 research and practice.
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8 **2. Literature Review**

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10 This section reviews the extant literature on the concepts addressed in this study. In sections
11 2.1 and 2.2, SC resilience and power concepts are discussed. In Section 2.3. CAS is employed
12 as a theoretical lens to understand PSC resilience and power. The gap in the literature is also
13 addressed.
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15 **2.1. SC resilience -reactive and proactive strategies**

16
17 Today's business environment encounters complex issues such as longer lead times,
18 globalisation, and increasing exposure to business risks (Ivanov, 2020). Addressing these
19 vulnerabilities necessitates resilience (Jüttner and Maklan, 2011). Resilience proponents
20 suggest that two or more independent firms in a SC work together successfully to plan for or
21 recover from a disruption (Hendry et al., 2019; Baz and Ruel, 2021). The dimensions of the
22 elements of SC resilience remain inconclusive. Some studies have sought to advance resilience
23 concerning its antecedents (Pettit et al., 2019). For instance, Weiland and Wallenburg (2013)
24 explored resilience regarding agility and robustness; Brandon-Jones et al. (2014) examined
25 visibility and connectivity, and Tukamuhabwa et al. (2017) provided an understanding of
26 resilience from a supply chain relationship and collaboration view. Some authors categorised
27 these elements as preparedness, recovery, resistance, and growth (Weiland and Wallenburg,
28 2013; Chowdhury et al., 2019). Other studies explained that the elements of readiness and
29 growth are entrenched in their proactive and reactive capabilities (Chowdhury et al., 2019).
30 Thus, SC resilience can be categorised into two broad dimensions: proactive and reactive
31 strategies (Melnyk et al., 2014; Hohenstein et al., 2015; Jia et al., 2020).
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34
35 Proactive strategies require anticipating, actively waiting, and a readiness to anticipate change
36 (Bode and Macdonald, 2017). Proactive strategies are developed after assessing potential
37 impact, improving prevention capabilities, and the readiness to prepare for a disruptive event
38 (Bode and Macdonald, 2017). Antecedents of proactive strategies include redesigning
39 products, processes and networks and effective relationships with SC partners. Reactive
40 strategies entail dealing with disruptions (Ali et al., 2018). It is the ability of the SC to respond
41 to and bounce back from a disruptive event. SC partners may be required to gather and interpret
42 relevant information on past disruptions to mitigate the disruptive impact. The speed in
43 collecting and analysing data provides a competitive advantage (Bode and Macdonald, 2017).
44 Reactive strategies include flexible operations through backup suppliers and/or flexible
45 distribution systems, visibility, collaboration in sharing crucial information, and establishing
46 joint efforts for response, recovery, and growth (Pettit et al., 2013; Hohenstein et al., 2015). It
47 is, therefore, pertinent to understand what these capabilities entail and if they differ regarding
48 PSCs.
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53 **2.1.1. PSC complexity and PSC resilience strategies**

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55 In defining SC complexity, Serdarasan (2013) focused on the SC's operational behaviour and
56 decision-making processes. As previously argued, the application of resilience strategies may
57 differ in a PSC due to its unique complexities. However, PSC complexity or the systemic
58 intricacies and interrelationships necessary for building optimal resilience strategies in the PSC
59 have not been previously considered (see Aigbogun et al., 2014; Sahouhi et al., 2018). The
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PSC has been considered different because of a unique number of features. These include massive investments in research, time and production requirements, precision requirements, safety storage requirements, distribution, and consumption requirements, longer lead times, demand forecasting complexity and stringent regulations (Narayana et al., 2014; Chen et al., 2020; Papalexi et al., 2020).

Further, the characteristics of competition in pharmaceutical markets entail the government's ability to balance clinical and economic interests and underlying anti-competitive laws (Rasekh et al., 2012). Iyengar et al. (2016) and Heiskanen et al. (2017), among others, identified the limited number of manufacturers in the PSC as a reason for medicine shortages due to their inability to meet increasing demand. The PSC has seen growth in short-line wholesalers and generic product providers in recent years to respond to growing product demand and industry development (Sarkis et al., 2021). These short-line wholesalers increase complexity, encourage competition, power dynamics exhibition, drive down prices, and offer more customer choices (Vann Yaroson et al., 2021). The complexity of PSC with limited manufacturers that dictate resource flow depicts power asymmetry (Wagner and Bode, 2006; de Jong and Benton, 2019). Power-based behaviours, particularly in the PSC, can affect healthcare systems' functioning. A holistic perspective of actors' interactions and decision-making processes to achieve resilience may suggest non-linear outcomes considering the PSC peculiarities. Therefore, the following section examines the literature on the role of power-based behaviours and PSC resilience.

Figure 1 PSC

We present an overview of a typical PSC in Figure 1. We focus our analysis on the downstream PSC, which entails getting the product to the final consumer. It involves the interaction of pharmaceutical manufacturing companies, wholesalers, hospital and community pharmacies and governing bodies to determine the flow of information and products to the final consumer (Sarkis et al., 2021). The complexities of the PSC inhibit collaboration where information sharing is deemed anti-competitive (Vann Yaroson et al., 2021). Incomplete information affects market demand forecasting and increases inventory holdings and costs, resulting in reduced profit margins and waste (Wu et al., 2014). In addition, the PSC lends itself to power-based behaviours as limited suppliers determine the flow of resources and may influence proactive strategies (Wagner and Bode, 2006). Also, some studies suggest that SC actors' power-based behaviours, decision-making processes, and relational positions facilitate proactive SC resilience (Jia et al., 2020). Therefore, understanding underlying PSC resilience strategies and how power-based behaviours influence them is imperative.

2.2. Power-based behaviours, partners dis(satisfaction) and PSC resilience

Extant literature identifies power as the ability of an agent/party to influence a process or an outcome (Handley and Benton, 2012; Chae et al., 2017). In these situations, SC partners control the decision variables of other SC partners (Shi et al., 2013; Hou et al., 2017). Resources are at the core of power-based behaviours in SCs, as firms require them to compete favourably in the SC (Reimann and Ketchen, 2017). Power asymmetry stems from the inability of firms to control these resources directly. The more powerful firms (firms with more resources) may use power to their advantage by limiting or granting access to their resources (Reimann and Ketchen, 2017). Power is considered a multidimensional construct categorised as mediated or non-mediated (Ireland and Webb, 2007). It is dichotomised based on SC relationships (Benton and Maloni, 2005; Mora-Monge et al., 2019; Glavee-Geo, 2019; Lanier et al., 2019). In

mediated power, the dominant party with critical resources influences the behaviour and decision-making process of the less dominant party (Cowan et al., 2015). Mediated power may inhibit inter-organisational relationships and collaborative outcomes (Siemieniako and Mitreęa 2018). It, however, remains inconclusive. For instance, Mora-Monge et al. (2019) examined the role of power in collaboration strategies and found the effect of power insignificant. Non-mediated power focuses on altering the behavioural outcomes of non-dominant firms through non-mediated activities. These include sharing expert knowledge and technology through strategic alliances (Ireland and Webb, 2017).

Partner satisfaction and power-based behaviours have often been used synchronously in existing literature as elements of relational quality (Flint et al., 2011; Odongo et al., 2016). Partner satisfaction is the feeling of fairness by SC actors concerning incentives and contributions when interacting with SC partners (Essig and Amman, 2009). High satisfaction levels breed fulfilling and gratifying relationships, propelling operational and financial performance, and low levels do the opposite. For instance, Mesic et al. (2018) identified that power (coercive and non-coercive) significantly influenced SC performance in the presence of partner satisfaction. Thus, power-based behaviours may have varying implications on SC resilience.

Considerable research has been dedicated to understanding how supplier satisfaction can be achieved (Mora-Monge et al., 2019). However, there is a paucity of literature on partner satisfaction's contribution to SC resilience when power-based behaviours are exhibited. The literature on SC resilience assumes that SC partners are willing and cultivate mutually beneficial relationships, leading to supplier satisfaction (Wieland and Wallenburg, 2013; Gölgeci et al., 2018). Therefore, SC resilience may be hindered by relational dissatisfaction (mistrust and goal incongruence) (Mesic et al., 2018). Gölgeci et al. (2018) explained that relational satisfaction is contingent on the relatively dependent position of SC partners. Thus, it is pertinent to assess supplier satisfaction when building SC resilience strategies in the presence of power.

The contribution of power-based behaviours to PSC resilience is limited, especially from a CAS perspective. Gölgeci et al. (2018) examined the reaction to power-based behaviours by SC partners. They found power reactions as a CAS where SC actors' back-and-forth interactions produced non-linear outcomes. It may therefore identify the role of power within a CAS whose effect on SC dimensions may be unpredictable. PSC resilience has also been touted as a CAS due to its complex interactions and decision-making processes among agents in response to disruptions (Kim et al., 2015; Yaroson et al., 2021). It would be helpful to examine the effect of power on PSC resilience through a CAS lens.

2.3. A Complex Adaptive Systems (CAS) view of power and PSC resilience

Existing research suggests that resilience capabilities in SCs should be approached from a CAS perspective (Day, 2014; Kim et al., 2015; Schiffing et al., 2020). The contention is that SC resilience is multidimensional, influenced by the dynamics of the external environment and the inherent uncertainties associated with SC complexities. CAS's unit of analysis is its adaptive and complex nature facilitated by agents' interactions within their changing environment (Choi et al., 2001; Holland, 2006). Thus, the power function within a SC due to partners' interactions may influence partner satisfaction and SC's ability to build resilience.

CAS comprises various elements, called agents, who follow internal rules or schemas that guide their actions (Nair and Reed-Tsochas, 2019). CAS theory has gained popularity in SC network studies (Choi et al., 2001; Tukamuhabwa et al., 2017; Schiffing et al., 2020). These studies advocate that most social systems have complex features that require simple reasoning.

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3 Other features of a CAS include emergence, which is a central component of a CAS where new
4 behaviours emerge based on the interactions between each agent and the overall system. Since
5 agents' interactions determine the system's behaviour, self-organisation is inherent as no single
6 agent controls how a system behaves.
7

8 A CAS also learns from previous interactions and decision-making processes. A SC partner
9 who chooses to exert mediated power on other SC partners may have developed this behaviour
10 from past experiences. The unpredictable nature of the SC may also affect the interactions and
11 outcomes. Based on the previous assertions, we argue that SC partners' interactions and
12 decision-making processes through their internal mechanisms may be influenced by power-
13 based behaviours (Gölgeci et al., 2018). These power dynamics may contribute to PSC
14 resilience. The dynamics of power-based behaviours have been suggested to possess several
15 features of a CAS (Gölgeci et al., 2018). Signalling back and forth among SC partners produces
16 an adaptive learning loop. Thus, the exhibition of power-based behaviours may distort the
17 ability of SC partners to achieve resilience.
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20 To this end, we examined power-based behaviour's influence on PSC resilience from a CAS
21 perspective concerning PSC actors' interactions and decision-making processes. A conceptual
22 framework of the elements discussed in this paper is presented in Figure 2. The following
23 section describes the methods used to achieve this research objective.
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26 Figure 2. Conceptual framework on the role of Power in PSC resilience.
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30 **3. Research Methodology**

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32 Our study aimed to determine what resilience strategies were employed in the PSC to mitigate
33 disruptions and examine the role of power-based behaviours in PSC resilience. Pharmaceuticals
34 are a vital component of healthcare provision, highlighting the importance of
35 medicine continuity and the need for PSC resilience. We approached this holistically,
36 demonstrating that agents' non-linear and complex interactions impacted PSC resilience,
37 especially when power-based behaviours were exhibited. Thus, evidence was collected using
38 the exploratory sequential mixed method design (Venkatesh et al., 2016). The mixed-methods
39 research design has been used extensively in supply chain management studies (Ali and
40 Gölgeci, 2020; Grenzfurtnner and Gronalt, 2020; Choudhary et al., 2021). The mixed-method
41 research design was considered appropriate for this study as it provides a more rigorous
42 methodology. It combines the quantitative approach's high internal and the qualitative methods'
43 external validity. This approach can validate research findings and facilitate theory
44 development and confirmation (Cresswell, 2016).
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48 Our decision to use a mixed-methods strategy stemmed from the need for further empirical
49 work in understanding resilience from a PSC perspective. PSC resilience differs significantly
50 from other SCs, due to its uniqueness (Narayana et al., 2014). In the first phase, the qualitative
51 data were collected, analysed, and then used to develop the survey tool for collecting the
52 quantitative data in the second phase (Creswell and Clark, 2017). The qualitative research
53 phase, thus, sought to address our first research question. It aimed to explore what resilience
54 strategies were used to mitigate the impact of PSC disruptions. The qualitative inquiry was
55 deemed suitable as it provided insights into the resilience strategies employed (Creswell, 2016).
56 The quantitative phase confirmed the qualitative phase's findings and answered our second
57 research question. These aims required quantitative techniques facilitated using a broader scale
58 of respondents (Saunders et al., 2019). Thus, data were generated and analysed using both
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3 qualitative and quantitative approaches. A summary of the research process is provided in
4 Figure 3.
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8 Figure 3 The Sequence of Activities of this Research Process
9 Source: Adapted from Creswell and Clark (2017)
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12 **3.1. Phase 1: Qualitative research and conceptual development**

14 The first phase of the research was the qualitative phase. The aim was exploratory as it sought
15 to explore types of resilience strategies used to mitigate the impact of disruption in the PSC.
16 Data were collected using semi-structured interviews. Interviews are deemed the most suitable
17 tool for exploring new topics or areas classified as sensitive where detailed insights from
18 participants are required (Holloway and Galvin, 2016). Semi-structured interviews were used
19 for data collection because they provided avenues to ask questions about the phenomenon
20 informed by the literature and allowed the researcher to explore further and probe for clarity
21 (Bryman et al., 2013).
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25 An interview protocol was developed from existing literature (Appendix D). This protocol
26 enabled the interview process to be replicated across the various supply chain actors, thus
27 ensuring reliability (Yin, 2003). The interview protocol consisted of twenty (20) questions on
28 why disruptions impacted the PSC and how these were handled. The interviews were
29 conducted with twenty-three (23) top-level managers across different organisations and levels
30 in the PSC. These included five manufacturers, one pre-wholesaler, two logistic service
31 providers, five hospital pharmacists, six community pharmacists, one pharmacist working in a
32 GP practice, and three participants representing various regulatory bodies. The number of
33 participants in our study reflects the design of the UK's PSC, where there are fewer
34 manufacturers than pharmacists. In addition, given the nature of the qualitative data collected,
35 the timing, and the competitive practices amongst manufacturers, the willingness of five
36 manufacturers to participate was more than initially expected. This research notably coincided
37 with external influences such as Brexit. We arrived at twenty-three (23) interviews as no added
38 information emerged after the 23rd interview indicating saturation (Morse, 1994). Our data
39 collection period was between June and August of 2018, and the interviews had an average
40 duration of thirty (30) minutes.
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44 The interviews were digitally recorded, transcribed verbatim and subsequently analysed using
45 thematic analyses within a six-step process elucidated by Braun and Clarke (2014). These steps
46 included listening carefully to the interview recordings to get familiar with the data and avoid
47 overlooking vital information. The data were then iteratively coded and analysed to select
48 relevant text according to the topics discussed in the interviews by the lead researcher. Two
49 forms of data coding were employed in a 'two-cycled' coding process. The first cycle employed
50 descriptive coding, while the second used pattern coding. Descriptive coding entailed assigning
51 vocabulary to the contents and forming the backdrop against which the second coding cycle
52 occurred (Saldana, 2015). Pattern coding was used to identify emerging themes. In this process,
53 most materials from the data were brought together to provide a more meaningful unit of
54 analysis (Miles et al., 2018). The pattern codes also highlighted significant quotes from
55 participants, which served as stimuli in developing the survey instruments for the quantitative
56 aspect of this study.
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3 Three other experienced researchers in SC Management and Pharmacy further reviewed the
4 generated themes. Any areas of disagreement were resolved through roundtable discussions.
5 An interdisciplinary research group (Operations Management and Pharmacy) reviewed the
6 output and validated the constructed themes for further confirmation. The use of multiple
7 researchers in developing themes aimed to reduce bias and enhance the validity of the research
8 (Corbin and Strauss, 2014).
9

10 **3.2. Findings from phase 1: qualitative phase**

11
12 The analysis of recorded data identified power-based behaviours (information, product, and
13 price control) and dimensions of resilience strategies (proactive and reactive strategies)
14 influenced by the PSC's characteristics. Our findings here were used as the foundation for
15 developing the survey instrument. Themes with similar nuances were merged to create
16 constructs. These constructs included partner (dis)satisfaction, power recovery and resistance
17 strategies. Our hypothetical development (H1 – H4) and theoretical framework (Figure 2)
18 demonstrate the relationship between these constructs.
19

20 **3.2.1. Power-based behaviours and reactive resilience strategies**

21
22 Our analysed data revealed collaborative practices, visibility, and flexibility as antecedents of
23 PSC resilience. For collaborative practices, PSC partners jointly investigated the causes of
24 disruptions and how best to tackle them. As a reactive capability, flexibility was identified in
25 suppliers and product forms from the analysed data. Product form flexibility entailed PSC
26 partners substituting prescribed products with suitable clinical alternatives. It required
27 administering a combination of strengths of a medicine to make up the correct dosage or
28 combining available products or different formulations for patients' treatment continuity. The
29 findings are consistent with existing studies (Fox et al., 2014; Iyengar et al., 2016). Supplier
30 flexibility strategies involved timeliness in sourcing alternative suppliers, which engaged 'short
31 liners' (limited specialist wholesalers) to meet patient demand. We also found that visibility in
32 the PSC involved dimensions of information sharing, including timing, quality and information
33 channels. Actors' ability to see through their PSC was sometimes powered by information
34 systems technology. Information-sharing strategies have been identified as SC visibility
35 features (Somapa et al., 2018).
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39 However, we found that PSC actors' power-based behaviours influenced these reactive
40 strategies' development. In these instances, PSC actors controlled the essential tenets of the SC
41 (product, information, and prices). These behaviours were mediated (an actor's conscious
42 effort). They could be seen emanating from the manufacturer, who determined the dynamics
43 of the relationships. Manufacturers from our respondents' sample explained that they controlled
44 the flow of medicines in the PSC by imposing quota systems and rationing. The aim was to
45 enhance the backup capability and ensure patient treatment continuity (operational
46 performance continuity) throughout the disruption. As provided in the statement below:
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48

49 *"There is a recent example where a manufacturer had a manufacturing*
50 *problem; we had limited supply and had to manage the supply of that*
51 *product carefully. We rationed the supply to zero, and we would only*
52 *supply a product if a pharmacy presented a genuine anonymised*
53 *script" ..MAN2*
54
55

56 *"It is a competition; they do not want to lose business. It is a reputational*
57 *thing. They do not want to panic the market to buy up all the available*
58 *stock. So, I guess it's about managing the market and releasing the*
59 *message at the right time." LSP1*
60

They argued that imposing the quota system prevented the sale of medicines stock abroad by some downstream PSC partners(parallel trade)(wholesalers and community pharmacists). It impacted the medicine supply within the country and their backup capabilities. The patient-facing PSC actors confirmed the existence of the quota systems. They complained about the consequences these had on their ability to plan/prepare for disruptions.

Another example of mediated power-based behaviour was the control of information by PSC actors. The data confirmed that PSC actors deliberately controlled the timing, type, and quality of information shared to protect their reputation and/or market share. For instance, a manufacturer explained that it took six weeks for their US partners to share news of regulatory issues. The manufacturing site had to shut down due to a failed FDA (Food and Drug Administration) inspection. Other manufacturers further explained that sharing timely information would result in patients switching treatments as General Practitioners (Doctors) had to cease prescribing. It implied disrupting service operations, revenue losses and financial performance. Controlling information is detrimental to building a resilient SC, as information sharing has increased resilience in PSC (Karmarker and Ahmed, 2020).

Information was also controlled to manage PSC actors' diverse reactions to supply chain disruptions. Interview responses revealed that some PSC actors engaged in panic buying and stockpiling alternative medicines to buffer stock when they received news of impending shortages. However, due to the complexity of the PSC, these activities had a domino effect on close substitutes, further disrupting the PSC (Papalexi et al., 2020). Thus, PSC actors control information flow in the PSC to avoid these outcomes. A discourse on medicine flow control among supply chain partners is provided in Table 1.

Table 1 Summary of excerpts on medicine flow

Information sharing is pertinent to building resilience (Colicchia et al., 2015). The absence of timely information increases opportunism and triggers poor demand signals, leading to dissatisfied partners and inadequate reactive capacities (Scholten and Schilder, 2015). Figure 4 summarises how power is displayed through information control, where energy flows from the manufacturers and regulatory bodies to secondary and primary care pharmacists. It was particularly demonstrated through hesitations to share timely and quality information. The statement below provides evidence:

"It was a difficult conversation to have, and some GPs said they would switch all their patients to alternative products". MAN1

"When people know about it is when you cannot buy it, and the word goes around, people say, oh that is something that we need. And people start panic buying".HOSP4

Figure 4. Control of Information Flow

Analysing the discourse and interactions between PSC actors in their decision-making process depicts varying power implications. We found that power-based behaviours benefitted firm-level resilience in a fragmented SC (Shi et al., 2013). However, the systemic nature of PSC resilience (where actors' actions influence other actors' decision-making process performance and profitability)(Vann Yaroson et al., 2021) produced non-linear outcomes. Hence, power-based behaviours using quotas or information control would affect the decision-making process of other PSC actors, as in Nakandala et al. (2020) study. They found that power-fuelled actions

1
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3 influenced the decisions of SC actors. Thus, the impact of power-based behaviours through a
4 CAS perspective is non-linear (Holland, 2006; de Sa et al., 2019), as the reaction of PSC
5 partners may produce undesired outcomes.
6

7 To this end, we proposed the following:
8

9 *H1a: Power-based behaviours significantly weaken reactive capabilities in the PSC*
10

11 **3.2.2. Power-based behaviours and proactive resilience strategies**

12 Our analysis revealed strategic alliances as the PSC's proactive capabilities. According to the
13 data, manufacturers have strategic alliances with downstream PSC actors (wholesalers and
14 pharmacists) where PSC partners share risks and information. These included borrowing
15 schemes, warehouses, and technological infrastructure sharing. For instance, a group
16 pharmacists representative explained that forming strategic alliances with their upstream SC
17 partners ensured continuity and enabled them to plan for a disruption. It was possible because
18 they had prior knowledge of impending SC issues, increased buying power and reliable demand
19 forecast. These alliances enhanced trust, increased goal alignment, provided buffering through
20 information sharing and enhanced decision-making capabilities. As evidenced in the statement
21 below:
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25 *"We work in partnership with the manufacturer; the manufacturer had*
26 *told us about the coming problems, so we sat down and worked out the*
27 *solution with them in advance".COMM2*
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31 Power-based behaviours may also foster PSC resilience in strategic alliances formed through
32 long-standing relationships where trust has been built over time (Nakandala et al., 2020). In
33 these instances, adverse outcomes are limited as the exhibition of power-based behaviours does
34 not require reactions from PSC actors. Power was considered balanced as PSC actors had
35 aligned goals and desired outcomes. Therefore, exhibiting power-based behaviours by PSC
36 actors may increase proactive strategies. Balanced power structures deliver positive effects,
37 especially in the PSC, often characterised by asymmetric relationships between manufacturers
38 and community/hospital pharmacists (de Jong and Benton, 2019). Accordingly, this study
39 proposed that:
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43 *H1b: Power-based behaviours significantly increase proactive capabilities in the PSC*
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45 **3.2.3. The moderating effect of PSC complexity on power-based behaviours and PSC** 46 **resilience**

47 The impact of power-based behaviours can be attributed to the PSC's complexity which
48 includes longer lead times, limited manufacturers, and stringent regulations (Heiskanen et al.,
49 2017; Acosta et al., 2019). The limited number of manufacturers places manufacturers in a
50 more powerful transactional dynamic where they can influence decision-making processes
51 (Benton and Maloni, 2005). Thus, in circumstances where there are limited manufacturers, the
52 exhibition of power-based behaviours limits the ability of PSC actors to plan for disruptions.
53 It becomes almost impossible to engage in flexible operations as there are no backup suppliers
54 or products for PSC actors to fall back on. The shortfall in adopting flexibility strategies in the
55 PSC included the reduced efficiency of substitute medicines and the 'domino effect' caused by
56 using close substitutes due to the nature of the PSC. The stringent regulations guiding
57 production and storage in the PSC also facilitate power-based behaviours and hinder resilience.
58 For instance, Vann Yaroson et al. (2021) showed that sharing information among PSC actors
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is an anti-competitive practice. PSC actors may withhold necessary information, impeding information sharing and visibility (Scholten and Schilder, 2015). Therefore, it is possible to suggest that the PSC's complexity negatively influences the impact of power-based behaviours on reactive strategies.

We, therefore, propose the following hypothesis:

H1c: PSC complexity moderates the relationship between power and reactive strategies such that PSC complexity negatively influences the effect of power on reactive strategy.

Some studies suggest a positive link between SC complexity and SC resilience. The argument is that dispersed SC networks, which drive complexity, enhance flexible operations that support resilience (Chowdhury et al., 2019). Therefore, complexity may support PSC if resources are shared to mitigate issues with longer lead times and storage and distribution capacities. To this end, we propose that

H1d: PSC complexity moderates the relationship between power and proactive strategies such that PSC complexity positively influences the effect of power on proactive strategies.

3.2.4. Partner dis (satisfaction) and resilience strategies

Our analysis identified that partner dissatisfaction in the PSC was caused by asymmetric relationships. It stemmed from goal misalignment, a lack of trust, and fairness. Incidences that required a PSC actor to impose quotas or scan prescription slips before products were supplied depicted power imbalances, asymmetric relationships, and general partner dissatisfaction. Power-based behaviours negatively influence the relationship between PSC actors, such as manufacturers and pharmacists (patient-facing) (de Jong and Benton, 2019; Fu et al., 2021). As a CAS, the interactions and decision-making processes between actors across various PSC levels may result in an uncondusive environment. It leads to dissatisfaction among partners (Wieland and Wallenburg, 2014). Therefore, using power-based behaviours supports the normative SC relationship tenets, which establish conflicts and the absence of trust. Accordingly, we propose that

H2: Power significantly increases partner dissatisfaction in the PSC

Similarly, dissatisfaction reduces the effect of resilience strategies. For instance, with the manufacturers' goal as profit, the NHS pursued the welfarist agenda and community pharmacists' service-oriented goal. It was particularly evident when other actors engaged in activities detrimental to each other's plan and could hamper their ability to prepare for disruptions. Thus, goal misalignment may weaken PSC resilience strategies by inhibiting collaborative practices (Kumar et al., 2020).

H3a: Partner dissatisfaction significantly weakens reactive capabilities in the PSC

H3b: Partner dissatisfaction significantly weakens proactive capabilities in the PSC

3.2.5. The relationship between proactive and reactive strategies

Although existing studies suggest proactive and reactive strategies as elements of SC resilience, the line between these two is blurred. For instance, the debate on the efficiency of collaborative practices as a proactive or reactive strategy is still ongoing. Some studies emphasised collaboration as a reactive strategy since it facilitates speedy information sharing (Jüttner and Maklan, 2011). Other studies have advocated for collaboration as a proactive strategy due to its capacity to build in slack resources and buffer stock (Wu et al., 2014; Cheng and Lu, 2017). Our findings suggest that increased proactive strategies through sharing of resources increased flexible operations and enhanced information sharing. Therefore, it may indicate that higher proactive strategies increase reactive strategies.

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3 *H4: Proactive capabilities positively increase reactive capabilities in the PSC*
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7 **3.3. Phase 2: Quantitative research-hypothesis testing**

8 The quantitative phase of this study was set up to address the second research question. The
9 research model was constructed based on a literature review and findings from the qualitative
10 phase of the study.
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13
14 Table 2 Profile of participants in the quantitative data collection phase
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16

17 **3.3.1. Survey instrument development and design**

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19 A two-step procedure involving (1) a literature review and (2) semi-structured interviews was
20 conducted to develop the instrument used in this phase. The questionnaire was piloted. Here,
21 ten experts conversant with the UK's PSC were invited to pre-assess the reliability and validity
22 of the instrument. Interviewees were asked to identify issues relating to questionnaire
23 formatting, wording, ambiguity, and contents. Based on the feedback from the experts,
24 redundant and ambiguous items were eliminated or modified, and new items were included
25 when necessary (Saunders et al., 2019). For member checking, reliability and validity, research
26 participants from the interview phase were invited to complete the questionnaire. They
27 represented the population to whom the questionnaire was targeted (Cunliffe, 2011).
28
29

30 Non-probability sampling was considered appropriate at this phase because it was pertinent to
31 identify respondents knowledgeable about the phenomenon being investigated to complete the
32 survey. Thus, snowball and purposive sampling were used to determine the sample size
33 (Saunders et al., 2019). It indicates that anyone identified as knowledgeable about the
34 investigated phenomenon was notified of the survey. The questionnaire items were sent via a
35 Web survey link. Since this study emphasised elements related to the PSC, the population that
36 met the participation criteria contained very few members who were challenging to access
37 (Saunders et al., 2019). A multi-channel approach via industry contacts and professional bodies
38 was adopted to assist recruitment. Several follow-up calls and emails were carried out to
39 increase the response rate.
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42 The measures for the survey design were from validated instruments of prior studies and
43 findings from the first phase of this study. This study mobilised four constructs: power, partner
44 dissatisfaction, reactive, and proactive strategies. A five-item scale was used to measure power
45 and was adapted from several studies (Kwon and Suh, 2004; Benton and Maloni, 2005). These
46 items measured mediated power through reputation, behavioural uncertainty, and price control,
47 as identified in the qualitative phase of this study. A four item-scale was used and adapted from
48 existing literature to measure partner dissatisfaction (Kwon and Suh, 2004; Benton and Maloni,
49 2005; Griffith and Zhao, 2015). This measured goal misalignment and partner dissatisfaction.
50 We measured PSC characteristics using a four-item scale adapted from Pettit et al. (2013).
51 Existing studies on SC resilience were used to develop item scales to measure PSC resilience
52 (Weiland and Wallenburg, 2013; Pettit et al., 2013). PSC resilience practices were measured
53 using reactive and proactive strategies. The measurement items used a seven-point Likert scale
54 (1 = not sure, 7 = strongly agree). A summary of item measurement is provided in Appendix
55 B.
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The data were gathered using online surveys from 106 respondents across the UK's PSC. It was pertinent that the respondents were crucial for the decision-making process in their organisation. Therefore, the respondents were from different firms across the UK's PSC. The demographic data showed that 54% of the respondents were secondary/hospital care pharmacists, 9% were manufacturers, 5% were pre-wholesalers/wholesalers, 28% were primary pharmacists, and 4% were regulatory bodies. The analysis of PSC experience highlighted that more than 70% of the respondents had over ten years of experience in this industry. A summary of the information is provided in Table 2.

A multi-phase approach was used to analyse the quantitative data using SPSS 25.0 and SmartPLS (v.3.2.6) (Dhir et al., 2021). Our initial data were cleaned, checked for missing data, and coded following the recommendations by Hair et al. (2019). The final dataset comprised 106 responses. Further analyses were conducted, which included testing for common method bias, cross-tabulation, and partial least square method (PLS: PLS-SEM). We also evaluated Common Method Bias (CMB) in this study using the full collinearity VIF criteria (Kock, 2017; Quieroz et al., 2022). Our results align with recommendations that accept VIF values ≤ 5 (see Appendix C). The CMB was tested further using Harmans' single-factor test (Harman, 1976; Fuller et al., 2016). The cumulative average variance was 27.5%, indicating the absence of common method bias.

3.3.2. Cross tabulation

It was pertinent at the quantitative stage of the research process to confirm the direction of power within the SC. Cross-tabulations were used to match the responses of SC actors to depict the interplay of power, satisfaction, and resilience strategies. The responses are provided in Appendix A. The findings show that power emanated from manufacturers. The highest frequency for resilience (proactive and reactive) strategies across PSC actors was also measured. The results are provided in Appendix B. We found that all PSC actors except primary care respondents agreed to the presence of flexibility and visibility in the PSC. It corroborates the qualitative findings, highlighting the difficulties in using reactive strategies; respondents disagreed with this statement. These findings confirm the qualitative phase of this research.

3.3.3. reliability and validation of measurement scales

Based on the guidelines from existing studies on SC resilience and power, the formative measurement model was chosen to measure PSC resilience and power. The reflective measurement model measured their antecedents (Wieland and Wallenburg, 2013; Gölgeci et al., 2018; Ivanov and Dolgui, 2020) (see Appendix 1). To validate our chosen position of formative and reflective elements, (i) item loadings and composite reliability, (ii) discriminant validity (AVE) and (iii) convergent validity were employed and are reported in Table 5. Therefore, SC resilience is modelled as a third-order hierarchical model of the measurement dimensions in this study.

This study's reliability constructs were established with all the outer loadings above the 0.60 thresholds. In contrast, the overall Cronbach alpha score and composite reliability exceeded the recommended 0.60 (Vaske et al., 2017). Likewise, all the constructs' convergent validity values were above the threshold of 0.60, suggesting that the model used in this study to measure the relationship between power and resilience strategies was a good fit.

Table 3: Reliability and Validation of Measurement scales

We used Fornell and Larcker's (1982) criterion to test for discriminant validity. It required that the AVE's square root for each construct be higher than its correlation with all other constructs to confirm the structural paths. Table 4 shows that these requirements were met. The values below 0.95 indicated that the items measured their intended constructs. It demonstrated distinctiveness and operationalisation.

Table 4. Estimation of the measurement model parameters

Diagonal elements (bold) are the square root of the variance shared between the constructs and their indicators (AVE). The quality of the structural model was also assessed and is presented in Table 5. Partner dissatisfaction was measured using four constructs with a significant R^2 (0.717 and 0.431). The six reactive and three proactive strategies are explained at 0.774 and 0.411, respectively. The Q^2 was also measured using Geisser's (1974) quality model measurements.

Table 5. Quality of the structural model.

3.3.4. Structural path analysis

The variance-based structural equation modelling: partial least square method (PLS: PLS-SEM), was employed to test our hypotheses. We used the PLS-SEM because it is a predictive approach that deals with complex models. PLS-SEM does not require the data to have prior assumptions and is suitable for studies with small sample sizes (Hair et al., 2019; Sarstedt et al., 2020). Similarly, our research goal was to achieve predictability. The sample size was 106, and the data emerged from an exploratory study. Thus, the data were analysed first by assessing the reliability and validity of the measurement model and then examining the structural model (Nitzl 2018). Meta-inferences were employed in this study, which are theoretical statements that offer holistic explanations of the research phenomenon using qualitative and quantitative findings (Venkatesh et al., 2016). This study used the PLS path coefficient with bootstrap resampling of 500 replications to examine the relationship among the variables and test the hypothesis.

Table 6 Hypothesis Testing

We tested our theoretical model and hypothesised relationships (Figure 2 and Figure 5) using SmartPLS. The results of the statistical data are presented in Table 6. The analysis revealed a significantly positive relationship between power and proactive strategies ($\beta = 0.764, p = 0.000$). Power has an insignificant effect on reactive strategies; thus, *H1b* is supported, and *H1a* is rejected. Our findings support *H2* ($\beta = 0.894, p = 0.000$), where power significantly increased partner dissatisfaction. The results for *H3a* are supported as partner dissatisfaction has a significant negative effect on proactive strategies ($\beta = -0.511$) ($p < 0.009$). The relationship between partner dissatisfaction and reactive strategies is positive and insignificant ($\beta = 0.003, p = 0.983$). We hypothesised that PSC complexity moderated the relationship between power and resilience strategies (*H1c and H1d*). The analysed data showed a negative and significant effect ($\beta = -0.099, p = 0.069$) on power and reactive strategies; hence *H1c* is supported. We, however, find a negative and insignificant effect of the interaction between power and proactive strategies (*H1d*). A visual representation of the interactions between

power, PSC complexities and reactive strategies are presented in Figure 6. *H4* is supported ($\beta = 0.624, p = 0.000$) as proactive strategies increased reactive strategies.

Figure 6 shows the moderating role of PSC in power-based behaviours and reactive strategies

4. Discussion and implications

Although the PSC is pivotal to the efficient functioning of healthcare systems, it is plagued with several disruptive activities, including medicine shortages (Kochan et al., 2018; Sabouhi et al., 2018). The proposition of resilience strategies to mitigate the impact of disruption may be limited due to PSC's complexities (Bastani et al., 2021). Therefore, this study explored the applicability of resilience strategies in the PSC and power's contribution to PSC resilience. Viewed through a CAS lens, several issues and implications have been identified.

The findings highlighted forms of resilience strategies, including flexibility, visibility collaboration and strategic alliances in line with existing studies (Busse et al. 2017). Also, PSC actors exhibited power-based behaviours (quota-based systems and information control) to ensure operational performance and business continuity. Power-based behaviours indicate negative connotations such as instigating conflict, creating dissatisfaction among actors and/or hindering collaborative practices, which is detrimental to SC resilience (Reimann and Ketchen, 2017). However, the impact of power-based behaviours on resilience was two-dimensional. First, power directly increased proactive strategies, which contrasts with existing studies that argued for the detrimental effects of power on SC performances (Lanier et al., 2019). Proactive strategies developed through strategic alliance by sharing resources, including risk expert knowledge, technology, and infrastructure, to form non-mediated power (Subramanian et al., 2018), which promotes mutual objectives. Our findings identify the need for strategic alliances through resource sharing to curtail the effects of negative power dynamics and build resilience in PSC.

Secondly, power-based behaviours decreased reactive strategies when PSC complexities moderated. Imposing quota/rationing systems on SC partners to control the profit flow or patients' treatment continuity denotes mediated power. PSC complexities include limited suppliers, longer lead times, complex production, and stringent regulation (Narayana et al., 2014; Bastani et al., 2021). The findings imply that engaging in flexible operations or forecasting or building backup capability to recover from disruption in the presence of quota systems (power-based behaviours) is almost impossible. It is due to limited substitutes and/or stringent regulations. Here, we argue that although flexible operations may be used in PSCs to recover from a disruption, they may be ineffective if power-based behaviours are exhibited. Thus, flexible operations are a short-term solution but do not offer long-term PSC resilience capabilities (Fayezi et al., 2017). Also, it may be impossible to seek backup suppliers as this may be costly or, in most cases, unavailable, defeating the aim of resilience. Thus, through the exhibition of power by influential PSC firms through limiting or granting access to resources (Reimann and Ketchen, 2017), other PSC actors could not employ reactive strategies to build resilience. We advance the current knowledge on PSC resilience as it provides a holistic insight into SC power and PSC resilience. It demonstrates how the decision made by one PSC actor affects another.

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3 Grounded in CAS theory and extending the existing literature, our study provides a novel and
4 practical understanding of PSC resilience. We develop a research model that explores the
5 operational conditions in which power-based behaviours enhance PSC resilience. We
6 document the circumstances through which power affects the different forms of PSC resilience
7 which is direct to proactive strategies and moderated by PSC complexity for reactive strategies.
8 Therefore, we extend CAS theory by exploring the moderating effect of complex features of
9 the PSC and its interactions in building resilience. It feeds into the interconnectedness of PSC
10 actors' decision-making processes in response to disruptions. It supports and extends the
11 general tenets of the CAS theory by identifying the role of power-based behaviours in the
12 decision-making process (Day, 2014; Tukamuhabwa et al., 2017). The findings demonstrate
13 the potential for explaining the intricacies of power's contribution to building resilience at
14 various stages in the PSC. As opposed to the conventional assumption of the direct impact of
15 PSC resilience, a systemic approach to understanding PSC resilience through the mediating
16 interaction of PSC complexity offers a novel contribution.
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20 Confirming a direct relationship between power-based behaviour and partner dissatisfaction
21 extends existing studies with similar findings (Benton and Maloni, 2005). The negative
22 relationship between partner dissatisfaction and proactive strategies implies that some PSC
23 firms engaged in strategic alliances may be insufficiently specialised. They may also be forced
24 into alliances for survival. These may create power imbalances and lead to partner
25 dissatisfaction. Mesic et al. (2018) explain that power imbalances produce unsuitable
26 cooperative partnerships, negatively impacting the weaker partners losing interest in the
27 relationships. Research on why and how SC firm partnerships transform trust and conflict to
28 achieve cooperation and resilience is limited. Our study suggests that the power exhibited may
29 not directly impact relational issues. However, proactive strategies, including resource sharing,
30 may be hindered when partner dissatisfaction is high. Therefore, it is vital to assess PSC actors'
31 satisfaction with strategic alliances to propel the efficacy of proactive strategies.
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35 **4.1. Theoretical implications**

36 We provide a mixed-method approach to discussing pertinent SC resilience issues. There is a
37 dearth of studies examining power-based behaviours and resilience, especially in a specialised
38 SC that is supplier-led (Wagner and Bode, 2006). Our study addresses this by providing
39 empirical evidence of the interaction between power, resilience, and PSC complexity. The
40 qualitative phase permits us to explore the forms of resilience strategies used in PSC. The
41 quantitative phase confirms the existence of these forms of resilience. It helps us identify the
42 relationship between our identified variables.
43
44

45 A new discourse on SC power's contribution to building resilience is opened. Existing studies
46 have examined power as a relational concept that hampers SC effectiveness (Ireland and Webb,
47 2007; Badara et al., 2017). Our findings suggest that through resource sharing and strategic
48 alliances, power has a positive impact on proactive strategies. However, the effect may be
49 hampered by partner dissatisfaction.
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51 In addition, we explicitly examined the moderating effect of PSC complexities in examining
52 the influence of power on resilience strategies. Our analysis revealed that PSC complexity
53 negatively moderated the link between power-based behaviours and reactive approaches. Thus
54 the exhibition of power-based behaviours inhibits reactive strategies in specialised SCs with
55 peculiar complexities such as limited suppliers, complex production, longer lead times, and
56 stringent regulations.
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59 In studying PSC resilience, however, power asymmetry relationships may be altered as
60 collaboration is pertinent to managing the impacts of disruptions. The complex and non-linear

nature of PSC resilience is often the outcome of collaborative practices, resulting in the exhibition of power among SC partners. Thus, understanding PSC resilience and power dynamics would be better addressed from a holistic and complex adaptive system perspective.

4.2. Practical implications

This study provides several managerial implications. First, our findings show that due to the nature of the PSC, the exhibition of mediated power is detrimental to reactive strategies such as flexible performance and joint decision-making. These findings suggest that the PSC characteristics significantly propel the impact of the reactive strategy. An in-depth understanding of the PSC is essential when making strategic decisions in the PSC. Our results suggest that non-mediated power-based behaviours depicted through strategic alliances and resource sharing may enhance proactive strategies. Managers, therefore, may need to be cautious when employing power-based behaviours to influence partners' outcomes as they may have both negative and positive impacts. They need to understand the relational transactions between PSC partners. Thus, PSC decision-makers are encouraged to undertake bespoke training to fully appreciate the PSC's complexities. They can also understand how the interactions with power-based decisions such as quota systems inhibit supply chain resilience. The transparency of decision-making by stakeholders at critical points in the PSC and associated power dynamics can inform the co-creation of training content with partners. Such activity is recommended and would be considered good practice. It is particularly relevant in promoting healthcare operations.

The positive and significant relationship between reactive and proactive strategies suggests that enhanced proactive strategies may facilitate reactive ones. Managers may use these findings to foster strategic partnerships, enhance operational practice and thus improve the reactive capabilities of the PSC. We also identify power-based behaviours that contribute to fuelling partner (dis)satisfaction which may indirectly inhibit proactive strategies. Our findings support firms regarding the conditions of their decisions and the effect after that. Considerations, therefore, should be to ensure partner satisfaction when making decisions, as this is critical to developing resilience in the PSC. From a practical perspective, the output of this study can be considered during tendering exercises, vendor appraisal activities and contract renewals.

5. Conclusion, limitations, and further research directions

Extant literature advocates for a systemic approach to SC resilience. Here, the actions and interactions of SC actors influence the decision-making process of other actors. Due to the competitive and confidential nature of the PSC, it can be challenging to engage stakeholders. Thus, studies that examine resilience in the PSC, considering its complexities, are limited. This paper first explored the forms of resilience strategies used in PSC. It examined the role of power-based behaviours in building PSC resilience strategies in the UK using a two-phased mixed-methods approach. The first phase involved conducting semi-structured interviews with 23 responding organisations across the various levels in the PSC. The analysis identified proactive and reactive strategies as forms of PSC resilience influenced by power-based behaviours. The complex interactions and reactions of PSC actors, coupled with the nature of the PSC, produced non-linear effects of resilience strategies in the presence of power-based behaviours. Power-based behaviours, therefore, reduced the effectiveness of reactive strategies due to the PSC's complexities but facilitated proactive strategies. We also found that power-based behaviours increased partner dissatisfaction and proactive and reactive strategies. The quantitative phase of the study confirmed our assertions. Our findings suggest that a systemic

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3 approach to understanding the role of power-based behaviours in PSC resilience offers both
4 negative and positive outcomes.
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6 There are some limitations to this study which can be used as avenues for further research.
7 First, our study was exploratory and investigated the UK PSC. Therefore, future studies should
8 explore other countries that might provide data regarding similarities or differences and other
9 contextual partners that have been omitted in this study. The study did not examine the
10 underlying power sources from various vantage points. For instance, it would have been
11 desirable to investigate power-based behaviours and resilience strategies for specific medicines
12 within the PSC, like orphan drugs. Future studies should consider testing the feasibility of
13 these, including training recommendations.
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16 Secondly, our data were collected at a particular point in time. Thus, conducting a longitudinal
17 study on the interactions between power, partner satisfaction, PSC complexity, and PSC
18 resilience may provide more insight into developing resilience strategies in the PSC. Also, the
19 study assumed that the PSC was linear and focused on critical partners: manufacturers,
20 wholesalers, primary care, secondary care, and regulatory bodies, to gather valuable insights.
21 It may limit the perspective of the interrelatedness within the PSC.
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24 Finally, we recognise the imbalance of the upstream and downstream participants at the
25 quantitative phase of the study. However, a systemic approach to studying PSC resilience was
26 adopted. It stemmed from the limited access to manufacturers. We would have preferred to
27 have more manufacturer participation, but despite our recruitment efforts, this was not possible.
28 Recruitment challenges stemmed from the timing of the data collection (mid-2018) and
29 competition in the pharmaceutical sector. Thus, our participants' ratio of manufacturers to
30 pharmacists may have biased the results. The limited access to manufacturers also made it
31 challenging to create a fully inclusive training package required to mitigate power-based
32 behaviours. It would be preferable if future studies strike more balance in the sample
33 composition and seek more engagement from manufacturers as actors in the PSC.
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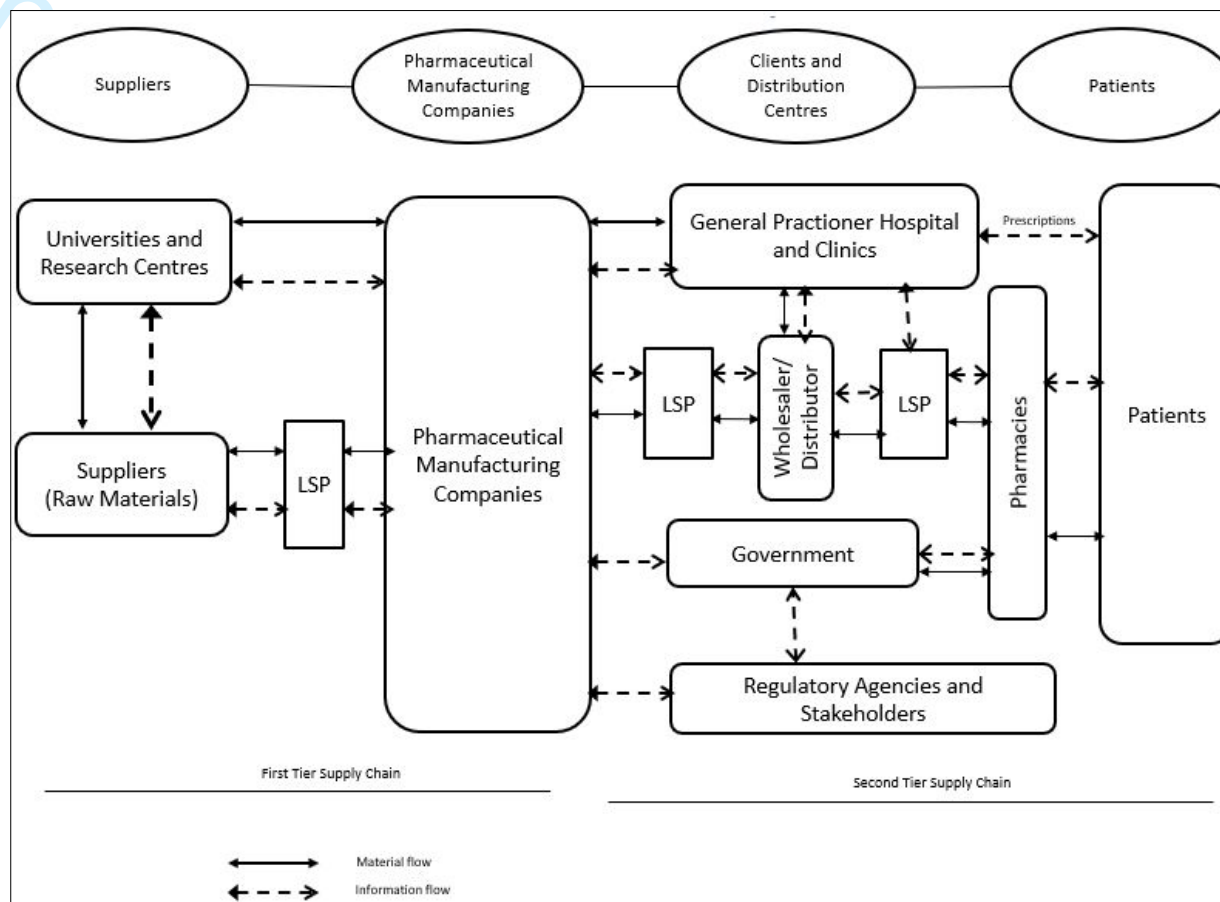


Figure 1. The Pharmaceutical Supply Chain

Source: Adapted from Evans and Gruber (2014)
*LSP: - Logistic Service Provider

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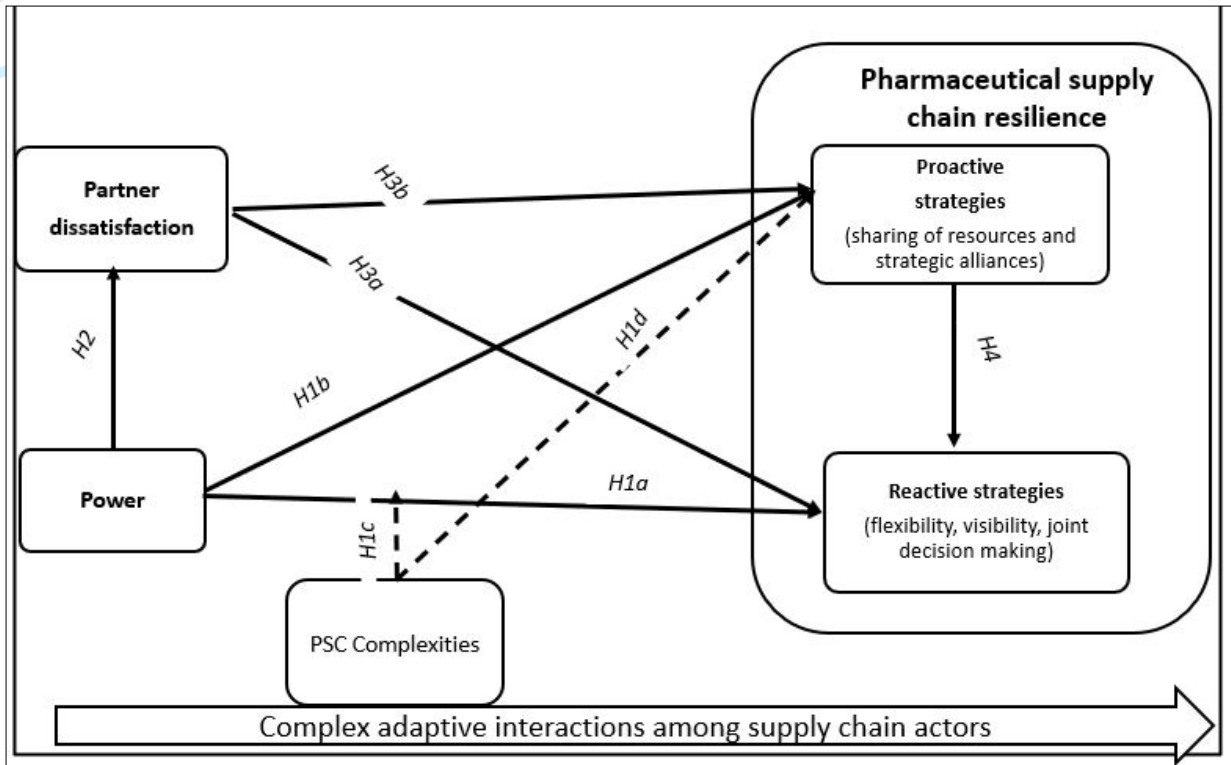


Figure 2. Conceptual framework on the role of power in PSC resilience

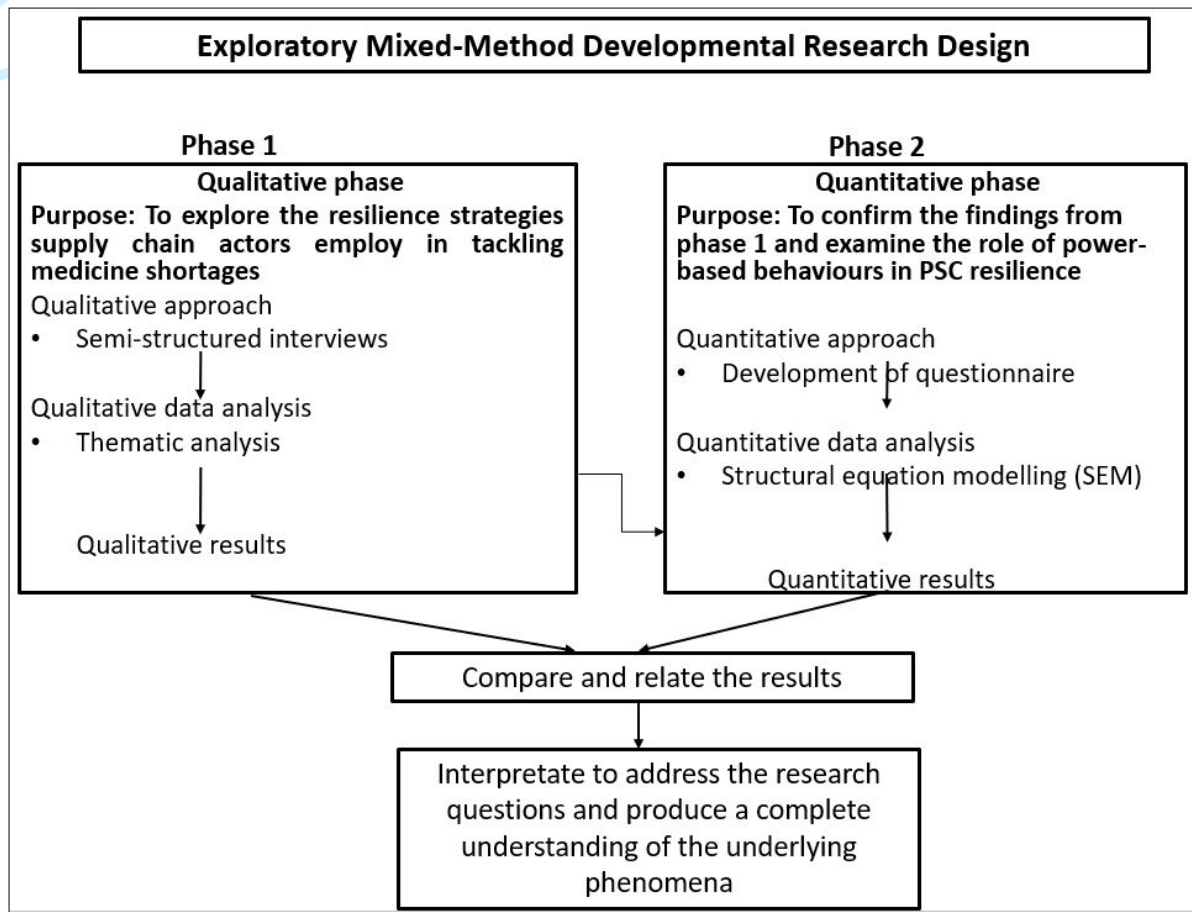


Figure 3 The Sequence of Activities of this Research Process
 Source: Adapted from Creswell and Plano-Clark, (2017)

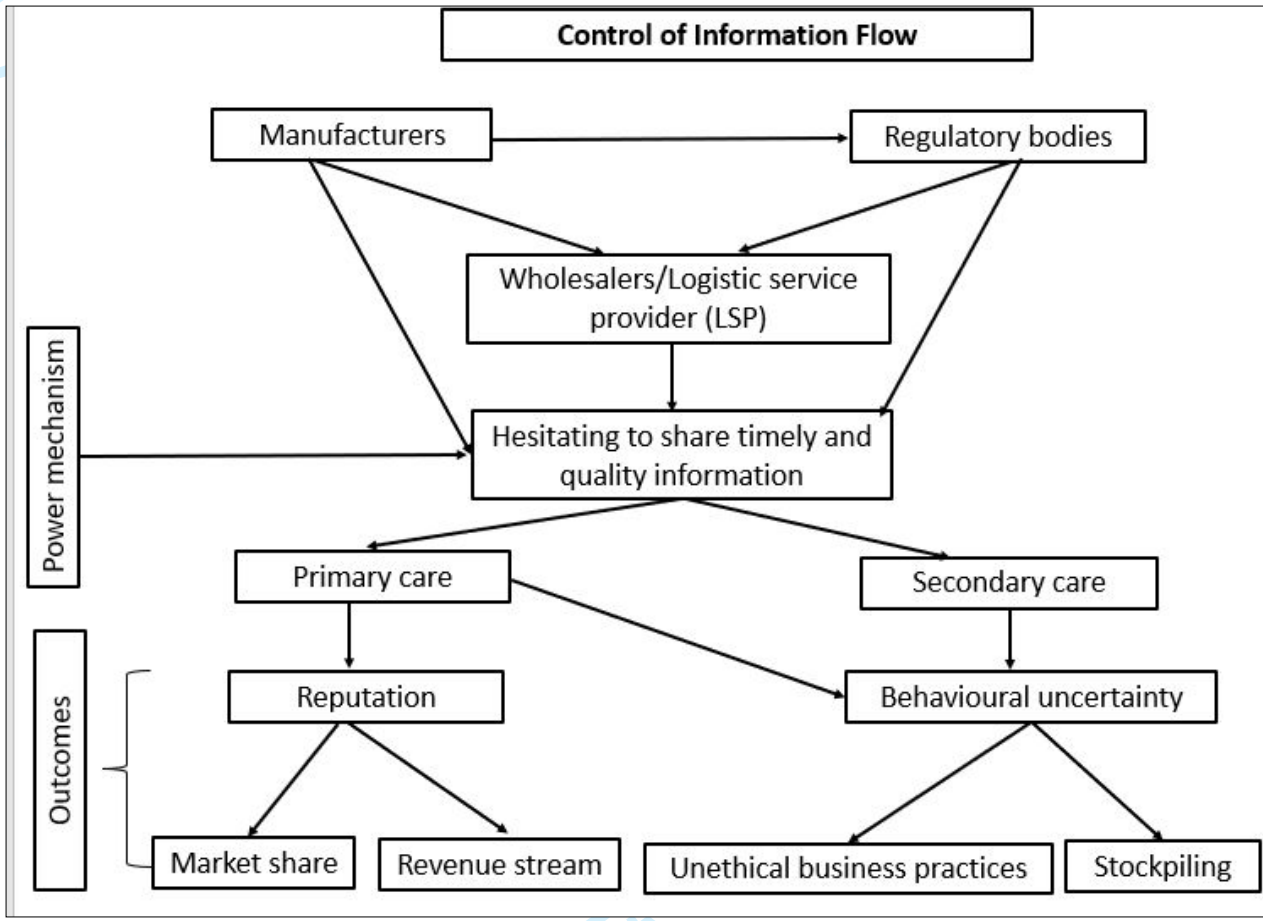


Figure 4. Control of Information Flow

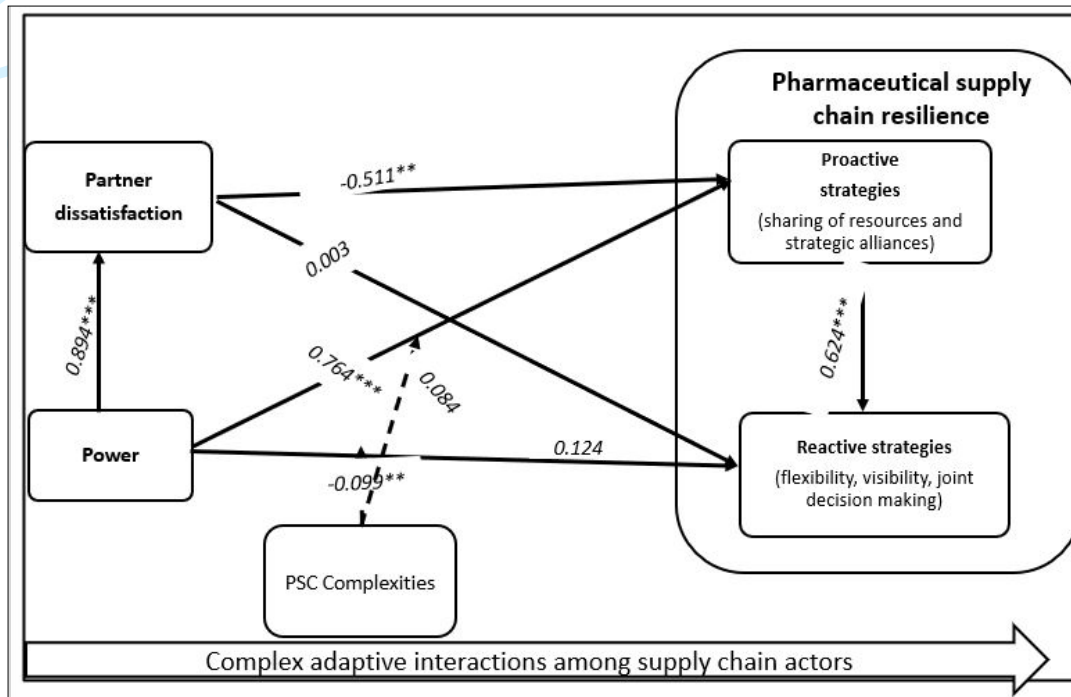


Figure 5 - Indicators

Notes: *, ** and *** denote significance at $\alpha = 0.05$, $\alpha = 0.01$ and $\alpha = 0.001$, respectively

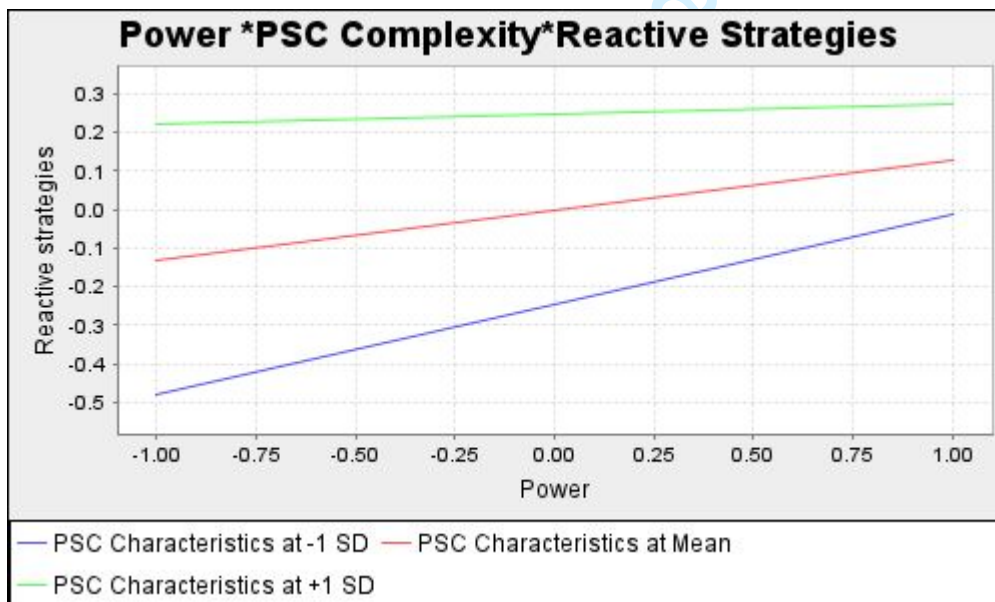


Figure 6 the moderating role of PSC in power-based behaviours and reactive strategies

Appendix A: Cross tabulation results
 Appendix D Interview guide

Pharmaceutical Supply Chain

Section One

Date and time of interview

Name of Interviewee and Company

Type of Company

Area of responsibility

Years of experience on the Job

Kindly provide a brief description of your supply chain position in terms of information and material flow.

Section Two

Supply Chain Disruptions

1. Could you describe a time when your firm faced a delay in the supply of its goods to consumers? How long did the delay last? Why do you think it lasted if it did?
1. How quickly did your firm discover this disruption or the event that may have triggered the disruption? Are there metrics available to detect early warning signals of a disruptive event?
1. How quickly does your firm assess the impact of the disruption when disruption is discovered? How does your firm efficiently assess what areas of the supply chain may be affected?
1. What kind of barriers to an effective disruption recovery does your firm face?
1. How would you describe the impact of Brexit on medicines supply?
1. How would you describe the impact of FMD on medicines supply?

Section Three

Supply Chain Vulnerabilities

1. Could you explain the major features of the products you supply to your consumers, and do you think any of these features amplify the effect of a disruptive activity?
1. How would you describe your supply chain? Do you think any of these features amplify the impact of disruptive activities?
1. Could you describe the role of your suppliers in the event of a disruptive activity? Do they have a role and if so, what do they do now?
1. How would you describe the effect of your managerial decisions on the supply chain in the face of a disruption?

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1. How would you describe the role of regulatory bodies in the supply of your goods to consumers?

Section Four

Supply Chain Resilience

1. Could you explain the type of strategies your firm employs when preparing and responding to a disruption?
1. What type of resources and process enablers are available to the firm to withstand the impact of a disruptive event?
1. How would you describe the effect these strategies have on reducing the impact of a disruption? How would you describe your firm's competitive position with respect to the adoption of these strategies?
1. How would you describe the process involved in getting information from the various stakeholders in the supply chain?
1. What type of activities are in place that foster sharing of information between other firms of the supply chain?
1. How would you describe your ability to source for goods on demand when faced with a disruptive activity? Are there readily available suppliers? What kind of hindrances do you encounter?
1. How can the pharmaceutical supply chain be better prepared for a disruptive activity?

Table 1 Summary of excerpts on product flow

SC partners (Manufacturers/Regulatory body/Logistics service provider (LSP))	SC partners (Community/Hospital pharmacists)
<i>'We introduce quotas because if pharmacists are selling a product to a competitor in Germany, the pharmacists take the profit and not the manufacturer' (MAN2).</i>	<i>'We have the quotas system imposed by the sole suppliers because of people like Pfizer and Glaxo amongst others; all like to impose quotas.' (COMM2)</i>
<i>'If we believe that our partners are either stockpiling the drugs or selling the drugs abroad for profit, we ration these allocations to zero until we have received scanned copies of anonymised patients prescription' (LSP1)</i>	<i>'Quotas are difficult because it makes it quite difficult to predict because you think you are doing the right thing' ... It is my belief that manufacturers are using the quota system to control (COMM1).</i>
<i>"If we have low stock, the first strategy is to investigate if we don't think we can react in time to bring in additional stock, we would need to put in allocation for the stock to ensure that all of our stock doesn't go to one consumer or a few consumers and make sure that we adopt everybody". (MAN3)</i>	<i>Scanning anonymised patients prescription is adding to extra workload and makes managing patients cumbersome as patients will only receive their medications after manufacturers have received scanned copies prescriptions. Sometimes we are not guaranteed the medicines' (GP).</i>
<i>'If the prescriptions are a long-term treatment, for example, where the patient had to pick up three months of a six months' worth of prescription, then the drug would be monitored to ensure that all the stock did not go to a single patient'. (MAN4)</i>	<i>"Oh, there are also disruptions which I think is almost artificial disruption around SC shortages are things around quotas within the marketplace.... This makes it difficult to pre plan and manage shortages". (COMM3)</i>

*Manufacturer -MAN, logistic service provider -LSP, community pharmacists -COMM, pharmacist at a GP practice -GP

Table 2 Profile of participants at the quantitative data collection phase

Respondents' Features	Category	Number of Responses	Frequency in Percentages (%)
Supply Chain Actors	Manufacturers	10	9.4
	Pre-Wholesaler/Wholesaler	5	4.7
	Secondary Care/Hospital Pharmacists	57	53.8
	Primary Care/Community Pharmacists	30	28.3
	Regulatory Bodies	4	3.8
Years of Experience	1-10 years	25	23.6
	11-20 years	28	26.4
	21-30 years	34	32.1
	31 and above	19	17.9

Table 3 Assessment of measurement model

Construct	Items	Loadings	Cronbach's Alpha (α)	Composite Reliability	AVE
Power			0.881	0.914	0.681
PW1	We do not have confidence in our SC partners actions	0.870			
PW2	Our supply chain partners encounter significant disruptions	0.755			
PW3	Our SC partners prevent us from doing what we want to do	0.805			
PW4	Our business supply chain partners do not exchange timely information	0.916			
PW5	Information regarding product pricing is not readily available within our SC	0.768			
Partner Dissatisfaction			0.908	0.936	0.785
SCPS1	We do not trust our supply chain partners	0.908			
SCPS2	Our supply chain partners do not understand the market demand	0.915			

SCPS3	Generally, we are not satisfied with our overall relationships with our suppliers	0.862			
SCPS4	There is no feeling of fairness with our supply chain partners	0.859			
PSC Complexity			0.822	0.878	0.643
PRC1	We depend on the use of regulated or restricted materials	0.841			
PRC2	Production of our products is very complex	0.705			
PRC3	Our products require strict storage or handling controls to maintain their purity and/or integrity which may cause delay	0.839			
PRC4	Regulation on pricing and reimbursement complicates transactions	0.815			
Reactive Strategies			0.852	0.920	0.659
SCR1	There is access to alternative supply chain partners	0.798			
SCR2	There is access to alternative products	0.818			
SCR3	We have access to tracking information throughout the SC	0.864			
SCR4	We have access to tracking materials throughout the supply chain	0.787			
SCR5	We have joint decisions with our SC partners when working on solutions	0.848			
SCR6	Joint employee training with other supply chain partners	0.750			
Proactive Strategies			0.852	0.910	0.770
RS1	Our SC partners share their resources with us	0.885			
RS2	We share resources with our SC partners	0.892			
RS3	We share resources internally	0.856			

Table 4. Estimation of the measurement model parameters

Constructs	PSC Complexity	Partner dissatisfaction	Power	Power * PSC Complexity* Reactive Strategies	Proactive strategies	Reactive strategies
PSC Complexity	0.802					
Partner dissatisfaction	0.385	0.886				
Power	0.503	0.894	0.825			
Power *PSC Complexity*Reactive Strategies	-0.061	-0.201	-0.265	1		
Proactive strategies	0.549	0.327	0.51	-0.203	0.878	
Reactive strategies	0.658	0.438	0.598	-0.275	0.838	0.812

Diagonal elements (bold) are the square root of the variance shared between the constructs and their indicators (AVE). Below the diagonal elements are the correlations between the construct's values.

Table 5. Quality of the structural model.

Constructs	R ²	Q ²
Power	0	0
Partner dissatisfaction	0.797	0.622
Reactive strategies	0.774	0.500
Proactive strategies	0.411	0.309

Table 6 Hypothesis testing

Path Analysis	β	T Stats	P Values	Remarks
Power -> Reactive strategies	0.124	0.752	0.452	H1a Not supported
Power -> Proactive strategies	0.764	3.945	0.000***	H1b Supported
Power *PSC Complexity*Reactive Strategies	-0.099	1.824	0.069*	H1c Supported
Power*PSC Complexity*Proactive strategies -	0.084	0.859	0.391	H1d Not supported
Power -> Partner dissatisfaction	0.894	44.76	0.000***	H2 Supported
Partner dissatisfaction -> Proactive strategies	-0.511	2.642	0.009***	H3a Supported
Partner dissatisfaction -> Reactive strategies	0.003	0.046	0.983	H3b Not supported
Proactive strategies -> Reactive strategies	0.624	6.620	0.000***	H4 Supported

Significance ***p < .01, **p < .05, *p < .10.

Appendix A Responses for the presence of power across SC actors

Variables	Statements	Agree	Disagree	Neutral
PW1	We do not have confidence in our SC partners actions	Primary care Secondary care	Manufacturers Regulators Wholesalers	
PW2	Our SC partners encounter significant disruptions frequently	Primary care Secondary care	Manufacturers Wholesalers	Regulators
PW3	We do not agree with SC partners on critical issues like the distribution of our products	Primary care	Wholesalers	Manufacturers Wholesalers Secondary care
PW4	Our SC partners prevent us from doing what we want to do	Primary care Secondary care	Wholesalers Manufacturers	Regulators
PW5	Information regarding products is not readily available within our SC	Manufacturers Wholesalers Primary care Secondary care	Regulators	

Appendix B Responses for resilience in the PSC

Variables	Statements	Agree	Disagree	Neutral
SCR1	There is access to alternative SC partners	Manufacturers Wholesalers Regulators Primary care Secondary care		
SCR2	There is access to alternative products	Manufacturers Wholesalers Regulators Primary care Secondary care		
SCR3	We have access to tracking information throughout the SC	Manufacturers Wholesalers Regulators Primary care Secondary care		
SCR4	We have joint decisions with our SC partners when working out solutions	Manufacturers Wholesalers Regulators Secondary care		Primary care
SCR5	We have joint decisions with our SC partners when working solutions	Manufacturers Wholesalers Regulators Primary care Secondary care		
SCR6	Joint employee training with other supply chain partners	Manufacturers Wholesalers Regulators Primary care Secondary care		
RS1	Our SC partners share their resources with us	Manufacturers Wholesalers Regulators Primary care Secondary care		
RS2	We share resources with our SC partners	Manufacturers Regulators Secondary care	Primary care	Wholesaler
RS3	We share resources internally	Manufacturers Wholesalers Regulators Primary care Secondary care		

Appendix C

Variance Inflation Factor

Variables	VIF
PRC2	1.936

1		
2		
3	PRC4	1.550
4	PRC8	1.441
5	PW1	3.392
6	PW2	1.636
7	PW3	2.195
8	PW4	4.287
9	PW5	1.924
10	PW6	1.487
11	RS1	2.241
12	RS2	2.018
13	RS3	2.054
14	SCPS1	3.323
15	SCPS2	3.564
16	SCPS3	2.433
17	SCPS4	2.468
18	SCR1	2.546
19	SCR2	2.960
20	SCR3	3.122
21	SCR4	2.397
22	SCR5	2.945
23	SCR6	2.454
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