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CRISIS MANAGEMENT AND CROSS-SECTORAL COLLABORATION AMONG PHARMACEUTICAL SUPPLY CHAIN STAKEHOLDERS DURING THE COVID-19 PANDEMIC

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ACADEMIC DISSERTATION

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ABSTRACT

Over the past few years, the global coronavirus disease (COVID-19) pandemic has created numerous challenges for societies, such as medicine and vaccine shortages compromising medical care and leading to severe health risks. Although pharmaceutical supply chain stakeholders have played a central role in the pandemic response, there is a lack of crisis management theory-based empirical research on this topic. Considering the vulnerabilities of the pharmaceutical supply chain and its importance to the functioning of healthcare systems and to patients' lives, there is a need for empirical studies shedding light on crisis management in this specific field. The present study aims to fill this gap in the Finnish context. The main objectives were to describe and explore crisis management among pharmaceutical supply chain stakeholders on organisational and cross-sector levels and identify areas for development to improve future crisis preparedness. Theories of organisational crisis management (I, II, III) and collaborative crisis management (IV) provided the theoretical framework for the study.

Data were collected in two phases. A cross-sectional survey served as the main data source in Studies I, II and III. It was developed based on the crisis management process models and sent to Finnish community pharmacy owners (n = 602, I), hospital pharmacy heads (n = 21, II) and managing directors of the pharmaceutical industry and wholesale (n = 73, III) during the pandemic's second wave in October–November 2020. Descriptive statistics were calculated (I, II, III), and logistic regression analysis was performed (I) to explore the effects of the crisis management efforts. Open-field responses were analysed qualitatively using deductive content analysis (I, II, III). Semi-structured interviews provided the main data source in Study IV and data triangulation in Studies II and III. Purposefully selected leaders and specialists from the pharmaceutical industry and wholesale (n = 9), community pharmacy owners (n = 9), hospital pharmacy heads (n = 6), government agency directors and officials (n = 5) and advocacy organisation representatives (n = 2) were interviewed in individual (n = 29) and paired (n = 2) interviews during March–May 2021. Interview transcripts were analysed qualitatively using inductive content analysis.

The theoretical contributions of Studies I–III included adding novel contexts to the empirical crisis management process research. The studies also provided a methodological contribution: By applying crisis management process models for survey development, they presented a new approach to data collection. In addition, Study II introduced another methodological contribution by employing a statistical data analysis method for investigating potential benefits of crisis management efforts. Overall, 221 (37%, I) community pharmacy owners, 12 (57%, II) hospital pharmacy heads and 20 (27%, III) leaders from the pharmaceutical industry and wholesale responded

to the questionnaire. Organisational preparedness improved concurrently with the pandemic response (I, II, III). Crisis decision-making relied mainly on teams (III) and shared decision-making (I, II), while dispersion existed. Community pharmacies were at the frontline of the pandemic experiencing hoarding and concerned patients (I). Their actions focused on outpatient care with novel solutions to maintain services. Shared decision-making protected pharmacies' finances (p = 0.040) and their owners' resilience (p = 0.025). Additionally, collaboration and communication with peers and stakeholders in the pharmaceutical supply chain protected pharmacy owners' resilience (p = 0.015). Hospital pharmacies' focus was on ensuring inpatient care by identifying critical medicines and their alternatives for infection, lung and/or intensive care units and by adjusting various operations (II). Their role in organising ultra cold vaccine storage and logistics was significant. The pharmaceutical industry and wholesale focused on responding to hoarding and stocking and preventing medicine shortages with increased monitoring of storage levels and collaboration with supply chain stakeholders (III). Innovative vaccines were developed as a solution to the pandemic. The respondents identified challenges related to anticipation and response to hoarding and stocking (I, III), medicine shortages (I, II), information sharing, coordination and collaboration (I, II, III).

Theoretical contributions of Study IV included building a new process model of organising for collaborative crisis management, adding knowledge about private third sector collaboration and issue-specific groups to the collaborative crisis management literature and extending this research field to a new context. The main findings described the organisation of cross-sector collaboration and its influence on the crisis management effectiveness. Without a predefined crisis management organisation, cross-sector collaboration was organised based on previous collaboration structures, channels and relationships and through the establishment of issue-specific groups by government agencies as per legal mandates. The third sector organisations were important collaborative partners for the private and public sectors. Cross-sector collaboration was necessary for coordinating crisis management efforts. Sharing knowledge, resources and problem-solving increased the effectiveness of crisis management.

Pharmaceutical supply chain's crisis preparedness could be improved with cross-sectoral crisis planning and simulations focusing on common issues. Organising around common (non-crisis-related) incentives during ordinary times enables better coordination and information sharing in collaborative crisis response. Decision-making in teams or, at community pharmacies, by two or more colleagues and existing data management systems enable rational decision-making during crises. Furthermore, developing prerequisites for cross-sectoral coordination and information sharing and preparing strategies to balance supply-demand issues would improve preparedness for future crises. Future research employing longitudinal and multi-perspective methods are needed to widen and deepen the study's results.

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Satu

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications, which are referred to in the text by their Roman numerals (I–IV):

I Latonen S, Neuvonen E, Juppo AM, Seeck H, Airaksinen M. Crisis management in community pharmacies during a pandemic. Research in Social and Administrative Pharmacy. 2024; 20(9):940-948. doi: https://doi.org/10.1016/j.sapharm.2024.06.010. *(Open Access)*

II Latonen S, Juppo AM, Seeck H, Airaksinen M. Crisis management in hospital pharmacies during the COVID-19 pandemic. *(submitted revision)*

III Latonen S, Pussila S, Seeck H, Airaksinen M, Juppo AM. Crisis management in the pharmaceutical industry during the COVID-19 pandemic. *(under review)*

IV Latonen SH, Suominen RM, Juppo AM, Airaksinen M, Seeck H. Organisation of cross-sector collaboration and its influence on crisis management effectiveness among pharmaceutical supply chain stakeholders during the COVID-19 pandemic. Public Health. 2023; 222:196-204. doi: https://doi.org/10.1016/j.puhe.2023.06.042. *(Open Access)*

ABBREVIATIONS

AFP	Association of Finnish Pharmacies
AI	Artificial Intelligence
API	Active Pharmaceutical Ingredient
COVID-19	Coronavirus disease 2019
ECDC	European Centre for Disease Prevention and Control
EMA	European Medicines Agency
ERP	Enterprise Resource Planning
FIMEA	Finnish Medicines Agency
FDA	Food and Drug Administration, USA
FIP	International Pharmaceutical Federation
GMP	Good Manufacturing Practise
ICS	Incident Command System
KELA	The Social Insurance Institution of Finland
MHRA	Medicines and Healthcare Products Regulator Agency, United Kingdom
NESA	The National Emergency Supply Agency, Finland
OTC	Over-the-counter
PIF	Pharma Industry Finland
PPE	Personal protective equipment
SARS	Severe acute respiratory syndrome
STM	The Ministry of Social Affairs and Health, Finland
THL	The National Institute for Health and Welfare, Finland
WHO	World Health Organization

e.g.	exempli gratia
etc.	et cetera
i.e.	id est
n/a	not applicable

1 INTRODUCTION

The global COVID-19 (coronavirus disease 2019) pandemic has affected widely public health, societies, economies and lives of people (Thielsch et al., 2020). The early phases of the pandemic were devastating without curative medicines and preventative vaccines against COVID-19. Stockouts of medicines were prevalent, as hoarding and stocking at pharmacies and hospitals challenged pharmaceutical supply (Gregory & Austin, 2020; Schumacher et al., 2023). Pharmaceutical supply chains around the globe suffered from demand fluctuations, manufacturing capacity issues and distribution problems already before, but these issues were further exacerbated during the pandemic (Socal et al., 2021). Preventing and managing medicine and vaccine shortages is vital for public health because disruptions in medical care may lead to severe health risks (Fox & McLaughlin, 2018).

Pharmaceutical manufacturing and supply are highly interdependent, and many vulnerabilities have been detected (Chowdhury et al., 2021; Heiskanen et al., 2017; Juhola, 2017). Dependence on foreign manufacturing, limited number of manufacturing companies and long or complex production chains increase the risk of disruptions (Heiskanen et al., 2017). Limited numbers of manufacturing sites for certain active pharmaceutical ingredients (APIs), pharmaceutical excipients and product components are global challenges (Heiskanen et al., 2017; Juhola, 2017). Extensive manufacturing disruptions may lead to interruptions affecting widely in many countries. National lockdowns and the border closures in China and India, two of the largest API manufacturing countries, posed delays in the medicine supply chain during the pandemic (Chowdhury et al., 2021). In addition, pharmaceutical supply chain logistics heavily depend on information systems and software, which are vulnerable to cyber-attacks, power outages or system failures (Juhola, 2017).

The availability of medicines and vaccines rely on pharmaceutical supply chain stakeholders, including pharmaceutical industry and wholesalers, community and hospital pharmacies and government agencies, each playing a specific role. This kind of cross-sector setting requires crisis management strategies and responses on both organisational and cross-sector levels (Ansell et al., 2010; Simo & Bies, 2007; Waugh & Streib, 2006). Coordination between stakeholders is often necessary in crises that cut across organisational borders (Boin & ’t Hart, 2010). Recent studies have further shown that the preparedness of information infrastructures and coordination among the stakeholders during disasters can help the pharmaceutical supply chain preserve its resilience and act more effectively (Bastani et al., 2023; Bø et al., 2023; Faggioni et al., 2023). Collaboration between stakeholders increases the agility and flexibility of the supply chain’s crisis response (Faggioni et al., 2023).

When this thesis was commenced in 2020, the pharmaceutical supply chain in Finland had experienced two major crises within three years (Ritala & Sandler, 2017; Sandler, 2020). In 2017, one of Finland's two main pharmaceutical wholesalers changed its enterprise resource planning (ERP) system, leading to disruptions in medicine distribution for several weeks (Ritala & Sandler, 2017). In 2020, the pandemic forced pharmaceutical supply chain stakeholders to adapt a series of actions to ensure the availability of medicines and continuity of services, care and business (Gregory & Austin, 2020; Kretchy et al., 2021; Sandler, 2020). Inter-organisational collaboration among pharmaceutical supply chain stakeholders increased during both disturbances (Ritala & Sandler, 2017; Sandler, 2020).

Different type of crises have become more frequent (Bordo et al., 2001; Coleman, 2006; Gregg et al., 2022). Natural disasters affect a wide range of organisations, and organisational crises extend to stakeholders due to many interdependencies. However, there is no general theory explaining how crises are best managed (Bundy et al., 2017; James et al., 2011; Pearson & Clair, 1998). One type of a crisis can differ significantly from another, such as pandemics and cyber-attacks causing electricity or information system breakdown. What is considered sufficient capacity and effective response and what is needed to achieve successful management may also vary. Due to the complexity and unpredictability of crises and the various decisions and actions required, crisis response usually comprises both successful and unsuccessful choices and decisions (Christensen et al., 2013; Kahn et al., 2013; Leonard & Howitt, 2010; McConnell, 2011; Pearson & Clair, 1998). Nevertheless, crisis management literature recognises a variety of components that support effective crisis planning, response and recovery.

Empirical pandemic management studies concerning community and hospital pharmacies have multiplied in recent years. However, there is still a lack of crisis management theory-based empirical research. Organisational crisis management research is fragmented, and many studies focus on single perspectives; thus, studies combining different perspectives are called for (Bundy et al., 2017). Although pharmaceutical supply chain stakeholders have had a central role in managing the pandemic, cross-sector level research on crisis management remains lacking. Considering the vulnerabilities of the industry and its importance to patients' lives and the functioning of healthcare systems, there is a need for empirical studies shedding light on crisis management in this specific field. The present study aims to fill this gap in the Finnish context. Theories of organisational crisis management and collaborative crisis management served as the study's theoretical framework, providing a view beyond the pandemic. The subsequent sections present the study's aims (1.1.) and structure (1.2.).

1.1 AIMS OF THE STUDY

This study aimed to describe and explore crisis management and cross-sector collaboration among pharmaceutical supply chain stakeholders during the first 15 months of the COVID-19 pandemic. The purpose was not to evaluate the effectiveness of crisis management efforts but to identify components that support effective crisis management, evaluate these components in the context of pharmaceutical supply chain stakeholders and draw learned lessons from the pandemic.

The specific objectives of the study were (the original publication number is provided in parentheses):

- To provide a holistic picture of organisational crisis management in Finland's pharmaceutical supply chain, covering community pharmacies, hospital pharmacies and pharmaceutical industry and wholesale (I–III)

- To identify components of effective crisis management from the literature and explore whether these efforts can protect community pharmacies' staff resilience, leader's resilience, organisational cohesion ('team spirit'), organisational resources or finances during the pandemic (literature review, I)

- To describe how pharmaceutical supply chain stakeholders organised cross-sector collaboration during the COVID-19 pandemic and how it influenced the crisis management effectiveness (IV)

- To identify development areas in which future crisis preparedness among pharmaceutical supply chain stakeholders could be improved (I–IV)

1.2 STRUCTURE OF THE THESIS

This thesis builds on four original publications that examine the crisis management and cross-sector collaboration among pharmaceutical supply chain stakeholders during the COVID-19 pandemic. The structure of this thesis is organised as follows.

The theoretical framing of the study covers organisational crisis management and collaborative crisis management literature. The first part of the literature review focuses on key definitions (Chapter 2.1.), followed by an overview of different types of crises and past and potential crises affecting pharmaceutical supply chain stakeholders (Chapter 2.2). The section about organisational crisis management focuses on the crisis management process models, especially Coombs (2007, 2023) and Pearson and Clair (1998), providing the theoretical framework for Studies I–III (Chapter 2.3). Moreover, components supporting effective crisis management at the organisational level are depicted. This is followed by an overview of collaborative crisis management and components driving effective crisis management at the cross-sectoral level (Chapter 2.4). The latter literature provides the theoretical framework for Study IV.

The Chapter 3 on context describes the pandemic outbreak in Finland, pharmaceutical supply chain stakeholders, legal preparedness framework and experiences from other countries. The methodology section (Chapter 4) describes and justifies the design, sampling, data collection and analyses, and research ethics. Crisis management among pharmaceutical supply chain stakeholders is depicted from organisational (Studies I–III) and cross-sectoral perspectives (Study IV) in the results section (Chapter 5). Finally, main findings, theoretical and methodological contributions, practical implications, research limitations and suggestions for future research are described and summarised in the discussion (Chapter 6) and conclusion (Chapter 7) sections. The original publications are presented at the end of this thesis.

2 REVIEW OF THE LITERATURE

2.1 DEFINITIONS

Definitions of a *crisis* usually constitute elements of threat, urgency and uncertainty (Rosenthal et al., 1989, 2001). According to a traditional definition, a crisis is a specific, unexpected, non-routine event that creates high level of uncertainty and a threat to high priority goals (Seeger et al., 2003). Some researchers use the phrases crisis, emergency, disaster and grand challenges interchangeably, while some find it important to differentiate (Boin & 't Hart, 2010). The phrase 'crisis' is used in this literature review for consistency even though some of the original articles differ in their terms.

According to the early work of Hermann (1963), *organisational crises* share three general attributes: 1) they threaten high-priority values, 2) they allow a short time for a response, and 3) they are unexpected or unanticipated (Hermann, 1963). Pearson and Clair's (1998) definition of organisational crisis utilises Hermann's (1963) work and is the most frequently cited definition in the literature today (Jaques, 2007; Williams et al., 2017). By their definition, organisational crisis is described from a management theory perspective as a 'low-probability, high-impact event that threatens the viability of the organisation, and is characterized by ambiguity of cause, effect, and means of resolution, as well as by a belief that decisions must be made swiftly' (Pearson & Clair, 1998). Organisational crisis has also been defined more generally as a disruptive and damaging extraordinary condition to the existing operating state of an organisation (Snyder et al., 2006).

C*risis management* is defined as 'a systematic attempt by organisational members with external stakeholders to avert crises or to effectively manage those that do occur' (Pearson & Clair, 1998). Crisis management is a part of organisational management, including crisis prevention and damage minimisation goals. Thus, it closely relates to issue and risk management, which can be seen as components of crisis prevention (Coombs, 2023; Jaques, 2007). A well-managed crisis can even benefit an organisation, leading to strengthened customer loyalty and improved competitiveness (Snyder et al., 2006). Ansell and Boin (2019) defined crisis management pragmatically as 'the set of preparatory and response activities aimed at the containment of a threat and its consequences' (Ansell & Boin, 2019).

Stakeholders are 'an organisation's individuals and constituencies that contribute to its wealth-creating capacity and activities and are, therefore, its potential beneficiaries or risk bearers' (Post et al., 2002). An organisation's stakeholders can include individuals, groups and organisations, such as customers, employees, suppliers, manufacturers or collaborative partners. An organisation's decisions and actions may positively or negatively affect its

stakeholders, giving them a right to expect certain actions (Freeman et al., 2010). Vice versa, stakeholders' actions may pose risks or provide advantage to an organisation (Alpaslan et al., 2009). Developing trust and coordination with stakeholders may assist in preventing crises or recovering from one more successfully.

Collaborative crisis management is defined as 'joint efforts of multiple actors to work across organisational borders, levels of authority and sectors to prepare for, respond to and learn from risks and extreme events' (Bynander & Nohrstedt, 2019). Collaborative crisis management, collaborative emergency management, new emergency management and transboundary crisis theory share similar inter-organisational cross-sector management strategies to crises and have been used interchangeably in the literature (Kapucu, 2006a; McGuire, 2006). These theories have a public management view of crises. In addition, the terms coordination, collaboration, and cooperation have been used interchangeably (Hattke & Martin, 2020; Kapucu et al., 2010). However, some researchers have conceptualised them in relation to a continuum of interaction intensity (Martin et al., 2016).

Cross-sector collaboration is defined as 'the linking or sharing of information, resources, activities and capabilities by organisations in two or more sectors to jointly achieve an outcome that could not be achieved by organisations in one sector separately' (Bryson et al., 2006). The importance of effective cross-sector collaboration in crises has been emphasised by several researchers (Maon et al., 2009; Nohrstedt et al., 2018; Simo & Bies, 2007; Waugh & Streib, 2006). The terms alliance and partnerships have also been used in addition to cross-sector collaboration to refer to cooperative inter-organisational relationships between organisations from different sectors to achieve a common purpose (Trujillo, 2018).

2.2 DIFFERENT TYPES OF CRISES

Potential crisis types vary depending on industry, organisation size, location, operations and personnel (Coombs, 2007, 2023; Fink, 1986). Crises can be intense and short or gradual and sustained (Snyder et al., 2006). They can originate inside or outside an organisation; they can stay inside or spread widely. Crises differ with respect to frequency and probability of reoccurrence. Originating from this background, Snyder et al. (2006) developed a crisis typology containing two dimensions: original source of a crisis (internal-external) and frequency of a crisis (normal-abnormal) (see Table 1). In this typology, natural disasters such as the COVID-19 pandemic are in the external-abnormal category, meaning that the crisis originates outside the organisation and is rare and, thus, not predictable with respect to the magnitude of consequences. In contrast, an internal-normal crisis originates within the organisation and is relatively predictable, such as a product recall. The degree

of predictability (i.e. the likelihood of the risk escalating to a crisis) is an important factor. Instead of attempting mitigate all kinds of crises, focusing preparedness efforts and limited resources on predictable crises is the ethically rational approach. Various other crisis typologies can be found in the literature (Coombs, 2023; Gundel, 2005; Mitroff & Alpaslan, 2003). In these typologies, differentiations have been made between man-made and natural crises or disasters, predictable (normal) and unpredictable (abnormal) crises and crises that are easy or difficult to manage.

Several crises affecting stakeholders in the pharmaceutical supply chain have been described in the scientific literature: electrical system failure, severe acute respiratory syndrome (SARS) and COVID-19 pandemics, safety recalls, failure to comply with Good Manufacturing Practise (GMP) requirements following a suspended licence to operate and ethics and corruption scandals (Austin et al., 2007; David-Barrett et al., 2017; Liu et al., 2020; O'Rourke, 2006; Priporas & Vangelinos, 2008; Rerup, 2009). The most common business crises in the pharmaceutical industry are product recalls, fine enforcement or prosecutions and reputational crises (i.e. scandals; Priporas & Vangelinos, 2008). Some crises may constitute multiple elements, such as the Vioxx product recall in 2004, which caused Merck & Co a loss of $2.5 billion in sales and approximately 9,200 lawsuits (O'Rourke, 2006). As described in the introduction, the change of an ERP system at one of Finland's two main pharmaceutical wholesalers interrupted medicine distribution for several weeks in 2017 (Ritala & Sandler, 2017). Potential sources of crises in the pharmaceutical sector include pandemics, telecommunication disruptions, cybersecurity threats, infrastructure or logistic failures, war and conventional threats such as water damage or fire (Juhola, 2017).

The COVID-19 pandemic had specific characteristics that distinguished it from many other crises (Thielsch et al., 2020). It was a long-term, sustained crisis, and it was not clear when it will end. It created a supra-regional problem and affected many areas of society. Changing dynamics characterised the pandemic: rapidly changing situations in the beginning and slowed dynamics when infection numbers decreased, and the pandemic became more controllable. Dynamics increased again during new waves. Because it was the first global pandemic after the World Wars, routines were lacking. The various threats from health to society and economy were not easy to predict or understand, and they remained partly theoretical in the early phase. The COVID-19 pandemic was perceived to be qualitatively different from other crises because all individuals were threatened by the virus, and all had to follow strict hygiene and distancing instructions. Crisis leaders faced unclear legal and political framework, and the legal conditions changed rapidly. Moreover, political responsibilities were partly unclear.

Table 1 Typology of Crises (adopted from Snyder at al. 2006)

Internal-normal

- Crisis originates within the organisation
- Crisis is relatively predictable with respect to timing and magnitude of consequences, and the frequency is not uncommon
- Crisis can be anticipated and prepared for
- Crisis is organisation-specific
- One organisation or its part suffers

  Examples:
  1. *Physical crises* (industrial accident, product recall)
  2. *Personnel crises* (strike, organisational rearrangement, sexual harassment)
  3. *Other* (internal supply chain disruption)

Internal-abnormal

- Crisis originates within the organisation
- Crisis is rare and not predictable with respect to magnitude of consequences and/or timing
- Crisis should be loosely expected and flexible resources allocation
- Crisis is organisation-specific

  Examples:
  1. *Criminal crises* (business ethics misconduct, corporate scandal)
  2. *Information crises* (information theft, copyright infringement, data protection violation)
  3. *Other* (product/brand boycott, firm-specific cyber-attacks)

External-normal

- Crisis originates outside the organisation
- Crisis is relatively predictable with respect to timing and magnitude of consequences, and the frequency is not uncommon
- Crisis should be loosely expected and flexible resources allocated
- Crisis can affect multiple firms
- All relevant organisations suffer

  Examples:
  1. *Economic crises* (recession, currency markets collapse)
  2. *Industry crises* (supplier or technology failure, product category failures)
  3. *Reputation crises* (malicious rumour, slander, logo tampering)

External-abnormal

- All relevant organisations suffer
- Crisis originates outside the organisation
- Crisis is rare and not predictable with respect to magnitude of consequences and/or timing
- Crisis is virtually impractical and/or impossible to anticipate
- Flexibility enables adequate response
- Crisis must advance to clarify environment
- No finalised response until crisis ceases

  Examples:
  1. *Political crises* (terrorism, war)
  2. *Industry deregulation* (legal changes, privatisation)
  3. *Other* (industry-wide cyber-attacks/viruses)
  4. *Natural disasters* (earthquake, tsunami, pandemic)
  5. *Other* (major supplier bankruptcy)

2.3 ORGANISATIONAL CRISIS MANAGEMENT

Organisational crisis management research is described as versatile, but fragmented (Buchanan & Denyer, 2013; Bundy et al., 2017; James et al., 2011; Shrivastava, 1993; Williams et al., 2017). It has been studied under different disciplines, such as organisation theory, organisational behaviour, strategic management, public relations and corporate communication. Research has been criticised for studies examining only one perspective and its lack of cross-discipline views (Bundy et al., 2017; James et al., 2011; Shrivastava, 1993). For example, scholars have studied topics like crisis typologies (Gundel, 2005; Snyder et al., 2006), decision-making during crisis (Al-Dabbagh, 2020; Coccia, 2020; Hale et al., 2006) and organisational learning and adaptation (Buhagiar & Anand, 2021; Lampel et al., 2009; Veil, 2011).

In addition to fragmentation, there are two aspects in organisational crisis research that create methodological challenges (Buchanan & Denyer, 2013; Bundy et al., 2017). First, there is no consensus regarding definitions or typologies concerning crisis events among researchers. For example, a crisis can be seen as an event or a process (Williams et al., 2017). The event perspective seeks to understand the dynamics of a crisis in its acute stage, how organisations react and learn from the crisis. Studies have focused on exploring interorganisational collaboration, disaster planning and prevention and organising for crisis response. In contrast to the event perspective, crisis from a process perspective focuses on the crisis evolution and the need to understand environments and processes of organisational weakening prior to the crisis (Lalonde & Roux-Dufort, 2010; Williams et al., 2017). This perspective focuses on a cumulative process of organisational failures that could be tracked before the acute phase, which follows a triggering event escalating to a crisis. Despite varying perspectives and typologies, common or widely accepted descriptions can be found from the literature (see Chapter 2.1.).

Second, as many of the conclusions are derived from case studies, small-scale studies or narrative descriptions, crisis research has been criticised for its lack of theoretical and empirical rigor (Buchanan & Denyer, 2013; Bundy et al., 2017). Due to the unpredictable nature of crises, researchers have adopted retrospective research designs and methods, which often suffer from data loss, faulty memories and perceptions that change with reflection. Furthermore, individuals may be reluctant to interact with researchers due to sensitivity or ethical problems, which can cause biased source data.

Theories of organisational crisis management range from sensemaking (Maitlis & Sonenshein, 2010; Weick, 1988) to extreme context (Hällgren et al., 2017) and crisis management process models (Coombs, 2007; Fink, 1986; Mitroff, 1988; Pearson & Clair, 1998; Turner, 1976). In addition, crisis leadership studies provide insights into leadership skills and capabilities nurturing effective crisis management (Sriharan et al., 2022). This part of the

literature review focuses on the crisis management process models that provides the theoretical background for the questionnaire development in Studies I–III. In addition, the present part aims to identify components that drive effective crisis management. The crisis management process models were chosen for the study due to their widely used, practical and holistic views on crisis management and advances in integrating internal, within-organisation dynamics as well as external perspective focusing on inter-organisational collaboration (Bundy et al., 2017). These models employ the event perspective to crises (Williams et al., 2017).

2.3.1 LIFE CYCLE APPROACH TO CRISES

Widely accepted crisis management process models represent the life cycle approach to crises (Coombs, 2023; González-Herrero & Pratt, 1995; Sellnow & Seeger, 2013). According to this view, a similar developmental structure can be seen in each crisis even though they all are unique in their nature. The early stages of a crisis affect its latter stages; for example, a failure to respond quickly and decisively at an early stage may result in the extension of subsequent crisis stages. An inadequate response to an emerging risk, such as the development of a novel virus outbreak, may result in widespread illness, social and economic problems and many deaths, eventually resulting in a global pandemic.

Developmental crisis models allow for some level of prediction, important in understanding and managing crises. Different phases of crises require different actions (Coombs, 2023; González-Herrero & Pratt, 1995). These actions should be integrated in normal operations of organisations rather than operated as a separate function. Process models have provided useful frameworks for crisis management, communication and leadership research and practice. The developmental approach has been utilised by the World Health Organisation (WHO) and the European Centre for Disease Prevention and Control (ECDC) in their guides for national pandemic preparedness and response, as well as in Finland's national pandemic preparedness plan for healthcare and social welfare (European Centre for Disease Prevention and Control (ECDC), 2017; Ministry of Social Affairs and Health, 2024; World Health Organization (WHO), 2017).

Process models have been criticised for ignoring the possibility of stages overlapping or occurring simultaneously, which often occurs during complex and dynamic crises (Jaques, 2007). Moreover, it has been recognised that learning, positioned in the post-crisis stage in the three-stage process model, is an important part of each stage (Veil, 2011). A relational model that views crisis management as a continuous discipline based on clusters and nonlinear elements has been suggested as an alternative model (Jaques, 2007).

Crisis management literature recognises various linear process models, including three- (Coombs, 2007), four- (Fink, 1986; González-Herrero &

Pratt, 1995), five- (Mitroff, 1988) and six-stage (Turner, 1976) models. This study employs the widely accepted three-stage process model, which divides crisis management into pre-crisis, crisis and post-crisis macro-level stages (Bundy et al., 2017; Coombs, 2007, 2023). Other linear process models share many similarities with the three-stage model but, for example, separate signal detection and the accumulation of pre-crisis settings into their own stages. Aspects from other process models and insights from crisis management research have been incorporated into the three-stage macro-level approach in its later developments (Coombs, 2023).

2.3.2 PRE-CRISIS STAGE

In the pre-crisis stage, risk factors accumulate, anticipating a future crisis (Coombs, 2007, 2023). Several researchers emphasise the importance of crisis prevention and preparedness activities in this stage (Carmeli & Schaubroeck, 2008; Coombs, 2023; Mitroff, 1988; Pearson & Clair, 1998).

2.3.2.1 Signal Detection and Risk Management

By detecting signals of potential issues and mitigating and managing risks, an organisation can reduce the likelihood of a crisis and minimise its impact when it occurs (Wooten & James, 2008). External information sources, such as traditional and social media, environmental and legal changes, product complaints and safety issues, can be monitored (Carmeli & Schaubroeck, 2008; Coombs, 2023). Likewise, internal information sources, such as potential frauds, legal or business ethics misconducts or employee concerns of potential risks serve as valuable information sources for signal detection (Carmeli & Schaubroeck, 2008; Coombs, 2023; Rerup, 2009).

Risks can be divided into strategy, finance, operations, compliance, reputation and technology related (Coombs, 2023). Risk management attempts to reduce vulnerabilities, which may require balancing to compare the costs of risk to its reduction. Effective crisis planning manages public expectations by recognising the compromises, such as the price of safety through prevention (Boin & 't Hart, 2010). In cases where interdependent organisations share risks, stakeholder collaboration is important in risk management.

Scenario planning is a widely used tool to map potential issues or risks that may escalate into a crisis (Wright & Goodwin, 2009). This tool often utilises the intuitive logics method, in which potential risks are mapped based on their likelihood and impact. These two dimensions form a 2 x 2 matrix: low likelihood-low impact, high likelihood-low impact, low likelihood-high impact and high likelihood-high impact. Velocity (i.e. the speed with which a crisis

can develop and affect an organisation and its stakeholders) may be added to the assessment (Coombs, 2023). However, the scenario planning method has weaknesses relating to improper framing, causality understanding and cognitive and motivational bias (Wright & Goodwin, 2009). In cases where predictability is low, challenging mental frames, observing human motivations, adopting the crisis management approach and assessing strategic options against scenario evaluation may enhance scenario planning.

2.3.2.2 Increasing Preparedness

Preparation begins with assessing potential crises and aligning them with risk assessment (Coombs, 2007, 2023). Examples of previous and potential crisis types in the pharmaceutical sector are described in Chapter 2.2. Institutionalised practices, industry regulations and management's risk perception influence the adoption of organisational crisis management preparations (Fowler et al., 2007; Pearson & Clair, 1998). Modest crisis management preparations may result in a false sense of security, leading to inadequate preparation and training (Coombs, 2023; Fowler et al., 2007; Pearson & Clair, 1998). After mapping potential crises, improving preparedness continues with establishing a crisis management team, creating contingency plans and conducting relevant exercises linked to an effective crisis management (Bundy et al., 2017; Coombs, 2023; King, 2002; Pearson & Clair, 1998; Thielsch et al., 2020).

The crisis management team, a cross-functional group of people who have been designated to handle crises, is responsible for creating and applying crisis plans in simulated or real settings and handling issues not covered by the plan (Coombs, 2023; King, 2002; Uitdewilligen & Waller, 2018). Researchers have proposed that organisations relying on crisis management teams in crisis preparation and response are more likely to succeed compared to organisations in which the crisis management responsibility lies with an individual (King, 2002; Pearson & Clair, 1998). The team should cover relevant knowledge, skills and organisational power sources, and its composition should reflect the nature of the crisis (King, 2002). Effective crisis management depends on several team-related factors, such as team members' prior crisis interactions and knowledge of the crisis management task, charismatic leadership style and support of the organisational culture for crisis planning. In addition, continuous information flow, tight leadership, clear structure and professional skills were reported success factors of the COVID-19 pandemic management teams (Thielsch et al., 2020). Interactions before the pandemic and knowledge of the crisis management task were also listed, similar to King (2002).

Crisis management plans save time during crises by preassigning tasks, collecting information in advance and serving as a reference source (Coombs, 2023; Hale et al., 2006). The purpose of such a plan is to mitigate the negative

effects of an ongoing crisis effectively. A written plan, even one created for a different event, assists in quickly identifying feasible actions (Hale et al., 2006). Without such, the response is less effective because more steps are required to make critical crisis response decisions. These plans should combine a generic all-hazards approach and well-chosen response strategies to known crisis scenarios (Boin & 't Hart, 2010). It should serve as a reference tool rather than a step-by-step guide because adaptation to each crisis and changing circumstances is necessary. At the same time, its purpose is to build organisational capacities to deal with known crisis scenarios that can be expected to occur. There is no accepted golden standard for these plans; however, they can include elements such as incident reports, management and communication strategies and stakeholders' contact details (Coombs, 2023). The content depends on the organisation's industry, size and location. Crisis management plans overlap to some extent with business continuity plans to ensure that an organisation continues to operate despite disruptions, major accidents or crises (Cerullo & Cerullo, 2004; Herbane, 2010).

Different levels of training and exercises exists (Coombs, 2023). The simplest training method is to familiarise relevant people to the crisis plan or the standard operating procedure; for example, all employees are typically trained for an evacuation plan (Fowler et al., 2007). This training then follows with more specific training, such as reviewing the crisis management process: roles, procedures, policies and equipment (Coombs, 2023). A drill is a supervised exercise that tests one crisis management function, such as employee notification or evacuation. A table-top analysis enables a crisis team to discuss what they would do in a particular crisis without time pressure. Functional exercises (i.e. simulations) imitate real crises that unfold in real time to create time pressure. The team will need to interact and coordinate the response with the stakeholders it would encounter in a crisis. These can be executed in a meeting room or in the field, the latter being time-consuming and expensive.

Researchers argue that building alliances and coordinating activities by sharing information and plans with external stakeholders before the crisis enhance successful crisis management (Pearson & Clair, 1998). The role of stakeholders in crises has been widely studied, and the importance of efficient communication has been highlighted. However, research in this area is theoretically diverse, and empirical investigations remain limited (Alpaslan et al., 2009; Bundy et al., 2017). Advancing positive stakeholder relationships in the crisis prevention stage is essential, as negative relationships can cause or escalate crises. Open lines of communication and reasonable expectations are needed for successful stakeholder management.

The aim of improving preparedness is to build crisis-resistant organisations (Coombs, 2023). The focus should not solely be on plans produced to meet legal or other obligations, but on building carefully aligned processes, such as ongoing risk monitoring, continuous education and training, learning through exercises, and building and maintaining relationships and mutual trust

between relevant stakeholders (Boin & 't Hart, 2010). Researchers suggest that crisis preparedness efforts should be continuously monitored, updated and adjusted according to crisis experiences, exercises, or examples from peer organisations or countries.

2.3.3 CRISIS STAGE

The crisis stage is initiated by a crisis event, which can emerge suddenly or evolve slowly (Coombs, 2023; Pearson & Clair, 1998). The response focuses on addressing the situation and maintaining core operations, often consisting of planned and ad hoc actions. Decision-making and communication with internal and external stakeholders are described from the organisational perspective in the following chapters. Collaboration is further discussed in Chapter 2.4.

2.3.3.1 Decision-making

Decision-making is a fundamental aspect of crisis response (Boin & Lagadec, 2000; Weick, 1988). It is characterised by time pressure, risk and a changing situation (Ansell & Boin, 2019; Hale et al., 2006; Williams et al., 2017). The complexity, instability and uncertainty challenge rational, data-driven decision-making (Ansell & Boin, 2019). In an urgent and high-pressure crisis environment, decision-makers tend to rely on ready-made solutions (Hale et al., 2006). Data analysis is used especially in cases where analysis capability is readily available. In those cases, decision-makers can take a rational approach, systematically collect information to reduce uncertainty, evaluate different options and optimise actions (Ansell & Boin, 2019). Proactive decision-making saves time, efforts and money and reduces the severe consequences of crises (Al-Dabbagh, 2020). The continuous update of a comprehensive situation picture enables correct and timely actions within crisis teams and with stakeholders. However, in situations of limited available data, a pragmatic approach may serve better than a rational data-driven approach (Ansell & Boin, 2019). A pragmatic approach accepts the limited available data and complexity of the environment, focuses on targeted inquiries of discrepancies, tests interpretations and builds creative solutions.

Setting goals and choosing strategy in crisis management can support an organisation's larger goals and strategy (Coccia, 2020; Coombs, 2023; Snyder et al., 2006). Johnson and Johnson's handling of poisoned Tylenol capsules is considered exemplary due to its speed and ethical decision-making towards stakeholders (Alpaslan et al., 2009; Barton, 2001). In 1982, seven people in the Chicago area died after taking Tylenol capsules that had been poisoned

with cyanide. Johnson and Johnson reacted swiftly with its recall and destroyed all 22 million capsules valuing $100 million. The company showed that it was willing to put the consumer safety before a discussion of liability. It took responsibility via widespread communication and set up telephone hotlines for consumers. Before the crisis, the company had incorporated ethical consideration into decision-making, enabling the swift response (Snyder et al., 2006). Decisions maintaining stakeholders' trust and safety are well accepted by the public, support company reputation and protect shareholder value (Alpaslan et al., 2009; Snyder et al., 2006). In addition to crisis response and business continuity decisions, crises may provide an opportunity to innovate new value (Margherita & Heikkilä, 2021; Pearson & Clair, 1998).

2.3.3.2 External and Internal Communication

A crisis creates an information vacuum, which is filled by the news media or rumours unless an organisation present its own side of the story first (Coombs, 2023; Turner, 1976; Weick, 1988). The crisis type and the level of an organisation's responsibility for the crisis influence stakeholders' perceptions (Coombs, 2007). Fast, accurate and consistent external communication (i.e. communication towards external stakeholders) enhance successful crisis management in cases where the organisation has high responsibility (Arpan & Roskos-Ewoldsen, 2005; Coombs, 2007, 2023; Pearson & Clair, 1998). Instructing information can be used to minimise the damage and increase public and stakeholders' trust. The traditional and social media may provide a useful way to reach a wide range of stakeholders promptly; however, to preserve trust and existing relationships, key stakeholders should be contacted directly. Expressions of concern help to lessen reputational damage and reduce financial losses (Dean, 2004). A company may create a separate website for the crisis or designate a section of its current website, for example, for a product recall and how it will be handled (Taylor & Kent, 2007). In some crises, a pre-established notification system designed to reach key stakeholders is needed (Coombs, 2007, 2023). While accuracy and consistency are crucial in external communication, time pressure increases the risk of inaccurate information.

Internal communication (i.e. communication towards an organisation's internal stakeholders) plays a central role in maintaining trust to enhance employee involvement and commitment (Coombs, 2023; Thomas et al., 2009; Tkalac Verčič et al., 2012). Both the quality and quantity of communication affect the level of trust and involvement of employees during crises, quality being more important in the relationships with coworkers and supervisors and quantity more important from the top management (Mazzei & Ravazzani, 2015; Thomas et al., 2009). Quality information is considered timely, accurate and useful. Positive employee communication instead of negative

communication would likely preserve good relationships and enhance adaptability to organisational turbulence (Mazzei et al., 2012). Because employees are effective advocates of a company's reputation, well-balanced internal communication during the crisis stage may facilitate the company's goals even after the crisis is resolved.

2.3.4 POST-CRISIS STAGE

Finally, the post-crisis stage begins when the crisis is over (Coombs, 2007, 2023). The immediate impacts of the crisis are passed, and the organisation can return to business as usual or its 'new normal'. This stage is dedicated to self-evaluation and learning from the experience, with the aim of enhancing prevention and preparedness for future crises.

2.3.4.1 Self-evaluation

According to Pearson and Clair (1998), crisis management effectiveness is evidenced when a potential crisis is avoided or when key stakeholders believe that the outcomes of a crisis are mostly successful rather than a failure. The evaluation of crisis management effectiveness is usually a combination of financial and non-financial variables, such as stakeholders' impacts, welfare and health (Snyder et al., 2006). The evaluation may consider sustained or resumed operations, organisational and stakeholder losses, the level of learning and the transferral of lessons to future incidents (Pearson & Clair, 1998).

Given the complexity and unpredictability of crises, along with the numerous decisions and actions required, no organisation can respond to a crisis in a completely successful or unsuccessful manner (Christensen et al., 2013; Kahn et al., 2013; Leonard & Howitt, 2010; McConnell, 2011; Pearson & Clair, 1998). Dividing the crisis evaluation data by crisis stages provides a structured way to identify different success and failure outcomes (Coombs, 2023; Seeck et al., 2008). Pearson and Clair (1998) presented a 'success-failure continuum' for evaluating crisis management comprising seven elements: signal detection, incident containment, business resumption, learning, reputation, resource availability and decision-making (see Table 2). This continuum can be utilised as a self-evaluation tool, and it has been employed in research to evaluate crisis management success in different environments, such as Hurricane Katrina and water damage crises (Knowles et al., 2019; Rizzuto & Maloney, 2008; Seeck et al., 2008).

Table 2 Examples of Crisis Management Success and Failure Outcomes (adopted from Pearson & Clair 1998)

Crisis Concern	Failure	Midground	Success
Signal detection	All signals of impending crisis are ignored; organisation is caught completely unaware	Signals of potential crisis send organisation in the state of alert	Signals are detected early so that the appropriate responses are brought to bear
Incident containment	Crisis escapes beyond boundaries of the organisation; external stakeholders are negatively impacted	Damage beyond organisation boundaries are light	Major impact is totally confined within the organisation, and there is no stakeholder injury or death
Business resumption	All operations are shut down, downtime is lost in bringing organisation back into operation	Areas of operation most affected are closed temporarily, functional down time is minimal with little effect on product or service	Business is maintained as usual during and after the crisis, there is no loss of product or service delivery
Effects on learning	No learning occurs, organisation makes same mistakes when similar incident occurs	Learning occurs but its dissemination is spotty	Organisation changes policies/ procedures because of the crisis, lessons are applied to future incidents
Effects on reputation	Organisation suffers long-lasting negative repercussions, industry reputation suffers because of organisation's crisis, public perceives organisation as villain as a result of ineffective crisis management	Negative effects of crisis are short lived, public perceives errors in details of crisis management effort but continues to consume product / service as usual	Organisational image is improved by organisation's effectiveness in managing crisis; organisation is perceived as heroic, concerned, caring and a victim
Resource availability	Organisation scrambles but lacks essential resources to address crisis	Organisation scrambles and scrapes by on own and other's ad hoc assistance	Organisation or external stakeholder's resources are readily available for response
Decision-making	Slow in coming because of internal conflicts, fantasy driven	Slow in coming because of extra-organisational constrains	Ample evidence of timely, accurate decisions, grounded in facts

2.3.4.2 Organisational Learning

As described in the previous chapter, organisational learning is an essential crisis outcome (Bundy et al., 2017; James et al., 2011; Pearson & Clair, 1998). Without such, leaders and employees may repeat the same mistakes and fail in improving competencies, policies and processes for future challenges (Wooten & James, 2004, 2008). Organisations that learn from crisis or other failures generate competitive opportunities over others that fail to learn. Organisational learning occurs when errors are shared and analysed following the distribution of lessons learned to enact changes in the routine process (i.e. to transform lessons into actions; Lampel et al., 2009; Popper & Lipshitz, 2000). Crises not only test organisations but also reveal new knowledge and productive opportunities (Lampel et al., 2009).

Learning processes are primarily focused on how to manage rare events and improve outcomes (Christianson et al., 2009; Lampel et al., 2009). Crises force organisations to reallocate managerial resources away from routine activities to issues that require additional attention (Rerup, 2009). The reallocation is used to manage the rare event but may also be needed in deriving lessons that can be used to improve organisational response to future crises. The focus on certain aspects, such as safety, can lead to the ignorance of other aspects, such as efficacy or innovation (Haunschild et al., 2015).

Once a crisis is over, an organisation is again in the pre-crisis stage (Figure 1; Coombs, 2007; Veil, 2011). If it learned from the crisis, there should be different capabilities in preparing for future crises. The opportunity to learn exists throughout the crisis cycle (Veil, 2011). Moreover, if learning occurs to address an issue in the pre-crisis stage, improved competencies in signal detection and risk management assist in preventing other crises.

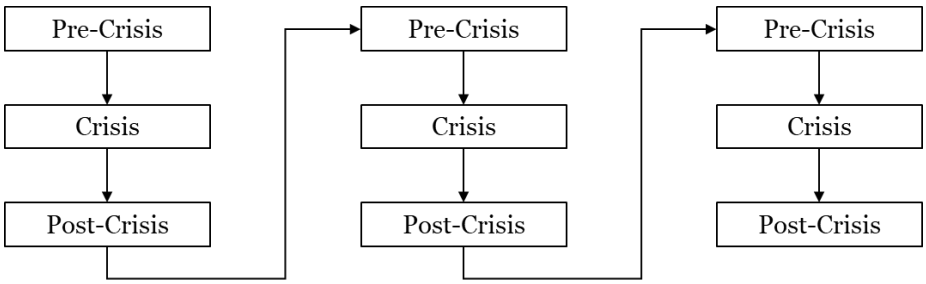

Figure 1 Three-Stage Crisis Cycle (adopted from Veil, 2011)

2.4 COLLABORATIVE CRISIS MANAGEMENT

The COVID-19 pandemic caused a transboundary crisis, as it exceeded geographical, public–private, legal and temporal boundaries (Ansell et al., 2010; Ansell & Boin, 2019). These kind of crises force organisations to collaborate across sectors and regions, but it is not always obvious which of these actors should be leading or coordinating the response (Nohrstedt et al., 2018). The risk to transboundary crises increases in complex system networks important to many supply and production chains, such as pharmaceutical supply and production chains.

Cross-sector collaboration is a complex, interdisciplinary phenomenon that forms a dynamic system (Bryson et al., 2015). Collaboration researchers combine multiple theories from different disciplines such as organisation studies, public administration, leadership, collective action, strategic management, conflict management, network theory and communication. The need to blend multiple theoretical and research perspectives has led to two different starting points for the research field (Bryson et al., 2006, 2015; O'Toole, 2015). The network theory perspective offers a rich theoretical base, which often focuses on structural variables but tends to ignore the uniqueness and different strengths and weaknesses of actors, ongoing process dimensions, especially leadership, and the dynamic nature of collaborative development. From the other starting point, researchers see collaborations as collective action solutions to public problems. This view constitutes less theoretically grounded research but may provide rich material on process dimensions, sources of ambiguity within collaborative work and findings that can be more easily translated to practice. This part of the literature review focuses on collaborative crisis management, providing the theoretical background for Study I. The study employs a collective action perspective; thus, the focus is on such literature (Bryson et al., 2015). The aim is to identify elements supporting effective and successful collaborative crisis management.

Additional methodological challenges include limitations of case studies and research focusing on variables for studying complex and dynamic phenomena. Instead, Bryson, Crosby and Stone (2015) called for multilevel studies that collect both qualitative and quantitative data, which could provide a better understanding of the impacts of context and changes in context, internal and external dynamics, causal connections and systemic connections in general. Some case studies already provide valuable insights into selected areas of cross-sector collaboration, such as strategy formulation and implementation (Clarke & Fuller, 2010), multilevel performance indicators (Herranz, 2010), integrative leadership (Malin & Hackmann, 2019) and impacts of initial stages of collaboration on its outcomes (Schmid & Almog-Bar, 2019).

2.4.1 CROSS-SECTOR COLLABORATION IN CRISIS

Although uncertainty and urgency challenge collaboration, crisis management research highlights the advantages of cross-sector collaboration in complex, abnormal crises (Maon et al., 2009; Nohrstedt et al., 2018; Parker et al., 2020; Simo & Bies, 2007; Waugh & Streib, 2006). The effective information flow across organisational boundaries is critical for crisis management in a dynamic environment (Comfort, 2007; Wolbers & Boersma, 2013). A common operating picture enables informed decision-making and action adjustments in accordance with other organisations. Shared resources, skills development and reflective lesson learning foster future crisis preparedness (Maon et al., 2009; Simo & Bies, 2007). In contrast, an asymmetric information process (top-down instead of two-way) and asynchronous dissemination of critical information to participating organisations weakens crisis response. Moreover, the heterogeneity of actors, unclear leadership and goal alignment, self-interests over collaboration in decision-making and power imbalances may impair collaboration (Comfort, 2007; Crosby & Bryson, 2010; Intindola et al., 2016). In addition, the perception of collaboration in crisis may vary due to differences in organisational goals, objectives and cultures (Kapucu et al., 2010).

Examples of empirical crisis management research in cross-sector collaboration settings are described in the following sections. Elements supporting collaborative crisis management, such as repeated collaborative interaction prior to the crisis (Chen et al., 2013), existing interorganisational structures (Butts et al., 2012; Kapucu, 2006b; Nolte et al., 2012; Simo & Bies, 2007), existing relationships (Martin et al., 2016), detecting transboundary vulnerabilities (Boin, 2019), common incentives (Nolte et al., 2012), trust (Chen et al., 2013; Curnin & O'Hara, 2019), a bridging or coordinating organisation (Butts et al., 2012), and role clarity (Curnin & O'Hara, 2019), were found in the literature. Table 3 summarises these elements in relation to the crisis stages, and the subsequent sections describe the research in more detail.

Table 3 Synthesis of the Literature: Elements Supporting Collaborative Crisis Management

Pre-Crisis	Crisis Response	Post-Crisis
Repeated collaborative interaction	Common perception of collaboration	Reflective lesson learning
Existing relationships	Common incentives	
Trust	Role clarity	
Existing interorganisational structures	Bridging or coordinating organisation	
Detection of transboundary vulnerabilities	Effective information exchange, interactive information infrastructure	
	Common operating picture	
	Shared resources	

Simo and Bies (2007) tested a cross-sector collaboration model developed by Bryson et al. (2006) in three cases of hurricane-exposed communities. The researchers found three crisis-specific extensions to the model: 1) non-profit organisations were identified as key initial conditions, 2) the role of informal activity appeared as a central factor, and 3) the temporary urgency of the crisis challenged some of the normal conditions placed in the model. Similar to Simo and Bies (2007), Kapucu (2006) investigated interorganisational collaboration between the non-profit and public sectors in response to attacks on the World Trade Center on 11 September 2001. The collective action by organisations in the non-profit sector was neither centrally controlled nor directed. Non-profit organisations responded with speed and agility to the urgent humanitarian needs without a reliable roadmap or formalised structures. Integration between the public and non-profit sector in existing interorganisational structures was lacking. Research emphasised the importance of establishing communications with other organisations before a crisis to know the right contact points and communicate effectively during a crisis. Other researchers have also found that the inadequacy of interorganisational structures contributes to a lack of collaboration (Martin et al., 2016).

Butts et al. (2012) explored the interorganisational collaboration in the non-profit and public sectors that emerged in response to Hurricane Katrina. The bridging role of the American Red Cross became an enabler of collaboration in this setting. Nolte et al. (2012) investigated cross-sector collaboration during a Haiti earthquake. Common incentives and high equality among organisations improved network coordination. Moreover, large and public organisations were more likely to take leadership roles during crisis. Curnin and O'Hara (2019) investigated crisis management in public and non-profit sectors during the Tasmanian floods. Similar to previous studies, they found interorganisational structures, trusting relationships and clarity of roles to be important facilitators for collaboration.

2.4.2 ORGANISATION OF CROSS-SECTOR COLLABORATION

The widely accepted command-and-control model provides a standardised approach to collaborative crisis management (Moynihan, 2008, 2009). The Incident Command System (ICS) was originally developed to respond to coordination problems in the California wildfires in 1970 (Moynihan, 2009). The idea of the ICS was to temporarily centralise the responsibility for directing and coordinating the multi-organisational response in crises. The ICS is successful in reducing coordination problems and enhancing collective response, especially in routine emergencies or incidents (Buck et al., 2006; Moynihan, 2008; Sederholm et al., 2021). However, predefined hierarchies and top-down coordination can hinder the management of complex crises (Ansell et al., 2010; Chen et al., 2013; Nohrstedt et al., 2018). The assumption

that a centralised command alone is sufficient to manage a multi-organisational response overlooks some of the managerial challenges (Moynihan, 2009). First, coordination becomes more difficult when the number and diversity of responding organisations increase. Second, multi-organisational crisis responses usually introduce some level of shared authority instead of a clear line of command. Third, working relationships and trust shape the multi-organisational response. Although the ICS attempts to coordinate multiple organisations with a hierarchical structure, collaboration within the network significantly affects the resulting operations. Transboundary and complex crises often require improvised, adaptive and inter-organisational collaborative responses (Ansell et al., 2010; Chen et al., 2013; Nohrstedt et al., 2018). As a conclusion, researchers acknowledge both, the need for a rapid and coordinated response and an adaptive network response (Moynihan, 2009; Nohrstedt et al., 2018).

Without a predefined crisis management governance structure, inter-organisational collaboration tends to self-organise to epistemic or ad hoc overlapping networks (Kapucu, 2006a; Kendra & Wachtendorf, 2003). Collaborative crisis management often involves some kind of centralised governance structure and the self-organisation of interdependent organisations (Nohrstedt et al., 2018). The establishment of partnerships and intermediate organisations offering pragmatic solutions before a crisis might prove fruitful. The balance between hierarchical instruments and network solutions is complicated and context-dependent (Christensen et al., 2016).

Moynihan presented a few solutions to overcome the confusion in collaborative, yet coordinated multi-organisational responses to crises (Moynihan, 2009). These include clarifying the basis for coordination, maintaining working relationships between crises, identifying actors with a central role in preventing, preparing and responding to a crisis and improving training among stakeholders. These solutions could be enhanced by bringing relevant actors together for any forms of collaboration, creating and ensuring the continuity of inter-organisational connections and encouraging the mobility of organisational actors within the network.

2.4.3 LEADERSHIP AND DECISION-MAKING IN THE CROSS-SECTOR SETTING

Leadership is an important determinant of the implementation and functioning of cross-sector collaboration (Bryson et al., 2015; Crosby & Bryson, 2010). Crisis settings require leaders to change from routine operations to an adaptive model (Comfort et al., 2020). Leadership in crises requires the capacity to recognise a change in operating conditions, adapt to that change with the most appropriate actions and resources, communicate to others to form a common response and correct errors or inaccurate assumptions (Comfort & Okada, 2013).

Public managers need to be capable of dealing with various organisations to formulise strategies and make quick and accurate decisions based on the available information mixture (Comfort et al., 2020; Waugh & Streib, 2006). Differing roles and authorities challenge leaders in cross-sector collaboration. Timely and valid information is a key component in mobilising collective action in response to a crisis (Comfort & Okada, 2013; Hess & Ostrom, 2007). Developing an interactive information infrastructure could improve decision processes by engaging a wider exchange of knowledge and skills.

Leadership in collaborative crisis management can manifest in forms of sponsors who have formal authority or champions who engage actors with informal authority (Agranoff, 2012). Government agencies may have a formal leader role if the collaboration relates strongly to their respective field. Leadership in a cross-sector context may also manifest through structures, processes and participants in the form of making things happen (Huxham & Vangen, 2000). These factors are interlinked so that they influence each other. Structures determine collaborating actors who can influence the collaboration agenda, who has the power to act and what resources are used. Thus, structure influences the power of participants. Communication spots, such as committees, workshops, seminars, phone calls and e-mails are seen as leadership processes. The frequency and form of communication influence information sharing and the development of a common understanding of issues; thus, processes impact the emerging structures and who can influence agendas. Participants are defined as individuals, groups and organisations influencing agendas. Any participant who has the power and knowledge to influence the agenda may take a lead. However, the leadership role is often given to a positional leader organisation, such as a government agency, a host organisation or the organisation that initiated the collaboration.

3 CONTEXT

3.1 FINLAND'S PHARMACEUTICAL SUPPLY CHAIN

Finland's pharmaceutical supply chain has a long tradition of interorganisational collaboration, defined by laws, regulations and contractual partnerships, as well as common healthcare responsibilities. The private, public and third sector stakeholders include government agencies, the pharmaceutical industry, wholesalers, community and hospital pharmacies and advocacy organisations. Table 4 summarises the stakeholders and their relevant legal mandates. Organisations within each group share similarities but also vary to some extent. They also share a common purpose of ensuring medicine and vaccine availability and quality in Finland. The characteristics of the supply chain stakeholders are described below.

The development of pharmaceutical supply and preparation of medicine-related legislation are responsibilities of the Ministry of Social Affairs and Health (STM). Government offices relating to pharmaceutical supply include Finnish Medicines Agency (FIMEA), the National Institute for Health and Welfare (THL) and the Social Insurance Institution of Finland (KELA). FIMEA provides licensing, medicines information and supervision to the pharmaceutical supply chain, inspects organisations, investigates and develops the supply. The THL advances social and health services to prevent social problems and diseases and is responsible for communicable diseases and preparedness for health threats. KELA decides on pharmaceutical reimbursement applications and develops the reimbursement system. The responsibilities of these government agencies are described in respective laws, such as the Finnish Medicines Act (395/1987) and the Degree (693/1987), the Act on Finnish Medicines Agency (593/2009), the Act on the National Institute for Health and Welfare (668/2008) and the Act on the Social Insurance Institution of Finland (731/2001).

The pharmaceutical industry consists of pharmaceutical importers and manufacturers, of which majority belong to multinational global companies. Advocacy organisations for pharmaceutical industry, namely Pharma Industry Finland (PIF), represent 39 pharmaceutical companies, mostly focusing on innovative medicines, and the Finnish Association for Generic Drugs (FAGD) represents eight pharmaceutical companies that concentrate on generic medicines (Finnish Association for Generic Drugs, 2024; Pharma Industry Finland, 2024).

Table 4 Public, Private and Third Sector Pharmaceutical Supply Chain Stakeholders in Finland (adopted from Study I)

Public Sector	**Tasks Mandated by Legislation[1]**
Government agencies: Regulators of the pharmaceutical supply and operations	
Ministry of Social Affairs and Health (STM)	Responsible for social and health policy, preparing legislation and guiding implementation
Finnish Medicines Agency (FIMEA)	Regulating pharmaceuticals, providing licensing, medical information and supervision, inspecting organisations, and developing the pharmaceutical supply and operations
National Institute for Health and Welfare (THL)	Responsible for communicable diseases and preparedness for health threats
The Social Insurance Institution of Finland (KELA)	Responsible for decisions on pharmaceutical reimbursement applications and for developing the reimbursement system
National Emergency Supply Agency (NESA)	Coordinating the supply security with relevant organisations to maintain sufficient buffers and safeguarding the production of necessary goods and services under emergency conditions
Hospital pharmacies: Municipalities are responsible for organising and financing healthcare. There are five public university hospitals and 16 central hospitals in Finland. Smaller hospitals may have dispensaries.	Responsible for pharmaceutical supply and logistics, ensuring medication quality and safety, providing clinical pharmacy and pharmaceutical manufacturing services in hospitals and primary care units, and maintaining crisis-related pharmaceutical stockpiles for 3–10 months
Private Sector	**Tasks Mandated by Legislation[1]**
Pharmaceutical industry: Manufacturing and importing companies that develop, produce, store and distribute medicines to wholesalers. They most often partner with one pharmaceutical wholesaler.	Ensuring quality and safety of pharmaceuticals in manufacturing, importation, storage and distribution. Maintaining crisis-related pharmaceutical stockpiles for 3–10 months
Pharmaceutical wholesalers: Two major pharmaceutical wholesalers store and distribute almost 100% of pharmaceuticals in Finland.	Ensuring quality and safety of pharmaceuticals in storage and distribution, and maintaining crisis-related pharmaceutical stockpiles for 3–10 months
Community pharmacies: A total of 632 private community pharmacy owners held licences in Finland at the end of 2021[2]. In addition, the University of Helsinki and the University of Eastern Finland each operate a pharmacy.	Responsible for pharmaceutical supply and operations in their respective areas and for stocking for a two-week need of pharmaceuticals.
Third Sector	**Tasks Mandated by Legislation[1]**
Advocacy organisations: Organisations that engage with government agencies on behalf of their members	
Pharma Industry Finland (PIF)	No legally mandated tasks
Finnish Association for Generic Drugs (FAGD)	No legally mandated tasks
Association of Finnish Pharmacies (AFP)	No legally mandated tasks

[1]Legal tasks have been simplified to ensure consistency and relevance. The responsibilities of government agencies are described in respective laws, such as the Finnish Medicines Act (395/1987) and the Degree (693/1987), the Act on Finnish Medicines Agency (593/2009), the Act on the National Institute for Health and Welfare (668/2008) and the Act on the Social Insurance Institution of Finland (731/2001). [2]The Association of Finnish Pharmacies, https://www.apteekkariliitto.fi/apteekkitieto/apteekit-numeroina.html; 2022 [accessed 12 Dec 2022].

The pharmaceutical companies manufacture and import medicines to wholesalers that store and distribute medicines and vaccines to pharmacies. Two major wholesalers, Tamro and Oriola, store and distribute almost 100% of all pharmaceuticals in Finland. Pharmaceuticals are distributed via one channel system, meaning that each pharmaceutical company has an exclusive agreement with one wholesaler, permitted to distribute its medicines to pharmacies and hospitals (Sarnola & Linnolahti, 2019).

Community pharmacies represent a regulated private sector responsible for pharmaceutical supply and care in their respected areas. A certified pharmacist's (MSc Pharm) degree and a licence from FIMEA are required for a pharmacy owner. In addition to private entrepreneur pharmacies, the University of Helsinki and University of Eastern Finland operate a pharmacy. At the end of 2019, there were 602 pharmacy owners in Finland, including two university pharmacies (The Association of Finnish Pharmacies, 2020). Majority of private pharmacy owners are members of the Association of Finnish Pharmacies (AFP), which represents them towards the media and government agencies. Most of the employees are pharmacists (MSc or BSc Pharm) and technicians. About half of the pharmacies have the facilities and competence to prepare medicinal products, mostly solutions, capsules and lotions (The Association of Finnish Pharmacies, 2017). Furthermore, three pharmacies have the facilities and licence for the contractual manufacture of pharmaceuticals for other pharmacies. Pharmacies are obliged to advise patients about the effectiveness and safety of medicine treatments.

Hospital pharmacies operating inside university hospitals and central hospitals represent the public healthcare sector. There are five university hospital pharmacies and 16 central hospital pharmacies in Finland. Hospitals are responsible for specialised care in 21 wellbeing services counties. At the time of the study's data collection, hospitals arranged specialised care for 20 hospital districts and Åland, similar areas as current wellbeing services counties. Hospital pharmacy heads are certified pharmacists (MSc Pharm) by their education, responsible for the operation of pharmacies and pharmaceutical services according to the Finnish Medicines Act. Most of the employees are pharmacists (MSc or BSc Pharm) and technicians specialised in following areas: pharmaceutical supply and logistics, quality and medication safety, clinical pharmacy and pharmaceutical production.

3.2 CRISIS PREPAREDNESS OF THE PHARMACEUTICAL SECTOR

Medicine availability in Finland is highly import-dependent (European Federation of Pharmaceutical Industries and Associations, 2023). Thus, mandatory reserve supplies have been considered necessary to ensure national availability of certain pharmaceuticals in crises and unexpected disruptions.

The Act on Mandatory Reserve Supplies (979/2008) obligates pharmaceutical industry and importers, healthcare units and the THL to maintain crisis-related pharmaceutical stockpiles for 3–10 months. The Decree on Mandatory Reserve Supplies (1114/2008) identifies the pharmaceuticals to be stocked.

The National Emergency Supply Agency (NESA) coordinates the security of supply with relevant organisations to maintain sufficient buffers (National Emergency Supply Agency, 2024). NESA's tasks include coordinating collaboration between public and private sectors, managing national emergency stockpiles, maintaining essential technical systems, monitoring international developments and overseeing various stockpiling efforts related to fuel, pharmaceuticals, critical materials, energy, food and healthcare services. In addition, NESA supports organisations in continuity planning, arranges exercises and collaborates with defence forces to ensure preparedness for potential crises.

Private community pharmacies and public hospital pharmacies ensure medication availability in their respective areas. Community pharmacies are required to store two weeks' worth of medicines, medical equipment, supplies and bandages for their regular clientele (Medicines Act 395/1987, 55 §). In addition, hospital pharmacies are responsible for vaccine logistics and distribution. These responsibilities aim to ensure the availability of essential medications and supplies during disruptions.

The legal framework affecting crisis preparedness in the Finnish pharmaceutical supply chain covers also laws such as the Emergency Powers Act (1080/1991), Health Care Act (1326/2010) and Communicable Diseases Act (1227/2016). The Emergency Powers and Health Care Acts mandate all hospital districts and municipalities to maintain preparedness and continuity management plans and implement them in their respective areas when needed.

3.3 CORONAVIRUS OUTBREAK IN FINLAND

In December 2019, first news about a novel coronavirus spread around the world. On 29 January 2020, Finland's first COVID-19 case was detected in Lapland, and one day later, the WHO director general declared that the COVID-19 had spread to 20 countries and that the outbreak constituted a public health emergency of international concern (World Health Organisation, 2020a). The STM raised the level of preparedness in Finland (The Ministry of Social Affairs and Health, 2020c). The national contingency plan for epidemics was updated to reflect new information about COVID-19. Municipalities, associations of municipalities, hospital districts and regional government agencies were instructed to update corresponding contingency plans.

On 11 March, the WHO director general declared COVID-19 a pandemic (World Health Organisation, 2020b). Five days later, on 16 March, the Finnish

government, in co-operation with the president of the republic, announced that Finland was in a state of emergency due to the COVID-19 situation (The Government of Finland, 2020a). The Emergency Powers Act was invoked for the first time since the Second World War, centralising power with the government. Several measures protecting citizens' health were introduced (The Government of Finland, 2020b). Finland began preparations for border control and decided to suspend passenger traffic. Uusimaa, a region in Southern Finland, was isolated to restrict the spread of infections to other parts of the country. The purpose of the restrictions was to slow down and prevent the spread of COVID-19 in Finland, secure the healthcare capacity throughout the country and protect citizens, especially risk groups.

Purchases of prescription medicines, especially for respiratory diseases (ATC R), increased significantly in February–March (see Figure 2; Tiirinki et al., 2020). The Emergency Powers Act enabled measures to protect pharmaceutical supply, and on 19 March, the STM restricted prescription medicine supply to a maximum of three months, emphasised over-the-counter (OTC) sales restrictions and obligated pharmaceutical wholesalers to prioritise the supply of medicinal products, medicines and medical supplies over other product groups (The Ministry of Social Affairs and Health, 2020e). On 9 April, the STM further restricted the supply of salbutamol products from a pharmacy for a maximum treatment period of one month (The Ministry of Social Affairs and Health, 2020b).

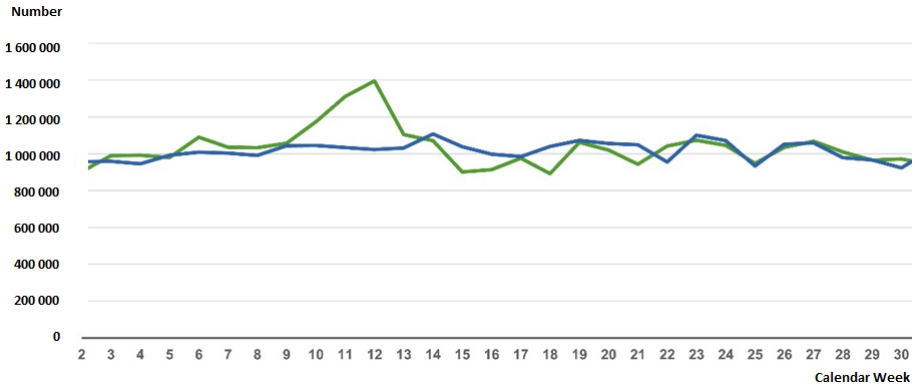

Figure 2 Number of Prescription Medicine Purchases in Community Pharmacies Per Week Prior to the COVID-19 Pandemic in 2019 (blue) and During the Outbreak in 2020 (green) in Finland; all ATC Categories Included (adopted from Tiirinki et al., 2020)

On 16 June, the government ended the emergency conditions in Finland, and thus, the Emergency Powers Act was no longer in force (The Government of Finland, 2020c). Many of the restrictions were gradually revoked as infection rates came close to zero. On 13 July, the Finnish Medicines Act, the Act on Mandatory Reserve Supplies and the Communicable Diseases Act were updated to give needed power for government officials to protect pharmaceutical supply without the Emergency Powers Act (The Ministry of

Social Affairs and Health, 2020a). The update allowed the STM to restrict or target the distribution and sale of medicinal products temporarily, if necessary, to protect public health in case of a disruption of medicine supply or a threat of disruption. On 18 August, the STM restricted the supply of prescription medicines containing paracetamol or dexamethasone to a maximum of three months and emphasised OTC sales restrictions based on the updated Finnish Medicines Act (The Ministry of Social Affairs and Health, 2020d).

The infection rate started to rise again in the autumn, accelerating in November (Saunes et al., 2022). Because the Emergency Powers Act was not in use, power lied in hands of regional government agencies and local public officials. The responsibility of individuals was highlighted, and hand disinfectants, masks, remote work and social distancing became the 'new normal'.

Comirnaty®, developed by Pfizer/BioNTech, was the first approved COVID-19 vaccine (European Medicines Agency, 2020; Food and Drug Administration, 2020; The Government of United Kingdom, 2020). On 27 December 2020, the first patient was vaccinated in Finland. Various infection waves occurred during years 2020–2024 (see Figure 3). In May 2023, it was declared that COVID-19 was no longer a public health emergency of international concern (World Health Organisation, 2023). The importance of supply security and preparedness was emphasised in the Finnish government programme published in June 2023 (National Emergency Supply Agency, 2023). In the healthcare sector, the programme aligned that the Act on Mandatory Reserve Supplies will be reformed, and other measures to secure the supply and availability of medicines will be taken.

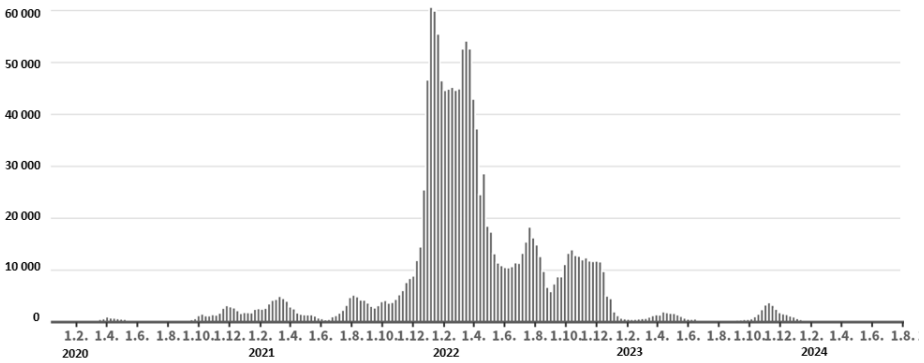

Figure 3 Weekly Coronavirus Infection Cases in Finland by the Date of the Statistics (adopted from The National Institute for Health and Welfare, 2024)

3.4 EMPIRICAL PANDEMIC MANAGEMENT STUDIES

The following sectors briefly describe empirical crisis management studies in contexts of community pharmacies, hospital pharmacies and the pharmaceutical industry, focusing on the COVID-19 pandemic. Literature search was conducted with the phrases 'crisis', 'pandemic' or 'COVID-19' and 'management', 'response', 'preparedness' or 'learned lessons' combined with the context.

3.4.1 COMMUNITY PHARMACIES

Empirical studies about community pharmacies' crisis preparedness, response and learned lessons during the COVID-19 pandemic cover insights from Europe, North America, Australia and Asia (Al Mazrouei et al., 2021; Bahlol & Dewey, 2021; Carpenter et al., 2021; Durand et al., 2022; ElGeed et al., 2021; Giua et al., 2021; Gregory & Austin, 2020; Hoti et al., 2020; Koster et al., 2021; Novak et al., 2021; Sum & Ow, 2021; Zaidi & Hasan, 2021; Zeenny et al., 2021; Zhao et al., 2021). Most of the studies collected data through online questionnaires, while minority gathered in-depth information through interviews. One study (Hoti et al., 2020) applied the transtheoretical model in the questionnaire development, while other studies did not specify a theoretical framework. Table 5 presents elements supporting effective crisis management in community pharmacies summarised from the literature. In addition to empirical studies, several commentaries and recommendations, as well as narrative descriptions of crisis preparedness and response, have been published (Aruru et al., 2021; Bukhari et al., 2020; Cadogan & Hughes, 2021; Kretchy et al., 2021; Liu et al., 2020; Siddiqui et al., 2020).

Table 5 Synthesis of the Literature: Elements Supporting Effective Crisis Management in Community Pharmacies

Pre-crisis	Crisis Response	Post-Crisis
Crisis response plans addressing 1) adequate supply of personal protective equipment 2) procedures to protect against medication shortages 3) describe infection control procedures 4) address workforce planning **Crisis training** via, e.g. externally organised training or drill	**Decision-making** supported by a rapid access to high-quality data and protocols **Infection prevention measures:** 1) adequate supply of surgical masks, gloves or other PPE 2) other infection control measures, such as protective barriers, social distancing, frequent cleaning, remote services, workforce planning **Strategies to manage shortages:** 1) limiting sales of certain drugs and personal protective equipment 2) repackaging bigger packs into smaller packs 3) providing counselling for patients and physicians on therapeutic alternatives 4) extending repeat prescriptions without doctors' agreements, in cases where special supply provisions are allowed by legislation	**List of learned lessons** to be better prepared for future crises **Maintenance of new methods or services**, such as digital tools or vaccination service

3.4.1.1 Pre-Crisis

Previous research providing insights into community pharmacies' crisis preparedness has studied crisis plans, training and pharmacists' willingness to participate in such training (Bahlol & Dewey, 2021; Carpenter et al., 2021; ElGeed et al., 2021; Zhao et al., 2021). A pre-existing crisis plan existed in 73% of rural pharmacies in the United States; however, in 27% of these pharmacies, the plan was inadequate for the COVID-19 pandemic due to the focus on physical or weather threats rather than infectious disease (Carpenter et al., 2021). These pharmacies suggested that a pandemic preparedness plan should address adequate supply of personal protective equipment, include procedures to protect against medication shortages, describe infection control procedures and address workforce planning. A preparedness plan was familiar to 65% of urban pharmacy respondents in the United States, and among those, 57% found their plan suitable for the COVID-19 pandemic (Zhao et al., 2021).

Public health disaster training was received by 10% of the rural pharmacists, while 32% of urban pharmacists received training or participated in an emergency preparedness drill in the past five years in the United States (Carpenter et al., 2021; Zhao et al., 2021). Training programmes were externally organised. These results were similar to an Egyptian study, in which 21% of pharmacists reported participation in a pandemic training. In addition, a significant majority of pharmacists were willing to engage in preparedness training (Carpenter et al., 2021; ElGeed et al., 2021; Zhao et al., 2021).

3.4.1.2 Crisis Response

Previous research focusing on community pharmacies' crisis response studied infection prevention and control measures, workforce planning and adaptation, strategies to manage product shortages and challenges faced by community pharmacies (Al Mazrouei et al., 2021; Bahlol & Dewey, 2021; Carpenter et al., 2021; Durand et al., 2022; ElGeed et al., 2021; Gregory & Austin, 2020; Hoti et al., 2020; Koster et al., 2021; Novak et al., 2021; Sum & Ow, 2021; Zaidi & Hasan, 2021; Zeenny et al., 2021). Numerous patients applying prescription renewals, OTC medicines and health advice, as well as medicine shortages increased pharmacists' workload (Gregory & Austin, 2020). Also, lack of information, workplace support, and standardised practices induced challenges during early stages of the COVID-19 pandemic. Pharmacists requested for a central repository of pharmacy-specific guidance providing rapid access to the right information during crises.

Key infection control practices included the use of surgical masks, gloves or other PPE, protective barriers, social distancing, frequent cleaning and work area disinfection (Bahlol & Dewey, 2021; Carpenter et al., 2021; Giua et al., 2021; Koster et al., 2021; Novak et al., 2021). Remote services, such as home

deliveries and phone or online consultations, were implemented to prevent infections and protect vulnerable groups.

Changes in workforce planning were made to protect customers and pharmacy personnel (Novak et al., 2021; Sum & Ow, 2021). Examples of different solutions were dividing employees into separate teams and applying, for example, 1-day or 7-day work rotations (Gregory & Austin, 2020; Novak et al., 2021). Immunocompromised or high health risks employees were reassigned (Sum & Ow, 2021). In some countries, pharmacists checked the infection status of the people entering the pharmacy and guided potential COVID-19 patients (Durand et al., 2022; ElGeed et al., 2021; Hoti et al., 2020; Novak et al., 2021; Zaidi & Hasan, 2021; Zeenny et al., 2021).

Majority of pharmacies faced medicine, PPE or disinfectant shortages (Bahlol & Dewey, 2021; Carpenter et al., 2021; Novak et al., 2021; Zaidi & Hasan, 2021; Zeenny et al., 2021). Strategies to manage shortages included limiting certain drugs and PPE, repackaging bigger packs into smaller packs, providing counselling for patients and physicians on therapeutic alternatives and extending repeat prescriptions without doctors' agreements in cases where special supply provisions were allowed by legislation (Novak et al., 2021; Paudyal et al., 2020). To overcome disinfectant shortages, 30.7% of pharmacies in Croatia and Serbia started to produce hand sanitisers (Novak et al., 2021).

3.4.1.3 Post-Crisis

Previous research provides valuable insights into the continuity of services, staff well-being and the maintenance of the quality of patient care during disruptions (Austin & Gregory, 2021; Koster et al., 2021). Lessons learned include elements such as appropriate shift lengths, team-based scheduling, dedicated office spaces to focus on specific tasks, the integration of technology and the inclusion of nonprofessional support staff in pharmacies. Some of the infection prevention measures adopted during the crisis became standard in pharmacies (Koster et al., 2021). Plastic screens enhance hygiene and provide security at pharmacy counters in cases of verbal abuse or violence. Various digital tools and services developed during the pandemic, such as online patient education tools, medication delivery services and online prescription renewal options, also provide value after the pandemic. Before the COVID-19 vaccinations were developed, pharmacists had already expressed their readiness to give vaccinations when available (Paudyal et al., 2020).

Dividing employees into separate teams and applying different working day rotations were applied in many pharmacies (Austin & Gregory, 2021). It was noticed that longer shifts (i.e. 12, 14, or longer working hours) produced cognitive and emotional overload, which led to delayed recovery. Providing dedicated office spaces for pharmacists to focus on specific tasks reduced multitasking, which reduced cognitive load and improved quality of care and

clinical outcomes. Technology provided a control over day-to-day tasks for pharmacy team members. Nonprofessional support staff who were, for example, able to handle deliveries and receive inventory reduced pharmacists' workload and stress.

3.4.2 HOSPITAL PHARMACIES

Researchers in hospital pharmacies have provided valuable descriptions and take-aways of strategies for staffing, logistics, procurement and clinical issues during the SARS and COVID-19 pandemics (Chin et al., 2004; Dzierba et al., 2020; Herranz-Alonso et al., 2020; Waldron et al., 2021; D. Wu et al., 2004), management of human resources (Adam et al., 2021), the establishment of temporal COVID-19 hospitals and pharmaceutical care of COVID-19 patients (Hua et al., 2020; Song et al., 2021; J. Wu et al., 2020). Empirical crisis studies in hospital pharmacies include the provision of clinical pharmacy services and pharmacist interventions (Al-Quteimat et al., 2023; Damuzzo et al., 2023; Paudyal et al., 2020), shortages, mitigation strategies and sources of information (Vinci et al., 2022) and the implementation of tele-pharmacy (Tortajada-Goitia et al., 2020), home delivery services (Bejarano et al., 2020) and other innovative strategies in hospital pharmacies during the COVID-19 pandemic (Li et al., 2021). A recent empirical survey study described crisis preparedness and response in Swiss hospital pharmacies (Schumacher et al., 2023).

3.4.2.1 Pre-Crisis

According to Schumacher et al. (2023), previously prepared internal standard operating procedures or plans for disaster management were used in 41% (17/41) of Swiss hospital pharmacies during the first wave of the pandemic in Switzerland (Schumacher et al., 2023). In addition, a business continuity plan was ready at 18% (7/39) of hospital pharmacies.

Some studies about methods for preparing hospital pharmacists for disasters exist (Schumacher et al., 2022; Watson et al., 2021). Swiss and Australian hospital pharmacists attended to either full-scale or table-top disaster simulations, which improved overall organisational preparedness and increased awareness of crisis management. The main challenges during full-scale simulations related to communication and crisis management (Schumacher et al., 2022). The WHO has published recommendations on practising emergency exercises in hospitals, which could be used to plan such a simulation (World Health Organisation. Regional Office for the Western Pacific, 2010).

3.4.2.2 Crisis Response

Constant changes to therapeutic protocols and regulatory requirements, increase in the demand for resources and health safety issues posed challenges during the initial stages of the pandemic (Herranz-Alonso et al., 2020). Hospital pharmacies were an integral part of hospitals' pandemic management (Herranz-Alonso et al., 2020; Paudyal et al., 2020; Schumacher et al., 2023). As a part of such, for example, in a Spanish hospital, regular meetings were held by the operational COVID-19 crisis committee and the COVID-19 protocolisation and treatment committee, composed of various hospital sections (Herranz-Alonso et al., 2020). Daily epidemiological reports and the scientific evidence on the treatment of COVID-19 were reviewed, the protocol for COVID-19 therapeutic management was defined, and the hospital was reorganised based on current disease situation. Guidelines from professional societies and public health agencies provided valuable information for decision-making (Paudyal et al., 2020).

Most Swiss hospital pharmacies (95%; 39/41) created a team to manage the crisis (Schumacher et al., 2023). The team usually consisted of the head pharmacist, representatives from the pharmaceutical logistics unit, the hospital's general crisis management team and/or clinical pharmacy unit. Half of the hospital pharmacies with a crisis plan (53%; 9/17) created a new electronic dashboard or another data management tool (e.g. an Excel® spreadsheet) specifically for the COVID-19 crisis, 24% (4/17) used pre-existing dashboards, and 24% (4/17) had no dashboards or other data management system. Many of the pharmacies (61%, 14/23) that did not have a pre-existing crisis plan created dashboards to manage the pandemic. The importance of data management was also highlighted by another study (Herranz-Alonso et al., 2020). The dashboards included information such as essential stock items requiring monitoring, the hospital's situation, the pharmacy's situation, problems faced by different units in the pharmacy, important contacts, list of key functions, pending issues and risk management (Herranz-Alonso et al., 2020; Schumacher et al., 2023).

Methods to address the shortages at hospital pharmacies included, for example, therapeutic substitution, generic substitution, monitoring medicines dedicated to COVID-19 patients, sourcing alternative medicines, additional strategic stock at the local, regional or national level, borrowing medicines from other hospitals or importing medicines from another country and using medicines from a national reserve supply (Schumacher et al., 2023; Vinci et al., 2022). After the first pandemic wave, only 22% (9/41) of the Swiss hospital pharmacies managed to avoid shortages completely (Schumacher et al., 2023). Specific medicine lists for COVID-19 patient units were developed, including, for example, COVID-19 treatment medicines (lopinavir/ritonavir, hydroxychloroquine, remdesivir and tocilizumab), sedatives (dexmedetomidine, lorazepam, midazolam), anaesthetics (etomidate, fentanyl, ketamine, propofol, remifentanil, sufentanil, suxamethonium),

antibiotics (amikacin, amoxicillin, azithromycin, ceftriaxone, cefuroxime, imipenem, meropenem, piperacillin/tazobactam) curares (atracurium, cisatracurium, rocuronium), electrolytes and perfusions (heparin, insulin).

In addition to procurement and stocking changes described in the previous chapter, adjustments were made in pharmaceutical production, clinical services, internal and external communication and leadership (Herranz-Alonso et al., 2020; Li et al., 2021; Paudyal et al., 2020; Schumacher et al., 2023; Vinci et al., 2022). Some of the Swiss hospital pharmacies (10%; 4/41) started to produce parenteral forms of hydromorphone, midazolam, morphine, ketamine and/or fentanyl plus hydroxychloroquine suspension (Schumacher et al., 2023). A Spanish hospital pharmacy produced antiviral medicines and immunomodulators for COVID-19 (e.g. tocilizumab), critical care unit medicines (e.g. standard infusions), repackaged medicines and developed formulations to mitigate shortages (Herranz-Alonso et al., 2020). Support for medical and nursing care teams included, for example, handling questions via a pharmaceutical hotline, creating documents regarding medicine administration, moving a clinical pharmacist and/or a pharmacy technician to the intensive care unit, providing product characteristic tables and monitoring prescriptions for interactions, contraindications and correct dosages (Li et al., 2021; Schumacher et al., 2023). In addition, infection control measures are described in a few studies (Herranz-Alonso et al., 2020; Paudyal et al., 2020).

3.4.2.3 Post-Crisis

Self-evaluation was conducted, and lessons were drawn during the pandemic response (Paudyal et al., 2020; Schumacher et al., 2023). Measuring success and failures were mostly based on patients', hospital pharmacy personnel's and other personnel's safety (Paudyal et al., 2020). The lack of benchmarks to measure successes or failures was recognised. Hospital pharmacists learned various knowledge and skills such as critical care, extemporaneous dispensing, use of telecommunications and telemedicine and adaptability.

Schumacher et al. (2023) listed guides for improving preparedness in hospital pharmacies. They issued the following recommendations:

1) Update procedures and crisis management plans and refine business continuity plans.
2) Develop worst-case scenario plans for dealing with supply chain problems and train for them (e.g. table-top exercises).
3) Maintain a data management system/dashboard to, for example, monitor and evaluate drug use, availability and shortages.
4) Ensure infection control and pharmacy stocks of disinfectants and PPE.
5) Anticipate needs and ensure minimal pharmacy stocks by preparing 'pandemic inventories' of critical medicines.
6) Talk directly with stakeholders (wards, government agencies etc.).

3.4.3 PHARMACEUTICAL INDUSTRY AND WHOLESALE

Empirical crisis management research in the context of the pharmaceutical industry and wholesale is limited, covering earlier studies regarding crisis preparedness (Priporas & Vangelinos, 2008; Watkins et al., 2008) and learning after an organisational crisis (Rerup, 2009). Descriptive communications have evaluated impacts of the COVID-19 pandemic (Ayati et al., 2020; Barshikar, 2020; Cundell et al., 2020; Uwizeyimana et al., 2021), and described management strategies (Kuo et al., 2021; Uwizeyimana et al., 2021). In addition, components and strategies of pharmaceutical supply's operations management during preparedness and response were identified in a recent scoping review (Ahmad Hamdi et al., 2024).

Studies focusing on crisis preparedness have been made before the influenza H1N1 (swine flu) pandemic (Priporas & Vangelinos, 2008; Watkins et al., 2008); thus, it is likely that preparedness has evolved since then. According to Watkins et al. (2008), biotechnology and pharmaceutical companies in Montgomery County, Maryland, United States, were not well prepared for a pandemic at the time of the study. Majority (80%, 40/50) of the participating companies did not have any type of preparedness plan. Priporas and Vangelinos (2008) explored the crisis management practice and crisis prevention in Greece. They found that crisis management departments and programmes existed mainly in large multinational companies (75%, 12/16), and the small pharmaceutical companies relied mainly on their executives' experience in handling crises. Majority (69%, 11/16) of the participating companies had experienced a crisis. The main priorities in crisis management departments were continuous education, signal detection and developing two-way communication systems.

The COVID-19 pandemic was characterised by demand changes and supply issues, changes in research and development and the shift towards remote communication in the pharmaceutical industry (Ayati et al., 2020; Barshikar, 2020; Cundell et al., 2020). Unavailability of raw materials and manufacturing supplies, shutdown of transportation systems, bottlenecks in global supply chains and the lack of employees due to infections or suspected infections elevated the medicine availability issues (Bø et al., 2023; Cundell et al., 2020). The pandemic posed risks to employees' personal health and safety, product quality, GMP manufacturing, supply availability and transportation infrastructure. Several infection prevention measures were applied (Barshikar, 2020; Cundell et al., 2020).

Some studies provided insights on the response strategies during the pandemic. Bø et al. (2023) interviewed a global pharmaceutical company as part of their study on supply chain resilience in Norway. This company had pre-established continuous risk monitoring and mitigation procedures that enabled fast prioritisation of critical medicines capacity at the expense of non-critical medicines and the employing of temporary personnel in the risk of critical medicines' supply disruption. Long-term relationships with key

suppliers and changing the distribution transport suppliers enabled fast response to hoarding and consequent demand falls. Sufficient and timely risk monitoring as well as actionable and sufficiently detailed mitigation strategies and contingency plans were emphasised. Pharmaceutical supply operations involve various interconnected components, which affect the capability to mitigate medicine shortages (Ahmad Hamdi et al., 2024). Issues posed by the pandemic can be solved with proactive actions, active information and resource exchange, and coordination and collaboration among stakeholders (Ahmad Hamdi et al., 2024; Faggioni et al., 2023; Kuo et al., 2021). Supply operations play an important role in preventing shortages. Tasks include elements such as needs assessment, demand forecasting, logistics assessment, procurement, storage, distribution and monitoring (Ahmad Hamdi et al., 2024). In addition, human resources management and information management are key components of managerial operations (Ahmad Hamdi et al., 2024; Bastani et al., 2023; Faggioni et al., 2023). A Taiwanese study identified strategies to manage medicine shortages in collaboration with authorities and the pharmaceutical industry (Kuo et al., 2021). These included listing and tracking medications in a shortage risk, identifying alternative sources of APIs or medications, reviewing applications for relevant APIs, establishing financial incentives and reimbursement plans to relieve the cost burden of alternative sources and reinforcing a supply-demand balance ruling to ensure rational medicine distribution, allocation and stockpiling. Official guidelines for pharmaceutical companies and healthcare facilities provided procedures to rational medicine supply and distribution, as well as purchase and stockpiling.

4 MATERIALS AND METHODS

The present study originated from a practical idea to advance the pharmaceutical sector's crisis preparedness. Therefore, it employs a pragmatic study approach (Morgan, 2007). Pragmatism seeks to find practical solutions to social problems that create meaningful change (Shannon-Baker, 2016). According to the pragmatic approach, people's actions cannot be separated from the context, and practices are shaped in interactions between people (Morgan, 2007). Pragmatism emphasises the researcher's close relationship with the studied subject and aims to find practical implications that can be used by professionals.

Studies I-III combine internally and externally oriented perspectives aiming to build a comprehensive picture of structural aspects of crisis management and stakeholder relationships during the pandemic (Bundy et al., 2017). These studies view the pandemic from an organisational perspective, while Study IV adopts the view of the pharmaceutical supply chain. Figure 4 illustrates the study design, theoretical frameworks and pharmaceutical supply chain stakeholders in Studies I-IV.

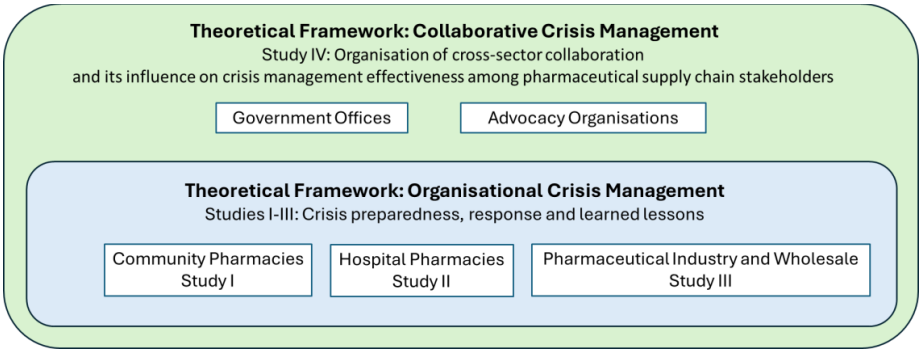

Figure 4 Study Design, Theoretical Frameworks and Pharmaceutical Supply Chain Stakeholders in Studies I-IV

This study employs both qualitative and quantitative research methods. A web-based questionnaire served as the main data source in Studies I–III. This method was selected as the data collection method to protect the health of the respondents at the time of increasing infection rates and save their time. It enabled crisis leaders' voices from relevant supply chain stakeholder groups. Organisational crisis management process models provided the theoretical framework to the questionnaire development. Utilising process models for developing the survey instrument provided a novel approach to investigating crisis management process theory, as previous studies drawing on such models were primarily based on interviews, documents or media data (Bundy et al., 2017). Descriptive statistical analysis was conducted in Studies I-III. In addition, in Study I, logistic regression analysis was applied to explore whether crisis management efforts can protect staff resilience, pharmacy owners' resilience, organisational cohesion ('team spirit') and pharmacies' resources or finances. Questionnaire data was enriched and confirmed in data triangulation with semi-structured interviews in Studies II and III. Theory orientation was deductive; however, abductive approach was applied in qualitative content analysis of open field questions (Elo & Kyngäs 2008; Graneheim et al., 2017).

Semi-structured interviews were chosen as the data collection method in Study IV to obtain an in-depth and holistic view of a complex and understudied subject (Gioia et al., 2013). Theory orientation in Study IV was abductive, combining deductive and inductive approaches (Graneheim et al., 2017). Collaborative crisis management literature guided the development of the interview protocol. Gioia methodology was chosen as a qualitative content analysis method because of its systematic approach providing transparency to an inductive analysis process and its presentation (Gioia et al., 2013). Finally, the literature was revisited to relate findings to the existing knowledge. Collaboration was seen as a collective action solution to the pandemic. This view constitutes less theoretically grounded research but provide rich material on process dimensions, sources of ambiguity within collaborative work and findings that can more easily be translated to practice (Bryson et al., 2015). Table 6 depicts the outline of the thesis.

Table 6 Outline of the Thesis

		STUDY	STUDY AIMS	DATA COLLECTION METHODS AND DATA SOURCE	DATA ANALYSIS
THEORETICAL FRAMEWORK	Organisational crisis management: sector-level perspective	I	1) To depict the crisis management process in Finnish community pharmacies and 2) To explore whether pre-existing crisis plans, crisis teams, shared decision-making or collaboration and communication with external stakeholders can protect staff resilience, pharmacy owners' resilience, organisational cohesion ('team spirit') and pharmacies' resources or finances during the pandemic	Web-based survey, community pharmacy owners (n = 221)	Descriptive statistical analysis, logistic regression analysis, qualitative content analysis
		II	1) To depict the crisis management process in Finnish hospital pharmacies and 2) To identify areas for development to improve future crisis preparedness	Web-based survey, hospital pharmacy heads (n = 12) Data triangulation with 6 semi-structured interviews	Descriptive statistical analysis, qualitative content analysis
		III	1) To depict the crisis management process in pharmaceutical industry and wholesale in Finland, and 2) To identify areas for development to improve future crisis preparedness	Web-based survey, leaders and specialists from the pharmaceutical industry and wholesalers (n = 20) Data triangulation with 10 semi-structured interviews	Descriptive statistical analysis, qualitative content analysis
	Collaborative crisis management: cross-sector perspective	IV	1) To depict how pharmaceutical supply chain stakeholders organised cross-sector collaboration during the COVID-19 pandemic, and 2) To investigate how cross-sector collaboration influenced the crisis management effectiveness	Semi-structured interviews (n = 31): Leaders and specialists from the pharmaceutical industry and wholesalers (n = 9), community pharmacy owners (n = 9), hospital pharmacy heads (n = 6), government agency directors and officials (n = 5) and advocacy organisation representatives (n = 2)	Qualitative content analysis

4.1 DATA COLLECTION

Research data were collected utilising two data collection methods: a web-based questionnaire and semi-structured interviews. The timing of the data collection is illustrated in the Figure 5 in relation to pandemic infection waves, medicine consumption peak and the beginning of COVID-19 vaccinations in Finland.

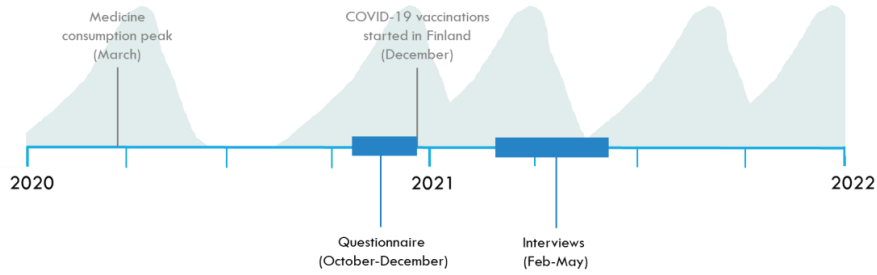

Figure 5 Timing of the Data Collection. Waves Illustrate the Timing (Not the Magnitude) of COVID-19 Infection Peaks in Finland (adopted from The National Institute for Health and Welfare, 2024).

4.1.1 QUESTIONNAIRE (I–III)

Crisis management literature (especially process models provided by Coombs 2007 and Pearson and Clair 1998) provided a theoretical framework for survey development. Existing publications on pandemic preparedness and response in community pharmacies, hospital pharmacies and the pharmaceutical industry and wholesale were explored to contextualise specific questions. The questionnaire was developed by the research group, whose members had both content-based and methodological expertise. It was evaluated by two experts from the AFP and one expert from the PIF. Finally, the questionnaire was sent for a face validity assessment to a pilot group (n = 6), resulting in three minor modifications for clarity. The pilot group's members were pharmacy owners (n = 2), hospital pharmacy heads (n = 2) and directors from the pharmaceutical industry and wholesale (n = 2). Pilot group members provided content expertise from different sizes and types of organisations. Four of them had research experience. The definition of a 'crisis', in the context of this study, was explained to the respondents in an information letter that accompanied the questionnaire: The term signified the global COVID-19 pandemic crisis, which affected the Finnish pharmaceutical supply chain. A traditional definition of resilience was applied (Finnish term 'jaksaminen'): Resilience is

defined as the ability to adapt to and maintain psychological equilibrium during times of high stress (Rakesh et al., 2017).

The questionnaire was divided into three parts: the pre-crisis, crisis response and post-crisis stages (see Appendix 1: Questionnaire). The questions in the first part focused on preparedness, such as pharmacy owners' perception of risks and crisis plans. The second part focused on responses and the continuity of operations with questions about crisis management teams, operational changes, collaboration with stakeholders and information sources. Some sector-specific questions were included. Finally, the third part focused on self-evaluation and lessons learned. The rationale for including questions about the post-crisis stage even though the pandemic was still ongoing was to gain data from the cross-sectional timepoint that could complement the lessons learned after the pandemic. The final questionnaire comprised 29 questions for industry and wholesale and 31 for pharmacies. Questions mainly applied a structured format with 'Yes/No' or Likert-scale options. Some open-ended question fields were included to gather additional narrative information for clarification. The online version of the questionnaire was created using the Microsoft 365 Forms web application (Microsoft Corporation, Redmond, WA, USA). An invitation to the survey was disseminated to pharmacy owners (I), heads of hospital pharmacies (II) and managing directors of the pharmaceutical industry and wholesale (III) via related associations or email (see Figure 6). A follow-up reminder was sent two weeks later.

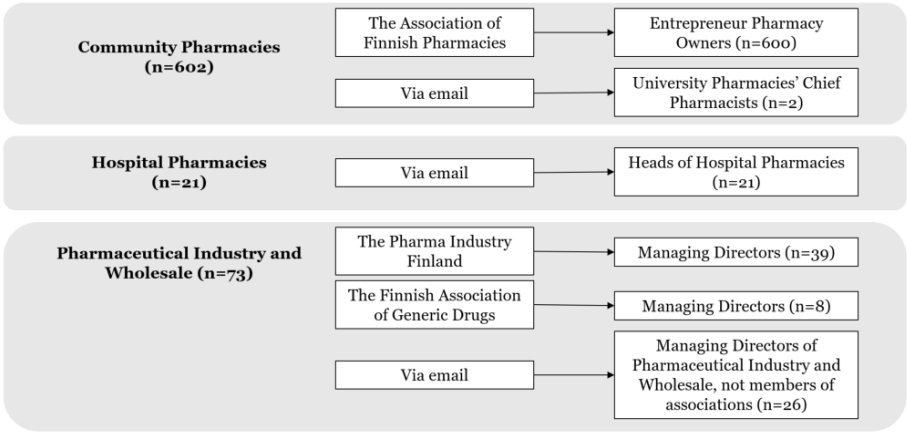

Figure 6 Invitations to Participate in the Questionnaire Was Sent via Different Channels (I–III).

4.1.2 SEMI-STRUCTURED INTERVIEWS (IV)

Purposeful selection was used to collect a representative sample of relevant stakeholders, who were leaders and specialists from the pharmaceutical industry and wholesalers (n = 9), community pharmacy owners (n = 9), hospital pharmacy heads (n = 6), government agency directors and officials (n = 5) and advocacy organisation representatives (n = 2; Table 7). In total, 31 leaders and specialists were interviewed. The primary selection criterion was the individual's or organisation's central role in pharmaceutical supply security during the pandemic. The secondary selection criteria considered geographical dispersion, organisational size and function and individuals' strategic and operational roles. Informed consent was obtained from the participants through a preliminary information sheet containing a data protection notice.

Table 7 Participants (IV). Titles have been simplified, as needed, to ensure anonymity.

Private Sector		**Public Sector**		**Third Sector**
Pharmaceutical Industry and Wholesalers	**Community Pharmacies**	**Hospital Pharmacies**	**Government Agencies**	**Advocacy Organisations**
Country Manager	Pharmacy Owner 1	Head of Pharmacy 1	Director 1	Representative 1
Director 1	Pharmacy Owner 2	Head of Pharmacy 2	Director 2	Representative 2
Director 2	Pharmacy Owner 3	Head of Pharmacy 3	Director 3	
General Manager 1	Pharmacy Owner 4	Head of Pharmacy 4	Official 1	
General Manager 2	Pharmacy Owner 5	Head of Pharmacy 5	Official 2	
General Manager 3	Pharmacy Owner 6	Head of Pharmacy 6		
Operational Manager	Pharmacy Owner 7			
Responsible Pharmacist 1	Pharmacy Owner 8			
Responsible Pharmacist 2	Pharmacy Owner 9			

A semi-structured interview protocol was developed (see Appendix 2: Interview Protocol). The literature review of collaborative crisis management guided the protocol development on four topics: organisation of cross-sector collaboration among pharmaceutical supply chain stakeholders during the COVID-19 pandemic, content of the collaboration and its influence on crisis management effectiveness, leadership and decision-making during crisis and lessons learned (Bryson et al., 2006; Curnin & O'Hara, 2019; Hesse et al., 2019; Nohrstedt et al., 2018). Study IV focused on the first two topics that included questions such as *'What kind of systematic or ad hoc collaboration did you have with pharmaceutical supply chain stakeholders during the pandemic?', 'What type of collaboration occurred in practice?', 'How did collaboration change during the crisis compared to normal times?', 'What kind of collaboration was the most important for you? Why?', 'What is the purpose of collaboration in the pharmaceutical supply chain during a crisis?', 'How was the pandemic crisis managed in the Finnish pharmaceutical supply chain?'* and *'Could you give concrete examples of crisis management efforts?'*.

The protocol was evaluated in individual pilot interviews (n = 3) conducted in February–March 2021. The pilot group's members were a pharmacy owner, hospital pharmacy head and managing director from the pharmaceutical industry providing content expertise from different sectors. The protocol was slightly adjusted based on feedback, allowing for the inclusion of pilot interviews in the data analysis. Individual (n = 29) and paired (n = 2) study interviews were conducted in March–May 2021 via Microsoft Teams (n = 29) or phone (n = 2), audio recorded and transcribed verbatim. They lasted from 37 to 106 minutes (average duration: 58 minutes). Two researchers participated in 27 of the 30 interviews, while three were conducted by one researcher. Each participant was given an opportunity to review their interview transcript for accuracy and provide any necessary clarification via email. Overall, 29 interview hours and 244 pages of interview data were studied.

4.2 DATA ANALYSIS

4.2.1 QUESTIONNAIRE AS THE MAIN DATA SOURCE (I–III)

In Studies I–III, descriptive quantitative data analysis and qualitative data analysis for open-ended responses were conducted using the Microsoft 365 Excel software (version 2311, Microsoft Corporation, Redmond, WA, USA). Open-ended responses were analysed qualitatively using abductive content analysis based on crisis management process models and existing publications on pandemic preparedness and response in community pharmacies (I), hospital pharmacies (II) and the pharmaceutical industry (III) (Elo & Kyngäs,

2008; Graneheim et al., 2017). The data were gathered by content and grouped based on similarities. The answers related to lessons learned regarding the pharmaceutical supply chain were analysed together (questions 28 [Q28] and Q29 in I–II; Q26 and Q27 in III). In addition, the responses related to lessons learned from organisational crisis management (Q30 and Q31 in I–II; Q28–Q29 in III) were analysed together.

In Study I, inferential statistics were calculated to explore whether (1) pre-existing crisis plans, (2) crisis teams, (3) shared decision-making in crisis management or (4) collaboration and communication with external stakeholders can protect staff resilience, pharmacy owners' resilience, organisational cohesion ('team spirit') and pharmacies' resources or finances.

The following questions were studied:

1. Did pharmacies whose pre-existing crisis plans had been utilised in response to the pandemic (Q5) experience fewer negative pandemic impacts than those whose plans had not (Q22–27)?

2. Did pharmacies with crisis teams (Q9) experience fewer negative pandemic impacts than those without such teams (Q22–27)?

3. Did pharmacies where decisions were made collectively with other employees (Q9b) experience fewer negative pandemic impacts than those where decisions were made by pharmacy owners alone (Q22–27)?

4. a. Did pharmacies whose collaboration and communication with other pharmacies or pharmaceutical supply chain stakeholders increased or improved (Q15) experience fewer negative pandemic impacts than those whose collaboration was unchanged or decreased (Q22–27)?

4. b. Did pharmacies whose collaboration and communication with social and healthcare stakeholders increased or improved (Q16) experience fewer negative pandemic impacts than those whose collaboration was unchanged or decreased (Q22–27)?

Logistic regression was chosen as an analysis method to account for potential confounding factors and investigate potential associations' strength and direction. This analysis was performed using IBM SPSS Statistics for Windows (Statistical Package for the Social Sciences, version 29, Chicago, IL, USA). Crisis management efforts were included in the logistic regression model as independent variables: crisis plans (Q5), crisis teams (Q9), shared decision-making (Q9b) and collaboration with external stakeholders (Q15–Q16). Collaboration with stakeholders was categorised as 'increased or improved' or 'decreased or unchanged'. 'Unchanged' was combined with

'decreased' under the assumption that, in these cases, collaboration was not used to solve pandemic-related issues. Self-evaluated pandemic impacts were included in the model as dependent variables (Q22–27). To simplify the analysis and interpretation, impacts were grouped into two categories: 'no impact–positive impact' (including no impact, positive and very positive impacts) and 'negative impact' (including negative and very negative impacts). 'No impact' was included in the positive category to isolate negative answers and reflect the statistical questions' phrasing. To account for potential confounding factors, the logistic regression analysis was adjusted for the following variables: years of experience as a pharmacy owner, pharmacy location and number of employees. The logistic regression results are presented using odds ratios (ORs) with 95% confidence intervals (CIs); *p*-values of less than 0.05 were considered statistically significant.

In Studies II and III, data triangulation was conducted with transcripts from semi-structured interviews (Study II: hospital pharmacy heads, $n = 6$; Study III: pharmaceutical industry and wholesale, $n = 9$). Interview transcripts were cross-referenced with survey responses to identify divergent, corroborative or additional quotations. Quotations related to the survey topics were primarily drawn from interview Q1, *'Tell us briefly about your personal experience in the hospital pharmacy's crisis management during the COVID-19 pandemic.'*, and Q22, '*How would you improve the preparedness of the Finnish pharmaceutical supply chain for future crises?'* Additional relevant parts of the interviews were also considered. The quotations were compiled using Microsoft 365 Excel® software and cross-referenced with each section of the survey results.

4.2.2 INTERVIEWS AS THE MAIN DATA SOURCE (IV)

A qualitative content analysis using Atlas.ti software (version 9.1.6., ATLAS.FI GmbH, Berlin, Germany) was conducted by two researchers to allow researcher triangulation and increase the study's reliability. Researchers worked independently but regularly compared codes, categories and themes. Gioia methodology provided a systematic approach for the qualitative content analysis (Gioia et al., 2013). The final dataset was formed following three distinct steps: open coding of quotations, systematically structuring the data from first-order categories to second-order themes and aggregate dimensions, and finally, revisiting the literature (see Figures 7 and 8). Following Gioia et al. (2013), the research questions guided open coding during the first analysis step.

The following questions were studied:

1. How did pharmaceutical supply chain stakeholders organise cross-sector collaboration during the COVID-19 pandemic?

2. How did cross-sector collaboration influence the crisis management effectiveness?

Experiences of systematic and ad hoc interorganisational collaboration on crisis management, including organisational structure details and the collaboration's formation, aims, content and frequency, were captured in open coding of quotations. Likewise, experiences related to the collaboration's purpose and positive/negative examples influencing crisis management effectiveness were obtained. One researcher coded all transcripts (30/30), resulting in 814 quotations and 377 codes; another coded half of them (15/30) to confirm the consistency of the emerging codes, resulting in 448 quotations and 286 codes.

In the second step, all codes were analysed to ensure multivocal first-order concepts. The codes were categorised based on similarities and differences in connection with the research questions. Informant terms and codes were further categorised into second-order themes and then aggregate concepts. The researchers compared independent analyses, revisited the data and discussed similarities and discrepancies. The interview transcripts were compared to one another to reduce the bias of the participants' self-evaluation of crisis management effectiveness and memory bias. In the third step, the researchers revisited the literature on collaborative crisis management to relate findings to the existing knowledge. Figures 7 and 8 present the example quotations, first-order concepts, second-order themes and aggregate concepts in the data structure for each research question, as guided by Gioia et al.'s (2013) methodology.

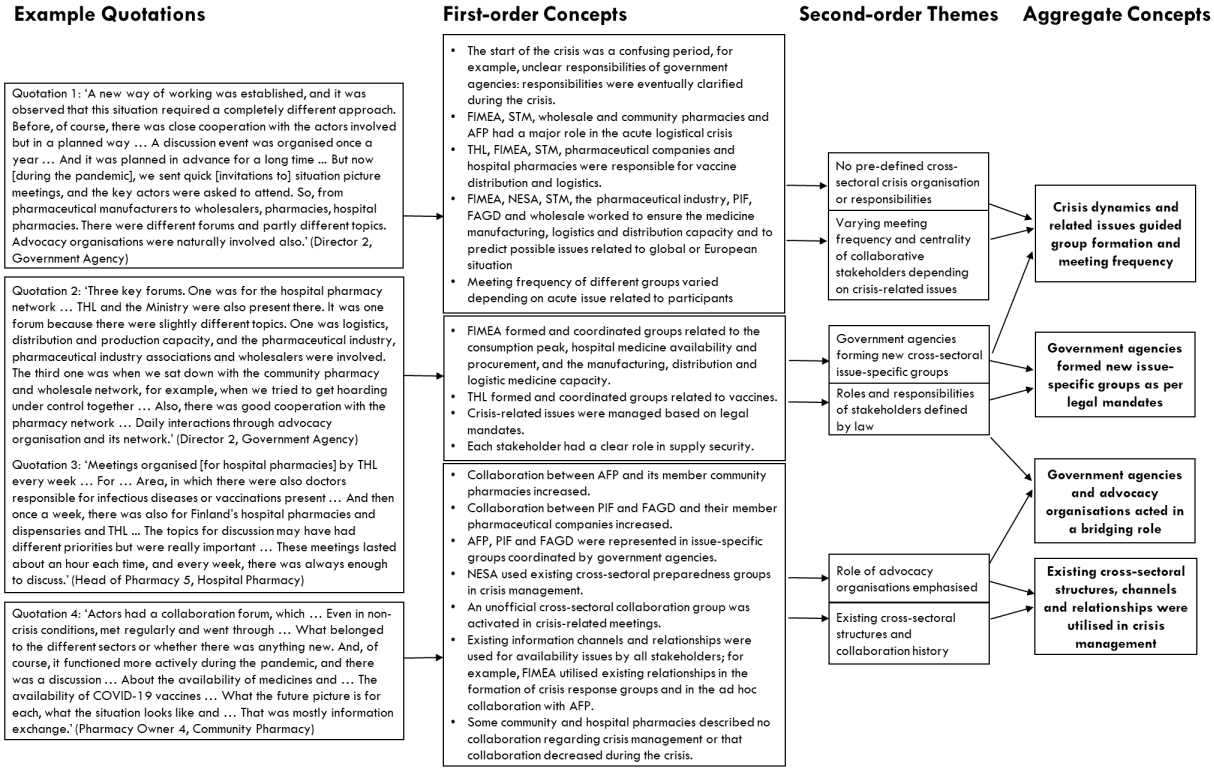

Figure 7 Data Structure: How Did Pharmaceutical Supply Chain Stakeholders Organise Cross-Sector Collaboration During the COVID-19 Pandemic? FIMEA = Finnish Medicines Agency, STM = Ministry of Social Affairs and Health, NESA = Emergency Supply Agency, THL = National Institute for Health and Welfare, AFP = Association of Finnish Pharmacies, PIF = Pharma Industry Finland, FAGD = Finnish Association for Generic Drugs, ERVA = Catchment area for highly specialised medical care

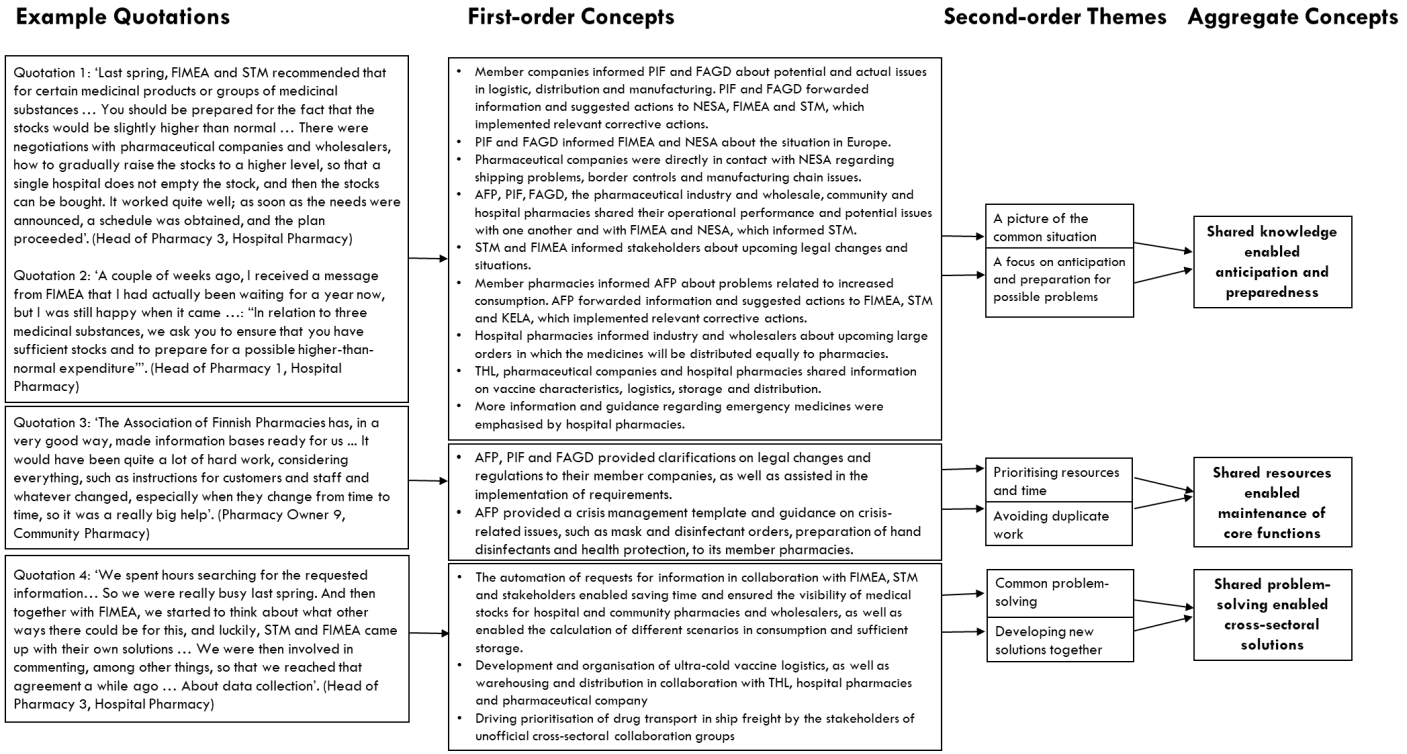

Figure 8 Data Structure: How Did Cross-Sector Collaboration Influence the Crisis Management Effectiveness? FIMEA = Finnish Medicines Agency, STM = Ministry of Social Affairs and Health, NESA = Emergency Supply Agency, THL = National Institute for Health and Welfare, KELA = The Social Insurance Institution of Finland, AFP = Association of Finnish Pharmacies, PIF = Pharma Industry Finland, FAGD = Finnish Association for Generic Drugs

4.3 RESEARCH ETHICS

The research followed guidelines of the Finnish National Board on Research Integrity (Finnish National Board on Research Integrity, 2012). Crisis studies require careful ethical evaluation due to abnormal circumstances, which may pose stress for the study participants. This study did not contain features that would require submitting the research to ethical review; however, an ethical statement was applied for the survey data collection due to journal requirements. An ethical pre-evaluation of the study protocol (I–III) was conducted by the University of Helsinki Ethical Review Board in Humanities and Social and Behavioural Sciences (reference number: 42/2020).

The study was designed considering the crisis situation. To prevent infections and save participants' time, data were collected remotely via an online questionnaire and virtual or telephone interviews. The adequacy of the questions was confirmed via pilot testing of the questionnaire and interviews. Acknowledging the workload caused by the pandemic, the response time to the questionnaire was extended.

The study data were collected, stored and handled based on national data protection instructions and the instructions of the University of Helsinki. A data protection notice was provided to the participants, and informed consent was obtained before data collection (I–IV). The participants were also provided with information about voluntary participation and the possibility of withdrawing from the study at any time. Personal identifiers were deleted from the interview transcripts. The questionnaire was answered anonymously.

5 RESULTS

5.1 ORGANISATIONAL CRISIS MANAGEMENT (I–III)

Overall, 221 community pharmacy owners (I), 12 hospital pharmacy heads (II) and 20 leaders from the pharmaceutical industry and wholesale (III) responded to the questionnaire, resulting in response rates of 37%, 57% and 27%, respectively. The participants' demographics are detailed in Tables 8, 9 and 10.

Table 8 Demographic Characteristics of Pharmacy Owners and Chief Pharmacists (Study I)

Characteristic	Description	n (%)
Job title	Pharmacy owner/chief pharmacist	221 (100.0)
Years of experience as owner of the pharmacy / in current position	0–5	56 (25.3)
	5–10	63 (28.5)
	10–15	46 (20.8)
	15–20	35 (15.8)
	>20	21 (9.5)
Work experience after graduation, years	10–15	1 (0.5)
	15–20	24 (10.9)
	>20	196 (88.7)
Pharmacy location (collaborative area for healthcare and social welfare)	Northern Finland	46 (20.8)
	Eastern Finland	25 (11.3)
	Inner Finland	42 (19.0)
	Western Finland	48 (21.7)
	Southern Finland	60 (27.1)
Number of employees	<10	96 (43.4)
	10–25	113 (51.1)
	>25	12 (5.4)

Table 9 Demographic Characteristics of Hospital Pharmacy Heads (Study II)

Characteristic	Description	n (%)
Job title	Head of pharmacy	12 (100)
Years of experience as owner of the pharmacy / in current position	0–5	3 (25)
	5–10	2 (17)
	10–15	3 (25)
	15–20	2 (17)
	>20	2 (17)
Work experience after graduation, years	15–20	3 (25)
	>20	9 (75)
Number of employees in the hospital pharmacy	<40	6 (50)
	40–80	2 (17)
	>80	4 (33)

Table 10 Demographic Characteristics of Leaders and Managers in the Pharmaceutical Industry and Wholesale (Study III)

Characteristic	Description	n (%)
Job title	Managing director, Country Manager / CEO	11 (55)
	Other titles*	9 (45)
Years of experience as managing director / in current position	0-5	9 (45)
	5–10	5 (25)
	10–15	1 (5)
	15–20	3 (15)
	>20	2 (10)
Work experience after graduation, years	10–15	2 (10)
	15–20	2 (10)
	>20	16 (80)
Organisation type	Pharma company, no pharmaceutical production in Finland	12 (60)
	Pharma company, pharmaceutical production in Finland	4 (20)
	Pharmaceutical wholesale	4 (20)
Number of employees	<50	7 (35)
	50–100	4 (20)
	>100	5 (25)

*Other directors/managers: production, quality, public relations, business management; CEO = Chief executive officer

5.1.1 PRE-CRISIS STAGE (I–III)

The initial section of the questionnaire explored management's risk perceptions and the adoption of crisis management efforts. The respondents evaluated the risk of a crisis affecting the pharmaceutical supply chain on a Likert scale before and during the pandemic (Figures 9, 10 and 11). Before the pandemic, 31% of pharmacy owners (I), 58% of hospital pharmacy heads (II) and 25% of pharmaceutical industry leaders and managers (III) considered a crisis likely or very likely. Following the onset of the pandemic, the corresponding percentages rose to 86%, 100% and 85%, respectively.

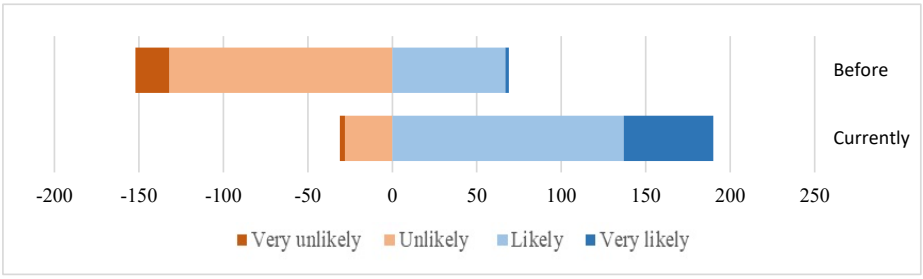

Figure 9 Pharmacy Owners' Perception of the Risk of a Crisis Concerning the Pharmaceutical Supply Chain Before and During the COVID-19 Pandemic (evaluated on a Likert-scale, *n* = 221; Study I). X-axis represents the number of the positive (likely-very likely) or negative (unlikely-very unlikely) responses.

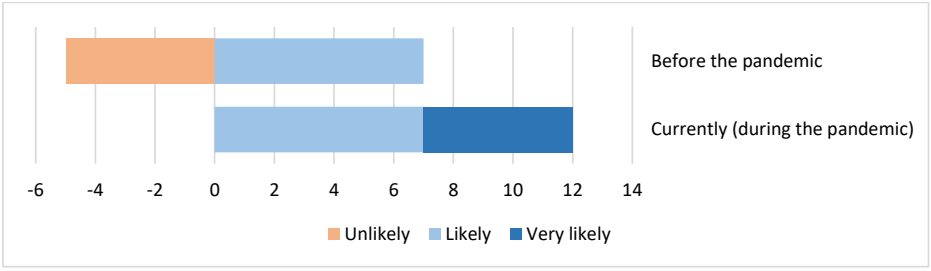

Figure 10 Hospital Pharmacy Heads' Perception of the Risk of a Crisis Concerning the Pharmaceutical Supply Chain Before and During the COVID-19 Pandemic (evaluated on a Likert-scale, *n* = 12; Study II). X-axis represents the number of the positive (likely-very likely) or negative (unlikely) responses. No 'very unlikely' responses were reported.

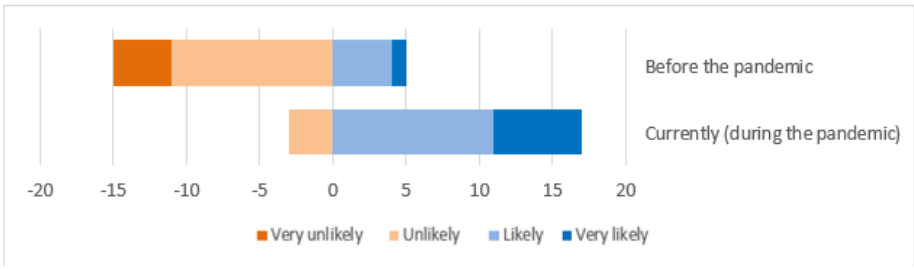

Figure 11 Pharmaceutical Industry and Wholesale Leaders' and Specialists' Perception of the Risk of a Crisis Concerning the Pharmaceutical Supply Chain Before and During the COVID-19 Pandemic (evaluated on a Likert-scale, *n* = 20; Study III). X-axis represents the number of the positive (likely-very likely) or negative (unlikely-very unlikely) responses.

5.1.1.1 Crisis Preparedness in Community Pharmacies (I)

Pharmacies established crisis plans or related standard operating procedures either before or during the pandemic. These plans addressed various scenarios, including infectious diseases, data connection system failures (including cyber threats), robberies or threatening situations, fire emergencies, power outages and sudden illness or the pharmacy owner's death. Crisis plans were taught either to the entire staff (*n* = 158, 72%), only to managing pharmacists (*n* = 27, 12%), only to the pharmaceutical staff (*n* = 14, 6%) or solely to the pharmacy owner (*n* = 14, 6%). Eight (4%) responses were in a pre-specified category 'other'.

Majority of the pharmacies (80%, *n* = 176) reported their ability to use pre-existing crisis plans to address the COVID-19 pandemic. Almost all pharmacies (91%, *n* = 202) created a new plan to minimise the harm caused by the pandemic. Pharmacies without a new plan either relied on guidelines provided by the AFP or operated without a formalised crisis plan.

5.1.1.2 Crisis Preparedness in Hospital Pharmacies (II)

Hospital pharmacies had pre-existing crisis response plans for a range of scenarios, including major disasters or catastrophes, pandemics, damage to the electricity system, data communication system and water system, staff shortages, fire, issues with medicine availability or logistics, robbery, war, acute evacuation or a general continuity plan for emergencies. These plans were taught to the entire staff (*n* = 10, 83%), to the pharmaceutical staff only (*n* = 1, 8%) or solely to the head of the hospital pharmacy (*n* = 1, 8%).

Pre-existing crisis management plans were activated in response to the pandemic in four hospital pharmacies (33%). Such plans were not used in eight (67%) pharmacies, primarily due to the absence of an existing plan or their inadequacy in a real-life scenario. A new crisis management plan for the COVID-19 pandemic was created in seven (58%) hospital pharmacies. Two of these pharmacies also had a pre-existing plan, which was not sufficient for the new situation. Interview data further explained the need for a new plan: *'Of course, there were those pandemic plans and others, but they were made with bird flu or swine flu in mind. And now, this was a completely different situation' (Hospital pharmacy head, Interview 3).* Reasons for not creating a new crisis management plan included being part of the hospital's pandemic plan, finding the existing general pandemic plan sufficient and a lack of time.

5.1.1.3 Crisis Preparedness in the Pharmaceutical Industry and Wholesale (III)

The pharmaceutical industry and wholesale had pre-existing contingency plans for various different scenarios. These were medicine safety or quality related, such as serious adverse events, product defects and recalls; disruptive event related, such as war, fire, robbery, explosion, accident, terrorism, cyber-attack and breakdown of machines, distribution hub or office; personnel related, such as strikes and staff shortages; damage of indispensable systems, such as electricity, water or data communication system; natural disaster, such as pandemics; reputation issues and medicine shortages in general. Business continuity plans were quoted; more specifically, continuity of logistics, manufacturing, mandatory reserves and raw materials. These plans were taught to the entire staff (n = 6, 30%), managers and supervisors (n = 6, 30%), only relevant persons (n = 3, 15%) or the managing director (n = 2, 10%). In some organisations, the plan was taught to the management team (10%, n = 2) or middle management and higher (5%, n = 1).

Pre-existing crisis management plans were activated in response to the pandemic in 15 companies (75%). Such plans were not used in five (25%) organisations, primarily due to the absence of an existing plan, inadequacy in a real-life scenario or a lack of significant influence on operations. A new crisis management plan for the COVID-19 pandemic was created by 19 (95%) companies. One organisation did not create a new plan because crisis management mainly required communication, and it could have been organised based on an old, existing plan. The interview transcripts also exhibited the variety of pre-existing preparedness plans. According to Interviewee 3, *'crisis revealed weak spots in company's preparedness that have been fixed now'.*

5.1.2 CRISIS RESPONSE (I–III)

The second part of the questionnaire focused on pandemic responses and the continuity of operations during the COVID-19 pandemic. Some community and hospital pharmacy respondents and most of the pharmaceutical industry respondents reported a rapid response to the pandemic, with initial actions taken either in February 2020 or earlier (7% of pharmacy owners, n = 15; 17% of hospital pharmacy heads, n=2; 60% of industry leaders and specialists, n = 12), while others took their initial actions in March 2020 (84% of pharmacy owners, n = 186; 83% of hospital pharmacy heads, n = 10; 35% of industry leaders and specialists, n = 7). A small fraction of the respondents implemented their first actions later (9% of pharmacy owners, n = 20; 5% of industry leaders and specialists, n = 1).

5.1.2.1 Crisis Response Teams and Decision-Making (I–III)

Pandemic response teams were appointed at 78 (35%) community pharmacies, four (33%) hospital pharmacies and 17 (85%) pharmaceutical industry and wholesale companies. In community pharmacies, these teams' responsibilities included monitoring the situation, communicating, creating and maintaining plans and guidelines, and implementing new measures (I). In hospital pharmacies, the roles of the team members related to their normal responsibilities or to the evaluation of medicine availability and storage, medicine procurement and personnel management (II). In the pharmaceutical industry and wholesale, team members' roles mainly related to crisis management and communication (III). More specifically, they followed national guidelines and collected updated information, created and revised internal instructions, communicated inside the company, updated risk management plans to cover different scenarios, and ensured transportations. The interviews further emphasised the focus on business continuity: ensuring employee safety and digital transformation, redefining new roles and ways of working and ensuring medicines for distribution and materials for production. Topics such as how to handle operational capacity or logistic issues and the current disease situation and its effects on the company's restriction measures were discussed constantly in crisis teams. According to survey responses, crisis team members were managing directors or directors/managers from communication, logistics and supply chain, medical, quality, regulatory, sales, marketing and business functions.

At pharmacies without such teams, decisions were made by two or more individuals (42% of community pharmacies, n = 92; 50% of hospital pharmacies, n = 6) or solely by the pharmacy owner or the hospital pharmacy head (23% of community pharmacies, n = 50; 17% of hospital pharmacies, n = 2). In cases where a crisis team was not set up in a pharmaceutical company

(n = 3), decisions were made by the managing director, responsible person or management board with other leaders responsible for human resources, logistics or sales.

Figures 12, 13 and 14 illustrate the usefulness of different information sources used to support decision-making in crisis management. The most useful source for community pharmacies was the AFP; for hospital pharmacies' internal experts and for pharmaceutical industry and wholesale, the THL.

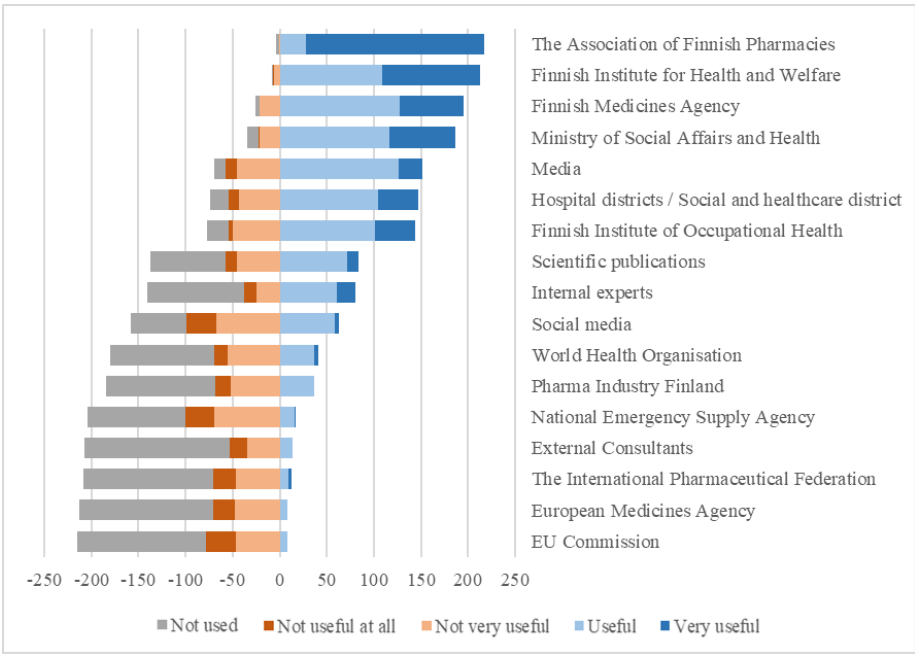

Figure 12 Usefulness of Different Information Sources to Support Decision-Making in Community Pharmacies During the COVID-19 Pandemic (estimated on a 5-point Likert-scale, n = 221; Study I). X-axis represents the number of the positive (useful-very useful) and negative (not very useful-not useful at all-not used) responses.

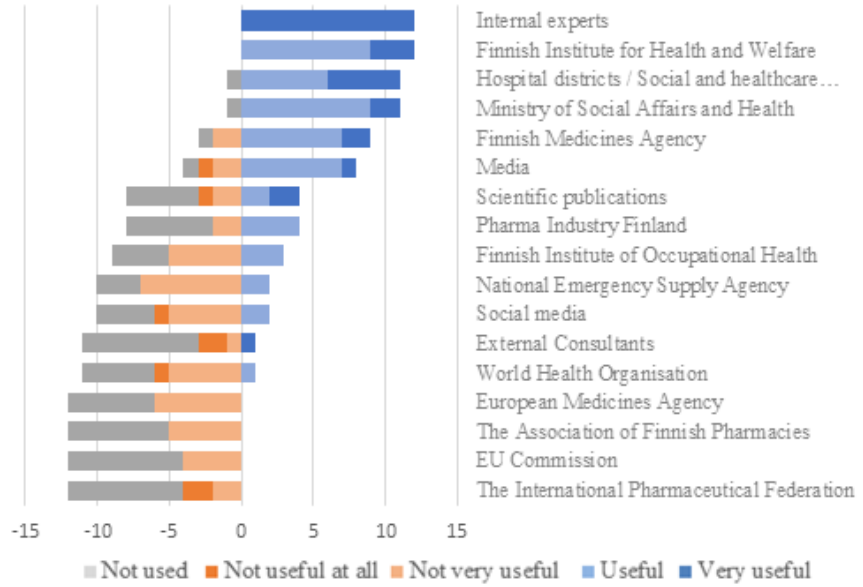

Figure 13 Usefulness of Different Information Sources to Support Decision-Making in Hospital Pharmacies During the COVID-19 Pandemic (estimated on a 5-point Likert-scale, *n* = 12; Study II). X-axis represents the number of the positive (useful-very useful) and negative (not very useful-not useful at all-not used) responses.

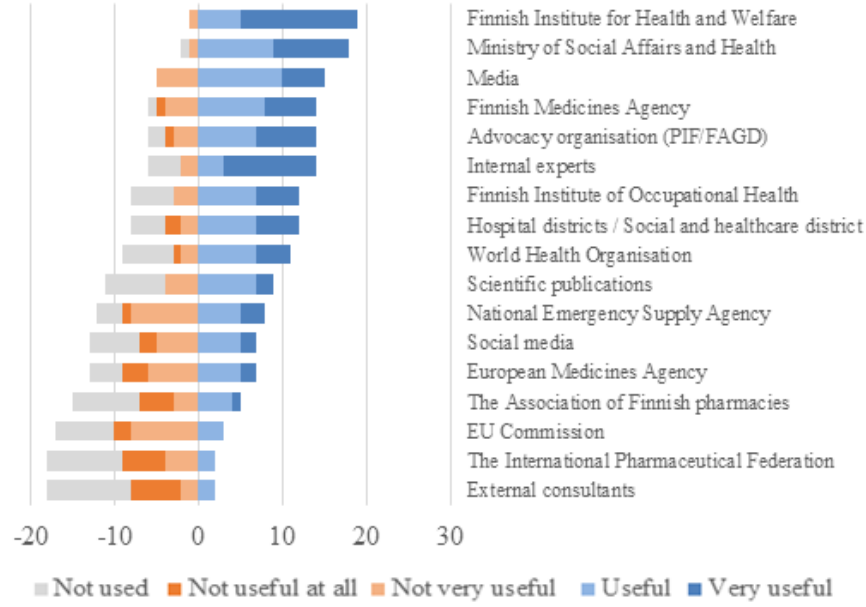

Figure 14 Usefulness of Different Information Sources to Support Decision-Making in Pharmaceutical Industry and Wholesale During the COVID-19 Pandemic (estimated on a 5-point Likert-scale, *n* = 20; Study III). X-axis represents the number of the positive (useful-very useful) and negative (not very useful-not useful at all-not used) responses.

5.1.2.2 Changes in Community Pharmacy Operations (I)

A range of changes in pharmacy operations were implemented to ensure the safety of employees and customers and the continuity of pharmaceutical services and care. A significant majority of the pharmacies (68%, n = 151) reported changes in medicine supply operations, such as setting up telephone order services, home deliveries and drive-in services. Internal communication and management changed at 116 (53%) pharmacies, mostly by increasing communication or moving to a virtual setting. Ninety-four pharmacies (43%) reported changes in their procurement operations, such as increased order volumes and the use of new suppliers. Eleven pharmacies (5%) reported pharmaceutical production adjustments. Notably, 34 pharmacies (15%) maintained their operations without any alterations.

Pharmacists worked at the healthcare frontline listening to patients' concerns about the pandemic (91%, n = 201) and correcting incorrect information about the pandemic or its medications (80%, n = 176). In addition, pharmacists instructed patients to apply for testing at 64% of the participating pharmacies (n = 141). All the participating pharmacies reported improving hygiene and cleaning efficiency. Notably, 90% set up or added resources to their telephone service, 87% set up or added resources to their home delivery of medications, and 34% of the pharmacies established their own hand sanitiser production.

5.1.2.3 Changes in Hospital Pharmacy Operations (II)

To prevent infections and secure services' continuity, hospital pharmacies employed changes in internal communication and management, clinical pharmacy, medicine supply, procurement and pharmaceutical production operations. Internal communication and management underwent changes in 11 (92%) hospital pharmacies, with leadership team meetings occurring daily or more frequently than before to update on the situation and decide on actions. Communication shifted primarily to virtual platforms, information sharing with staff became more frequent, and the pharmacy head was included in the hospital's pandemic response team. Adjustments in clinical pharmacy operations were noted in eight (67%) pharmacies, including reallocating pharmacists to reinforce COVID-19 and cohort wards and intensive care units, reducing movement between wards and the pharmacy and shifting away from patient-facing roles to support medicine supply operations. Seven (58%) respondents reported changes in medicine supply operations, such as creating lists of COVID-19-related medicines, delivering these medicines to wards and home hospitals, enhancing information sharing on medicine availability, improving the cleaning of internal medicine delivery boxes or employing disposable delivery boxes for infection wards. Procurement operations were

altered in five (42%) pharmacies, which involved increasing stock levels for certain medicines, monitoring the consumption of pandemic-related medicines and exploring procurement options for pandemic-related medicines or products. Pharmaceutical production operations were adapted in three (25%) pharmacies to increase the readiness to prepare pandemic-related medicines, produce pandemic-related products, such as hand disinfectant and hydrogen peroxide mouthwash, and decentralise production to two locations. These findings were reinforced by the interviewees.

To ensure the availability of medicines during the pandemic, hospital pharmacies monitored medicine consumption and prepared to increase stocks. Stocks for essential medicines were increased, necessary medicines and their alternatives were defined with doctors, and instructions from government agencies were followed. Alternative medications were searched for in 10 (83%) pharmacies. To ensure the quality and safety of medicines during the pandemic, seven (58%) hospital pharmacies implemented specific measures, such as sending more guidance letters to wards, increasing the number of clinical pharmacists and centralising pharmaceutical production expertise.

At the time of the study, eight (75%) pharmacies had organised medicine lists and logistics for the COVID-19 patient wards. Clinical pharmacy staff were reassigned to COVID-19, infection or intensive care wards; more pharmacists were recruited and/or trained for clinics. In total, seven (58%) hospital pharmacies had redirected or augmented human resources. Other resource changes included training additional pharmacists to pharmaceutical supply and moving personnel to such tasks.

5.1.2.4 Changes in Pharmaceutical Industry and Wholesale Operations (III)

Most of the pharmaceutical companies (90%, n = 18) adjusted internal communication and management due to the pandemic. Crisis management teams were established, anticipation of potential issues intensified, and potential disruptions in supply with a low threshold were reported to authorities. Communication increased in general and changed to various digital platforms. Furthermore, the shift to remote work transformed internal and external communication, managerial work and working methods. Changes in storages were noted by eight respondents (40%), mainly due to medicine stock increase. In addition, in a manufacturing company, stocks for raw materials and PPE were increased to the extent possible. Adjustments in procurements were made in five (25%) companies. These included increasing monitoring, anticipating increased consumption and ensuring upcoming deliveries. At the time of the study, manufacturing changes were made in one manufacturing company, which focused on responding to the increased demand of certain products. At the time of hoarding during early stages of the

pandemic, this caused significant effort and overtime work. These findings were reinforced by the interviewees.

All pharmaceutical industry and wholesale companies (100%, n = 20) took actions to anticipate and prevent medicine shortages during the pandemic. These included monitoring orders, delivery and transportation times and changes in demand. Stocks were raised, manufacturing and supply were adjusted to reflect increased need, and products were ordered from the manufacturer earlier than usual. Alternative manufacturing sites were investigated, and critical products were identified. In case of possible interruptions, preventive actions were made. For example, efforts were required to secure freight medicine importation and deliveries through the isolated area of the Southern Finland. Reserve supplies were taken in use and prioritising was adopted in the distribution of critical medicines over other products. Continuous internal discussions and communication with the headquarter were applied to ensure medicine availability in Finland. Furthermore, collaboration with manufacturing sites, hospitals, authorities and other industry stakeholders intensified to identify potential risks or heightened needs. The interview data confirmed the survey findings and further elaborated logistic challenges. According to interviews, border controls and restrictions in truck, ship and aeroplane freight and Asian logistic issues caused delays and needs for alternative solutions in medicine and material transportation.

Eight (40%) companies reported changes in human resources. Employees were trained and redirected to digital team, production and quality functions. Tasks were reduced in research and development, sales and marketing departments. Outsourced personnel were added to enable rapid reaction to possible sick leaves. One company underwent organisational changes, centralising functions from Finland to a regional organisation.

5.1.2.5 Collaboration and Communication with Stakeholders (I–III)

The last part of the response stage consisted of questions related to collaboration and communication with stakeholders. According to Study I, 99 (44.8%) community pharmacy owners reported changes in their collaboration with other pharmacies or pharmaceutical supply chain stakeholders: It either increased or improved (74.5% of the subsample, n = 74) or decreased (10.1% of the subsample, n = 10). Fifteen open-ended response fields were either empty, or responses were unrelated to crisis management. Changes in collaboration and communication with social and healthcare stakeholders were reported by 78 (35.3%) pharmacy owners. Most of this was an increase or improvement (76.9% of the subsample, n = 60), while a small proportion experienced a decrease in collaboration (11.5% of the subsample, n = 9). Nine open-ended response fields were empty.

Majority of pharmacy owners (72.9%, *n* = 161) acknowledged a need to develop collaboration with pharmaceutical supply chain and healthcare stakeholders to prepare for future crises. The need to enhance information exchange (43.4% of the subsample, *n* = 70), such as by integrating pharmacies into information channels or improving reachability, was a prominent suggestion. Forty respondents (24.8% of the subsample) expressed a desire to increase or improve collaboration overall – for example, with healthcare centres or wholesalers. Some pharmacy owners detailed a need to standardise collaboration and establish common collaboration protocols (5.8% of the subsample, *n* = 11). According to one response, '*There should be a national model for collaboration. Now, everything depends too much on local guidelines and even individuals. It should not be like this; the same operational models should be in use throughout Finland. We lack almost entirely a collaboration model between social and healthcare operators and the pharmacy' (Pharmacy owner 220).*

Hospital pharmacies' collaboration and communication with the hospital's internal stakeholders changed in 10 (83%) pharmacies (II). Collaboration intensified, with more meetings, discussions and planning with infection, respiratory medicine and intensive care doctors and hospital management. Moreover, collaboration shifted to virtual formats. Three (25%) respondents reported participating in the hospital's pandemic response team. Ten (83%) pharmacies noted changes in collaboration and communication with other hospital pharmacies or stakeholders in the pharmaceutical supply chain. Most described more frequent or regular collaboration with peer hospital pharmacies (*n* = 7) or other stakeholders, including government officials. Topics related to medicine availability issues at the time of the survey. Collaboration with peer hospital pharmacies was praised in the interviews: '*Really good and smooth collaboration; medicines can be transferred from one place to another as needed, and patients can also be transferred if needed, so it has brought good things' (Hospital Pharmacy Head, Interview 5).* However, in two (17%) pharmacies, collaboration or communication did not change, and in one (8%) pharmacy, it decreased, indicating potential information gaps at the time of the survey. Interview data broadened collaboration to COVID-19 vaccine storage and distribution, in which hospital pharmacies played a major role. This collaboration is depicted in more detail in Study IV.

Eight (67%) hospital pharmacy heads reported a need to develop collaboration during times of crisis. Suggested areas for development included sharing information, equitably distributing restricted resources, encouraging open discussions rather than adhering strictly to agendas, incorporating pharmaceutical expertise in ward care and reducing redundant work.

In most of the pharmaceutical industry and wholesale companies, collaboration and communication with peers or other pharmaceutical supply chain stakeholders changed (80%, *n* = 16, III). Thirteen (65%) respondents described either improved or increased collaboration. The number of

questions and instructions increased, and information sharing was more open than before. Both formal and informal communication was described. According to Respondent 2, *'Collaboration has intensified and increased… Everyone clearly has the same common mission and goal (minimizing the disease situation and morbidity and ensuring the continuity of operations and supply security)'.* Information sharing between industry and wholesale, hospital and community pharmacies and authorities and other pharma companies via advocacy organisations were described. Collaboration between supply chain stakeholders enabled forming a common situation picture. Three responses were empty. A significant portion (35%) of the responding companies were not part of a crisis response collaboration, increasing the risk for potential information gaps. Due to reduced access to healthcare, communication changed to virtual forms. The interview results confirmed and deepened the information about variety in collaboration. In addition, interview data further added information about collaboration in ultra-cold vaccine importation and distribution to hospital pharmacies through pharmaceutical companies and the THL instead of any wholesale company.

A little more than half (55%, n = 11) of the respondents reported a need to develop collaboration among pharmaceutical supply chain or social and healthcare stakeholders in times of crisis (III). Continuous and transparent collaboration was emphasised, and coordination from authorities was requested. Collaboration could enable a common message from stakeholders to consumers and media to avoid vague and misleading information. Coordination and collaborative leadership were also requested: *'There should be one authorized actor who could be able to communicate centrally, fast and authentic manner, with pharmaceutical industry, wholesalers and health care districts and would be authorised to give instructions (e.g. in sharing scarcity!). In case of crisis, that actor should have a good knowledge of companies', hospitals', and the ministry of social and health officers' operational prerequisites' (Respondent 15).*

5.1.3 POST-CRISIS STAGE (I–III)

The third part of the questionnaire focused on the post-crisis stage and comprised an evaluation of the pandemic's impacts, self-reflection and lessons learned from the organisational and pharmaceutical supply chain perspectives. The respondents assessed the pandemic's impacts on staff and management resilience, organisational cohesion ('team spirit') and organisation's resources and finances on a Likert scale, as shown in Figures 15, 16 and 17.

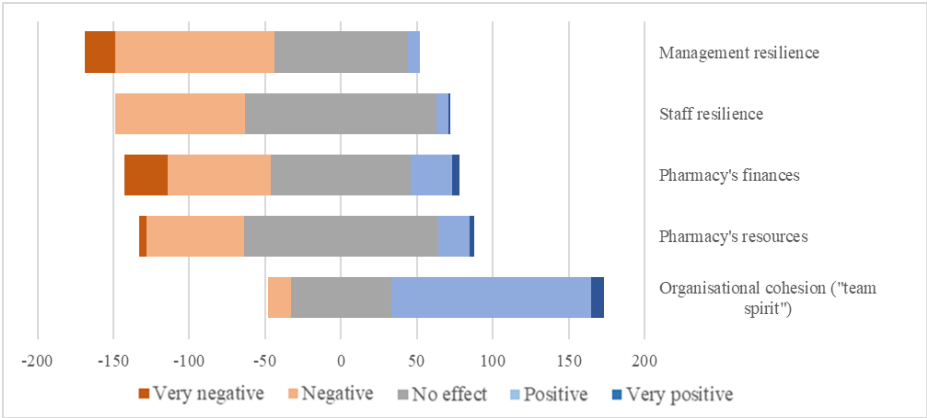

Figure 15 Community Pharmacy Owners' Self-Evaluated Pandemic Impacts (evaluated on a 5-point Likert scale, *n* = 221; Study I). X-axis represents the number of the positive (positive-very positive), neutral (no effect) or negative (negative-very negative) responses. Neutral responses (no effect) are positioned around zero.

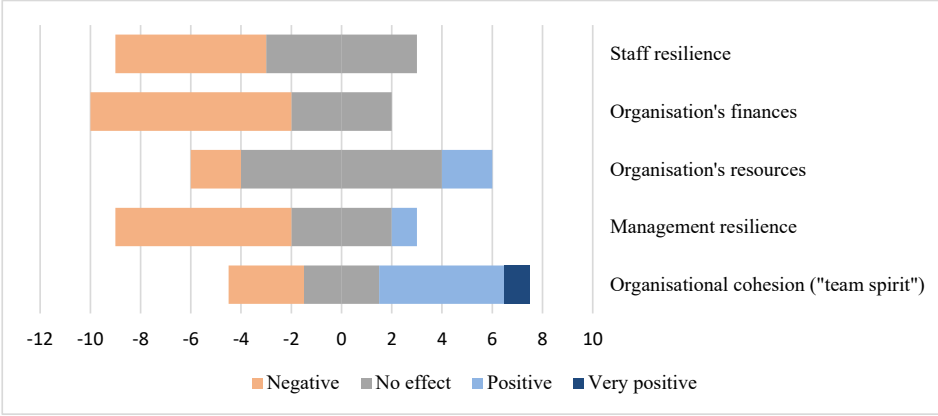

Figure 16 Hospital Pharmacy Heads' Self-Evaluated Pandemic Impacts (evaluated on a 5-point Likert scale, *n* = 12; Study II). X-axis represents the number of the positive (positive-very positive), neutral (no effect) or negative (negative) responses. Neutral responses (no effect) are positioned around zero. No 'very negative' responses were reported.

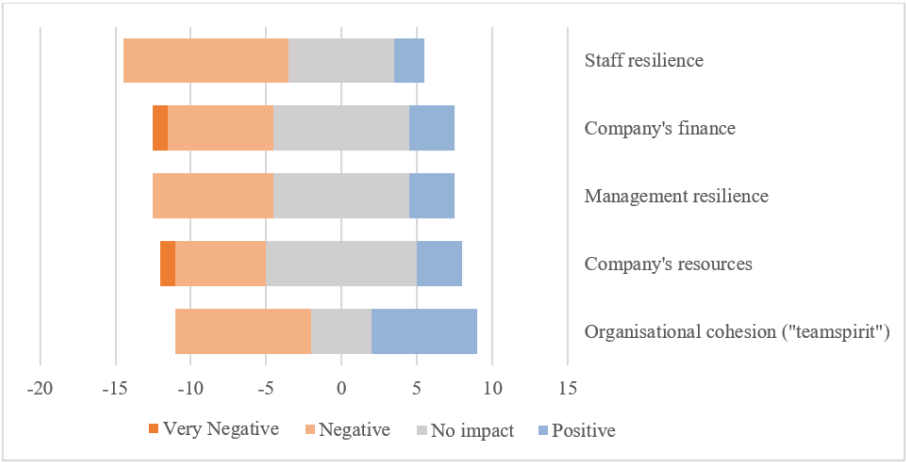

Figure 17 Pharmaceutical Industry and Wholesale Leaders' and Specialists' Self-Evaluated Pandemic Impacts (evaluated on a 5-point Likert scale, *n* = 20; Study III). X-axis represents the number of the positive (positive-very positive), neutral (no effect) or negative (negative) responses. Neutral responses (no effect) are positioned around zero. No 'very positive' responses were reported.

5.1.3.1 Self-Reflection and Lessons Learned (I–III)

Half of the community pharmacy owners (52.5%, *n* = 116) did not identify anything they would have done differently after looking back on their pharmacies' pandemic response at the time of the study (I). Lessons learned were communication-related, decision-making-related, leadership-related and personnel-related. Fifty pharmacy owners (22.6%) emphasised the need for improved internal communication, especially clear and effective communication, precise instructions and regular updates to ensure that all staff members are informed about the evolving situation. Decision-making-related lessons included swift and decisive actions (*n* = 47, 21.3%), updated crisis plan and established procedures (*n* = 37, 16.7%), signal detection and timely responses. In addition, 35 respondents (15.8%) highlighted leadership qualities, such as a calm demeanour and firm leadership. Personnel-related lessons included paying attention to staff resilience (9%, *n* = 20), organisational cohesion and shared responsibility (8.6%, *n* = 19). Involving and listening to staff members and fostering a collaborative spirit were emphasised.

Like the community pharmacy owners, half of the hospital pharmacy heads (*n* = 6) identified no areas for development at the time of the study (II). Lessons learned were categorised into collaboration-related (*n* = 8), leadership-related (*n* = 7) and personnel-related (*n* = 6) themes. Collaboration-related lessons included timely and clear communication and the need for rapid meetings and solutions. Leadership-related lessons emphasised staying calm, focusing on what is most relevant, making and offering detailed, fact-based and justifiable decisions and guidance and taking care of one's own resilience. Personnel-related lessons highlighted the

importance of management presence, the difficulty of predicting the right actions to ensure staff sufficiency and safety, the opportunity to discuss concerns, and the training of multiple individuals in different areas to ensure backup support.

Although about half of the respondents (45%, n = 9) in the pharmaceutical industry and wholesale did not identify areas for development at the time of the study; all provided insights on crisis management lessons (III). Such lessons were categorised into communication (60%, n = 12), leadership and decision-making (55%, n = 11), organisational capacity (35%, n = 7) and preparedness (15%, n = 3) themes. Communication-related lessons included the importance of internal and external, continuous and clear communication even when there is 'no news'. It is also critical to repeat important messages multiple times and ensure that all employees receive the message. Leadership and decision-making-related lessons included understanding the (extent of the) situation, clear and fast goal setting instead of reactivity, consistency, clear responsibilities and authorisation in decision-making, staying calm and not panicking, anticipating and making fast and effective decisions in the early phases to prevent prolongation of the situation and clear procedures. According to survey respondent 11, response had to be adjusted based on local needs: *'We realised that there are differences in the needs of different countries and even regions within countries. At first, a broad global, EMEA or Nordic approach was adopted but in hindsight we could have moved to more localised action plans sooner'.* Organisational capacity-related lessons included the importance of a strong crisis team with enough resources, organisational capability to adapt in change and human resources support. Finally, preparedness-related lessons included the importance of preparing and regularly practising for potential crises during ordinary times.

5.1.3.2 Finnish Pharmaceutical Supply Chain's Successes and Challenges in the Pandemic Response (I–III)

The respondents identified pharmaceutical supply chain's successes and challenges in Studies I-III. Responses were mixed related to medicine availability and collaboration with stakeholders. In Study I, positive factors were identified in relation to services' continuity, medicine availability and collaboration and communication. Community pharmacy services were well maintained during the pandemic at the time of the study (24%, n = 53). Prompt response and clear guidance by Finnish health authorities (16,7%, n = 37) and the AFP (10.9%, n = 24) were instrumental in effective crisis management. In particular, authorities' imposition of sales restrictions and additional powers granted to pharmacies helped ensure medicines' consistent availability even during periods of heightened demand. Pharmacists were, for example, allowed to provide exceptional dispensations of medications in cases where a medication could not be supplied according to a prescription. Despite shortages in hand sanitisers, masks, gloves, alcohol and painkillers, the

respondents expressed satisfaction with medicines' availability (14,9%, *n* = 33). According to one pharmacy owner, *'The medications were obtained successfully, even in March, despite almost doubling customer numbers. All essential prescription medications were consistently available, and the authorities' swift response effectively curbed both customer and pharmacy hoarding, as well as prescriptions dispensed for incorrect indications' (Pharmacy owner 20).*

In Study II, hospital pharmacy heads identified availability-related success factors (75%, *n* = 9), such as the use of the mandatory reserve stockpile, generally good availability of medicines (even in intensive care), equitable distribution of medicines and availability of hand sanitiser and alcohol. The interview data corroborated these findings. Collaboration and communication-related positives (42%, *n* = 5) included collaboration with government agencies or other pharmaceutical supply chain stakeholders and sufficient information. In addition, collegial collaboration among hospital pharmacies was emphasised in the interviews.

In Study III, crisis leaders and managers at the pharmaceutical industry and wholesale identified pharmaceutical supply chain's successes related to collaboration and information exchange (45%, *n* = 9), medicine availability (15%, *n* = 3), mandatory reserve stockpile (10%, *n* = 2) and authorities' flexible and rapid action (10%, *n* = 2). Collaboration was described as good, dense, constructive, open and solution-oriented. Information exchange was good, and pre-existing collaboration structures such as an informal cross-sectoral group of supply chain stakeholders provided a forum for discussion and information sharing. Collaboration with authorities and between pharma companies and wholesalers were mentioned. After the initial phase of the pandemic characterised by hoarding and stocking, medicine availability was rather good, one reason being domestic pharmaceutical production. Mandatory reserve supplies provided a buffer for certain medicine shortages. Rapid actions by authorities, such as FIMEA and NESA, were important in the response. While one respondent saw NESA's actions as a success, another respondent asserted that NESA did not provide real help or resources. Interviews further revealed NESAs' role in the pharmaceutical industry's crisis management. NESA's value was evident in its assistance with border control and ship freight issues, coordination of local supply security collaboration, and provision of information on alternative PPE providers and prerequisites for country entries of foreign employees. Interviewee 8 praised local supply security group coordinated by NESA, which focused on critical infrastructure, disease situations and local solutions. However, some interview respondents noted that NESA did not coordinate the crisis response as they had expected.

In Study I, challenges were identified in relation to the availability of medicines, disinfectants and PPE and collaboration and communication. Community pharmacies were strongly affected by wholesalers' challenges in scaling delivery capabilities when order volumes surged (41.6%, *n* = 92). Irregular delivery times, delays in product deliveries and insufficient information regarding deliveries caused problems at pharmacies. Shortages of essential items, such as hand sanitiser, masks, gloves, alcohol and painkillers,

were prevalent, especially at the beginning of the pandemic (28%, *n* = 62). Community pharmacies faced problems with external communication, such as unclear instructions, conflicting guidance from health authorities and a slow information flow (12,2%, *n* = 27). Issues with hoarding arose because of media reports on shortage issues and announcements of sales restrictions, which contributed to panic buying and led to spikes in demand (11,8%, *n* = 26). According to one respondent, *'The role of the media in the emergence of hoarding was significant. For example, paracetamol and asthma medications. Could the pharmaceutical supply chain and media communicate better together to prevent unnecessary buying pressure and, consequently, disruptions in the pharmaceutical supply chain?' (Pharmacy owner 5).*

In Study II, hospital pharmacy heads identified challenges related to collaboration and communication (58%, *n* = 7) or medicine, disinfectant and PPE availability (25%, *n* = 3). Collaboration and communication-related issues included unclear or contradictory guidance on procedures or masks, time-consuming data requests from FIMEA during the acute crisis, absence of guidance on essential medicines to be stocked from FIMEA, slow response by NESA and inadequate information about availability issues. These problems were echoed by two interviewees, who called for more specific guidance from authorities: *'the availability of medicines, [...] their limitations or restrictions, and the anticipation of availability problems for different groups of medicines' (Hospital Pharmacy Head, Interview 3).* Availability issues included shortages and the inequitable distribution of medicines. Although the interview data reported no serious interruptions in medical care, it further elucidated challenges due to availability issues. Hemofiltration solutions were not delivered according to orders, because a pharmaceutical company had restricted its use: *'... had to call the pharmaceutical company and ask them to release [the product] from the stock balance for distribution, specifically for this [use]... Such a situation caused a little confusion ... A wholesaler announced that it was not available, but no detailed instructions were given, who to contact and how to act in order to get it' (Hospital Pharmacy Head, Interview 6).* When reliable substituting suppliers for hand sanitisers and their packaging materials were not available, wards were instructed to return hand sanitiser pump bottles to central storage, where they were refilled from large containers and relabelled in the hospital pharmacy.

In Study III, challenges identified by pharmaceutical companies' and wholesalers' crisis leaders related to anticipation of and response to increased demand and stocking (30%, *n* = 6), lack of coordination and collaboration (30%, *n* = 6) and medicine availability problems (10%, *n* = 2). As order volumes surged rapidly, pharmaceutical wholesalers could not react as fast as expected. Despite early preparations, the magnitude of the escalation surprised companies and the demand peak was not anticipated. Finland's one channel system, in which majority of the pharmaceutical companies accompany with one wholesaler, increases the risk to such problems in case of rapid increase in demand or other disruptions. Interview data confirmed these findings and added a perspective of a company trusting on a decentralised approach: *'...Now we have more wholesalers in our chain. This made it easier*

for us during the pandemic – the idea that not everything goes through [a wholesale company]. In my opinion, that decentralized solution is quite good because more routes can be used' (Pharmaceutical Industry Leader, Interview 4). Although collaboration was praised by many respondents, many challenges were identified in relation to it. Continuous and transparent collaboration was emphasised, and coordination from authorities was requested. Transparency was also demanded by Interviewee 3, who noted that their painkiller medicines were not delivered according to pharmacies' orders, instead, they were completely stopped for a few weeks based on the wholesaler's decision without any discussion and without informing the company. Described by one interviewee, FIMEA potentially played a role in controlling the demand-supply: '*FIMEA knows what the product quantities are … for example, on the basis of which, of course, the distribution of scarcity is potentially made' (Pharmaceutical Industry Leader, Interview 6).* However, according to the survey responses, attempts to control the demand–supply balance (i.e. sharing scarcity) were not centrally coordinated, leaving pharmaceutical companies the responsibility for reasoning without knowing what authorisation they were acting under. Solutions to prevent hoarding and collaboration between authorities and pharmaceutical companies were requested in the survey and interview responses. Collaboration could enable a common message from stakeholders to consumers and media to avoid vague and misleading information. According to survey respondent 11, '*…new regulations introduced during the pandemic (for example on safety stock levels and export of drugs required on certain products) were not created in collaboration with pharma suppliers and this would have been good to plan for.'*

5.1.4 POTENTIAL BENEFITS OF CRISIS MANAGEMENT EFFORTS (I)

Study I explored whether crisis management efforts can protect staff or pharmacy owners' resilience, organisational cohesion ('team spirit') and pharmacies' resources or finances during the pandemic (Table 11). The analysis showed statistically significant values for the results, which were adjusted for experience years of the pharmacy owner, pharmacy location and the number of employees. Shared decision-making during crisis management protected pharmacy owners' resilience (p = 0.025) and pharmacies' finances (p = 0.040). Although having a crisis team did not exhibit statistically significant values, when grouped with shared decision-making, pharmacy owners' resilience (p = 0.024) suffered less compared with pharmacies where decisions were made solely by the pharmacy owner. Moreover, increasing or improving collaboration and communication with other pharmacies or pharmaceutical supply chain stakeholders protected pharmacy owners' resilience (p = 0.015) compared to unchanged or reduced collaboration. Notably, the use of pre-existing crisis plans during the pandemic reduced pharmacy resources (p = 0.006). Furthermore, increasing or improving collaboration and communication with social and healthcare stakeholders was not associated with any pandemic impacts. For the study's full statistical analysis results, see Appendix 3: Logistic Regression Results.

Table 11 How (1) Crisis Plans, (3) Shared Decision-Making and (4) Collaboration and Communication with External Stakeholders Associate with Pandemic Impacts on Community Pharmacies (I)

	Factor	n (%)	n (%)	Un-adjusted OR (Cl)	*P*-value	Adjusted* OR (Cl)	*P*-value
RQ1: Crisis plans	**Pharmacies' resources**						
	Pre-existing crisis plans were used	Positive impact/ No impact	Negative impact				
	No	36 (80.0)	9 (20.0)				
	Yes	116 (65.9)	60 (34.1)	2.07 (0.94–4.58)	0.073	3.85 (1.48–10.03)	0.006
RQ3: Shared decision-making	**Pharmacy owners' resilience**						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Pharmacy owner alone	16 (32.0)	34 (68.0)				
	Team	36 (46.2)	42 (53.8)	0.55 (0.26–1.15)	0.113	0.44 (0.18–1.05)	0.064
	Multiple people	44 (47.8)	48 (52.2)	0.51 (0.25–1.06)	0.070	0.39 (0.17–0.89)	0.025
	Pharmacies' finances						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Pharmacy owner alone	29 (58.0)	21 (42.0)				
	Team	38 (48.7)	40 (51.3)	1.45 (0.71–2.97)	0.306	0.76 (0.31–1.87)	0.547
	Multiple people	56 (60.9)	36 (39.1)	0.89 (0.44–1.79)	0.739	0.41 (0.17–0.96)	0.040
RQ4: Collaboration and communication with external stakeholders (other pharmacies or operators of the pharmaceutical supply chain)	**Pharmacy owners' resilience**						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	Unchanged or less collaboration	52 (39.4)	80 (60.6)				
	More or improved collaboration	38 (51.4)	36 (48.6)	0.62 (0.35–1.09)	0.098	0.46 (0.24–0.86)	0.015

OR = Odds ratio
CI = Confidence interval
**Adjusted for experience years of the pharmacy owner, pharmacy location and the number of employees*

5.2 COLLABORATIVE CRISIS MANAGEMENT (IV)

5.2.1 ORGANISATION OF CROSS-SECTOR COLLABORATION (IV)

The beginning of the pandemic was confusing and comprised *'extinguishing fires' (Head of Pharmacy 2, Hospital Pharmacy)* with unclear contact points for various situations and conflicting information. Although pharmaceutical legislation described stakeholders' roles and responsibilities, accountability for crisis-related issues had to be clarified during the crisis. Without a pre-defined cross-sectoral crisis organisation, collaboration was organised based on existing structures, channels and relationships and through the establishment of issue-specific groups by government agencies as per legal mandates. Crisis dynamics and related issues guided the group formation and meeting frequency. According to one interviewee, '*It was noticed that this situation requires a completely different approach. Before, of course, there had been close cooperation with the actors, but in a planned way, that a discussion event had been organised once a year … and it was planned for a long time … But now we sent quick situation picture meetings, and these key actors were asked to attend. So, from pharmaceutical manufacturers to wholesalers, pharmacies, hospital pharmacies. There have been different forums and partly with different topics. And advocacy organisations were naturally involved also' (Director 2, Government Agency).*

Figure 18 depicts the organisation of collaborative crisis management among pharmaceutical supply chain stakeholders. The model illustrates the connections between aggregate concepts identified in the content analysis (see Figure 7). These concepts are described in the following sections.

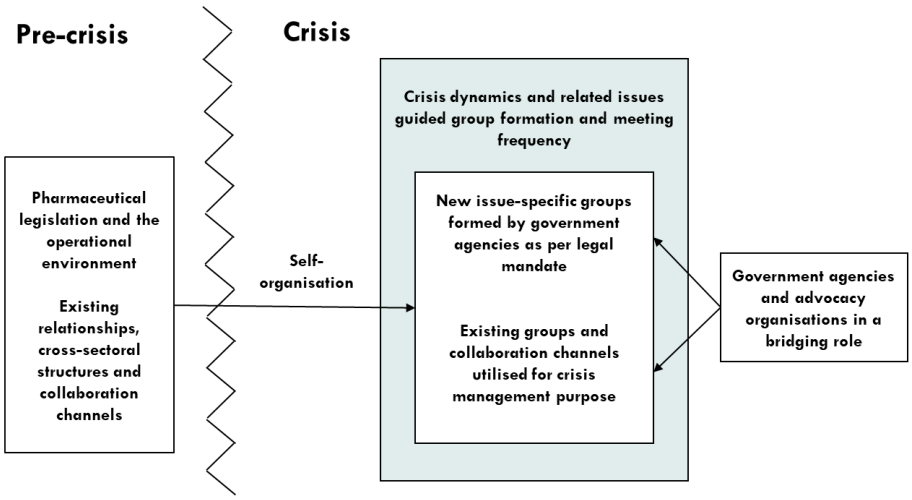

Figure 18 Process Model: Organisation of Collaborative Crisis Management (IV)

5.2.1.1 Pre-Existing Groups, Collaboration Channels and Relationships

Advocacy organisations, namely PIF, the FAGD and the AFP, organised member company discussions, supported problem-solving efforts and shared information on regulation changes and recommendations. The AFP provided guidance on medicine availability, hygiene controls and masks and provided a crisis management plan template for community pharmacies. Advocacy organisations played a bridging role between their member companies and government agencies by forwarding problems to the authorities. NESA requested information from its contact persons from the pharmaceutical industry and wholesalers frequently; however, the meeting frequency of existing national preparedness groups for the chemistry and healthcare fields did not increase significantly, and the utility of the meetings for the study participants varied.

An informal cross-sectoral group of representatives of the AFP, PIF, FAGD, community and hospital pharmacies, the pharmaceutical industry and wholesalers was formed to discuss ongoing regulatory changes before the pandemic. One interviewee explained: '*Actors have a collaboration forum, which … even in non-crisis conditions met regularly and went through … what belongs to the different sectors or whether there is anything new. And, of course, it has worked here now during the pandemic also more actively and there has been a discussion… about the availability of medicines and … the availability of corona vaccines and … what is the future picture for each, and what does the situation look like, and… that is mostly information exchange' (Pharmacy Owner 4, Community Pharmacy)*. The group had a rotating convener role instead of a coordinating actor and normally met a few times a year. At the beginning of the pandemic, the group activated rapidly and formed a sub-group for pandemic issues affecting the pharmaceutical supply chain. The sub-group met multiple times a week during spring 2020. As common issues became rarer, the meeting frequency decreased. The group shared information on current issues and operating performance and helped members maintain a dynamic, common operating picture of the supply chain function. Hospital pharmacy representatives informed pharmaceutical companies and wholesalers about large upcoming orders, and pharmaceutical companies informed others about possible availability disruptions. When freight medicine shipments were in danger of being stopped, participants brought the problem to government agencies via multiple voices.

5.2.1.2 New Issue-Specific Groups Formed by Government Agencies as per Legal Mandates

New cross-sectoral groups focusing on solving different crisis-related issues were formed by government agencies. By coordinating these groups, FIMEA and the THL played a bridging role between stakeholders. Despite many collaborative groups working simultaneously, there was *'surprisingly little overlapping' (Director 1, Government Agency)*. Meeting frequency varied based on current needs. The cross-sectoral groups dealing with medicine and vaccine availability are described below.

Medicine consumption peak in community pharmacies affected wholesalers through massive order increases, escalating to a logistical crisis because wholesalers did not have the capacity to respond to the increased consumption. FIMEA formed a group for information sharing between wholesalers and community pharmacies to solve consumption peak issues. One interviewee described: *'Three key forums… One was, we sat down with the community pharmacy and wholesale network, for example when we tried to get hoarding under control together… Also, there has been a good cooperation with the pharmacy network for a long time… daily interactions through advocacy organisation and its network' (Director 2, Government Agency)*. The meeting frequency was high during the acute crisis. FIMEA redirected relevant information to the STM, which prohibited medicine overstocking and restricted the bronchodilator (salbutamol) supply to a one-month maximum treatment period based on the Emergency Powers Act (The Ministry of Social Affairs and Health, 2020e, 2020b; Tiirinki et al., 2020). Issues related to daily pharmacy work were shared in the group and in direct interactions with the AFP and FIMEA and, for example, forwarded to KELA, enabling flexibility in prescription medicine delivery intervals and remote services.

Medicine logistics and production and distribution capacities were discussed in a group of pharmaceutical industry, wholesalers and PIF and FAGD representatives coordinated by FIMEA. The global medicine availability, the European situation, the national production and distributions' operational performance status, border controls and potential issues were discussed. FIMEA shared relevant information from these meetings with the STM and NESA. FIMEA also formed a group including hospital pharmacy and STM and THL representatives. Medicine delivery to emergency departments and established COVID-19 wards relied on the function of hospital pharmacies, so information about medical treatments, availability issues and pharmacies' operational performance status were shared between participants. The procurement of emergency medicines and other COVID-19-related pharmaceuticals was planned together.

Organising COVID-19 vaccine logistics began at the end of 2020. As the first vaccines arrived during the Christmas holidays, pharmaceutical companies and the THL worked remotely *'at Christmas tables'* to ensure urgent vaccine

delivery to Finland *(Director 2, Pharmaceutical Industry and Wholesale)*. The THL held regular meetings with COVID-19 vaccine marketing authorisation holders and wholesalers regarding logistics and vaccine characteristics. Also, the THL coordinated regular meetings with all hospital pharmacies and dispensaries and separate meetings with clinicians responsible for infectious diseases or vaccinations and hospital pharmacists from highly specialised medical care catchment areas. According to one interviewee, *'Meetings organised [for hospital pharmacies] by THL every week … For this ERVA area, where there are also doctors responsible for infectious diseases or vaccinations present … And then once a week there is also for Finland's hospital pharmacies and dispensaries and THL … The topics of discussion may have different priorities but are really important … these meetings last about an hour each time and every week there is always enough to discuss' (Head of Pharmacy 5, Hospital Pharmacy).*

5.2.2 THE INFLUENCE OF CROSS-SECTOR COLLABORATION ON CRISIS MANAGEMENT EFFECTIVENESS (IV)

Three concepts on how cross-sector collaboration influenced crisis management effectiveness were identified in the content analysis (Figure 8). First, shared knowledge enabled the anticipation of and preparedness for potential availability and operating issues throughout the pharmaceutical supply chain. Member organisations informed the PIF, FAGD and AFP about potential and actual logistic, distribution, manufacturing and operational performance issues: Information was forwarded to relevant government agencies that implemented corrective actions. Constant information exchange helped stakeholders to form a dynamic common situation picture and plan actions in line with others, as noted by one interviewee: *'Last spring, FIMEA and STM recommended that for certain medicinal products or groups of medicinal substances, … You should be prepared for the fact that the stocks would be slightly larger than normal… There were negotiations with pharmaceutical companies and wholesalers, how to gradually raise those stocks to a higher level, so that a single hospital does not empty the stock and then these can be bought. It worked quite well, as soon as the needs were announced, a schedule was then obtained, and proceeded with' (Head of Pharmacy 3, Hospital Pharmacy).* Hospital pharmacy representatives who were not involved in collaborative groups during the early crisis described a lack of information on the needed emergency medicines, preparation for increasing consumption and what to do in sales restrictions. One interviewee stated: *'A couple of weeks ago, I received a message from FIMEA that I had actually been waiting for a year ago, but was still happy when it came, that … In relation to three medicinal substances, we ask you to check that you have sufficient stocks and to prepare for a possible higher-than-normal*

expenditure' (Head of Pharmacy 1, Hospital Pharmacy). This emphasised the importance of knowledge sharing.

Second, shared resources enabled the maintenance of core functions. The AFP, PIF and FAGD helped their member companies concentrate on daily operations and saved their time by unpacking regulations, creating guidance regarding masks and hygiene controls and advocating for them in multiple cross-sectoral groups. This was particularly pronounced in community pharmacies that were able to prioritise resources to ensure pharmaceutical supply and service continuity, described by one interviewee: *'The Association of Finnish Pharmacies has, in a very good way, made information bases ready for us… It would have been quite a lot of hard work and considering everything, such as instructions for customers and staff and whatever changed, especially when they change from time to time, so it was a really big help' (Pharmacy Owner 9, Community Pharmacy)*.

Third, shared problem-solving enabled cross-sectoral solutions. In the early pandemic, FIMEA made frequent information requests to hospital pharmacies about pharmaceutical stocks. As these were laborious and time-consuming, FIMEA and the STM, in collaboration with stakeholders, developed an automated data collection system to enable real-time stock visibility at wholesalers and hospital and community pharmacies. This enabled FIMEA to react quickly to potential availability problems and reduced the workload at hospital pharmacies, as noted by one interviewee: *'We spent hours searching for requested information… so it was really busy last spring. And then together with FIMEA, we started to think about what other ways there could be for this, and luckily STM and FIMEA came up with their own solutions for that… We were then involved in commenting, among other things, so that we reached that agreement a while ago… About data collection' (Head of Pharmacy 3, Hospital Pharmacy)*. Other cross-sectoral problem-solving examples included organising ultra-cold logistics, warehousing and distribution to ensure vaccine preservation and safety in collaboration with the THL, hospital pharmacies and pharmaceutical companies and driving drug transport prioritisation in ship freight by the participants of the unofficial cross-sectoral collaboration group.

6 DISCUSSION

The present study aimed to describe and analyse crisis management among pharmaceutical supply chain stakeholders on organisational and cross-sector levels. The purpose of a descriptive research is to describe a phenomena and, for example, explain it in different contexts (De Vaus, 1994). This description has a practical meaning: to shed light on a marginally explored, yet necessary part of the healthcare system function and provide practical solutions to identified challenges based on the study's findings and the literature. Focus of crisis preparation is often on material preparedness, which may ignore the value of other aspects, such as prerequisites for efficient decision-making and collaboration.

The main findings and contributions of the study are summarised in Table 12 and discussed in the subsequent sections. Based on the literature and the challenges identified in the present study, practical implications are suggested for supply chain stakeholders.

Table 12 Summary of the Main Findings, Theoretical and Methodological Contributions

		STUDY	MAIN FINDINGS	METHODOLOGICAL AND THEORETICAL CONTRIBUTIONS
THEORETICAL FRAMEWORK	Organisational crisis management: sector-level perspective	I-III	**Crisis preparedness** improved concurrently during the pandemic due to increased risk perception, preparedness plan coverage and operational adjustments (II-IV) **Crisis response:** decision-making trusted mainly on teams (IV) and shared decision-making (II-III), while dispersion existed *Community pharmacies* were in the frontline of the pandemic experiencing hoarding and concerned patients (I). Their actions focused on outpatient care with novel solutions to maintain the services. Shared decision-making protected pharmacies' finances (p = 0.040) and their owners' resilience (p=0.025). Collaboration with peers and stakeholders in the pharmaceutical supply chain protected pharmacy owners' resilience (p = 0.015). *Hospital pharmacies* focus was on ensuring inpatient care by identifying critical medicines and their alternatives with infection, lung, and/or intensive care units, and by adjusting various operations (II). Their role in organising ultra cold vaccine storage and logistics was significant. *Pharmaceutical industry and wholesale* focused on responding to hoarding and stocking, and preventing medicine shortages with increased monitoring, storage levels and collaboration with supply chain stakeholders to identify potential risks or heightened needs (III). Innovative vaccines were developed. **Challenges:** The respondents identified challenges related to anticipation of and response to increased demand and stocking (I, III), medicine shortages (I, II), information sharing, coordination and collaboration (I, II, III)	**Methodological contribution:** 1) A novel approach for data collection utilising crisis management process models for survey development (I-III) 2) A new approach for data analysis employing statistical method to study potential benefits of crisis management efforts (I) **Theoretical contribution:** 3) Extended the crisis management process models with new contexts of community pharmacies (I), hospital pharmacies (II) and pharmaceutical industry (III)
	Collaborative crisis management: cross-sector perspective	IV	**Organisation of cross-sector collaboration:** Without a pre-defined crisis management organisation, cross-sector collaboration was organised based on previous collaboration structures, channels and relationships and through the establishment of issue-specific groups by government agencies as per legal mandates. The third sector was an important collaborative partner for the private and public sectors **Cross-sector collaboration's influence on crisis management effectiveness:** Cross-sectoral collaboration increased the crisis management effectiveness. Shared knowledge among stakeholders enabled anticipation and preparedness during crisis; shared resources fostered maintenance of core functions; and shared problem-solving facilitated cross-sectoral solutions.	**Theoretical contribution:** 1) Build a new process model of organising for collaborative crisis management 2) Added knowledge about private-third sector collaboration and issue-specific groups to this research field 3) Extended the collaborative crisis management literature with a new context of pharmaceutical supply chain

6.1 THEORETICAL AND METHODOLOGICAL CONTRIBUTIONS (I–IV)

A methodological contribution of Studies I–III is utilising a novel approach for data collection by applying crisis management process models for the development of the survey instrument. Previous studies drawing on process models were primarily based on interviews, documents or media data (Bundy et al., 2017). This online survey approach enabled responses even when infections were increasing and could also serve in the acute phase of a crisis when data collection often poses a challenge (Buchanan & Denyer, 2013; Bundy et al., 2017). Although a focus on a specific phase could have yielded more detailed findings, the process perspective showed advantages in its holistic and structured approach. The post-crisis results provided data from the cross-sectional timepoint, which complement the learnings acquired after the pandemic. In line with the previous literature, phases were found to have overlapped, while preparedness was improved, and lessons were learned during the crisis response (Jaques, 2007; Veil, 2011). Study I introduced another methodological contribution by employing a statistical data analysis method to investigate the potential benefits of crisis management efforts. Components of effective crisis management, more specifically, crisis teams, plans and collaboration with external stakeholders, were investigated in relation to self-assessed pandemic impacts on organisations' staff and management resilience, organisational cohesion ('team spirit'), organisational resources and finance.

The theoretical contributions of the Study IV include developing a new process model of organising for collaborative crisis management (Figure 18), adding knowledge about private third sector collaboration and issue-specific groups to this research field and extending the collaborative crisis management literature to a new context of the pharmaceutical supply chain.

6.2 FINDINGS ON CRISIS PREPAREDNESS (I–III)

Personal experience and the rise of risk perception may lead to improvements in organisational crisis management preparations (Fowler et al., 2007; Pearson & Clair, 1998; Wachinger et al., 2013). The risk of a crisis affecting the pharmaceutical supply chain was evaluated by pharmacy owners, hospital pharmacy heads and pharmaceutical industry leaders and specialists before and during the pandemic (I–III). Following the onset of the pandemic, the risk perception rose to 86%, 100% and 85%, respectively, indicating improved risk perception due to an ongoing crisis. To the best of the researcher's knowledge, these are the first studies reporting pharmaceutical sector leaders' risk perception and how COVID-19 has affected it.

Crisis management plans enable effective response with preassigned tasks and collected information (Coombs, 2023; Hale et al., 2006). Study I found

that majority of community pharmacy owners (80%, n = 176) were able to use pre-existing crisis plans. The number was slightly higher compared to rural and urban pharmacies in the United States, in which 43% and 57% found their plan suitable for the COVID-19 pandemic, respectively (Carpenter et al., 2021; Zhao et al., 2021). According to Study II, 25% of hospital pharmacies had a pre-existing preparedness plan, which was used during the pandemic. However, 67% of pharmacies either developed a new pandemic response plan after the beginning of the pandemic or were able to use an existing one. These numbers are comparable to those of Swiss hospital pharmacies, where 24% had an existing pandemic plan before and 70% after the pandemic (Schumacher et al., 2023). According to Study III, pre-existing crisis management plans were activated in response to the pandemic in 15 pharmaceutical industry and wholesale companies (75%), and a new plan for the COVID-19 pandemic was created by 19 (95%) companies. Compared to preparedness plan coverage (14%) among biotechnology and pharmaceutical companies in Maryland, United States, the crisis preparedness of Finnish pharmaceutical companies was much higher (Watkins et al., 2008). These findings suggest that COVID-19 has improved pandemic preparedness in community and hospital pharmacies and the pharmaceutical industry and wholesale (I–III).

Some respondents incorporated a new plan despite an existing one. Detailed plans tailored for a specific situation may not serve in a different crisis, however, a written plan, even one created for a different event may assists in quickly identifying feasible actions (Hale et al., 2006). Without such, the response is less effective because more steps are required to make critical decisions. Incorporating a generic all-hazards approach to crisis plans, combined with well-chosen response strategies to known crisis scenarios is recommended instead of detailed plans, because adaptation to changing circumstances is required in each crisis (Boin & ‘t Hart, 2010). Appropriate actions may vary depending on problems that arise, crisis characteristics and organisational capacities.

A plan or a standard operating procedure on paper does not help much if only a few are aware of it (Coombs, 2023). Crisis plans or related standard operating procedures were taught to the entire staff in 72% of community pharmacies, 83% of hospital pharmacies and 30% of industry and wholesale companies. Differences in organisational settings may affect the rather small number at the industry and wholesale level; however, potential crises affecting the entire staff may exist, and increasing the number of aware employees could provide security and advantage when a crisis strikes.

Despite the positives related to crisis plans, Study I found that such plans were associated with the reduction of community pharmacies’ resources. A clear explanation to this finding was not found. Although pre-existing plans often serve as useful guidance, the plan should be adjusted based on the situation and the organisation’s needs (Coombs, 2023). Additionally, the subgroup that reported negative impacts on organisational resources was

small in sample size (n = 9), which might have influenced the statistical outcomes and which warrants a cautious interpretation of the finding. No explanatory factor was found in this subgroup's open answer fields. However, participants' answers revealed that some pharmacies utilised a template provided by the Association of Finnish Pharmacies, while some used their own templates, indicating that 'pre-existing plans' should have been defined more clearly in the questionnaire.

6.3 FINDINGS ON CRISIS RESPONSE (I–III)

Researchers have proposed that organisations relying on crisis management teams in crisis preparation and response are more likely to succeed compared to organisations in which the crisis management responsibility lies with an individual (King, 2002; Pearson & Clair, 1998). Crisis management teams were widely adopted at the pharmaceutical industry and wholesale (85%) level, while only one-third applied a dedicated pandemic response team at the community and hospital pharmacies levels (35% and 33%, respectively). Without such teams, decisions were made by two or more individuals (42% community pharmacies, 50% hospital pharmacies and 15% industry and wholesale companies) or solely by the pharmacy owner or the hospital pharmacy head (22.6% community pharmacies and 17% hospital pharmacies). A slightly smaller number (19%) of hospital pharmacies in Switzerland established a dedicated pandemic response team, while no comparable study was found from the community pharmacy or pharmaceutical industry context.

In Study I, having such a team did not protect staff or pharmacy owners' resilience, organisational cohesion ('team spirit'), pharmacies' resources or finances during the pandemic. Crisis management studies that emphasise the importance of teams were conducted in industrial and public management contexts, focusing on large organisations (King, 2002; Uitdewilligen & Waller, 2018). Conversely, Study I indicated that a crisis team may not add value in the community pharmacy context. Such a team can, however, provide an effective platform for shared decision-making in some bigger pharmacies. Although a team did not provide advantage for community pharmacies, according to Study I, shared decision-making (i.e. decisions were made by two or more individuals) protected pharmacies' finances and pharmacy owners' resilience during the pandemic. This is the first study demonstrating a buffer to financial hits during a crisis with statistical methods. The beneficial team-related elements, such as varying perspectives and skills, generating more information, stimulating creativity and fostering consensus on important decisions, may also be related to shared decision-making and explain the finding to some extent (Coccia, 2020; King, 2002). No previous studies regarding shared decision-making in the community pharmacy context were found from English literature. Shared decision-making has been studied in the

context of crisis management teams (Santen et al., 2009; Uitdewilligen & Waller, 2018).

The information sources deemed most useful in crisis management were the AFP (I), internal experts (II), hospital districts (II) and government offices, such as the Finnish Institute for Health and Welfare and the Ministry of Social Affairs and Health (I, II, III). Previous research suggests that health professionals rely on official, proximal and familiar information sources and readily accessible information (Brauer et al., 2021; Edwards et al., 2013; Hoti et al., 2020). This study strengthens the suggestion. Fast access to critical information supports leaders and enables rational decision-making in crises, thus, readily accessible data management and information sharing practices are a crucial part of crisis preparedness.

Previous research has shown that sharing information and resources, as well as problem-solving, coordination and trusting relationships with external stakeholders, increase the effectiveness of crisis management (Alpaslan et al., 2009; Bundy et al., 2017). Studies I–III found that collaboration and communication with peers or pharmaceutical supply chain stakeholders increased or improved in 34% of community pharmacies, 75% of hospital pharmacies and 65% of industry and wholesale companies during the pandemic. Previous research has provided little information regarding collaboration among pharmaceutical supply chain stakeholders in crises (Kuo et al., 2021). Studies I–III complement the results of Study IV and provide community and hospital pharmacies' and pharmaceutical industry and wholesale companies' perspectives on collaboration with stakeholders.

According to Study I, increasing or improving collaboration and communication with external stakeholders protected pharmacy owners' resilience during the pandemic. This finding is statistically significant for collaboration with other pharmacies and pharmaceutical supply chain stakeholders but not for social or healthcare stakeholders. Pharmacy owners and the supply chain share the responsibility for medicine availability, which enables common problem-solving and goals. The interdependency between social and healthcare operators is lower, which may explain why collaboration with these professionals did not protect pharmacy owners' resilience.

6.4 SELF-EVALUATION, SUCCESSES AND CHALLENGES (I–IV)

The pandemic's impacts on organisations' staff and management resilience, organisational cohesion ('team spirit'), organisation's resources and finances were self-assessed by the respondents in Studies I–III (Figures 15–17). It is worth noting that at the time of the study, the pandemic's impact on community and hospital pharmacies' team spirit has been mostly positive. Similar results have been reported from the healthcare industry in Sweden (Rücker et al., 2021). The extreme workload forced healthcare practitioners to

focus on core tasks, and feelings of meaningfulness and pride were felt. All the other indicators of the pandemic's impacts on organisations were mainly negative, while dispersion existed. Unexpected workload surge, ambiguity and insecurity that occurred during the pandemic challenged leaders, which is seen in decreased management resilience (i.e. the ability to adapt to and maintain psychological equilibrium during times of high stress; Rakesh et al., 2017). This is especially prominent in the responses of pharmacy owners' resilience, whereof 57% were negatively or very negatively impacted (I). It also emphasises the importance of preventative actions to protect pharmacy owners' resilience.

Mandatory reserve stockpiles were identified as a success in Studies II–III, although development needs of the legislation were also noted. Despite shortages in hand sanitisers, masks, gloves, alcohol and painkillers, most of the respondents expressed satisfaction with medicines' availability at the time of the study (I–III). However, preventing shortages required a variety of mitigating actions by authorities, community and hospital pharmacies and the pharmaceutical industry and wholesale (I-IV). Hospital pharmacies' collegial collaboration and collaboration with authorities, the pharmaceutical industry and wholesale companies had an important role in the pandemic response (III, IV). Similarly, clear guidance by Finnish health authorities and the AFP were instrumental in community pharmacies' effective crisis management (I, IV). No serious interruptions in medical care were reported by the respondents (I–IV).

Most of the pharmacy owners (72.9%), hospital pharmacy heads (67%) and industry leaders and specialists (55%) acknowledged a need to develop collaboration with the pharmaceutical supply chain and healthcare stakeholders to prepare for future crises. A need to enhance information sharing was emphasised by all respondent groups (I–III). Continuous and transparent collaboration was emphasised, and coordination from authorities was requested. These suggestions align with the collaborative crisis management literature, which acknowledges the importance of both collaboration and coordination in multi-organisational response to crises (Christensen et al., 2016; Moynihan, 2009; Nohrstedt et al., 2018).

The availability of medicines, information sharing with stakeholders and equal distribution of medicines from restricted resources were reported in both positive and negative experiences by hospital pharmacy heads, indicating inequalities between hospital pharmacies (II). Similar results were described in Studies III and IV: An authorised coordinating actor, who can communicate effectively to all stakeholders and decide on sharing scarcity was requested. Study I further emphasised the need for better communication between authorities and stakeholders to prevent unnecessary buying pressure due to media reports and, consequently, disruptions in the pharmaceutical supply chain. Solutions to prevent hoarding caused by the media were also requested in Study III. In addition to ensuring medicines' availability, equal distribution

of medicines and information are areas for development to ensure equal patient care in future pandemics.

In Study I, a high proportion (42%) of community pharmacies described wholesalers' challenges in scaling delivery capabilities when order volumes surged. In Norway, a pharmaceutical company was able to tackle the hoarding fast by changing the distribution transport suppliers (Bø et al., 2023). In Study III, pharmaceutical companies' and wholesale's crisis leaders identified anticipation of and response to increased demand and stocking as a challenge. One interviewee described positive experiences of a decentralised approach, in which the company accompanied more than one wholesaler. Such approach reduces the risk to problems in case of rapid increase in demand or other disruptions.

6.5 COLLABORATIVE CRISIS MANAGEMENT (IV)

Previous studies have described the importance of pre-existing interorganisational structures and repeated collaboration prior to a crisis (Boin and t'Hart 2010; Kapucu 2006b; Curnin and O'Hara 2019). Findings of the Study IV support this. However, according to crisis management research, impact of legislation, technical equipment and a formal structure is overrated compared to that of network building, leadership and training (Waugh and Streib 2006; Boin and t'Hart 2010). The Study IV indicates that legislation provides necessary mandates for government agencies and clarifies stakeholder roles during crisis. Despite legal obligations in material preparedness, NESA did not play a bridging role in the collaborative pandemic response of the pharmaceutical supply chain. Instead, FIMEA and THL took over that role, focusing on solving crisis-related issues that were within their legal mandates.

Study IV showed that without a pre-defined crisis management organisation, cross-sector collaboration organised based on previous collaboration structures, channels and relationships and through the establishment of issue-specific groups by government agencies as per legal mandates. According to previous research, in the absence of a predefined crisis management governance structure, interorganisational collaboration self-organises to overlapping networks (Kapucu, 2006b; Kendra & Wachtendorf, 2003; Nohrstedt et al., 2018). In contrast, no overlapping was found in the Study IV. Pandemic-related issues guided group formation and the meeting frequency of various groups. Collaboration partners had common issues and interdependent roles in problem-solving. Recent research suggests that actor and task interdependency relate to the effectiveness of multi-agency response (Bodin et al., 2022; Nohrstedt, 2016). Study IV supports this suggestion and adds knowledge about issue-specific groups.

The third sector was an important collaborative partner for the private and public sectors (IV). Previous studies illustrate the importance of public-

nonprofit (Curnin & O'Hara, 2019; Kapucu, 2006b; Simo & Bies, 2007) and public-private (Kim et al., 2022) partnerships in crises. Private-third sector collaboration has been studied in a non-crisis and disaster relief context (Dahan et al., 2010; Maon et al., 2009). The Study IV extends that focus by illustrating the third sector's central role in supporting both the private and public sectors during the pandemic. Advocacy organisations shared information and resources with member companies, provided information on issues and operational performance with government agencies and participated in problem-solving in collaborative groups. Advocacy organisations were selected for groups formed by FIMEA, as they combined information from member companies and represented a national perspective.

6.6 PRACTICAL IMPLICATIONS FOR PHARMACEUTICAL SUPPLY CHAIN STAKEHOLDERS

The present study describes and summarises various pandemic mitigation strategies in the context of the pharmaceutical supply chain. Examples of previous and potential crises and effective crisis management at community pharmacies, hospital pharmacies and the pharmaceutical industry and wholesale are depicted in the literature review. Practical implications to improve preparedness at organisational and cross-sectoral levels are depicted in the following chapters.

6.6.1 ORGANISATIONAL PERSPECTIVE

Organisational crisis planning is an indispensable starting point. It should include developing and critically evaluating crisis plans and related standard operation procedures (Carmeli & Schaubroeck, 2008; Coombs, 2023; Mitroff, 1988; Pearson & Clair, 1998). Do you know potential issues for core functions which could arise in a crisis? Do you know how to solve these issues based on the plan? The plan should serve as a reference document, enabling fast and accurate actions (Boin & 't Hart, 2010). Appropriate actions may vary depending on the problems that arise, crisis characteristics and organisational capacities. Relevant crisis plans should be taught widely in the organisation. Who is aware of crisis preparations?

Crisis simulations (a table-top or a full-scale) enable detecting vulnerabilities and information gaps (Coombs, 2023; Fowler et al., 2007). Such simulations could be organised internally or, for example, by an external organisation. Do you know how to secure core functions in case of an electricity system failure or a data management system breakdown?

Developing organisational decision-making capacities during ordinary times offers prerequisites to rational decision-making when a crisis hits (Boin & 't Hart, 2010; Hale et al., 2006). Data management systems assist in the formation of an accurate situation picture. Artificial intelligence (AI) could be developed, for example, in scenario planning. Decision-making in teams or, at community pharmacies, by two or more colleagues provides advantages (Study I, King, 2002; Pearson & Clair, 1998). Such shared decision-making may protect community pharmacies' finances and pharmacy owners' resilience during crises (I). Furthermore, active collaboration with peers and key stakeholders enables a shared situation picture (IV).

Despite a high level of preparedness, accommodating rapidly increased needs takes time. Could **early notifications** of upcoming regulation or concerns from authorities to stakeholders enable better anticipation? Advancing signal detection for potential crises and risk management at the organisational level could also improve the anticipation and effectiveness of the response. Signal detection on global trends, for example benchmark to Italy in case of COVID-19, might have improved anticipation.

6.6.2 CROSS-SECTORAL PERSPECTIVE

Cross-sectoral crisis planning should focus on selected problems affecting various stakeholders, such as consumption peaks, core function interruptions and logistical challenges that may arise in different crises (IV). Planning could include evaluation of potential crises and discussion of rational level of preparedness. As many of the problems are predictable, solutions, potential accountability gaps and collaboration partners can be considered prior to a crisis to some extent. Breaking complex problems into manageable pieces, task interdependency, and preparing, simulating and exercising for adaptive and networked responses build a good ground for an agile and effective collaborative crisis response (Boin & 't Hart 2010; Chen et al., 2013; Nohrstedt et al., 2018).

Organising around common (also non-crisis-related) incentives during normal times would enhance preparedness and learning and reduce duplicate work and information gaps during crises (IV). Informal collaborations and intermediate organisations sharing information and offering pragmatic solutions prior a crisis might prove fruitful. For example, organising through advocacy organisations and informal cross-sectoral stakeholder groups are good examples of utilising existing networks for crisis management purposes.

Although collaboration was praised by many respondents, lack of coordination and collaboration was identified as a challenge (I, II, III). **Improving prerequisites for coordination and information sharing** in collaborative crisis response is important for ensuring effective response, equal medicine availability and patient safety (II, III, IV). Some level of

coordination could improve transparency and equality between actors. A collaborative crisis management model could clarify stakeholders' and government offices' roles and responsibilities, and coordination responsibility. Official guidelines for managing medicine supply and to avoid misallocation and excess stockpiles of medications among healthcare facilities (i.e. hospitals, community pharmacies and primary care) could be issued (Kuo et al., 2021). An authorised coordinator and interactive information infrastructure could improve decision processes by engaging a wider exchange of knowledge and skills and enable equal and fast access to correct information.

6.7 RELIABILITY AND VALIDITY OF THE RESEARCH

6.7.1 STUDIES I-III

Several steps were taken to ensure validity of the new survey instrument. To ensure construct validity, i.e. whether the questionnaire measures a phenomenon it is planned for, the questionnaire was developed based on crisis management process models. The development of the questionnaire is explained in detail in Chapter 4.1.1. Content validity was assessed by the research group, two experts from the AFP, and one expert from the PIF. Furthermore, face validity was assessed by a pilot group (n = 6). To avoid sampling bias, the questionnaire was sent to all target group members.

The response rates of 36.7% (n = 221 community pharmacy owner), 57% (n = 12 hospital pharmacy heads) and 27.4% (n = 20) leaders and specialists from the pharmaceutical industry and wholesale are too low to allow for generalisable results but can be considered sufficient for indicative findings that must be interpreted with caution. However, the response rates were similar to the response rates of previous survey-based studies in community pharmacy and pharmaceutical industry context (Jokinen et al., 2019; Kallio et al., 2021; Matikainen et al., 2015). The survey data were complemented with semi-structured interviews for data triangulation in Studies II and III. No deviations appeared in the triangulation; instead, the survey data were supported and deepened.

Due to the cross-sectional survey design, studies' findings reflect self-reported answers at a single time point and cover only the early stages of the pandemic. This limited time frame does not capture the full spectrum of changes and adaptations that organisations underwent as the pandemic evolved. For example, Studies I–III do not cover the development of COVID-19 vaccines, logistics, storage and distribution or vaccine procurement or areas in which hospital pharmacists and pharmaceutical industry in collaboration with government agencies played a significant role according to Study IV. Moreover, recall bias is important to acknowledge because the participants were asked to remember events and experiences from the beginning of the

pandemic, possibly leading to hindsight bias, through which the participants may have inadvertently reshaped their memories to fit their current understanding of events. Such biases may have influenced their responses' accuracy and completeness.

Another notable limitation is the studies' primary focus on a management perspective. An employee perspective may have added understanding of how crisis management strategies and their effectiveness were perceived and experienced. In Study II, including other relevant hospital pharmacy staff such as heads of procurement, dispensary, clinical or production departments may have enriched insights into hospital pharmacies' crisis management, particularly in cases of large hospital pharmacies. Respondents of Study III were leaders and managers from different functions. Respondents' different professional backgrounds may have affected the focus of the responses, although it provided a broader variety of actions in crisis management compared to identical backgrounds.

6.7.2 STUDY IV

Gioia methodology provided guiding steps for the Study IV to obtain qualitative rigor (Gioia et al. 2013). In addition, COREQ-checklist was applied to evaluate research reliability and validity (Tong et al., 2007). Research group, study design, data analysis and findings were evaluated according to the checklist. The research group members had both content-based and methodological expertise. The interview protocol was developed by the research group and evaluated in pilot interviews including crisis leaders from community pharmacy, hospital pharmacy and pharmaceutical industry. The study interviews were conducted by two researchers, one as interviewer and one as observer taking notes. Interviews were audio recorded and transcribed verbatim allowing the reliability assessment. Furthermore, each participant was given an opportunity to review their interview transcript for accuracy and provide clarification if needed. Study participants (n = 31) represented a wide range of crisis leaders from private, public and third sector increasing the validity of the study.

A qualitative content analysis was conducted by two researchers to allow researcher triangulation and increase the study's reliability. Researchers worked independently but regularly compared analyses, discussed similarities and discrepancies. The interview transcripts were compared to one another to reduce the bias of the participants' self-evaluation of crisis management effectiveness and memory bias. Description of the coding three was provided in figures 7 and 8 presenting the data structure for each research question (Gioia et al. 2013). Furthermore, several quotations were presented to illustrate the findings and to increase the validity.

Despite robust study design and analysis, some study limitations remain. Some information may have been omitted because of the limited number of

interviews and the focus on leaders instead of employees. As the interviews were held one year after the pandemic's acute phase, a possible recall bias in the responses may have existed. Finland has a unique pharmaceutical sector set-up, and professionals know one another well in the small country, so caution is recommended in translating the results to other settings. National, European and global pandemic responses, other industries, the healthcare and local infrastructure affected Finland's pharmaceutical supply chain, but these considerations were excluded in the study. Furthermore, interorganisational and interagency collaboration within sectors was excluded to focus on cross-sectoral collaboration. Finally, although the influence of cross-sector collaboration on crisis management effectiveness was explored qualitatively based on the participants' experiences, it was not measured quantitatively.

6.8 FUTURE RESEARCH

Further research is needed to develop innovative and practical tools for pharmaceutical supply chain stakeholders to better prepare and respond to crises. Research could explore developing AI in scenario planning, which could be utilised in identifying vulnerabilities and preventing crises as well as comparing different response strategies during a crisis. Research is needed to identify information gaps and what information is essential for different stakeholders to maintain core services during crises. Who provides this information and where it is located? These could be studied on both organisational and supply chain levels.

A longitudinal study is required to obtain more comprehensive picture of crisis management efforts and their changes during the pandemic, and to cover all stages of the crisis management process model. Also, studies covering multiple countries, such as Nordic, European Union (EU) or the Organisation for Economic Co-operation and Development (OECD) areas, would enable a more comprehensive view to prevention, preparation, response and learned lessons in the current context.

The present study focused on the views of crisis leaders and managers. However, an employee perspective is also important in evaluating crisis management efforts. Were there unnecessary decisions that wasted time or resources? Moreover, the government office perspective was obtained only from interviews (n = 5), and a study focusing on such a perspective could provide important information.

More research on collaborative crisis management in healthcare is needed, as majority of the studies focus on emergency and public organisations. Building on the findings of Study IV, these studies could compare the effectiveness of issue-specific and other forms of organising. Studies could also focus on developing structures that improve coordination and information sharing during ordinary times and crises. Post-crisis learning in the cross-sectoral context is also an unexplored area.

Process models have been criticised for ignoring the possibility of stages overlapping or occurring simultaneously, which often occurs during complex and dynamic crises (Jaques, 2007). Furthermore, it has been recognised that learning, positioned in the post-crisis stage in the three-stage process model, is a crucial part of each stage (Veil, 2011). A relational model that views crisis management as a continuous discipline based on clusters and nonlinear elements could be utilised for building holistic descriptions of crisis management in future crises.

Study I found that shared decision-making provided a buffer to financial hits and pharmacy owner's resilience during the pandemic. Studying decision-making in community pharmacies would also provide an interesting research avenue for the non-crisis context.

7 CONCLUSIONS

The current study depicted crisis management in Finland's pharmaceutical supply chain at the sector and cross-sector levels during the COVID-19 pandemic. Questionnaire studies (I–III) provided the data for organisational perspective, complemented with the interview transcripts in Studies II–III. Interview data served as a base for the cross-sectoral perspective (Study IV). Components that support effective crisis management were gathered in the literature review and evaluated in the context of pharmaceutical supply chain stakeholders. Finally, practical implications were provided for recognised challenges.

Theories of organisational crisis management and collaborative crisis management served as the backbone in the thesis, aiming to look beyond the pandemic. Studies I–III provided methodological contributions to the crisis management process literature by utilising process models for survey development. In addition, Study I introduced another methodological contribution by employing a statistical method for data analysis to investigate the potential benefits of crisis management efforts. Studies I-III extended crisis management process models to new contexts of community pharmacies, hospital pharmacies and the pharmaceutical industry and wholesale. The main theoretical contribution of Study IV was a new model of organising for collaborative crisis management.

The crisis management of the pharmaceutical industry and wholesale and hospital and community pharmacies focused on maintaining core operations and responding to the pandemic with adjustments in processes, initiating infection prevention measures, solving problems and creating innovations. Preparedness evolved concurrently with the pandemic response (I–III). Crisis decision-making relied mainly on teams (III) and shared decision-making (I–II), while dispersion existed. Community pharmacies were at the frontline of the pandemic experiencing hoarding and concerned patients (I). Their actions focused on outpatient care with novel solutions to maintain the services. Pharmacies implemented home deliveries and remote consultations, established hand sanitiser production, provided additional counselling and corrected incorrect information concerning the pandemic. Hospital pharmacies focused on ensuring inpatient care with critical medicines (II). Examples of key actions included collaborating with the infection, lung, and/or intensive care units, issuing instructions, ensuring availability of infection and/or emergency medications and implementing operational changes to maintain services. Hospital pharmacies' role in organising ultra cold vaccine storage and logistics was significant. In the pharmaceutical industry and wholesale, potential issues were anticipated with increased monitoring, storage levels and collaboration with supply chain stakeholders

(III). Pharmaceutical companies shifted the pandemic's narrative with novel vaccines for COVID-19.

The crisis management literature identifies crisis plans, teams and collaboration with external stakeholders as elements that increase the effectiveness of crisis management. Study I explored whether these efforts protected community pharmacies' staff resilience, leader's resilience, organisational cohesion ('team spirit'), organisations' resources or finances during the pandemic. The study found that shared decision-making with pharmacy colleagues protected pharmacies' finances and their owners' resilience during the pandemic compared to individual decision-making. Also, increasing or improving collaboration and communication with other pharmacies or pharmaceutical supply chain stakeholders protected pharmacy owners' resilience compared to unchanged or reduced collaboration.

Cross-sector collaboration among pharmaceutical supply chain stakeholders focused on ensuring medicines' availability and organising vaccine storage and delivery (IV). Without a predefined crisis management organisation, cross-sector collaboration organised based on previous collaboration structures, channels and relationships and through the establishment of issue-specific groups by government agencies as per legal mandates. The third sector organisations were important collaborative partners for the private and public sectors. Cross-sector collaboration was necessary for coordinating crisis management efforts.

The respondents identified challenges related to anticipation of and response to hoarding and stocking (I, III), medicine shortages (I, II), information sharing, coordination and collaboration (I, II, III). Pharmaceutical supply chains' crisis preparedness could be improved with cross-sectoral crisis plans and well-selected simulations focusing on common issues (IV). Developing prerequisites for coordination and information sharing and preparing strategies to balance supply-demand issues would improve transparency, equality between stakeholders and equal patient care (II, III, IV). Coordination and information sharing could also be improved by organising around common (non-crisis-related) incentives during ordinary times (IV). Organisational crisis preparation should include continuous signal detection and regular crisis simulations, which provide insights for updating crisis plans. Developing organisational decision-making capacities during ordinary times offers prerequisites to rational decision-making in crises. Future research employing longitudinal and multi-perspective methods are needed to strengthen and deepen the study results. Research is also needed to develop innovative and practical tools for pharmaceutical supply chain stakeholders to better prepare and respond to crises.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE

Background Questions (I-III)

Community Pharmacy Specific Questions (I)

Respondent
1. Job title
a. Owner of the pharmacy
b. Other, please specify

2. Years of experience
a. As Owner of the Pharmacy / In current position
0–5, 5–10, 10–15, 15–20,> 20 years
b. Working years after graduation
0–5, 5–10, 10–15, 15–20,> 20 years

Pharmacy
3. In which region is the pharmacy located?
a. Uusimaa
b. Satakunta
c. Kanta-Häme
d. Pirkanmaa
e. Päijät-Häme
f. Kymenlaakso
g. South Karelia
h. Southern Savonia
i. Northern Savonia
j. North Karelia
k. Central Finland
l. Southern Ostrobothnia
m. Ostrobothnia
n. Central Ostrobothnia
o. Northern Ostrobothnia
p. Kainuu
q. Lapland
r. Southwest Finland or Åland

4. How many employees are there in the pharmacy?
<10, 10–25,> 25 employees

Hospital Pharmacy Specific Questions (II)

Respondent
1. Job title
a. Executive hospital pharmacist
b. Other, please specify

2. Years of experience
a. As Hospital Pharmacy Head / In current position
0–5, 5–10, 10–15, 15–20,> 20 years
b. Working years after graduation
0–5, 5–10, 10–15, 15–20,> 20 years

Organisation
3. How many employees are there in the hospital pharmacy?
<40, 40–80,> 80 employees

Industry and Wholesale Specific Questions (III)

Person answering the questionnaire
1. Job title
a. Managing Director / Country Manager / CEO
b. Other, please specify

2. Years of experience
a. In current position
0–5, 5–10, 10–15, 15–20,> 20 years
b. Working years after graduation
0–5, 5–10, 10–15, 15–20,> 20 years

Organisation
3. Is the organisation:
a. Pharmaceutical company, no pharmaceutical manufacturing in Finland
b. Pharmaceutical company, pharmaceutical manufacturing in Finland
c. Pharmaceutical wholesale

4. How many employees does the Finnish organisation have? (not asked from wholesalers)
<50, 50–100,> 100 employees

Pre-Crisis Phase (I-III)

1. Before the COVID-19 pandemic: How likely did you consider a crisis concerning the pharmaceutical supply chain to be? *Very likely - likely - unlikely - very unlikely*

2. Currently: How likely do you consider a crisis concerning the pharmaceutical supply chain in the future?
Very likely - likely - unlikely - very unlikely

3. What kind of crises does the organisation have a plan / a standard operating procedure for?
Open answer field

4. Who are these plans / standard operating procedures educated for?
Sector specific (community and hospital pharmacy, I-II)
a. Pharmacy owner
b. Managing pharmacists
c. Pharmaceutical staff
d. Whole staff

e. Other, please specify
OR (pharmaceutical industry and wholesale, III)
a. Managing director / Country manager / CEO
b. Management team
c. Supervisors
d. Whole staff
e. Other, please specify

5. Were pre-existing plans / standard operating procedures used to minimise the harm of the COVID-19 pandemic? *Yes/No*
If not: Why not? *Open answer field*

6. Did the organisation create a new plan / a standard operating procedure to minimise the harm of the COVID-19 pandemic? *Yes/No*
If not, why not? *Open answer field*

Crisis Response and Business Continuity during the Pandemic (I-III)

7. When was the first action taken by the organisation to minimise the harm of the COVID-19 pandemic?
MM/YYYY

8. What was this action? *Open answer field*

9. Was a pandemic crisis team set up in the organisation? *Yes/No*
a. If yes, what are the roles of the team members? *Open answer field*
b. If not, who made the decisions to minimise the harm caused by the pandemic? *Open answer field*

10. What data sources were used to minimise the harm of the COVID-19 pandemic? Evaluate the usefulness of the data source. *Very useful - useful - not very useful - not useful at all - not used*
a. Hospital districts / Social and healthcare district
b. Finnish Medicines Agency
c. Ministry of Social Affairs and Health
d. Department of Health and Welfare
e. National Institute of Occupational Health
f. Security of Supply Centre
g. World Health Organisation
h. The International Pharmaceutical Federation
i. European Medicines Agency
j. EU Commission
k. Internal experts
l. External Consultants
m. The Association of Finnish pharmacies
n. Pharma Industry Finland
o. Scientific publications
p. Media
q. Social media
r. Else, please specify *Open answer field*

Community Pharmacy Specific Questions (I)

11. What measures have been taken in the pharmacy to prevent infections?
a. Personal protective equipment
b. Other protection, such as safety glass for drug delivery and cashier
c. Improving cleaning efficiency
d. Improving hygiene: hand sanitiser and hand washing instructions
e. Pharmacy's own hand sanitiser production
f. Precautions for incoming goods: e.g., disinfection of transport boxes
g. Dividing staff into shifts at different times
h. Remote work, what kind of work was done remotely? *Open answer field*
i. Ensuring social distance in a pharmacy, with, e.g., marks on the floor
j. Restrictions on the number of customers on pharmacy premises
k. Set up or add resources to an online pharmacy
l. Set up or add resources to home delivery of medicines
m. Set up or add resources to a hatch / drive-in service
n. Set up or add resources to pharmaceutical telephone consultation
o. Set up a telephone order service for consumer customers
p. New digital solutions or additional resources for digital solutions, please specify *Open answer field*
q. Prohibition of visits of sales representatives
r. Written instructions for customers at the pharmacy (only asymptomatic customers allowed, hand and cough hygiene)
s. Instructions for staff on coronavirus, protection measures, applying for a coronavirus test, how to instruct customers
t. Visiting time for risk groups
u. Transfer of risk group personnel away from customer work
v. Other key measures to prevent infections, please specify

12. How has the pharmacy operations changed during the pandemic? *Tick a box*
a. Changes in pharmaceutical manufacturing or manufacturing processes
b. Changes in procurement or procurement process
c. Changes in supply of medicinal products or supply processes
e. Changes in internal communication and management

13. Please specify changes in processes. *Open answer field*

14. Additional tasks caused by the pandemic. *Tick a box*
    a. Staff have listened to patients' concerns during the pandemic
    b. Staff have corrected incorrect information regarding the pandemic and / or its medication
    c. The staff has instructed the patient to apply for testing
    d. Arrival assessment (TRIAGE) for clients: symptoms, recent travel and contacts with infected

15. Has collaboration and communication with other pharmacies or operators of the pharmaceutical supply chain changed? *Yes / No*
a. If yes, please specify *Open answer field*

16. Has collaboration and communication with social and health care operators changed? *Yes / No*
a. If yes, please specify *Open answer field*

17. Is there a need to develop collaboration during crisis with other pharmacies, operators of the pharmaceutical supply chain or operators of social and health care in times of crisis? *Yes / No*

a. If yes, how should collaboration be developed? *Open answer field*

Hospital Pharmacy Specific Questions (II)

11. What measures have been taken in the hospital pharmacy to prevent infections? *Tick a box*
a. Increasing the use of personal protective equipment
b. Improving cleaning efficiency
c. Improving hygiene: hand sanitiser, hand washing instructions
d. Precautions for incoming goods: e.g., disinfection of transport boxes
f. Dividing staff into shifts at different times
g. Remote work
h. New digital solutions or additional resources for digital solutions
i. Prohibition of visits to sales representatives / other nonhealthcare operators
j. Written instructions for visitors (only asymptomatic visitors allowed, hand and cough hygiene)
k. Instructions for staff on coronavirus, protection measures, applying for a coronavirus test, how to instruct hospital wards
l. Transfer of risk group personnel away from patient work
m. Other key measures to prevent infections, please specify *Open answer field*

12. Has operations of a hospital pharmacy changed during the COVID-19 pandemic? *Tick a box*
a. Changes in pharmaceutical production
b. Changes in procurement
c. Changes in supply of medicinal products
d. Changes in clinical pharmacy
e. Changes in internal communication and management

13. Please specify changes in processes. *Open answer field*

14. Additional tasks caused by the pandemic. *Tick a box*
f. Preparation of medicine lists and organisation of drug logistics in the COVID-19 patient ward
h. Searching for alternative medications in case of availability problems
i. Development of treatment algorithms for alternative medications

15. Has collaboration and communication with other hospital pharmacies or operators of the pharmaceutical supply chain changed? *Yes / No*
a. If yes, please specify *Open answer field*

16. Has the hospital pharmacy's collaboration and communication with the hospital's internal actors changed? *Yes / No*
a. If yes, please specify *Open answer field*

17. Is there a need to develop collaboration with other hospital pharmacies, operators of the pharmaceutical supply chain or hospital's internal actors in times of crisis? *Yes / No*
a. If yes, how should cooperation be developed? *Open answer field*

Industry and Wholesale Specific Questions (III)

11. What measures have been taken in the organisation to prevent infections?
a. Personal protective equipment
b. Improving cleaning efficiency
c. Improving hygiene: hand sanitiser, hand washing instructions
d. Dividing staff into shifts at different times
e. Remote work, what kind of work was done remotely?
f. New digital solutions or additional resources for digital solutions, please specify *Open answer field*
g. Instructions for staff on coronavirus, protection measures, applying for a coronavirus test
h. Other key measures to prevent infections, please specify

12. How has operations of the organisation changed during the COVID-19 pandemic?
a. Changes in pharmaceutical manufacturing or manufacturing processes, please specify
b. Changes in procurement or procurement process, please specify
c. Changes in storage or storage processes, please specify
d. Changes in internal communication and management, please specify
e. Other changes, please specify

13. Has cooperation and communication with other pharmaceutical companies, pharmaceutical wholesalers or other operators of the pharmaceutical supply chain changed? *Yes / No*
a. If yes, how? *Open answer field*
14. Has cooperation and communication with operators of social and health care changed? *Yes / No*
a. If yes, how? *Open answer field*
15. Is there a need to develop cooperation with other operators of the pharmaceutical supply chain or social and health care in times of crisis? *Yes / No*
a. If yes, how should cooperation be developed? *Open answer field*

Common Questions (I-III)

18. Has the organisation taken measures to ensure availability of medicines during a pandemic?
a. Yes, measures required by the authorities
b. Yes, the measures required by the authorities and other measures, please specify *Open answer field*

19. Has the organisation taken specific measures to ensure quality of medicines, safety of medicines and / or medication safety during the pandemic? *Yes / No*
a. If yes, please specify *Open answer field*

20. Has the organisation taken measures to ensure staff resilience during a pandemic? *Yes / No*
a. If yes, please specify *Open answer field*

21. Has the organisation's human or other resources been redirected, increased or reduced? *Yes / No*
a. If yes, please specify *Open answer field*

Post-Crisis Phase (I-III)

22. What kind of impact has the pandemic had on staff resilience so far?
Very negative - negative - no effect - positive - very positive

23. What kind of impact has the pandemic had on management resilience so far?
Very negative - negative - no effect - positive - very positive

24. What kind of impact has the pandemic had on organisational cohesion so far ('team spirit')?
Very negative - negative - no effect - positive - very positive

25. What kind of impact has the pandemic had on public visibility of the pharmaceutical sector?
Very negative - negative - no effect - positive - very positive

26. What kind of impact has the pandemic had on the organisation's resources?
Very negative - negative - no effect - positive - very positive

27. What kind of impact has the pandemic had on the organisation's finances so far?
Very negative - negative - no effect - positive - very positive

28. What has not worked in the crisis response of the Finnish pharmaceutical supply chain? Why? *Open answer field*

29. What has been successful in the crisis response of the Finnish pharmaceutical supply chain? Why? *Open answer field*

30. What would you do differently in the crisis response of your own organisation? *Open answer field*

31. What have you learned from crisis management during the COVID-19 pandemic? *Open answer field*

APPENDIX 2: INTERVIEW PROTOCOL

1. Tell us briefly about your personal experience with your organisation's crisis management during the COVID-19 pandemic.

2. What kind of systematic collaboration did you have with pharmaceutical supply chain stakeholders during the pandemic? What kind of ad hoc collaboration did you have?

3. What type of collaboration occurred in practice?

4. How did collaboration change during the crisis compared to normal times?

5. What kind of collaboration was the most important for you? During crisis preparation or crisis management? Why?

6. What is the role of your own organisation in the crisis management efforts of the pharmaceutical supply chain? What about the role of the sector?

7. What is the purpose of collaboration in the pharmaceutical supply chain during a crisis?

8. Has something surprised you in the collaboration with stakeholders?

9. Has something delighted you in the collaboration with stakeholders?

10. Has something disappointed or frustrated you in the collaboration with stakeholders?

11. What kind of cross-sectoral collaboration would be optimal in a crisis? Is a coordinating body needed?

12. What are the most important factors that enhance collaborative crisis management in the Finnish pharmaceutical supply chain? Why?

13. What are the most important factors that prevent/impede collaborative crisis management in the Finnish pharmaceutical supply chain? Why?

14. How was the pandemic crisis managed in the Finnish pharmaceutical supply chain?

15. Could you give concrete examples of crisis management efforts?

16. What kind of crisis management occurred at different levels?

17. From your point of view, what were the most important decisions in the crisis response to the pandemic?

18. What kind of leadership is needed in a crisis concerning the pharmaceutical supply chain (now or in the future)? Why?

19. Should something have been done differently in the collaboration among pharmaceutical supply chain stakeholders during the crisis?

20. Should something have been done differently in the collaboration among pharmaceutical supply chain stakeholders before the crisis? What about in terms of crisis preparedness?

21. Have you shared crisis management experiences or lessons learned with stakeholders? In which channels and how?

22. How would you improve the preparedness of the Finnish pharmaceutical supply chain for future crises?

23. Finally, is there anything else you want to add?

APPENDIX 3: LOGISTIC REGRESSION RESULTS

Table. How (1) crisis plans, (2) teams, (3) shared decision-making and (4) collaboration and communication with external stakeholders associate with pandemic impacts on staff resilience, pharmacy owners' resilience, organisational cohesion ("team spirit"), pharmacies' resources and finances.

	Factor	n (%)	n (%)	Unadjusted OR (CI)	P-value	Adjusted OR (CI)	P-value
Q1: Crisis plans	**Staff resilience**						
	Crisis plans were used	Positive impact/ No impact	Negative impact				
	No	27 (60.0)	18 (40.0)				
	Yes	108 (61.4)	68 (38.6)	0.94 (0.48-1.84)	0.867	1.21 (0.58-2.51)	0.612
	Pharmacy owners' resilience						
	Crisis plans were used	Positive impact/ No impact	Negative impact				
	No	18 (40.0)	27 (60.0)				
	Yes	78 (44.3)	98 (55.7)	0.84 (0.43-1.63)	0.602	0.99 (0.49-2.02)	0.987
	Organisational cohesion ("team spirit")						
	Crisis plans were used	Positive impact/ No impact	Negative impact				
	No	43 (95.6)	2 (4.4)				
	Yes	163 (92.6)	13 (7.4)	1.72 (0.37-7.89)	0.489	2.64 (0.46-15.03)	0.276
	Pharmacies' resources						
	Crisis plans were used	Positive impact/ No impact	Negative impact				
	No	36 (80.0)	9 (20.0)				
	Yes	116 (65.9)	60 (34.1)	2.07 (0.94-4.58)	0.073	3.85 (1.48-10.03)	0.006
	Pharmacies' finances						
	Crisis plans were used	Positive impact/ No impact	Negative impact				
	No	24 (53.3)	21 (46.7)				
	Yes	100 (56.8)	76 (43.2)	0.87 (0.45-1.68)	0.674	0.99 (0.47-2.10)	0.982
Q2: Crisis team	**Staff resilience**						
	Crisis team was established	Positive impact/ No impact	Negative impact				
	No	91 (63.6)	52 (36.4)				
	Yes	44 (56.4)	34 (43.6)	1.35 (0.77-2.37)	0.293	1.62 (0.85-3.09)	0.146
	Pharmacy owners' resilience						
	Crisis team was established	Positive impact/ No impact	Negative impact				
	No	60 (42.0)	83 (58.0)				
	Yes	36 (46.2)	42 (53.8)	0.84 (0.48-1.47)	0.548	0.86 (0.46-1.61)	0.634

	Organisational cohesion ("team spirit")						
	Crisis team was established	Positive impact/ No impact	Negative impact				
	No	134 (93.7)	9 (6.3)				
	Yes	72 (92.3)	6 (7.7)	1.24 (0.43-3.63)	0.693	1.16 (0.34-3.92)	0.816
	Pharmacies' resources						
	Crisis team was established	Positive impact/ No impact	Negative impact				
	No	104 (72.7)	39 (27.3)				
	Yes	48 (61.5)	30 (38.5)	1.67 (0.93-3.00)	0.088	1.84 (0.93-3.65)	0.080
	Pharmacies' finances						
	Crisis team was established	Positive impact/ No impact	Negative impact				
	No	86 (60.1)	57 (39.9)				
	Yes	38 (48.7)	40 (51.3)	1.59 (0.91-2.77)	0.103	1.45 (0.75-2.81)	0.270
Q3: Shared decision making	**Staff resilience**						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Team	44 (56.4)	34 (43.6)	1.26 (0.61-2.61)	0.531	1.31 (0.56-3.09)	0.535
	Multiple people	59 (64.1)	33 (35.9)	0.91 (0.45-1.86)	0.801	0.75 (0.34-1.67)	0.478
	Pharmacy owner alone	31 (62.0)	19 (38.0)				
	Pharmacy owners' resilience						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Team	36 (46.2)	42 (53.8)	0.55 (0.26-1.15)	0.113	0.44 (0.18-1.05)	0.064
	Multiple people	44 (47.8)	48 (52.2)	0.51 (0.25-1.06)	0.070	0.39 (0.17-0.89)	0.025
	Pharmacy owner alone	16 (32.0)	34 (68.0)				
	Organisational cohesion ("team spirit")						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Team	72 (92.3)	6 (7.7)	0.96 (0.26-3.58)	0.950	0.62 (0.12-3.28)	0.578
	Multiple people	87 (94.6)	5 (5.4)	0.66 (0.17-2.58)	0.551	0.41 (0.08-2.19)	0.297
	Pharmacy owner alone	46 (92.0)	4 (8.0)				
	Pharmacies' resources						
	Decisions were made by	Positive impact/ No impact	Negative impact				
	Team	48 (61.5)	30 (38.5)	1.46 (0.68-3.11)	0.329	1.41 (0.57-3.46)	0.456
	Multiple people	68 (73.9)	24 (26.1)	0.82 (0.38-1.77)	0.618	0.68 (0.29-1.61)	0.383
	Pharmacy owner alone	35 (70.0)	15 (30.0)				
	Pharmacies' finances						

	Decisions were made by	Positive impact/ No impact	Negative impact				
	Team	38 (48.7)	40 (51.3)	1.45 (0.71-2.97)	0.306	0.76 (0.31-1.87)	0.547
	Multiple people	56 (60.9)	36 (39.1)	0.89 (0.44-1.79)	0.739	0.41 (0.17-0.96)	0.040
	Pharmacy owner alone	29 (58.0)	21 (42.0)				
Q4a: Collaboration and communication with external stakeholders (other pharmacies or operators of the pharmaceutical supply chain)	**Staff resilience**						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	80 (60.6)	52 (39.4)				
	More or improved collaboration	46 (62.2)	28 (37.8)	0.94 (0.52-1.68)	0.936	0.82 (0.44-1.55)	0.547
	Pharmacy owners' resilience						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	52 (39.4)	80 (60.6)				
	More or improved collaboration	38 (51.4)	36 (48.6)	0.62 (0.35-1.09)	0.098	0.46 (0.24-0.86)	0.015
	Organisational cohesion ("team spirit")						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	120 (90.9)	12 (9.1)				
	More or improved collaboration	72 (97.3)	2 (2.7)	0.28 (0.06-1.28)	0.100	0.24 (0.05-1.21)	0.083
	Pharmacies' resources						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	91 (68.9)	41 (31.1)				
	More or improved collaboration	53 (71.6)	21 (28.4)	0.88 (0.47-1.64)	0.687	0.77 (0.39-1.51)	0.438
	Pharmacies' finances						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	71 (53.8)	61 (46.2)				
	More or improved collaboration	47 (63.5)	27 (36.5)	0.67 (0.37-1.20)	0.177	0.62 (0.32-1.21)	0.161
Q4b: Collaboration and communication with social and healthcare operators	**Staff resilience**						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	94 (61.8)	58 (38.2)				
	More or improved collaboration	35 (58.3)	25 (41.7)	1.16 (0.63-2.13)	0.637	0.96 (0.50-1.87)	0.911

	Pharmacy owners' resilience						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	70 (46.1)	82 (53.9)				
	More or improved collaboration	21 (35.0)	39 (65.0)	1.59 (0.85-1.94)	0.145	1.24 (0.64-2.43)	0.525
	Organisational cohesion ("team spirit")						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	143 (94.1)	9 (5.9)				
	More or improved collaboration	55 (91.7)	5 (8.3)	1.44 (0.46-4.50)	0.526	0.91 (0.25-3.32)	0.891
	Pharmacies' resources						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	108 (71.1)	44 (28.9)				
	More or improved collaboration	39 (65.0)	21 (35.0)	1.32 (0.70-2.50)	0.390	1.13 (0.56-2.28)	0.737
	Pharmacies' finances						
	Change in collaboration and communication	Positive impact/ No impact	Negative impact				
	No change or less collaboration	85 (55.9)	67 (44.1)				
	More or improved collaboration	35 (58.3)	25 (41.7)	0.91 (0.50-1.66)	0.750	0.79 (0.40-1.58)	0.503

OR = Odds ratio
CI = Confidence interval
*Adjusted for years of experience as a pharmacy owner, pharmacy location and number of employees