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## Article

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# Challenges and Measures in Disruptive Times of Grocery Retailing: Lessons Learned from the Covid-19 Pandemic

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## ABSTRACT

The Covid-19 pandemic has caused huge uncertainties in retail supply chains and put significant pressure on grocery retailers. This paper addresses the impact and consequences of the pandemic on grocery retail logistics. We applied an embedded multiple case study to analyze the impact and consequences of the pandemic on grocery retail logistics. The study consists of six case companies, which are leading German grocery retailers. Semi-structured interviews were the main data source, conducted in three rounds over a two-years period at each case company. The aim of our case studies is to explore how grocery retailers could better deal with potential future disruptive times and to derive core insights about the developments of German grocery retail operations triggered by the pandemic. Our contribution highlights the early impact of the pandemic on grocery retail supply chains in the initial phase of the pandemic. Building on this experience, we identify the weaknesses of the standard business revealed in the first year of the pandemic. We then discuss the long-term development of grocery retail operations and the lessons-learned after a two-year review, and then go on to formulate core insights for the development trends. The study is the first one to analyze the effects of the pandemic on the grocery retail supply chain over two years, and to identify the trends in its long-term development.

**KEYWORDS:** Grocery Retail · Covid-19 · Operations · Logistics Planning · Case Study

## 1. INTRODUCTION

The Covid-19 pandemic (hereinafter referred to as pandemic) has greatly impacted supply chains, revealing their insufficient resilience and readiness to deal with such a disruption [1]. The ripple effects have been felt by every industry and every part of society. They occur when a disruption is not confined to one part of the supply chain, gradually builds up and becomes stronger [2]. Grocery retailing in particular has faced huge uncertainties during the pandemic. As the disruptions influenced the wellbeing of society, the pressure on retailers has been high [3]. In the initial phase of the pandemic, grocery retailers faced panic shopping and a high demand for non-perishable groceries. This was repeated every time when stricter regulations were announced by the government and new infection waves evolved creating a bullwhip effect in the supply chain [4]. Additionally, demand in bricks-and-mortar stores has remained at a higher level as consumers cooked more at home due to homeschooling and working. Moreover, online demand has increased sharply due to the fear of infection [5]. This had a direct impact on the transport market as the number of new infections influenced the demand for non-cooled transport capacity [6], which highlights the interconnection between the sales development and supply chain challenges, as an example.

For many product groups, a clearly visible bullwhip effect has developed that could not be prevented despite existing cooperative approaches between suppliers and retailers, such as efficient consumer response (ECR), or collaborative planning, forecasting, and replenishment (CPFR). A reduction in the bullwhip effect can be achieved if appropriate measures are taken promptly (see, e.g., Aastrup et. al. [7]). However, the question remains open, in how far retailers were able to apply

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such approaches achieving an adequate short-term response during the pandemic, and which weaknesses can be identified that need to be tackled developing the retailers' supply chain robustness for potential future disruptive events.

Generally, supply chain disruptions and risk management have been considered extensively in the past, but proactive mitigation strategies and internal crisis management dominate. These approaches do not sufficiently cover the situation of a global pandemic [8, 9]. The global pandemic is a "super-disruption event" affecting the supply chain over an extensive time horizon, while its duration is not immediately foreseeable [10]. Respective contributions in literature examine the adaptations in supply chain management during the pandemic [11], and the impact of the pandemic has received considerable attention in operations management research [12, 13, 14, 15, 16, 17]. Several papers investigate opportunities to mitigate the disruption caused by the pandemic and to increase the resilience of supply chains in the face of future disruptions [18, 19, 20, 21, 22].

Moreover, the growing importance of risk management and visibility in supply chains is mentioned as an impact of the pandemic [23, 24]. Most contributions, however, remain on a generic level or focus on sectors other than retailing, such that the transferability of the findings to the retail sector with its specifics remains open.

However, there are some contributions available that already refer to the retail market. Schleper et al. [25], for example, highlight the changes to retail operations and supply chain management that the pandemic has brought about, and suggest research gaps. Similarly, Pantano et al. [26] identify the critical retail areas in the era of the pandemic. According to them, the perception of the company in society, agile management, the means of communication and the focus on consumers need to be revised. A specific focus on the food and grocery sector is set by Saarinen et al. [27] who analyze changes in the food supply chain and define agile planning as an essential feature of resilient supply chains. Moreover, Raassens et al. [28] analyze crisis management strategies for supply chains of food service firms at the beginning of the pandemic. In addition, Carissimi et al. [29] classify supply chain resilience strategies of grocery supply chains according to their time horizon. They distinguish whether strategies were used permanently or temporarily during the pandemic and when they were designed (pre-/post-disruption). Despite these publications, the effect of the pandemic on grocery retail operations has still not been analyzed. Insights into weaknesses in standard, non-crisis business operations revealed by the pandemic and how they will shape grocery retail supply chain developments in the future are lacking.

Besides these gaps in literature, a major motivation for this paper results from retail practice. After decades of relatively stable business developments, the industry

is already facing increased uncertainty due to an unclear development of online grocery retailing. This is now compounded by the unclear impact the pandemic will have on business developments. Representatives from retail companies responsible for supply chain management therefore reflect that a well-founded and differentiated view of the industry's assessments and activities is very essential with regard to their own logistical design tasks. By means of a multiple case study, this paper therefore aims to provide answers to the following three research questions (RQ):

- RQ 1.** What effects has the crisis had on operational logistics in grocery retailing? Why have these effects been challenging?
- RQ 2.** What are the main areas of development in grocery logistics resulting from the weaknesses identified during the pandemic?
- RQ 3.** How are grocery retailers modifying their supply chain operations in the post-Covid-19 era?

Thereby, the paper reflects the short- and long-term implications for the grocery retail industry. With the help of a multiple case study covering all relevant selling formats in German grocery retailing, several grocery retailers were analyzed both individually and comparatively across cases to conclude a complete picture of logistics and operations developments during the Covid-19 pandemic. The aim of the contribution is to crystallize the lasting impact on grocery retail logistics and to identify the new developments that have been triggered.

The remainder of this paper is organized as follows. First, Section 2 details the research design. Section 3 then portrays the case companies investigated and outlines their development throughout the pandemic. Section 4 focuses on the early impact of the pandemic on grocery retail supply chains in the initial phase of the pandemic. Section 5 then identifies the weaknesses of the standard business revealed in the first year of the pandemic. Afterwards, Section 6 discusses the long-term development of grocery retail logistics after a two-year review in light of pertinent literature. Finally, Section 7 concludes the paper by summarizing the results and proposing areas for future research.

## 2. METHODOLOGY

The following section gives an outline of the research design, specifying our research method, the selection of our cases, the data collection process, and the analysis.

## 2.1. Research method

We chose a qualitative research approach and applied an embedded multiple case study according to Yin [30] that is appropriate to answer the “why” and “how” research questions that have been formulated, and to explore a “real-world phenomenon” such as the pandemic in grocery retailing (see van Hoek [1] or Hohenstein [31] for further Covid-19 publications with case study approaches). Enhancing the external validity, we decided to develop a multiple instead of a single case study design [32]. The design is guided by the quality criteria of transferability, truth-value, and traceability to ensure high-quality [33].

## 2.2. Defining and bounding the cases

The German grocery retail market was defined as the focus area for the cases, because the occurrence of infections and government strategies created country-specific conditions. For example, the announcement of lockdowns affected demand, and high infection rates led to more online orders, which occurred at different times and with a different scope in each country. We determined the period under review from the first panic shopping at the end of February 2020 until April 2022. This period covers the beginning and sufficient progression of the pandemic in Germany, allowing for identification of the actions implemented and the development paths followed by the retailers. We further specified the units of analysis to develop a clear focus [30]. We oriented ourselves around the short-term operational planning areas of the planning framework for grocery retailing by Hübner et al. [34], which led to the following units under investigation: store management, transport management, warehouse management and procurement. It became obvious during our study that demand planning and order dispatching play a major role in all the areas investigated and thus we added it as a further unit of analysis.

After bounding the case, we selected our cases according to the literal replication logic [30]. We made our inquiries among the 20 top-selling German grocery

retailers as few players dominate the German market. We ensured that all prevalent sales formats (full-range provider, discounter, hypermarket, wholesaler, organic supermarket, drugstore) were covered by our selection to display the variety of the grocery market. Nevertheless, we assume similar results from each case as all case companies faced the unprecedented Covid-19 pandemic without preparation time.

## 2.3. Data collection

Multiple sources of data were used to strengthen construct validity [30]. We collected data from databases such as those of the European Retail Institute (EHI), which published several retail surveys and sales data [35, 36]. Additionally, some case companies handed over data reports enabling a deeper analysis and understanding of their situation during the pandemic.

The main data sources were semi-structured interviews with supply chain and logistics managers of the case companies, who proved well informed about logistics operations during the pandemic [30]. Table 1 shows the participating interviewees and their position in the case company. We set up three rounds of interviews to answer our research questions. Not all case companies could be gained for all interview rounds, as the attention of logistics managers was on operational business due to the Covid-19 pandemic and appointments were canceled in few cases.

The results of the cross-case analysis of the respective interview rounds are reported within Section 4-6, while Section 3 portrays the case companies and outlines their development throughout the pandemic offering a within-case perspective. Figure 1 displays an overview of interview rounds and the paper structure.

There were always two researchers conducting the interviews to minimize observer bias. Additionally, they used the interview guidelines as case protocols, strengthening the reliability of the multiple case study [32]. All the interviews were then conducted via video calls and lasted 60 minutes on average.

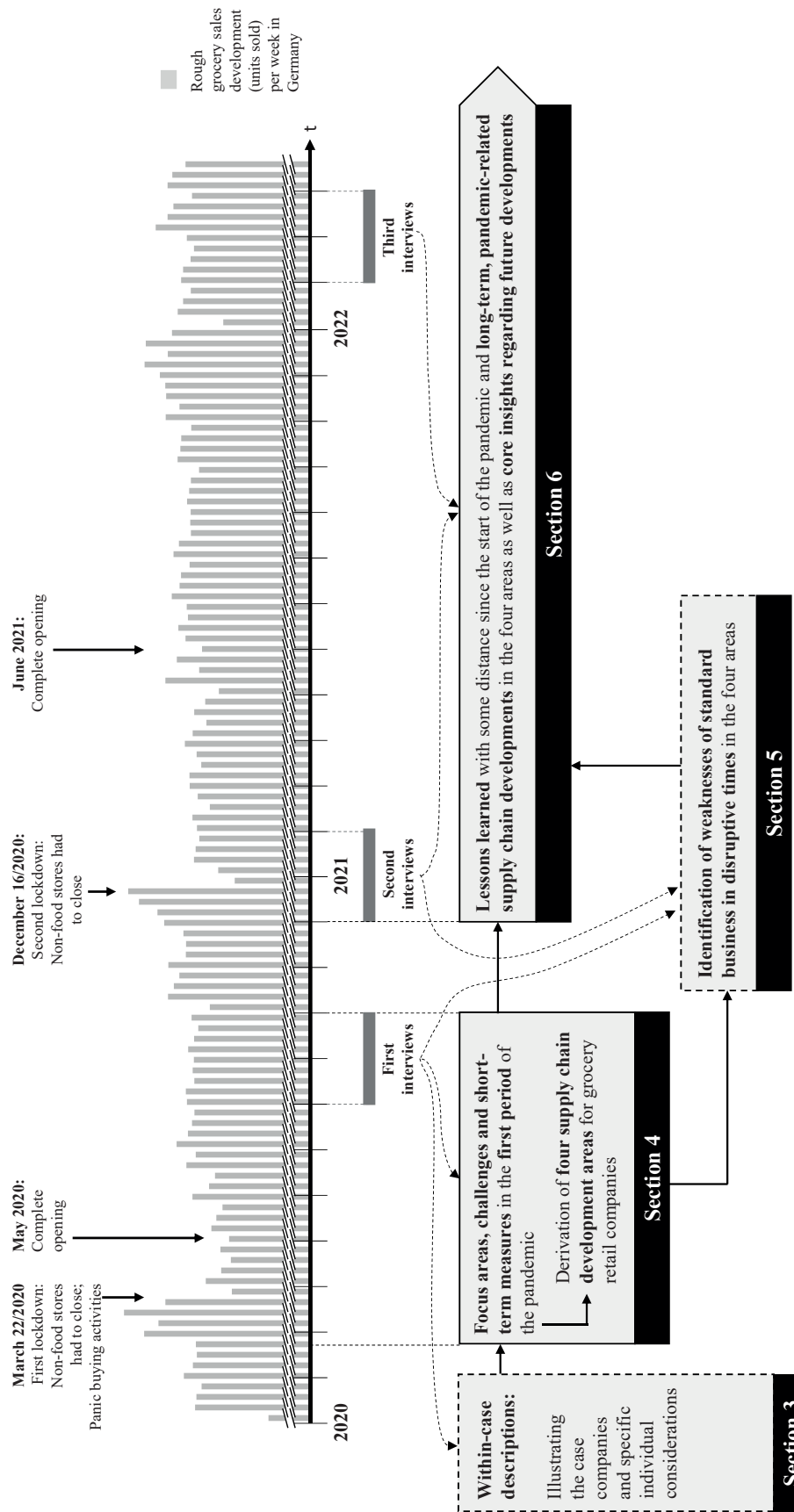


Figure 1: Sequence of interviews and structure of the paper



Table 1: Overview of interviewees

Case	1	2	3	4	5	6
<b>Sales format</b>	Full-range provider	Discounter	Hypermarket	Wholesaler	Organic supermarket	Drugstore
<b>First interviews</b> Position of interviewee	Division Manager SCM	Division Manager Logistics	Head of SCM	Chief Operating Officer	Head of Department SC Development, Analyst	Division Manager Logistics, Analyst Order Dispatching, Analyst Demand Forecasting
<b>Second interviews</b> Position of interviewee	Division Manager SCM		Head of E-Logistics			Division Manager Logistics, Head of Department Forecasting and Order Dispatching
<b>Third interviews</b> Position of interviewee	Division Manager SCM	Division Manager Logistics	Head of SCM	Chief Operating Officer		Division Manager Logistics

The first interview guideline was organized as follows: introduction, the challenges and initial responses within the different units of analysis (see RQ 1) and the post-Covid-19 outlook (see RQ 2). The design was still open and flexible to give the interviewee the opportunity to report freely [30]. After piloting the interview protocol in a test interview with a retailer [32], six interviews were conducted from mid-August until mid-September 2020.

After analyzing the interviews, we were able to systematize the challenges of the retailers during the initial phase of the pandemic and the future developments into development areas for the post-Covid-19 era (see RQ 2 and 3). We decided to conduct additional interviews to gain a deeper understanding of how retailers are likely to modify their supply chain within these areas in the future. We developed a second interview guideline for this purpose, contacted the people in charge of the development areas within our case companies and conducted the respective interviews from December 2020 until January 2021. To find out which of the plans mentioned in the second round of interviews had really been pursued by the retailers, a third round of interviews with managers of our case companies was conducted in February and March 2022.

## 2.4. Data analysis

We followed an inductive strategy for the case study analysis. Open, axial, and selective coding was applied

as codes were assigned to the data, grouped them and focused next on the relevant categories [37]. The coding was done using the qualitative computer data software MAXQDA [30, 33]. We first considered each case separately to understand the retailer-specific situation [32]. After coding each case, we went through the codes again and built more abstract groups summarizing specific retailer examples [33]. For example, we have grouped codes such as “administrative staff deployed operationally” or “use of temporary staff” into the first order category “increase headcount.” This first order category was combined with other first order categories such as “Sunday shift” or “introduction third shift” to form the second order category “increase in personnel resources.” Next, the cross-case synthesis from an inductive perspective was applied [30]. We compared the cases in the course of doing this, and the research team intensively discussed the situations at the retail companies and their developments as well as commonalities and differences between the case companies. The reports of the case companies and further institutions were used to validate the codes and to ensure the correct interpretation of the interview statements. We repeated this process after each round of interviews. Coding, categorization and synthesis both, within and across the cases, gave us deep insights into the case companies and helped us derive our findings. The interviewees reviewed our findings and discussed them with us in order to validate the findings and fulfill the refutation criteria [30, 33].

Due to confidentiality restrictions and the highly concentrated German grocery retail market, we are not allowed to present our with-in analysis in detail and thus focus on the cross-case insights. However, we provide some introductory details on the case companies, outline their development throughout the pandemic within the following section (see Section 3) and refer to challenges and measures observed (see Section 4). We also present development strategies pursued by the specific companies within our results sections (see Section 5 and 6).

### 3. CASE DESCRIPTIONS

Our case studies consist of six companies that are among the leading grocery retailers in Germany, covering all major sales formats (see Table 2).

hours were agreed upon with the works council. New procurement and scheduling methods were also found, such as an automatic reduction of store orders when stocks are low. The goal was a market-oriented and fair distribution of all goods to the stores determined by the head office. The Division Manager Supply Chain Management could be gained for all interview rounds, thus providing a comprehensive picture of the course of the pandemic in the company's logistics.

**Case company 2.** The second case company is a large discounter with 3,000-5,000 stores in Germany. The bricks-and-mortar stores are dominated by private label products, which are not offered online. The discounter provides solely promotional non-food products in its online shop that are delivered by courier, express and parcel (CEP) service providers. Its sales doubled for about three weeks in March 2020, while customer frequency decreased. However, this consumer behavior quickly returned to normal. As a discounter, processes

Table 2: Overview of cases

Case	1	2	3	4	5	6
<b>Sales format</b>	Full-range provider	Discounter	Hypermarket	Wholesaler	Organic supermarket	Drugstore
<b>Stores in country</b>	>5,000	3,000-5,000	<500	<500	<500	1,000-3,000
<b>Sales in EUR</b>	30-50bn	30-50bn	5-10bn	5-10bn	<5bn	5-10bn
<b>Online services</b>	C&C, home delivery	Non-food home delivery	C&C	Home delivery		C&C, home delivery

**Case company 1.** The first case company is one of the market leaders. The full-range provider operates more than 5,000 stores across the country and is one of the “winners” of the pandemic according to turnover generated. Moreover, the retailer offers home delivery and click&collect (C&C) services. The retailer has expanded its home delivery time slots during the pandemic, and has opened additional pick-up stations. Its sales in the online channel have been growing in double digits since the start of the pandemic. The picking of online orders is done purely by an online distribution center, which still has spare capacity. In principle, the retailer relies on internal IT know-how and mainly uses systems developed in-house, which it considers to be a competitive advantage. As a result, the retailer is able to quickly implement changes in analysis and reporting requirements representing a competitive advantage in the pandemic as well as beyond. In addition, the advanced IT infrastructure has allowed most of the administrative staff to work from home immediately and office staff was kept to a minimum. During the pandemic, the case company focused on building capacity throughout the supply chain and generating resources. More flexible working

are highly standardized and rigid. Above all, inventory levels and capacities are not prepared for exceptional situations and therefore meant a serious challenge during the sales peaks of the pandemic. Nevertheless, the pandemic has shown that short-term deviations from standard procedures are possible and the logistics processes are resilient. However, the short-term shift away from standard processes was associated with higher costs, which is why there was a quick return to standard processes. During the pandemic, decision-making authority remained centralized. However, knowledge carriers of internal processes were established in order to be able to react more flexibly in exceptional situations and not to be dependent on only a few people. The interviews were attended by the Head of Logistics of the discounter, who has held this strategic position for several years and therefore has a broad knowledge of the company.

**Case company 3.** The third case company is a hypermarket with less than 500 large stores. An online service had not been established until the pandemic but then an in-store pick-up service was rolled out in 2020 due to consumer demand. The number of pick-up

stations has continuously expanded but is still small, and the hypermarket generates an almost negligible amount of revenue with them. At the beginning of the pandemic, non-food product groups such as clothing, decoration or electronics had to be closed for a short period of time in bricks-and-mortar stores prescribed by the government for competitive reasons. Therefore, sales in these product groups dropped as well as the sales in stores in border regions as customers from neighboring countries stayed away due to border closures. On the other hand, sales in the food and drugstore sectors rose by a double-digit percentage year-on-year at the beginning of 2020. The Head of Supply Chain Management took part in the first and third round of interviews, in which we were able to discuss the impact of the pandemic comprehensively for the bricks-and-mortar business. Since the retailer expanded the online business considerably, we conducted the second interview with the Head of E-Logistics.

**Case company 4.** A wholesaler forms the fourth case. It primarily serves restaurants, hotels or canteens, which can buy from stores or are supplied directly. The turnover nearly halved in April 2020 compared to the previous year due to restaurant closures and extensive home office use. The decline would have been even greater if smaller independent consumers had not compensated for part of the drop in sales. The industries of the wholesaler's customers were hit by sales slumps during the Covid-19 pandemic. Since the wholesaler relied on a significant proportion of logistics staff provided by labor leasing companies, these were cut back first. Moreover, the wholesaler opened its stores to private customers in addition to its usual business-to-business customers at the beginning of the pandemic, to compensate the lost turnover at least partially. However, in the summer of 2021, when the catering trade reopened and sales increased again, the staff could not be built up quickly enough. Labor leasing companies were not able to recruit enough employees, as many former employees had left for other industries. Due to the shortage of personnel, the case company was no longer able to serve the volumes that arose. The next slump occurred in the Christmas business of 2021 because of imposed restrictions in restaurants. Precise forecasts remain still a substantial challenge for the wholesaler, as customer demand (from canteens, the tourism industry, etc.) has changed with increased volatility in the long term. The Head of Operations, who is responsible for all of the company's logistics, took part in the first and third interviews, which covered the entire course of the pandemic.

**Case company 5.** Case company five is an organic supermarket chain with less than 500 stores. The retailer offers mainly private label products, which it also delivers as a supplier to other bricks-and-mortar and online grocery retailers in Europe (including

Germany). Its private label products are only non-temperature controlled products. The retailer does not operate an online store, but its ambient and non-food products can be ordered by consumers from partner retailers. Additionally, the case company has begun a cooperation with an e-grocery delivery service provider, and tests for a home delivery service were planned for the second quarter of 2022. The supermarket chain is growing not only in the online business but also in the stationary business. Especially in the bricks-and-mortar setting, it often has to deal with out-of-stocks or lack of capacity, which was extremely intensified during the pandemic. The sales peak of 300% was reached in calendar week 12 in 2020, which subsequently leveled off. The case company has strict corporate guidelines and principles regarding the sustainability of its products, which were followed even in the exceptional demand phases of the pandemic, causing out-of-stock situations. The supply of products was hardly scalable and short-term procurement of alternative products during the Covid-19 pandemic was not possible, as the internal quality checks and certifications of new suppliers are too time-consuming. The organic supermarket participated in the first round of interviews with the Deputy Head of the Supply Chain Development Department and an employee of the same department. By interviewing an operational employee and one member of the management team, it was possible to draw a comprehensive picture of the experience during the pandemic.

**Case company 6.** The sixth case is a leading drugstore chain with more than 2,000 stores in Germany, where pick-up services are also offered. In addition, home delivery of online orders is possible via CEP service providers. The company experienced significant sales peaks when lockdowns were announced, especially in the categories of ambient food and hygiene products. Compared to the pre-pandemic years, the high volatility of demand during the pandemic period was a particular challenge for the company, which attaches importance to a high degree of price stability in their selling prices and was thus used to comparatively constant demand structures in the past. Even in the light of high demand and scarce products there were no remarkable changes of the selling prices in order to signal to customers that they have a trustworthy and reliable partner, especially in times of crisis. Although the stores were not closed, online sales reached new maximum values during the lockdowns that were also fulfilled by picking significant volumes in the stores. Due to border closures, sales at some stores fell significantly because customers from other countries were no longer able to reach the stores. These stores were used in particular to pick online orders, which was possible within a short time thanks to an already existing self-developed IT solution.

The sales peak in the online and bricks-and-mortar business was reached in March 2020. Customer demand rose so abruptly in that period that significant short-



term out-of-stock situations could not be avoided. Then, after panic-buying situations sales of the bricks-and-mortar stores fell temporarily below the previous year's level. Online business sales grew during the pandemic years, benefiting from the planned expansion of the omni-channel strategy. From 2020 to 2021, a significant double-digit growth rate was achieved. This can be partially explained by the fact that provisioning times for C&C orders were reduced significantly against the backdrop of customer requirements during the pandemic. C&C orders subsequently grew overproportionally. The share of online sales measured against total sales, however, is still small. The drugstore participated in all interview rounds. In some cases, several employees from different supply chain departments were available as interview partners, which gave us comprehensive insights into the influences of the pandemic and the resulting measures for the future development of the logistics structure and operational processes.

The following three sections, i.e., Section 4, 5, and 6, present the findings and interpretation of the cross-case analysis. These sections differ in the time horizons considered.

#### 4. SHORT-TERM CHALLENGES AND MEASURES IN THE INITIAL PHASE OF THE PANDEMIC

This section portrays the short-term impact of the pandemic focusing on the results of the first round of interviews. In the following, the challenges and measures are presented from a shelf-back perspective [38], as the change in demand behavior at the point of sale was the main trigger for the challenges across the whole supply chain.

**Demand planning and order dispatching.** Automatic store ordering (ASO) systems were not prepared for a pandemic and were not properly able to deal with the uncontrolled and unpredictable reaction of consumers mentioned by all retailers interviewed. The high sales figures from panic buying were registered in the ASO systems. However, reliable short-term forecasts and reasonable order proposals could not be generated due to the spontaneous level-shifts in the sales time series. ASO systems were still very helpful to execute daily store orders. The forward-looking planning function, however, was heavily affected by the disruption. In addition, extremely high orders were placed manually by store managers, who were guided by the irrational panic buying of consumers. As a result, most retailers surveyed froze their ASO forecasting processes and disregarded the first-come-first-served procedure for processing incoming orders. This caused a high manual effort for adapting and reprioritizing store orders. The

head offices partially carried out centrally organized order dispatching focused on the reasonable and fair distribution of scarce products.

*The ASO system is normally controlled by the store managers, but during Covid-19 we controlled it centrally. Partly, the independent retailers did not follow the centrally-decided order sizes within the ASO system and ordered full truck-loads of toilet paper.* [Division Manager SCM, Full-range provider]

**Store management.** The ability to accept high-volume shipments is limited in stores due to small storage areas. On peak days, the stores received twice the normal volume of incoming goods, as reported by the hypermarket. Another case company reported that the weekly store order sizes and delivery volumes just before the first lockdown were by far the largest in the history of the company. More staff was required as a result. Besides refilling shelves, store employees had to serve a large number of customers and implement a variety of hygiene measures. The companies report that the shopping atmosphere and thus the work for the employees was sometimes very stressful, which was explained by high customer traffic, distancing rules, scarce stocks and the nervousness of the customers. Faced with these challenges, stores and the online shops of all case companies limited the sales of hoarded products, such as disinfectant, flour, yeast, toilet paper, or noodles. In addition, extremely extended store delivery times, spontaneous deliveries, continuous refilling of the shelves and additional employees were intended to ensure product availability.

*To counteract hoarding, we sold certain products only in usual household quantities, for example two disinfectants per household. At the beginning of the pandemic, we introduced the over-the-counter principle for disinfectants, as theft of restricted products had risen sharply.* [Division Manager Logistics, Drugstore]

**Transport management.** In transportation, panic buying caused an increased demand for transport capacity for store and home deliveries. The discounter acquired transport capacity and drivers available from other industries, some of which were partly shut down, such as the automotive industry. Additionally, the discounter, the hypermarket and the drugstore struggled with border closures that heavily complicated international inbound transport execution. Long traffic jams in the border areas, for example from Germany to Poland, meant that outbound trucks carrying food and hygiene products had difficulty reaching the stores and in some cases were even escorted by the police. All retailers surveyed therefore established crisis teams that were also in contact with ministries. The relaxation

of transport laws agreed in the course of this created flexibility by allowing longer driving times, Sunday and night deliveries.

*Transit traffic was stuck in traffic jams at the European borders [...] The time delays of the trucks were incalculable.* [Head of SCM, Hypermarket]

**Warehouse management.** The various uncertainties, e.g., store demand volatility, delayed and postponed deliveries, led to massive fluctuations in the volumes handled, which revealed a lack of sufficient buffer space and picking capacity. Thus, for example, employees from other departments and temporary staff were used to cope with volume peaks in distribution centers. However, they were untrained and thus less efficient. The wholesaler stood out from the other retailers because of the volume drops in the hospitality industry. It cut back on its large share of personnel leasing to compensate for the volume decline. Moreover, a greater number of employees in the warehouses intensified the fear of a Covid-19 outbreak. As the consequences were unclear, retailers assessed the risk of a warehouse closure as high. To reduce contact between warehouse employees and keep processes running, working hours were extended and additional shifts were introduced. In addition, fixed team constellations were formed to reduce contacts and shifts were planned without any overlaps.

*To handle more volume in the warehouse, we relied on man-power. We used office staff for operational processes, e.g., the logistics planner from the supply chain development department picked in the warehouse. Since he was not properly trained, he was less efficient.* [Head of Department SC, Organic supermarket]

**Procurement.** The rapid increase in demand led to the limited availability of hoarded articles at both the retail and supplier level. For example, noodles manufacturers reached their capacity limits at short notice, and canned tomatoes could not be replenished because production is seasonal. Moreover, the short-term establishment of new procurement channels or new suppliers was partly considered to be too difficult due to the complexity of integrating new suppliers and the exceptional process of accepting one-time deliveries. Retailers ordered the maximum possible quantities of hoarded articles to meet the high demand. Close cooperation and intensive communication with suppliers were considered highly essential because the expected incoming products were planned for immediate picking and transport to stores. Additionally, the full-range provider succeeded in establishing new short-term procurement channels with suppliers that shifted production capacity away from products for large commercial customers,

which were shut down, e.g., cruise ships or hotels. Centralized management was therefore advantageous for procurement as it improved internal and external communication.

*The production capacity of manufacturers was quickly reached. [...] By mid-March, out-of-stock situations increased significantly. One to two weeks later, the delivery ability of industry partners was at 0% for critical products. [...] Until today [October 2020], some products are hardly available due to the lack of components, e.g., tomato cans, because the production is only seasonally possible.* [Head of SCM, Hypermarket]

**Summary and Outlook.** Table 3 summarizes the major challenges and measures identified within the different areas of focus in German grocery retailing in the initial phase of the pandemic. In light of these challenges and measures we discussed the expected consequences of the pandemic for future operations and supply chain development of the case companies. The respective answers by the retailers especially emphasize the need for flexibility of resources, the expansion of real-time reporting, internal and external collaboration, and functions of ordering systems, as well as investments in online services (enumerated in descending order of mentions, each development mentioned by at least half of the retailers surveyed).

Following the inductive approach, the coding of the challenges and measures as well as the outlook provided by the retailers in the first round of interviews resulted in a grouping of the respective codes into major categories. This led to a systematization of the weaknesses of grocery retailing revealed by the pandemic and future developments into four development areas (see Figure 2):

- Behavioral demand planning and order dispatching
- Agile supply chain
- Transparent supply chain
- Sales channels

The first three areas contribute to achieving a stable and a permanently high or at least acceptable service level in extraordinary situations, like the pandemic. The focus in such disruptive times is clearly more on effectiveness rather than on efficiency. However, even in extreme situations customer service should thereby principally be achieved at minimal costs due to thin margins and a strong competitive pressure in German grocery retailing. Nevertheless, cost increases are widely accepted due to the increased uncertainties caused by the pandemic. The fourth development area depicts the weaknesses identified and the necessary development of the sales channels, especially the online business. Thereby the focus is on fulfilling extraordinary customer demand and stabilizing overall

Table 3: Challenges and measures taken by grocery retailing in the initial phase of the pandemic

Area	Challenges	Measures
<b>Demand planning and order dispatching</b>	High manual workload (4), Distribution of scarce products (3)	Centralized and fair distribution of scarce products (5), Focus on critical products (4)
<b>Store management</b>	Acceptance of increased incoming volume (4), Differing local regulations (3), Complex hygiene measures (2)	Product sales rationing (4), Continuous shelf re-filling (2), Additional employees (2)
<b>Transport management</b>	Boarder closures (3)	Use of transport law relaxations (4), Establishment of crisis team and cooperation with government (3), Close consultation with stores (2), Additional CEP-capacity (2)
<b>Warehouse management</b>	Uncertain delivery quantities (6), Delayed deliveries (5), Lack of storage space (4), Untrained temporary staff (3), Risk of warehouse closure (2)	Additional shifts (5), Increase in the number of employees (5), Fixed team constellations (2)
<b>Procurement</b>	Limited availability (4), Critical products briefly not available (3), Effort to acquire new suppliers (2)	Order of maximum possible quantities (6), Close collaboration with suppliers (4), Acquisition of new procurement channels and suppliers (3), Centralization (2)
<b>Outlook</b>		Flexibility of resources (6), Expansion of real-time reporting (5), Internal and external collaboration (4), Expand functions of demand planning and order dispatching system (4), Invest in online services (3)

**Note.** The numbers in brackets indicate how many case companies mentioned the respective topic in an unprompted manner.

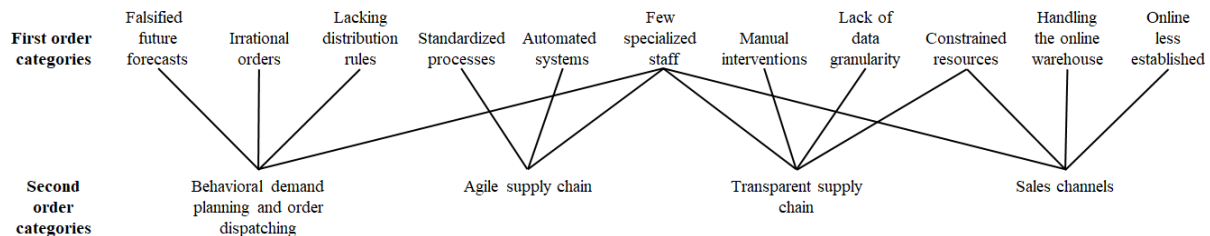


Figure 2: Weaknesses of the standard business assigned to the four development areas considered

sales compensating possible decreases in the traditional sales channels, for example caused in the pandemic due to the customer preference of avoiding personal contacts.

## 5. WEAKNESSES OF STANDARD BUSINESS

In the following, we explore the weaknesses of the standard business in grocery retail operations in more detail focusing on the four development areas derived after the first round of interviews. The weaknesses identified in the first round are enriched by a second round of in-depth interviews. Standard business in

this case describes the way processes are planned and executed in non-crisis periods.

### 5.1. Behavioral demand planning and order dispatching

Retailers, such as the hypermarket, reported that their ASO systems could not meet the high ad-hoc demand and volatility in the initial phase of the pandemic. In addition, the full-range provider for instance identified that basic non-temperature controlled products such as noodles or toilet paper, which previously had stable demand patterns, were especially affected. The ASO systems, however, were not able to proactively deal with such peaks for basic products. Besides that, several retailers stated that the ASO algorithms did not contain

any rules for an automatic rationing and an equitable distribution. The full-range provider highlighted the lack of sensible maximum order limits in the systems, such that irrational orders from store managers were accepted.

*A major challenge in store scheduling was the “psychology on the store side.” The ASO system had to be switched off in some cases because the store managers massively overreacted and would otherwise have ordered 20 pallets of noodles, for example. This behavior had an impact on the employees at headquarters, who had to determine the final order quantities.* [Division Manager SCM, Full-range provider]

Moreover, the ASO systems used the values for future forecasts because unexpected demand peaks were mostly not recognized as one-time events. There was an erroneous upward shift of subsequent forecasts as a consequence. Given these shortcomings of the ASO systems, most of the retailers surveyed manually modified the system proposals and sales history subject to events or extraordinary demand situations. However, the weaknesses of the systems identified also led to a quick setup of respective development projects, e.g., at the full-range provider.

*Due to Covid-19, we have explosively introduced the “sales order manipulation” project. In case of shortage, the system automatically cuts market orders in the markets with the highest reach, and in case of surplus, the surplus is distributed among the markets according to their respective market reach.* [Division Manager SCM, Full-range provider]

The conclusion to be drawn is that human behavior influenced order sizing in disruptive times significantly. Besides the problem of irrational behavior of store employees also the personal knowledge of the employees at the headquarters played an important role during the pandemic. The retailers recognized their shortage and importance given the limited functionality of the ASO systems for extraordinary events.

*In terms of personnel, we were not prepared for this. A great level of knowledge is required for demand planning, and not every colleague or even service provider can replace or relieve these employees.* [Division Manager Logistics, Discounter]

## 5.2. Agile supply chain

An agile supply chain requires fast and flexible adaptations and reactions against the backdrop of changing external conditions. However, the drugstore, for instance, argued that agility was mostly only a secondary aspect in decision-making. Resources and logistics processes have been continuously optimized

with the primary aim of minimizing costs. Buffer inventories and capacities were sized to a minimum based on the comparatively stable conditions. A high degree of standardization (e.g., fixed store delivery patterns and time windows) had been established, resources such as warehouse space, inventory, means of transportation and personnel had been dimensioned to maintain a high degree of efficiency in the highly competitive grocery market with its very low margins in Germany. A change in capacity and processes was usually only considered in the context of known seasonal peaks in demand or anticipated growth of the company. Furthermore, the grocery industry in Germany has invested in highly automated storage and picking systems that are not easily scalable, with a negative impact on the possibility to increase necessary capacities in the short-term.

*Long battery charging times for industrial floor vehicles or pick-by-voice devices leave only little leeway for additional shifts or more employees in the picking system.* [Division Manager Logistics, Discounter]

As a result, flexibility suffered, which became apparent as soon as standard processes were disrupted by level shifts and high volatility in demand. The normally stable environment, which favors a strong cost focus, changed rapidly to a very uncertain and volatile world that required flexible and fast adaptation.

*Agility is now [January 2021] more valued. In decision-making, the flexibility potential of capacities is weighted higher than before Covid-19 and not only cost minimization is considered.* [Division Manager Logistics, Drugstore]

## 5.3. Transparent supply chain

Grocery retail supply chains lacked data availability, analysis and sharing for a degree of transparency during the pandemic. The full-range provider and the organic supermarket stated that plenty of data were recorded but they were not analyzed at the granularity required to read off appropriate measures to deal with pandemic circumstances. Especially the ability to analyze store inventories in real time was missing at several retailers.

*There was a lot of data available, but we could not evaluate it in real time. Data preparation needs to be optimized and accelerated, as more transparency is required.* [Head of Department SC, Organic supermarket]

In addition, rare extreme situations could not be reconstructed in data warehouses comprehensively enough as they were mostly resolved manually on an ad-hoc basis without being adequately reflected in databases. The potential of innovative approaches to



process a high volume of data, incorporate external factors, and update forecasts in real time was not yet exploited. The full-range provider and the discounter further emphasized that non-intuitive user interfaces limited system adaptation capacity and data provision as only a few employees were able to handle exceptional situations.

*In terms of personnel resources, we were not even close to being set up properly. The limiting factor for generating transparency was often not the availability of data but personnel resources with the corresponding knowledge of data structures, systems and the necessary analytical background.* [Division Manager Logistics, Discounter]

#### 5.4. Sales channels

Online grocery sales increased dramatically at certain times during the pandemic as consumers were keen to minimize their contacts and thus the infection risk. However, most grocery retailers in Germany had little experience in online retailing [39]. Only limited capacity has been allocated to the online channel due to its low proportion of sales in the past. Furthermore, scaling online volume was limited in the short term by the constrained resources that were assigned to the online channel.

*The crisis has given our online business a boost. The limiting factors were not enough picking boxes and drivers for the delivery trucks.* [Division Manager SCM, Full-range provider]

Thus, the drugstore used in-store picking in many stores to respond more flexibly to significant capacity effects. Interviewees reported that they were able to build on a previously developed solution and that the rollout was accelerated due to the pandemic. Challenges included getting sufficient packaging material to stores in the short term, especially to those stores that had experienced pandemic-related sales declines and therefore got allocated more online orders. However, most companies reported that the in-store picking volume was only scalable to a limited extent. Pickers and store customers competed for scarce products in the store, which also limited the hypermarket's online volume during the pandemic. In addition, the full-range provider and the drugstore treated their online distribution centers like stores, which were not prioritized in the event of supply bottlenecks. At the full-range provider, long delivery times resulted, as the online demand doubled in the initial phase of the pandemic.

*The limiting factor in online business is that online and bricks-and-mortar demand fluctuate in exactly the same way. The demand is low from Monday to Wednesday and on weekends it is enormous.*

*The problem is the available space. [...] The FCFS principle is applied to the distribution of scarce products – regardless of whether the picker or a store customer was first at the shelf.* [Head of E-Logistics, Hypermarket]

## 6. LONG-TERM DEVELOPMENTS AND LESSONS LEARNED DUE TO THE PANDEMIC

One year after the second interview round, we revisited the development areas together with the retailers in a third interview round to substantiate which of the weaknesses identified are being prioritized when developing the future grocery retail supply chain, and which lessons learned from the pandemic are having a lasting impact. We structure our findings again into the four development areas defined and discuss them in light of the literature.

### 6.1. Behavioral demand planning and order dispatching

#### 6.1.1. Findings

The retailers interviewed note two main issues for improvement and enhancement of their ordering systems in the future. First, they suggest a situation-dependent approach when assigning decision-making authority to the different organizational units. Second, they have discovered several features of their ASO systems that are not designed appropriately for disruptive times and therefore offer room for improvement.

**Allocating decision-making authority in ASO systems.** ASO replenishment systems in general follow a decentralized responsibility concept, i.e., store managers are often given wide-ranging rights to intervene in the system. However, the retailers change this concept to a more centralized system in special situations. All interviewees confirmed that they significantly limited the ability of store managers to intervene on their own authority during the pandemic and will continue to do so in the future in the case of scarce product supply or insufficient operational capacities. The discounter, for example, intensively controls the flow of goods into the numerous regional distribution centers by having the central planning entity of the headquarters applying an integrative supply chain perspective. The hypermarket changes the store supply of critical products from pull-based orders to a fully centralized push system by centrally assigning the available quantities to the outlets. The main reason for centralization is the fact that stocks, that are scarce, can be controlled much more effectively from a central level and a significant increase of speed of decision making. A permanent team has been put



together for this purpose, which will meet in future in disruptive times.

*The head office controls the distribution centers (e.g., for an uplift of an article of 300%) and the product availability via multiple sourcing. The head office also checks the stores' orders and balances the quantities in case of shortages. Scarce products are allocated to the stores by the head office. [...] Allocation is based on volumes in the distribution center and sales volumes of the stores in a reference period. [Division Manager Logistics, Discounter]*

#### **Measures for improvements of ASO systems.**

The centralization of decision making by the case companies during the pandemic required significant manual effort, as the necessary decisions have been inadequately supported by the respective ASO system until now. Thus, additional support functions and adequate parameterization of the store ordering systems are required in disruptive times to increase the resilience of the supply chain network.

The drugstore reported, for example, that the logistics supply chain network was always balanced by manual intervention so that the sum of store order quantities just corresponded to the maximum network capacity. In this case the company preferred to keep to the original delivery schedule with adapted store order sizes rather than to deliver ideal order sizes with postponed, i.e., delayed deliveries. This feature will be improved in the ASO system supporting the central planning unit in the future. The hypermarket is attempting to adjust the time series ex post, eliminating panic purchases but retaining seasonality effects to be able to use the time series as a reliable basis for future forecasts. This functionality has been missing in the ASO system currently applied.

*It is necessary to control the ending of crisis measures at an early stage. [...] The system needs manual intervention as information to distinguish seasonal and hoarding purchases in order to have a reliable database for forecasting in the future. [Head of SCM, Hypermarket]*

The full-range provider is working on a project to manipulate store orders of scarce products in an automated and rule-based manner. In the event of a shortage, the ordering system automatically cuts store orders so that the inventory range of critical products is equally leveled for all stores, taking different sales categories of the stores into account. This mechanism has been applied intensively during the pandemic and was feasible due to the high number of in-house data scientists and developers at the full-range provider.

The parameterization of the store ordering system is of central importance since it controls in-store product availability and influences the volumes to be handled in the distribution centers and transport system within

the planning period considered. When picking and/or transportation capacities are tight, the drugstore has applied a critical product-group-parameterization approach during the pandemic. This ensured that the product groups that are essential for consumers have the necessary shelf availability and that less important product groups were given lower priority. However, for some scarce products, the parameterization must be decoupled from the product group settings to increase the accuracy of the control, as the demand for these products has behaved significantly differently compared to the overall product group. The drugstore will additionally include this previously unavailable feature into its ASO system such that individual scarce products, such as rapid tests for Covid-19 during the pandemic, can be controlled in a more targeted manner. The demand for such articles fluctuated strongly and had a high level of attention among customers. In the first phase of the pandemic, the hypermarket identified relevant products and product groups, and defined scenario-dependent parameter sets to steer the order quantities of the store replenishment system related to the current situation. This approach can easily be adopted and quickly applied in corresponding situations in the future. Furthermore, they recently started considering available backroom space at each store when determining push orders. In addition, they identify substitutes for potentially scarce products. All these additional features will be incorporated into the ASO system of the hypermarket, making the system's order proposals more appropriate to the respective demand situation.

*In the event of a crisis, critical articles, product groups and their parameter settings have already been predefined for various scenarios on the basis of the Covid-19 experience. There are thus pre-parameterized settings that only need to be transferred to the system. [...] In the event of a shortage of components or an inability to deliver, the purchasing department now [February 2022] defines external or internal alternative products for a quick compensation. These reallocations are then included in the ASO system. [Head of SCM, Hypermarket]*

#### **6.1.2. Discussion and core insights**

ASO systems had already undergone significant developments in the years leading up to the pandemic to increase their resilience to supply chain risks [40]. However, our results show that the systems still offer room for improvement, and they reveal weaknesses in the allocation of the planning authority of the decision makers involved in disruptive times. These observations are consistent with the findings in the literature [41]. However, some of those issues have not yet been addressed.

One important factor is that current replenishment systems do not consider the costs of in-store handling and the opportunity to generate additional sales through reduced out-of-stocks [42]. Another is that previous studies show that store manager behavior has a positive impact on out-of-stocks [7]. Both issues are reasons why today's ASO systems give store managers a high degree of authority. For example, the store managers are allowed to overwrite the system's order proposals. However, this proved counterproductive during the pandemic. The central business unit therefore took over and monitored the orders manually. This is in line with the observations of Alftan et al. [43], who note that more centralized forecasting is valuable in times of extraordinary demand. In an exceptional situation, store managers are unsettled and influenced by customer behavior and the personal behavior of risk avoidance. In addition, readily available information, such as media coverage, influences decision makers, which can lead to cognitive bias and worse decisions [13]. Nevertheless, central planning employees are also affected by the behavioral issues just mentioned. Further technological developments such as artificial intelligence (AI) or intelligent automation (IA) are required to improve forecasts and avoid any cognitive bias of decision makers. All retailers interviewed confirm this statement. AI approaches can analyze and describe the current situation and significantly improve forecast accuracy even when demand is highly volatile [44]. In addition, IA supports a flexible procurement strategy, which is important when changing suppliers in shortage situations. In all cases, a clear definition of the human-machine interface and areas of human decision-making is required in those contexts [45].

In disruptive times, manual ordering causes a disproportionate amount of additional work, so ASO systems that are already advanced need to be appropriately adapted and enhanced in line with our observations so that they can bring to bear their inherent capabilities.

Our results show that retailers recognize the lack in their ASO systems and are going to further enhance their systems. In addition, they are learning to organize the structure of planning responsibilities (decentral vs. central), depending on the given situation. Furthermore, the experiences of the pandemic foster the development of AI and IA applications to improve supply chain resilience in grocery retailing. The further development of data architecture in the direction of data lakes enables large volumes of structured and unstructured data to be used for big data analysis, machine learning or AI tools during data processing [46]. Consequently, all existing data could be processed improving the forecasts. These developments support ordering decisions, substantially reduce manual workload and make product flows independent of subjective, possibly irrational manual decisions in disruptive times. The following core insights can be derived from these observations.

**Core insight 1.** In disruptive times, retailers limit the wide-ranging rights of store managers in the ASO systems and centralize the replenishment for specific product categories facing high additional demand and potential supply shortages.

**Core insight 2.** The central store ordering system will be further developed including AI and IA methods to enhance the forecasts and to support the respective dispatchers in distributing the limited products available to the various stores in a demand-oriented and fair manner during disruptive times.

## 6.2. Agile supply chain

### 6.2.1. Findings

The retailers were able to master the critical phases of the pandemic with their current supply chain setup. Given this experience, all of the retailers interviewed are confident that they are also able to manage potential future demand shifts and crises.

*Fluctuations in demand of up to 20% compared with standard business can be handled relatively smoothly. Higher deviations are problematic and have to be managed with special and more costly measures.* [Division Manager SCM, Full-range provider]

In consequence, all formats highlight that their main focus will still be on cost efficiency to remain competitive in the tight German grocery market, and that there will be no substantial changes in the supply chain design. The retailers thus refuse to build up excess workforce in the long run, although the availability of human resources gained temporary attention after the high sales peaks of the pandemic. Instead, the retailers are making efforts to ensure that current employees receive a wider range of training to extend their operating flexibility. Besides that, there are three types of emerging concepts and measures regarding agility that remain relevant in the long run: the flexibility of allocating stores to different warehouses, the extension of storage space and picking capacities at the warehouse level and higher stocks at the stores, as well as the preparation for future crises with emergency agility concepts.

**Flexible allocation of stores.** The change of the allocation of stores to different warehouses has proven an effective short-term measure to overcome capacity shortages in certain regions, and has been practiced by all of the formats with multiple regional warehouses. At these formats, the implementation of this measure was improved during the pandemic and will continue to be a basic element for providing agility short-term without changing the overall supply chain structure.

The drugstore reports that normally a change of store allocation to a warehouse took about four weeks of preparation to build up the new transportation links, but is possible within a few days in times of crisis. This is equivalent to the developments at the wholesaler.

*A very frequently used measure to increase agility was the change of store-warehouse assignments of the core assortment between the warehouses within one day in case of staff shortages. Reassignment is possible thanks to a uniform IT solution in all warehouses and was already carried out before the Covid-19 pandemic in the event of local IT failures and holiday bottlenecks. But it was used more frequently as a result of the pandemic and is now [February 2022] established as a standard procedure. [Chief Operating Officer, Wholesaler]*

**Extension of storage space, picking capacities and inventories.** The need for additional storage space at the warehouses and higher safety stocks for critical products—also at the stores—uncovered by the pandemic is leading to investments in this direction. This is not true for the full-range provider and the discounter, which are refusing to make such adaptations because of the aligned cost increase. The remaining formats have increased storage space and picking capacities at the warehouse to be able to handle unforeseeable short-term fluctuations of volumes. The drugstore for example reports an increase of the picking capacities beyond the tight standard requirements, and the establishment of a multi-purpose “break-out warehouse” to increase capacity flexibly and swiftly. The hypermarket highlights a similar strategy that relies on external rented overflow facilities, following the strategy to keep investment costs low. The wholesalers as well as the hypermarket also report that they will retain the higher inventory levels introduced during the pandemic at their stores post Covid-19, too, for critical non-perishable food articles. This means they accept higher inventory and storage costs while keeping a strict cost efficiency focus in terms of logistics processes, strategically required in the price-driven German grocery market.

*Picking capacity increases (about 5% compared to a very tight capacity situation before) have increased logistics costs, but we reach a better on-time and in-full service rate during volatile demand periods and seasonal peaks. [...] In addition, extra capacity has been built up through a small flexible manual warehouse, where both store and online orders can be picked. Here, in special situations, capacity can be expanded by 100% to 200% at comparatively short notice. [Division Manager Logistics, Drugstore]*

**Preparation of emergency agility concepts.** While long-term agility measures are rare, the retailers are trying to increase their agility potential in case of need

by preparing emergency concepts. They are using their experience from the pandemic to increase their short-term reaction speed. The full-range provider, for example, is defining agile cross-functional crisis teams that can take important decisions quickly. The discounter is preparing concepts for virtual inventory pooling or employee sharing across stores and warehouses, which the wholesaler has practiced during the pandemic. Additionally, contracting dual source suppliers reduces the risk of product shortages. The hypermarket especially is focusing on predefining inventory level shifts at the stores and prioritizing product segments for various crisis scenarios.

*It was decided that in the event of a crisis, inventories would be increased in the stores due to the possibility of rising customer demand and in the distribution center. [...] Articles have been defined for which an increase in inventories will be targeted. [Head of SCM, Hypermarket]*

#### 6.2.2. Discussion and core insights

The tight market on the one hand and the high logistics costs for warehousing and delivery processes on the other hand have led to a high focus on logistics costs in practical and theoretical concepts for German grocery retailing [34]. However, the severe problems during the pandemic have mainly been caused by cost-optimized configurations of the retail supply chains. Against the backdrop of experience from the pandemic, other studies emphasize that the design of supply chains will increasingly be driven by multiple factors such as risk response, risk exposure or sustainability [24, 47, 48, 49]. Nevertheless, our results show that although the retailers recognized that they lack agility, they were able to master the crisis with their existing systems using their inherent agility potential. This supports the thesis of Patrucco and Kähkönen [49], who postulate that mass retail and the grocery sector have been among the branches, which demonstrated a comparably high degree of agility during the pandemic. The retailers mostly attribute the urgency to strengthen flexibility to potential future crisis scenarios for which they have prepared logistics concepts based on their lessons learned. This is in line with the findings of Hohenstein [31], who highlights that the experience gained during the pandemic is especially a key factor for supply chain adaptations in future disruptive cases. For the standard business, however, the focus remains on cost optimization. Besides this, the retailers recognize that their supply chain network design has to ensure increased adaptation velocity to a changing environment. By implementing respective measures, the German grocery retailers are preparing their supply chains in anticipation of future extraordinary scenarios (as postulated in recent literature [50]). An important element is the flexible allocation of stores to warehouses, which is an option for virtual inventory



pooling and the flexible use of resources and staff without building excess capacity. This measure can be seen as an intertwining concept within the companies' supply chain. Intertwining – although usually used in reference to an inter-company context – is also recognized as one of four major adaptation strategies within the pandemic [51]. While the flexible allocation of stores to warehouses is mainly a technical issue, the retailers are further improving their product availability by extending their storage space, stock levels and picking capacities. This is in line with other studies that highlight low inventory levels as a major risk in crises like the pandemic [11, 47, 52]. Moreover, it is a sensible reaction given the strong cost focus in German grocery retailing, as inventory holding costs account for a relatively small share of total logistics costs in grocery retailing compared to the labor-intensive process costs in warehousing, transportation and in-store [38].

Given these observations, we formulate the following core insights regarding the development of supply chain agility due to Covid-19:

**Core insight 3.** Grocery retailers learned to use their inherent supply chain agility potential during the pandemic and use the knowledge gained to prepare emergency concepts for future crisis scenarios.

**Core insight 4.** As a consequence of Covid-19, grocery retailers are developing their supply chain agility, and are particularly using measures that are considered cost efficient. This means a focus on low-investment measures such as flexible store allocation to warehouses or an extension of buffer space and stocks, rather than increasing the number of staff.

### 6.3. Transparent supply chain

#### 6.3.1. Findings

The importance of transparency in the supply chain significantly increased in the context of the pandemic. The retailers unanimously confirm this and report on measures initiated that improve both horizontal (between companies and operational functions) and vertical (between different organizational hierarchies) transparency in the supply chain to expand the monitoring options and enable faster responses in critical times.

**Horizontal supply chain transparency.** We understand horizontal transparency to be all measures that contribute to providing the internal and external information and insights required for the operational management of the supply chain in a suitable form to the relevant parties involved. Horizontal transparency has been increased both on the market and supply side as well as in the internal system. The drugstore retailer reports, for example, that the internal management reports on the market side were already updated and

modernized during the first pandemic wave, i.e., in 2020. Point-of-sale (POS) data is now integrated in logistics information dashboards in real time and is very granular, i.e., includes options to drill down to sales units (SKU) and the store level. Similarly, the organic supermarket already reported in the first round of interviews that they had implemented an alert system that detects unusual sales at an early stage.

*In order to be able to react to sudden changes in demand, we introduced an early warning system after the first demand wave. A strong sell-off of products is passed on very quickly to the producers. The aim is to achieve a fast and transparent flow of information.* [Head of Department SC Development, Organic supermarket]

However, the opposite risk is already evident that in very volatile times ad-hoc decisions could become prevalent and thus increase planning nervousness. The full-range provider confirms this reporting of overreactions when real-time transparency is available. Access to the internal KPI dashboard is restricted as a result. In summary, transparency is critical, but so is appropriate interpretation and reaction.

The retailers mention fast communication adequate to the problems in question between internal organizational units as a critical success factor. The wholesaler and organic supermarket, for example, emphasize that effective solutions can be found by communicating quickly between departments and highlighting capacity bottlenecks in the supply chain. The aim of newly developed systems is to quickly provide meaningful KPIs, whereby self-developed applications can lead to competitive advantages. Transparency in the direction of the market has also been significantly improved for the retailers' suppliers and will be further expanded in future. The drugstore already provides its suppliers with product-specific sales and inventory figures that are updated daily, which they aim to extend using further information. The full-range provider that previously operated the provision of POS data as a separate business model and only passed on this data to its suppliers for a not inconsiderable fee, will provide this data at cost price in the future. Additionally, the retailer is developing a completely new supplier portal based on the experience gained during the pandemic. So far, for example, rationing and the distribution of scarce supply quantities have been performed manually at the full-range-provider, which tied up ten employees full time.

*A new level of information exchange and collaboration with the supplier is established. [...] A new portal is expected to improve product availability and reduce inventory. [...] A clustering of the suppliers according to their size into different categories (A-C) and different layers is under discussion, in which the POS data will be made available to the suppliers,*

*e.g., national level, regional level, markets/article level.* [Division Manager SCM, Full-range provider]

The retailers of the other sales formats are establishing comparable measures. The wholesaler for example reports that they have introduced a new software tool for tracking and tracing the flow of goods. This is in line with the drugstore's strategic efforts to build information systems that enable a largely digital representation of the supply chain as a basis for decision-making (digital supply chain twin).

**Vertical supply chain transparency.** We understand vertical transparency as the cross-hierarchical communication of information and KPIs in organizations, including top management and the board level. New reporting systems are being introduced or existing ones updated and expanded to improve vertical transparency. Top management defines the activities of supply chain management and the performance measurement of logistics as a key success factor. For instance, the full-range case company provides weekly top-management reports that illustrate relevant KPIs of supply chain performance (inventory ranges, service levels, etc.) and their developments over time. In the quarterly reporting rounds, the content has shifted from project-oriented to performance-oriented reporting. The need for an integrative supply chain management is noticeably increasing in top management, i.e., away from a predominantly division-oriented to a cross-divisional mindset. The full-range provider (as an example) is significantly increasing its professional supply chain management staff and expanding its supply chain management content in training programs for next-generation managers.

*The weekly top-management report on overall KPIs (e.g., customer pain) contains all relevant developments in the supply chain performance of the previous week. [...] The reporting cycle at the top-management level has not been changed. However, there are more frequent queries about the weekly reports, which shows that they are noted.* [Division Manager SCM, Full-range provider]

Comparing the diverse sales formats, the third round of interviews clearly shows that formats with a higher level of complexity due to the number of products offered and number of stores operated (e.g., the drugstore and full-range provider) are initiating more measures to increase transparency than the other formats (wholesaler, hypermarket, discounter).

### 6.3.2. Discussion and core insights

Our observations are in coherence with findings from literature before or at the beginning of the pandemic. Choi et al. [53] for example note that investments in supply chain network transparency are necessary to be

digitally prepared for future disruptions. Ivanov [54] and Dolgui and Ivanov [55] confirm this statement. In addition, close interorganizational relationships supported by shared and linked systems are required to achieve the desired transparency [56] and uncover hidden and invisible stock [23]. These measures will increase the visibility of risks in the supply chain and therefore reduce the bullwhip effect in volatile times, and offer the opportunity to ensure higher product availability for consumers [27]. Similarly, the ECR approach shows that a cooperative strategy between suppliers and retailers reduces the bullwhip effect. Changing consumer behavior can be responded faster and more cost-efficiently. However, an essential prerequisite for this is trust between the two parties, which is still the greatest challenge for close cooperation and data exchange [7, 57].

In summary, our results show that retailers recognize the lack of transparency in the supply chain as a real challenge and are willing to address the barriers that still exist, such as a lack of trust in supply chain partners, internal divisional thinking, and the investment backlog in new technologies, to substantially improve transparency in the supply chain. In addition, supply chain thinking is gaining noticeable attention among retailers' top management. The following core insights can be derived from these observations.

**Core insight 5.** The lack of interorganizational collaboration and reporting is identified as a key weakness in providing timely, decision-relevant information across the supply chain during the pandemic. This already led to ad-hoc measures during the pandemic, e.g., the provision of real-time POS data, but further measures are needed, such as the establishment of digital supplier information systems, to improve transparency in the long term.

**Core insight 6.** The pandemic has considerably increased the importance of supply chain management in the top management of grocery retailers. In the future, decisions will be more strongly oriented towards integrative supply chain management perspectives. Advanced reporting systems are being established to provide top management with the relevant supply chain insights they need in disruptive times.

## 6.4. Sales channels

### 6.4.1. Findings

Prior to the pandemic, not all of the retailers surveyed operated an online channel and, in addition, some retailers offered only a limited assortment online, e.g., non-food articles. The online share of total sales ranged from 1-2%, while other European countries such as the UK had already reached 8%, or France 6% [58]. Given this context, one retailer interviewed illustrates that economic efficiency is difficult to achieve in the



German grocery market. On the one hand, the market is driven by tight margins and the retailer has to pay EUR 17-22/hour for a picker. On the other hand, consumers are very price-sensitive and have limited willingness to pay for online service. Most online consumers have the retailer's bonus card and pay a rate of EUR 1.99 for the service. For several retailers in Germany, the online market is thus still considered not profitable enough. For example, the discounter surveyed has not entered the online market in Germany so far despite the fact that the company already successfully operates online activities abroad.

**Accelerated development.** Nonetheless, the pandemic has given online retailing a particular boost. Retailers are establishing new ordering options and services that would have taken several years to implement without the pandemic. The hypermarket introduced a C&C service in March 2020. Until the last round of interviews in February 2022, the online demand has remained high at around 2,000 orders per week, which is limited by the available pick-up stations and time windows offered. Another retailer surveyed has launched an improved express C&C service in nearly all stores, shortening the provisioning time from six to three hours. This helped to realize a double-digit increase in online sales between 2020 and 2021, with the share of total online sales reaching an all-time high during the pandemic. The full-range provider reports that online sales doubled during the first closure and have maintained a high double-digit growth rate. Online sales account for a proportion of total sales that the retailer would have expected five years later without the pandemic. According to the companies surveyed, the importance of online retailing will continue to grow after the pandemic.

*Online demand was strongly accelerated by the pandemic. We had growth rates in the high double-digit percentage range and growth rates of over 100% during the lockdown months. C&C was very well accepted by our customers. [...] The logistics network for online orders is being expanded with additional automated fulfillment centers and dark stores.* [Division manager SCM, Full-range provider]

**Expansion of C&C.** C&C services especially have been expanded during the pandemic for several reasons. The hypermarket quickly established a C&C system to meet high ad-hoc online demand without setting up complex home delivery systems. The retailer is benefiting from its bricks-and-mortar processes by picking in-store and treating online orders as additional store customers. According to the hypermarket, the store pick-up stations also solve the problem of substitute items:

*If a product is not available, the customer is offered a choice of two to three substitute products at the in-store pick-up station. When choosing the substitute*

*products, product know-how is required, which is available in the respective departments in the store. Our online business benefits from this and the customer satisfaction increases.* [Head of SCM, Hypermarket]

In disruptive times with supply bottlenecks, this is a major advantage, as online consumers place particularly high value on product availability. In addition, with C&C, consumers cover the last mile. Consequently, it is the more cost-efficient delivery method for the retailer, which is increasingly in demand and is therefore being expanded. The full-range provider supports this statement. Picking stationary and online orders from the same inventory minimizes costs and allows C&C to be offered at a lower price to the consumers than home delivery. Interconnecting the logistics of online and bricks-and-mortar business is essential for success – especially when products are scarce as at the beginning of the pandemic. This allows for a more flexible cross-channel resource allocation in disruptive times. In addition, the German market specifics, such as price-sensitive consumers and a high store density, favor the C&C delivery mode as opposed to home delivery. In terms of cross-selling potential the interviewees report different observations. The drugstore achieves cross-selling profits as consumers pick up the order at the stores. In contrast, the full-range provider indicates that cross-selling and impulse buying are absent as consumers choose the service to save time. Nevertheless, the full-range provider is greatly expanding its pickup stations. An express pick-up service is in the planning to compete with the quick-commerce startups that are heavily investing in shorter delivery times. Fast online order fulfillment even when volumes are high and a wide range of delivery and pick-up options are therefore becoming central objectives of grocery retailers.

*Express pick-up is being planned because of the current development in the area of "quick commerce start-ups" such as Gorillas or Flink, which are experiencing rapid growth. [...] Without the Covid-19 pandemic, the rapid development in the fast-e-grocery sector would not exist. Therefore, [case company] would not have turned to this segment so quickly without this development (e.g., express pick-up).* [Division Manager SCM, Full-range provider]

#### 6.4.2. Discussion and core insights

Several contributions in literature have already analyzed the changes in shopping behavior, which are assumed to have a lasting impact on grocery retailing [5]. The pandemic is increasing the acceptance of online and mobile shopping for groceries. Some customers started online shopping during the pandemic and maintained their behavior afterwards. However, online grocery retailing shows high volatility in the German market

[59]. Moreover, consumers are now more concerned about the risk associated with these new technologies, so trust and convenience in the online platform used by the retailer is becoming a more prominent factor than in previous times [60]. Our findings support this, e.g., the hypermarket highlights the acceptance of the C&C service of the silver ager. German retailers have already made substantial investments during the pandemic. REWE, for instance, installed more pick-up points in April 2020 than originally planned for the entire year [61]. The hypermarket and drugstore interviewed are heavily expanding and investing in their C&C services, too. New startups, e.g., Gorillas or Flink, launched their business in Germany during the pandemic and provide short delivery times of 10 minutes [62]. New retailers were thereby able to benefit from the rising online market share in Germany, which achieved an average growth of 59.6% from 2019 to 2020 [63].

Regarding the delivery mode, in Germany it is mainly home delivery that is offered, or in combination with C&C concepts [64, 39, 65, 66]. However, home delivery is the more expensive delivery mode for both retailer and consumer due to the last mile. The willingness to cover these costs is limited, which is why online retailing is barely profitable [67]. This is also confirmed by our case companies. In the pandemic, motivated by reduced personal contacts, online retail is gaining many new consumers, who are increasingly choosing C&C because they are only reluctantly willing to pay for delivery costs. Introducing C&C options gives retailers a competitive edge in moving to become an omni-channel retailer [68], and increasing sales under the pandemic conditions [69]. The aforementioned observations lead to the following core insights:

**Core insight 7.** The low profit margins, cost-sensitive consumers, and high store density in German grocery retail are driving large players to further expand the lower-cost C&C delivery mode that was experienced by many new customers during the pandemic.

**Core insight 8.** Grocery retailers can more flexibly absorb volume fluctuations in disruptive times with C&C, especially in-store pick-up stations, than with home delivery, thereby leveraging the store's resources and infrastructure.

## 7. CONCLUSION AND FURTHER AREAS OF RESEARCH

**Conclusion.** This multiple case study has explored the effects of the pandemic on grocery retail operations. We have summarized the challenges grocery retailers faced and the initiatives and measures they took in the early stages of the pandemic, and analyzed the vulnerabilities of standard business operations revealed by the pandemic. From the insights gained,

we derived four areas of development for grocery retail logistics: changing behavioral demand planning and order dispatching, improving the agility of the supply chain, digitizing the supply chain to provide more transparency, and developing the sales channels. These areas have been investigated in detail and we have reviewed which developments are being pursued by the retailers. This has enabled us to derive the lessons-learned with a lasting impact on grocery retail operations. While the first three developments will contribute to achieving more stable service levels in disruptive times, the development of the sales channels, in German grocery retailing especially the online business via C&C, targets to retain a stable turnover and market share. The core development in demand planning and order dispatching lies in improving the functionality of ASO systems and centralizing their control, aiming at better, data-driven ordering decisions and less manual workload in disruptive times. Here especially pre-defined products with high demand or low availability are in focus of the retailers. In addition, supply chain agility will be expanded with a focus on low-investment measures, such as the establishment and improvement of a flexible store allocation to warehouses or an extension of buffer space and stocks. Supporting investments will be made in information and reporting systems to provide relevant supply chain insights, ideally in real-time, enabling a quicker reaction to demand changes and a better, data-driven internal and external collaboration. Core of these developments are the ideas of ECR and CPFR which have already been postulated for many years, but the pandemic has revealed a lacking rootage in industry practice. We have discussed these findings in light of contributions from the relevant fields and formulated corresponding core insights.

Our paper has several practical implications. The findings provide grocery retailers with guidance to identify potential weaknesses in their standard business and to understand the long-term implications of the pandemic. Moreover, the core insights derived can be seen as managerial implications for retail managers. Retailers can thus improve their current practice by knowing the direction future grocery retail logistics is likely to take.

**Further areas of research.** The core insights inductively derived based on the cases we examined can serve as a starting point for future research and corresponding hypotheses can be examined and tested in subsequent studies. Besides this, they can guide future research. Past studies on grocery retail logistics have often focused exclusively on a cost-optimization perspective. They strive to minimize operations costs of procurement [70], warehousing [71], transport [72] and in-store operations [38] of the bricks-and-mortar business. Numerous concepts have also been developed for the online business to minimize the two major cost blocks of picking and last-mile delivery [64]. Future

optimization could thus more intensively emphasize initiatives to quickly achieve agility, flexibility and responsiveness without having a significant negative impact on the cost structure. Another field that has emerged in our study as a major development area is the behavioral response to demand planning, order sizing and dispatching. It became apparent that human behavior in the process and system landscape was of particular importance for supply chain success during the pandemic. Our findings point towards human interventions being limited in future, at least in special situations in which a more centralized perspective appears more appropriate. Additionally, the impact of uncertain events and supply chain disruptions on behavioral operations management needs to be further explored [73].

There is also the possibility of expanding our sample. We focused our investigation on six large grocery retailers. This may have led to a bias in the results, as these retailers benefit from the experience of their extensive logistics structures. Investigating the situation of small- and medium-sized companies, pure online grocery retailers and start-ups could thus be an interesting complementary field for timely future research. In addition, the case study presented was limited to the German market, as the infection rates and government strategies have created country-specific conditions. The weaknesses identified and development areas may not all apply to other markets. It would therefore be worthwhile expanding the study to an international context and analyzing whether the findings generated are transferable to other countries.

Of course, it must be taken into account that all statements made by the interviewees were made in the direct light of the pandemic or at the respective time of the interview, which in some cases was relatively shortly after the lockdowns. The extent to which the core insights are valid in the long term will depend on the extent to which the development approaches are actually pursued further, even when the direct impression of the pandemic fades more and more over time. Nevertheless, this article shows the approaches being pursued at the time of the interviews and reflects the lasting impact of the pandemic until two years after it had started. Future research could address at a much later date whether and how the lessons learned from the pandemic have manifested themselves in retail companies.

## REFERENCES

- [1] R. van Hoek. Research opportunities for a more resilient post-covid-19 supply chain – closing the gap between research findings and industry practice. *International Journal of Operations & Production Management*, 40(4):342–355, 2020.
- [2] A. Dolgui and D. Ivanov. Ripple effect and supply chain disruption management: new trends and research directions. *International Journal of Production Research*, 59(1):102–109, 2021.
- [3] V. Ahlqvist, A. Norrman, and M. Jahre. Supply chain risk governance: Towards a conceptual multi-level framework. *Operations and Supply Chain Management: An International Journal*, 13(4):382–395, 2020.
- [4] K. Nikolopoulos, S. Punia, A. Schäfers, C. Tsiniopoulos, and C. Vasilakis. Forecasting and planning during a pandemic: Covid-19 growth rates, supply chain disruptions, and governmental decisions. *European Journal of Operational Research*, 290(1):99–115, 2020.
- [5] N. Eriksson and M. Stenius. Changing behavioral patterns in grocery shopping in the initial phase of the Covid-19 crisis – A qualitative study of news articles. *Open Journal of Business and Management*, 8(5):1946–1961, 2020.
- [6] D. Loske. The impact of COVID-19 on transport volume and freight capacity dynamics: An empirical analysis in German food retail logistics. *Transportation Research Interdisciplinary Perspectives*, 6:100165, 2020.
- [7] J. Aastrup, H. Kotzab, D.B. Grant, C. Teller, and M. Bierre. A model for structuring efficient consumer response measures. *International Journal of Retail & Distribution Management*, 36(8):590–606, 2008.
- [8] M. Natarajarathinam, I. Capar, and A. Narayanan. Managing supply chains in times of crisis: a review of literature and insights. *International Journal of Physical Distribution & Logistics Management*, 39(7):535–573, 2009.
- [9] S. Xu, X. Zhang, L. Feng, and W. Yang. Disruption risks in supply chain management: a literature review based on bibliometric analysis. *International Journal of Production Research*, 58(11):3508–3526, 2020.
- [10] D. Ivanov. Exiting the Covid-19 pandemic: after-shock risks and avoidance of disruption tails in supply chains. *Annals of Operations Research*, 335:1627–1644, 2024.
- [11] D. Ivanov. Introduction to supply chain resilience. In: *Classroom Companion: Business*. Springer, 2021.
- [12] P. Chowdhury, S. Paul, S. Kaisar, and M.A. Moktadir. Covid-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E: Logistics and Transportation Review*, 148(102271), 2021.
- [13] S. Gunessee and N. Subramanian. Ambiguity and its coping mechanisms in supply chains lessons from the covid-19 pandemic and natural disasters. *International Journal of Operations & Production Management*, 40(7/8):1201–1223, 2020.



- [14] M.S. Golan, L.H. Jerneagan, and I. Linkov. Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic. *Environment Systems and Decisions*, 40:222–243, 2020.
- [15] M. Melacini, S. Perotti, M. Rasini, and E. Tappia. E-fulfilment and distribution in omnichannel retailing: a systematic literature review. *International Journal of Physical Distribution & Logistics Management*, 48(4):391–414, 2018.
- [16] M.M. Queiroz, D. Ivanov, A. Dolgui, and S. F. Wamba. Impacts of epidemic outbreaks on supply chains: mapping a research agenda amid the COVID-19 pandemic through a structured literature review. *Annals of Operations Research*, 319(1):1159–1196, 2022.
- [17] S. Verma and A. Gustafsson. Investigating the emerging COVID-19 research trends in the field of business and management: A bibliometric analysis approach. *Journal of Business Research*, 118:253–261, 2020.
- [18] M.T. Chowdhury, A. Sarkar, S.K. Paul, and M. A. Moktadir. A case study on strategies to deal with the impacts of COVID-19 pandemic in the food and beverage industry. *Operations Management Research*, 15(1-2):166–178, 2022.
- [19] K.S. Hald and P. Coslugeanu. The preliminary supply chain lessons of the covid-19 disruption—what is the role of digital technologies? *Operations Management Research*, 15:282–297, 2022.
- [20] C. Münch and E. Hartmann. Transforming resilience in the context of a pandemic: results from a cross- industry case study exploring supply chain viability. *International Journal of Production Research*, 61(8):2544–2526, 2023.
- [21] S.K. Paul and P. Chowdhury. Strategies for managing the impacts of disruptions during COVID-19: an example of toilet paper. *Global Journal of Flexible Systems Management*, 21(3):283–293, 2020.
- [22] M.S. Sodhi, C.S. Tang, and E.T. Willenson. Research opportunities in preparing supply chains of essential goods for future pandemics. *International Journal of Production Research*, 61(8):2416–2431, 2023.
- [23] D.J. Finkenzstadt and R. Handfield. Blurry vision: Supply chain visibility for personal protective equipment during Covid-19. *Journal of Purchasing and Supply Management*, 27(3):100689, 2021.
- [24] R. Handfield, G. Graham, and L. Burns. Corona virus, tariffs, trade wars and supply chain evolutionary design. *International Journal of Operations & Production Management*, 40(10):1649–1660, 2020.
- [25] M.C. Schleper, S. Gold, A. Trautrim, and D. Baldock. Pandemic-induced knowledge gaps in operations and supply chain management: Covid-19's impacts on retailing. *International Journal of Operations & Production Management*, 41(3):193–205, 2021.
- [26] E. Pantano, G. Pizzi, D. Scarpi, and C. Dennis. Competing during a pandemic? Retailers' up and downs during the Covid-19 outbreak. *Journal of Business Research*, 116:209–213, 2020.
- [27] L. Saarinen, L. Loikkanen, K. Tanskanen, R. Kaipia, S. Tukkonen, and J. Holmström. Agile planning: Avoiding disaster in the grocery supply chain during Covid-19 crisis. *BUSINESS + ECONOMY*, 1, 2020.
- [28] N. Raassens, H. Haans, and S. Mullick. Surviving the hectic early phase of the Covid-19 pandemic: a qualitative study to the supply chain strategies of food service firms in times of a crisis. *International Journal of Logistics Management*, 33(3):877–900, 2022.
- [29] M.C. Carissimi, L.B. Pratavia, A. Creazza, M. Melacini, and F. Dallari. Blurred lines: the timeline of supply chain resilience strategies in the grocery industry in the time of Covid-19. *Operations Management Research*, (16):80–98, 2023.
- [30] R.K. Yin. *Case Study Research and Applications*. SAGE Publications Inc., 6 edition, 2018.
- [31] N.-O. Hohenstein. Supply chain risk management in the covid-19 pandemic: strategies and empirical lessons for improving global logistics service providers' performance. *The International Journal of Logistics Management*, 33(4):1336–1365, 2022.
- [32] C. Voss, N. Tsikriktsis, and M. Frohlich. Case research in operations management. *International Journal of Operations & Production Management*, 22(2):195–219, 2002.
- [33] A. Da Mota Petrosa, D. Näslund, and C. Jasmand. Logistics case study based research: towards a higher quality. *International Journal of Physical Distribution & Logistics Management*, 42(3):275–295, 2012.
- [34] A. Hübner, H. Kuhn, and M. Sternbeck. Demand and supply chain planning in grocery retail: An operations planning framework. *International Journal of Retail & Distribution Management*, 41(7):512–530, 2013.
- [35] EHI Retail Institute. Auswirkungen der Corona Pandemie auf die Warendistribution im Handel (April 2020), 2020.
- [36] Lebensmittel Zeitung. Absatzentwicklung ausgewählter Food- und Nearfood-Sortimente im deutschen Lebensmitteleinzelhandel in der Coronavirus-Krise, 04 2020. Nielsen, April 2020.
- [37] J. Corbin and A. Strauss. Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, 13(1):3–21, 1990.

- 
- [38] H. Kuhn and M.G. Sternbeck. Integrative retail logistics: An exploratory study. *Operations Management Research*, 6(1):2–18, 2013.
  - [39] P. Piroth, E. Rüger-Muck, and J. Bruwer. Digitalisation in grocery retailing in germany: an explorative study. *The International Review of Retail, Distribution and Consumer Research*, 30(5):479–497, 2020.
  - [40] G. Avlijas, V. Vukanovic Dumanovic, and M. Radunovic. Measuring the effects of automatic replenishment on product availability in retail stores. *Sustainability*, 13(3):1–14, 2021.
  - [41] J.C.F. Ehrenthal, D. Honhon, and T. van Woensel. ‘demand seasonality in retail inventory management. *European Journal of Operational Research*, 238(2):527–539, 2014.
  - [42] K. van Donselaar, V. Gaur, T. van Woensel, R. Broekmeulen, and J. Fransoo. Ordering behavior in retail stores and implications for automated replenishment. *Management Science*, 56:766–784, 2010.
  - [43] A. Alftan, R. Kaipia, L. Loikkanen, and K. Spens. Centralised grocery supply chain planning: improved exception management. *International Journal of Physical Distribution & Logistics Management*, 45(3):237–259, 2015.
  - [44] S. Modgil, R.K. Singh, and C. Hannibal. Artificial intelligence for supply chain resilience: learning from Covid-19. *The International Journal of Logistics Management*, 33(4):1246–1268, 2022.
  - [45] R. Handfield, S. Jeong, and T. Choi. Emerging procurement technologies: data analytics and cognitive analytics. *International Journal of Physical Distribution & Logistics Management*, 49(10):972–1002, 2019.
  - [46] A. Harby and F. Zulkernine. From data warehouse to lakehouse: A comparative review, 2022.
  - [47] O. Schatteman, D. Woodhouse, and J. Terino. Supply chain Lessons from Covid-19: Challenges and measures in disruptive times Time to Refocus on Resilience. Bain Company, Inc., 2020.
  - [48] Q.N. Do, N. Mishra, N.B.I. Wulandhari, A. Ramudhin, U. Sivarajah, and G. Milligan. Sc agility responding to unprecedented changes: empirical evidence from the uk food supply chain during covid-19 crisis. *Supply Chain Management*, 26(6):737–752, 2021.
  - [49] A.S. Patrucco and A.-K. Kähkönen. Agility, adaptability, and alignment: new capabilities for psm in a postpandemic world. *Journal of Purchasing and Supply Management*, 27(4):100719, 2021.
  - [50] M. Rozhkov, D. Ivanov, J. Blackhurst, and A. Nair. Adapting supply chain operations in anticipation of and during the covid-19 pandemic. *Omega*, 110:102635, 2022.
  - [51] D. Ivanov. SC viability and the covid-19 pandemic: a conceptual and formal generalisation of four major adaptation strategies. *International Journal of Production Research*, 59(12):3535–3552, 2021.
  - [52] R. van Hoek. Exploring progress with supply chain risk management during the first year of the covid-19 pandemic. *Logistics*, 4/5(70), 2021.
  - [53] T.-M. Choi. Innovative “bring-service-near-your-home” operations under corona-virus (COVID-19/ SARS-CoV-2) outbreak: Can logistics become the messiah? *Transportation Research Part E*, 140:101961, 2020.
  - [54] D. Ivanov. Viable supply chain model: integrating agility, resilience and sustainability perspectives - lessons from and thinking beyond the COVID-19 pandemic. *Annals of Operations Research*, 2020.
  - [55] A. Dolgui and D. Ivanov. 5g in digital supply chain and operations management: fostering flexibility, end-to-end connectivity and real-time visibility through internet-of-everything. *International Journal of Production Research*, 60(2):442–451, 2022.
  - [56] A. Norrman and A. Wieland. The development of supply chain risk management over time: revisiting ericsson. *International Journal of Physical Distribution & Logistics Management*, 50(6):641–666, 2020.
  - [57] H. Kotzab and C. Teller. Value-adding partnerships and co-opetition models in the grocery industry. *International Journal of Physical Distribution & Logistics Management*, 33(3):268–281, 2003.
  - [58] Bain & Company Inc. How to ramp up online grocery – without breaking the bank, September 2020.
  - [59] P. Brüggemann and R. Olbrich. The impact of Covid-19 pandemic restrictions on offline and online grocery shopping: New normal or old habits? *Electronic Commerce Research*, 23:2051–2072, 2023.
  - [60] S. Habib and N.N. Hamadneh. Impact of perceived risk on consumers technology acceptance in online grocery adoption amid covid-19 pandemic. *Sustainability*, 13(18):10221, 2021.
  - [61] P. Dannenberg, M. Fuchs, T. Riedler, and C. Wiedemann. Digital transition by COVID-19 pandemic? The German food online retail. *Tijdschrift voor Economische en Sociale Geografie*, 111(3):543–560, 2020.
  - [62] B. Loderhose. Angriff der Hastigen. *Lebensmittel Zeitung*, 9:29–30, 2021.
  - [63] HDE. Online-monitor 2021, May 2021.
  - [64] J. Wollenburg, A. Holzapfel, A. Hübner, and H. Kuhn. Configuring retail fulfillment processes for omni-channel customer steering. *International Journal of Electronic Commerce*, 22(4):540–575, 2018.



- [65] A. Hübner, H. Kuhn, and J. Wollenburg. Last mile fulfilment and distribution in omni-channel grocery retailing: A strategic planning framework. *International Journal of Retail & Distribution Management*, 44(3):228–247, 2016.
- [66] C. von Viebahn, M. Landwehr, and M. Trott. The future of grocery shopping? A taxonomy-based approach to classify e-grocery fulfillment concepts. In 15th International Conference on Wirtschaftsinformatik (WI), pages 955–971, Potsdam, Germany, 03 2020. Association for Information Systems.
- [67] C. Lodni, M. Najmaei, and S. Mansori. The effect of COVID-19 pandemic on the german e-grocery industry with respect to challenges for retailers and customer satisfaction. *Journal of Marketing Management and Consumer Behavior*, 3(3):1–31, 2021.
- [68] A. Davies, L. Dolega, and D. Arribas-Bel. Buy online collect in-store: exploring grocery click&collect using a national case study. *International Journal of Retail & Distribution Management*, 47(3):278–291, 2019.
- [69] M. Delasay, A. Jain, and S. Kumar. Impacts of the covid-19 pandemic on grocery retail operations: An analytical model. *Production and Operations Management*, 31(5):2237–2255, 2022.
- [70] J. Lyu, J. Ding, and P. Chen. Coordinating replenishment mechanisms in supply chain: From the collaborative supplier and store-level retailer perspective. *International Journal of Production Economics*, 123(1) :221–234, 2010.
- [71] N. Boysen, R. de Koster, and D. Füssler. The forgotten sons: warehousing systems for brick-and-mortar retail chains. *European Journal of Operational Research*, 288(2):361–381, 2021.
- [72] A. Holzapfel, A. Hübner, H. Kuhn, and M. Sternbeck. Delivery pattern and transportation planning in grocery retailing. *European Journal of Operational Research*, 252(1):54–68, 2016.
- [73] H.N. Perera, B. Fahimnia, and T. Tokar. Inventory and ordering decisions: a systematic review on research driven through behavioral experiments. *International Journal of Operations & Production Management*, 40(7/8):997–1039, 2020.