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Logistics challenges in omni-channel grocery retailing

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Declaration

I declare that this thesis has been composed solely by myself, without the unpermitted aid of others, except where explicitly stated in the text. All text passages taken in letter or in spirit from published writings and all information based on oral statements are clearly referenced as such.

I have adhered to the principles of good scientific practice as laid down in the Statutes of Hochschule Geisenheim University to ensure good scientific practice in the studies I have carried out and which are referred to as such in the doctoral thesis.

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Summary

The present dissertation addresses logistics challenges in grocery retailing considered in an omni-channel context. Omni-channel retailing gains in importance as online grocery retailing is continuously growing. Besides pure online retailers, traditional bricks-and-mortar retailers are also entering the online grocery market. The development of existing structures towards an omni-channel retailing represents a complex challenge for the traditional bricks-and-mortar retailers. The first contribution of the dissertation analyzes omni-channel distribution concepts for traditional bricks-and-mortar grocery retailers. A multiple-case study with European grocery retailers serves as the basis for the analysis. Since different concepts dominate in the countries, their respective advantages and differences are elaborated. The focus of this research are the central components of a distribution network design, which are the assortment range, the picking system and the last-mile delivery, in terms of delivery mode and time.

In addition to the growing online business, controlling of logistics processes due to volatile demand is a complex task in grocery retailing. In the German market, this is particularly challenging, as low margins and fierce competition are driving constant cost optimization in logistics. Public holidays are a recurring issue in grocery logistics, which is discussed in the second contribution. The ban on working on holidays means that grocery retailers have less time to carry out the logistics process. In addition, there is usually a higher weekly volume to manage than in standard weeks, as customers' willingness to buy increases before holidays. Although holiday weeks are planned and prepared in detail, many challenges have to be met on an ad hoc basis. Consequently, the focus of the analysis of holiday issues is on the operational planning areas of demand planning and disposition, warehouse management and transport management.

Within the scope of an explorative study, fields of action and solution approaches of German grocery retailers are crystallized and subsequently systematized. The results of the study provide potential measures for efficiently and effectively controlling the planning areas considered around public holidays.

The third issue considers the challenge of the Covid-19 pandemic for the German grocery retailing. In contrast to the public holiday challenge, the outbreak of the pandemic in spring 2020 led to unexpected demand peaks and uncertainties in grocery retailing. Using an exploratory research approach, the impact of the initial phase of the Covid-19 pandemic on the planning and execution areas of demand planning and order dispatching, store management, transport management, warehouse management and procurement is highlighted. The focus of this study lays on the long-term impact on the logistics. Based on a two year review, trends for the German grocery retailing are identified. The findings show in which direction logistics processes might be further developed in order to meet the potential future requirements.

The cumulative dissertation includes the three studies described, which contribute to the qualitative research of omni-channel retail logistics. Current challenges of the grocery retail industry are examined from an European, especially a German perspective. The exploratively generated results provide courses of action for volatile and disruptive times as well as possible development directions for grocery retailers.

Zusammenfassung

Die vorliegende Dissertation beschäftigt sich mit logistischen Problemstellungen im Lebensmitteleinzelhandel, welche im Omni-Channel Kontext betrachtet werden. Der Omni-Channel Ansatz gewinnt im Lebensmitteleinzelhandel an Bedeutung, da der Onlinehandel mit Lebensmittel kontinuierlich wächst. Neben reinen Onlinehändler, treten auch traditionell stationäre Händler in den Onlinemarkt ein. Die Weiterentwicklung von bestehenden Strukturen hin zu einem Omni-Channel Konzept stellt für die Händler eine komplexe Herausforderung dar. Der erste Beitrag der Dissertation widmet sich dieser Fragestellung und analysiert Omni-Channel Vertriebskonzepte für traditionell stationäre Lebensmittelhändler. Als Basis der Analyse dient eine Fallstudie mit europäischen Lebensmittelhändlern. Da unterschiedliche Konzepte in den Ländern dominieren, werden deren jeweiligen Vorzüge und Unterschiede herausgearbeitet. Im Fokus stehen die zentralen Komponenten eines Distributionsnetzwerkes, welche die Sortimentsbreite, das Kommissioniersystem und die Ausgestaltung der letzten Meile, hinsichtlich Lieferart und -zeit, darstellen.

Neben dem wachsenden Onlinegeschäft ist eine feine Aussteuerung von logistischen Prozessen aufgrund von volatilen Nachfragen eine komplexe Aufgabe im Lebensmitteleinzelhandel. Im deutschen Markt ist dies besonders herausfordernd, da geringe Margen und ein starker Wettbewerbskampf die ständige Kostenoptimierung in der Logistik treiben. Eine immer wiederkehrende Problematik in der Lebensmittellogistik, welcher sich der zweite Beitrag widmet, sind Feiertage. Das Beschäftigungsverbot an Feiertagen führt dazu, dass Lebensmittelhändler weniger Zeit zur Durchführung der logistischen Prozesse haben. Zusätzlich ist meist ein höheres wochenbezogenes Volumen als in Standardwochen zu bewältigen, da vor Feiertagen die Kaufbereitschaft der Kunden

zunimmt. Obwohl Feiertagswochen detailliert geplant und vorbereitet werden, müssen viele Herausforderungen ad hoc gelöst werden. Folglich liegt der Schwerpunkt der Analyse der Feiertagsproblematik auf den operativen Planungsbereichen: der Disposition, der Lagerplanung, der Transportplanung und dem Filialmanagement. Im Rahmen einer explorativen Studie werden Handlungsfelder und Lösungsansätze von deutschen Lebensmitteleinzelhändlern im Bereich der Feiertagslogistik herauskristallisiert und systematisiert. Die Ergebnisse der Studie liefern potenzielle Handlungsweisen, um die betrachteten Planungsbereiche rund um Feiertage effizient und effektiv gestalten zu können.

Der dritte Beitrag beschäftigt sich mit den Herausforderungen der Covid-19 Pandemie für den deutschen Lebensmitteleinzelhandel. Im Gegensatz zu der Feiertagsproblematik, führte der Ausbruch der Pandemie im Frühjahr 2020 zu unerwarteten Nachfragespitzen und Unsicherheiten im Lebensmitteleinzelhandel. Anhand eines explorativen Forschungsansatzes werden die Auswirkungen der Anfangsphase der Covid-19 Pandemie auf die Planungsbereiche der Beschaffung, der Lagerhaltung, der Disposition, dem Transport und dem Filialmanagement untersucht. Der Schwerpunkt der Studie liegt auf den langfristigen Auswirkungen der Pandemie auf die Lebensmittellogistik. Basierend auf einem zweijährigen Betrachtungszeitraum werden zukünftige Entwicklungsfelder für den deutschen Lebensmitteleinzelhandel identifiziert. Sie zeigen auf, in welche Richtung logistische Prozesse weiterentwickelt werden könnten, um potenziellen zukünftigen Anforderungen der Branche begegnen zu können.

Die kumulative Dissertation umschließt die drei beschriebenen Studien, welche einen Beitrag zur qualitativen Forschung der Omni-Channel Handelslogistik leisten. Aktuelle Herausforderungen des Lebensmitteleinzelhandels werden aus europäischer, insbesondere deutscher Perspektive betrachtet. Die explorativ generierten Ergebnisse liefern Handlungsweisen für volatile und disruptive Zeiten sowie mögliche Entwicklungsrichtungen für Lebensmittelhändler.

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List of abbreviations

AI	Artificial intelligence
ASO	Automatic store ordering
B&M	Bricks-and-mortar
C&C	Click-and-collect
CEJOR	Central European Journal of Operations Research
CEP	Courier, express and parcel
EJTL	EURO Journal of Transportation and Logistics
EJOR	European Journal Operations Research
HD	Home delivery
IA	Intelligent automation
IJLRA	International Journal of Logistics Research and Applications
IJLSM	International Journal of Logistics Systems and Management
IJPDLM	International Journal of Physical Distribution and Logistics Management
IJRDM	International Journal of Retail and Distribution Management
KPI	Key performance indicator
No.	Number
POS	Point-of-sale
RTE	Research in Transportation Economics
UK	United Kingdom
USA	United States of America

1 Introduction

Retailing, including grocery retailing, has dramatically changed in the recent years due to digital transformation. New technologies enable new services and a more extensive shopping experience (Hagberg et al., 2016; Hänninen et al., 2021). Digitalization simplifies the market entrance and new market participants change market structures (Haas, 2019; Piroth et al., 2020). Therefore, the omni-channel approach is gaining in importance in the retail logistics. Generally, three channel strategies can be distinguished from a logistics perspective (Hübner et al., 2016c). First, a retailer can provide its products via one sales channel. Thus, one logistics structure is operated for bricks-and mortar (B&M) stores or for an online shop. The next development stage is a multi-channel retailer offering multiple channels. These channels are separated from each other and their logistics processes are not connected. Further in omni-channel retailing, grocery retailers offer their products through multiple sales channels, such as B&M stores, pick-up points, or online. In this case, the customer can choose any channel for each purchase process. For example, the product selection can be made online and payment can be made in a store. Customers and retailers can act in all channels, which is why omni-channel retailers share inventory, picking, organization and IT systems across channels (Beck and Rygl, 2015; Hübner et al., 2016c). Omni-channel retailing strives creating a seamless customer experience (Verhoef et al., 2015). However, different channels result in different order sizes and delivery conditions (Ishfaq et al., 2016). Aligning and simultaneously managing this logistics processes increase the complexity (Vazquez-Noguerol et al., 2022). The task is further intensified by a dynamic environment and high customer expectations (Ishfaq et al., 2016).

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In 2021, the global online share of grocery retailing achieved 7.1% of the total market turnover (Statista, 2022i). While China has one of the strongest online grocery markets with over 30%, in Europe, meanwhile, the online share of the grocery market accounted 2.9% in 2021 (Statista, 2022c,d). However, the online share is increasing steadily as shown in Table 1.1. In Germany, for example, online grocery share accounted only 1.9% in 2020 and rose up to 3.1% in 2021, representing a growth rate over 60% (Statista, 2022f). This development was accelerated by the Covid-19 pandemic.

Table 1.1: Development of the online share of grocery retail markets

Online share \ Year	2019	2020	2021	2022	2023	2024	2025
China	18.5%	24.2%	32.4%	33.6%	34.6%	35.4%	36.5%
Europe	1.3%	2.4%	2.9%	3.4%	4.2%	5.0%	5.0%
France	1.3%	2.0%	2.6%	3.4%	4.3%	5.6%	7.1%
Germany	1.4%	1.9%	3.1%	4.0%	5.0%	6.2%	7.6%
Global	4.0%	5.2%	7.1%	7.8%	8.5%	9.3%	10.2%
Netherlands	1.9%	2.8%	3.6%	4.6%	5.9%	7.4%	9.3%
UK	7.9%	11.2%	12.7%	14.4%	16.1%	17.9%	19.7%

(Statista, 2022c,d,e,f,g,h,i)

In March 2020, the German government enacted the “stay home” concept in order to contain the Covid-19 pandemic outbreak. People reduced their daily contacts and increasingly bought groceries online. For many customers, the pandemic was the trigger for trying online retailing for the first time (Dannenberg et al., 2020; Eriksson and Stenius, 2020). Start-ups used the pandemic’s change in purchasing behavior to their advantage and entered the online grocery market in Germany. One example of a new enterprise entering in 2020 the German online grocery market and providing a home delivery (HD) service in different cities is Gorillas, a Berlin-based start-up. Pure online retailers are enforcing competition in the market, increasing pressure for traditional B&M retailers to further develop services in order to maintain their market shares (Loderhose, 2021; Piroth et al., 2020). Consequently, renewed impetus is given to the omni-channel retailing ecosystem.

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Nonetheless, in Germany, the online share is lower in grocery retailing compared to other industries, as for example fashion with 36.3% or consumer electronics 54.3% in 2021 (Statista, 2022a,b). From the consumer's point of view, the biggest barrier constitutes the inability to haptically sense groceries and the associated doubt that retailers select the best available product (Klepek and Bauerová, 2020). On the retailer's side, high picking and last mile costs hamper the online business. High costs arise because a huge number of items per order, 60-80 items on average, must be picked from a large assortment of up to 25,000 items. In addition, the groceries are stored in different temperature zones and the cold chain must be guaranteed at all times (Fernie and Sparks, 2014). The temperature requirements and the range of assortments lead to large warehouses, long and complex picking processes, which cause high costs. These expenses are further increased by the need for fast delivery due to customers expectations and the perishability of groceries (Wollenburg et al., 2018b). Consequently, the success of a grocery omni-channel retailer is closely linked to the effectiveness of its logistics processes, especially in the picking and last-mile distribution (Eriksson et al., 2019; Murfield et al., 2017).

1.1 Literature review

First, the existing literature was screened to search for reviews about omni-channel grocery retailing from a logistics perspective. Several reviews have been published about omni-channel retailing as interest in this research field has grown in the last decade. Some of these reviews refer specific topics like customer experience (see, e.g., Gereá et al. (2021)), and leave out the logistics perspective, which is the most relevant for this literature review. Further reviews highlight omni-channel retailing research more broadly and outline the current state of logistics research, including knowledge gaps, among other areas. For example, Cai and Lo (2020) describe a lack of supply chain, inventory management and technology based papers. Hänninen et al. (2021) call for more attention to be

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paid to the perspective of retailers. Mahadevan and Joshi (2021) demonstrate a lack of qualitative or case-based research of the last mile fulfillment and operational logistics of successful omni-channel retailers. Bijmolt et al. (2021) connect the marketing and operations perspective of challenges in the following omni-channel areas: assortment and inventory, distribution and delivery, and returns.

Besides broad overviews of omni-channel literature, reviews focusing on omni-channel logistics are conducted. Agatz et al. (2008) provide an overview of model-based papers discussing the fulfillment and distribution in multi-channel retailing. Thereby, papers, concentrate purely on the online channel, are included. Melacini et al. (2018) extend the literature review of fulfillment and distribution contributions in the omni-channel context. More research is called for dynamic assignment policies of online orders, assortment planning, store involvement strategies and context factors for specific omni-channel models. Galipoglu et al. (2018) conduct omni-channel literature in the field of logistics and supply chain management and determine a lack of logistics issues in omni-channel research. This statement is supported by Wollenburg (2017) conducting a similar literature review but specifying on empirical contributions and retail logistics. Qualitative works with a separation between food and non-food are examined as research gap. Raza and Govindaluri (2021) apply bibliometric tools to determine the current state of omni-channel research and consider case studies, empirical research and industrial applications as future research directions.

Further reviews focus on specific logistics areas. Kembro et al. (2018) analyze warehouse operations and their modifications with a view to moving to an omni-channel approach. An extension of warehouse insights is recommended. An overview of contributions about reverse logistics in omni-channel retail is given by de Borba et al. (2020). Contributions to the last mile and corresponding research gaps are analyzed by Lim et al. (2018) or Olsson et al. (2019). Moreover, Hübner et al. (2022) conduct a review of operations research literature focusing on store-related omni-channel issues. A lack of demand forecasting and inventory replenishment contributions is thereby identified. Finally, published literature reviews demonstrate the research interest in omni-channel logistics and

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the corresponding changes in its structures and processes. To my best knowledge, a specific review of the grocery retail literature is currently not existing. The aim of this Section [1.1](#) is to close this knowledge gap by presenting an overview over the significant contributions for omni-channel grocery logistics. Thereby, the methodological procedure of the review consists of four steps based on the concept of Seuring and Gold (2012): material collection, descriptive analysis, category building and material evaluation.

1.1.1 Material collection

The literature review contains peer-reviewed articles from January 2000 to May 2022, with the start year oriented on the beginning of e-commerce. Scopus, being one of the largest database of academic articles, was chosen as the main source. The following words were selected in their various spelling ways and related terms to search for in titles, abstracts and keywords.

- omni-channel or multi-channel
- logistics or operations or supply chain management
- retailing or retail
- grocery or e-grocery or food

The chosen search code can be found in Table [1.2](#). The material collection and selection of the search results is documented in an Excel file. The table and filter functions enable to avoid duplications, to add and categorize keywords, and to obtain an overview of the papers screened in the cross-checks. In total, the search yielded 450 contributions.

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Table 1.2: Search code for the database

Scopus	(TITLE-ABS-KEY (omni-channel) OR TITLE-ABS-KEY (omnichannel) OR TITLE-ABS-KEY (omni AND channel) OR TITLE-ABS-KEY (multi-channel) OR TITLE-ABS-KEY (multichannel) OR TITLE-ABS-KEY (multi AND channel) OR TITLE-ABS-KEY (click-and-collect) OR TITLE-ABS-KEY (bricks-and-mortar) OR TITLE-ABS-KEY (online) OR (everywhere AND commerce) OR (cross AND channel) AND TITLE-ABS-KEY (logistics) OR TITLE-ABS-KEY (operations) OR TITLE-ABS-KEY (supply AND chain AND management) OR TITLE-ABS-KEY (inventory) OR TITLE-ABS-KEY (fulfillment) OR TITLE-ABS-KEY (fulfilment) OR TITLE-ABS-KEY (picking) OR TITLE-ABS-KEY (distribution) OR TITLE-ABS-KEY (last AND mile) OR (delivery) AND TITLE-ABS-KEY (retail) OR TITLE-ABS-KEY (retailing) AND TITLE-ABS-KEY (grocery) OR TITLE-ABS-KEY (e-grocery) OR TITLE-ABS-KEY (food))
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In a first step, papers were restricted to English-language contributions and to peer-reviewed journal articles, as this is the main form of research communication (see, e.g., Galipoglu et al. (2018) or Raza and Govindaluri (2021)). Subsequently, papers from research areas that do not correspond to the economic context, such as pharmacology, toxicology, or microbiology, were excluded. This resulted in 210 articles.

The next step was to eliminate contributions that did not have a logistics, operations or supply chain focus. Among those were economic articles dealing with general management topics (see, e.g., Iglesias-Pradas et al. (2021)). A large number of articles (108) deal with marketing issues, such as for example the consumer behavior or loyalty (see, e.g., Koistinen and Järvinen (2009) or Garcia Gomez et al. (2012)). Consequently, 62 out of 210 were retained. From the remaining contributions, some focus purely on B&M retailing (see, e.g., Wensing et al. (2018) or Burgos and Ivanov (2021)) or purely on online retailing (see, e.g., Rodríguez García et al. (2021)). These contributions were excluded as logistics of omni-channel retailing differs greatly from B&M or pure online retailing (Hübner et al., 2016c; Wollenburg, 2017). Finally, 13 contributions classified as relevant.

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The next step was to review the bibliographies of the 13 identified papers to find additional literature. 99 new papers were found, which seem worth to read according to the context used as reference, the title and the publishing journal. All 99 are peer-reviewed English written articles in the logistics area and have not appeared in the previous Scopus search. The majority of the contributions focuses on pure online issue without an omni-channel perspective. Due to high costs, order picking and the last mile delivery is in interest of researchers as well as practitioners (see, e.g., Boyer et al. (2003) or Al-nawayseh et al. (2013)). Delivery modes, as HD or reception boxes, are analyzed for grocery retailing (see, e.g., Boyer et al. (2009); Kämäräinen (2001) or Kämäräinen et al. (2001b)). Further omni-channel contributions were excluded due to the missing grocery focus or the missing distinction of food- and non-food findings (see, e.g., Bernon et al. (2016); Hübner et al. (2016a,c); Ishfaq et al. (2016) or Saghiri et al. (2017)). Three of the 99 papers do not use the omni-channel term and do not refer to it explicitly (see Aksen and Altinkemer, 2008; Colla and Lapoule, 2012 and de Koster, 2002). However, existing B&M structures are leveraged by adding an online service. Consequently, those three papers can be seen as basis for the omni-channel literature or as omni-channel literature in its pre developing stage. The view is supported by omni-channel literature reviews (see, e.g., Melacini et al. (2018)) including these papers. As they do not mentioned omni-channel retail, they are separated in Table 1.3 (see Number 15-17).

Additionally, the following four literature reviews are frequently cited in the 16 identified papers: Agatz et al. (2008), Galipoglu et al. (2018), Kembro et al. (2018) and Melacini et al. (2018). Galipoglu et al. (2018) analyze the industry focus of the omni-channel papers by noting the amount of paper with a grocery focus. An assignment of the corresponding papers is missing and the findings do not refer back to it. Melacini et al. (2018) conclude a frequent grocery focus of the last mile contributions having mostly a single channel perspective. The other two reviews do not highlight grocery aspects. Consequently, none of literature reviews analyzes contributions specifying grocery retailing from an omni-channel logistics perspective or differentiates between findings in food and non-food retail sectors. Finally, a cross-check was performed in Google Scholar to find recently published articles and verify the result of the conducted literature review. One

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recently published paper can be added to the list of relevant contributions meeting all defined search criteria. In total, more than 550 articles were screened, of which 17 were classified as relevant. Table 1.3 summarizes the most significant contributions for omni-channel grocery logistics under the above assumptions.

Table 1.3: Summary of main contributions in grocery omni-channel logistics

No.	Author(s) (Year)	Journal	Methodology	Geographic context	Dimensions		
					(1)	(2)	(3)
1	Aktas et al. (2021)	IJLRA	Model	UK		X	X
2	Buldeo Rai et al. (2019)	IJPDLM	Interviews	Belgium	X		
3	Dethlefs et al. (2022)	EJTL	Model	Europe		X	X
4	Eriksson et al. (2019)	IJRDM	Case study	Nordic countries	X		X
5	Eriksson et al. (2022)	IJRDM	Case study	Sweden		X	X
6	Hübner et al. (2016b)	IJRDM	Interviews	Europe	X		X
7	Marchet et al. (2018)	IJPDLM	Case study	Italy	X		
8	Mkansi and Nsakanda (2021)	RTE	Case study	UK		X	X
9	Paul et al. (2019)	EJOR	Model	Netherlands		X	X
10	Pietri et al. (2021)	Algorithms	Model	Germany		X	X
11	Rasini et al. (2021)	IJLSM	Case study	Italy		X	X
12	Seghezzi et al. (2022)	IJPDLM	Interviews, analytical model	Italy		X	X
13	Vazquez-Noguerol et al. (2022)	CEJOR	Model	Spain		X	X
14	Wollenburg et al. (2018b)	IJPDLM	Case study	Europe	X		X
15	Aksen and Altinkemer (2008)	EJOR	Model	Turkey		X	X
16	Colla and Lapoule (2012)	IJRDM	Interviews, focus group	France		X	X
17	de Koster (2002)	IJPDLM	Interviews, survey	Europe, USA	X		X

Dimensions: (1) Conceptualization, (2) Performance, (3) Sole grocery

1.1.2 Descriptive analysis

The characteristics of the identified contributions, such as the name of the published journal, the methodology used and the geographic context, were classified. The articles have been published in Algorithms, the Central European Journal of Operations Research (CEJOR), EURO Journal on Transportation and Logistics (EJTL), European Journal of Operations Research (EJOR), International Journal Logistics Research and Applications (IJLRA), International Journal of Logistics Systems and Management (IJLSM), International Journal of Physical Distribution and Logistics Management (IJPDLM), International Journal of Retail and Distribution Management (IJRDM) and Research in Transportation Economics (RTE). As shown in Table 1.4 below, IJPDLM is the leading journal publishing five of 17 papers. The majority of the papers appeared in the last decade predominantly in 2021 and 2022, showing the timeliness and interest of the research topic.

Table 1.4: Overview of journals published the main contributions und publishing year

Journal \ Year	2001-05	2006-10	2011-15	2016	2017	2018	2019	2020	2021	2022	Total
Algorithms									1		1
CEJOR										1	1
EJTL										1	1
EJOR		1					1				2
IJLRA									1		1
IJLSM									1		1
IJPDLM	1					2	1			1	5
IJRDM			1	1			1			1	4
RTE									1		1
Total	1	1	1	1	0	2	3	0	4	4	17

Considering the research methodologies used, qualitative approaches dominate with eleven compared to seven quantitative approaches. One paper is counted twice due to a mixed method approach. Case studies and interview research approaches are most frequently used. In view of methodology, it must be emphasized that the quantitative contributions mostly do not meet the chosen selection criteria (see Section 1.1.1) and are therefore underrepresented. Hübner et al. (2022), identify 44 relevant contributions for the operations research litera-

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ture dealing with the role of B&M stores in the omni-channel retailing. A review of these articles in terms of title, abstract, and keywords is conducted. Only one contribution (see Dethlefs et al. (2022)) relates to the grocery retailing, which is already included in our research. Consequently, a missing focus on grocery sector leads to the low amount of quantitative contributions.

Next, the Scopus citations are analyzed in order to determine the influence of a contribution. Of course, the year of publication must be taken into account by interpreting. Hübner et al. (2016b) leads the ranking with 210 co-citations correspondingly as illustrated in Figure 1.1. Papers, which are not yet cited due to recent publication date, are not included in the figure.

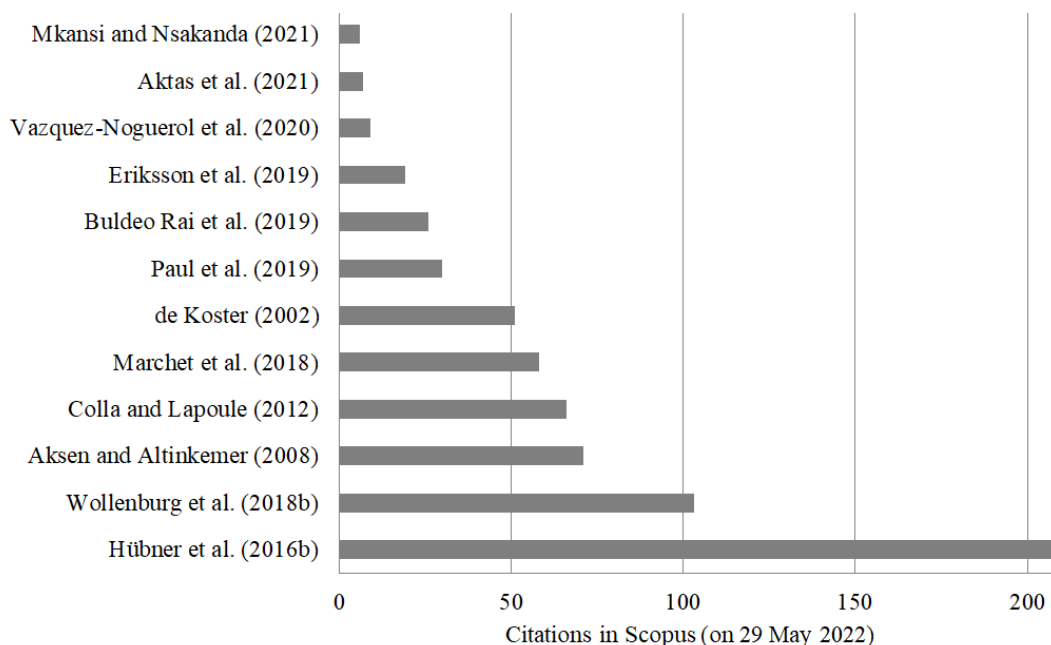


Figure 1.1: Scopus citations of the main contributions

The geographical context of the data is defined according to the market considered and the origin of the retailer surveyed. If this information is not specified in the paper, the authors' location is used. The country or region is taken accordingly as mentioned in the papers, which is why Europe and individual European countries are listed, for instance. One study was conducted in two regions, which

is why the total amount in the brackets adds up to 18. The contributions show the following geographical context: Belgium (1), Europe (4), France (1), Germany (1), Italy (3), Netherlands (1), Nordic countries (1), Spain (1), Sweden (1), Turkey (1), United Kingdom (UK) (2) and United States of America (USA) (1). Consequently, European regions dominate considering the geographic context of the data collections.

1.1.3 Category building

During reading and coding of the papers, categories could be inductively formed. The following three dimensions have emerged, according to which the contributions are illustrated: (1) Conceptualization, (2) Performance, and (3) Sole grocery. The dimension conceptualization is attached to contributions developing omni-channel concepts, designing logistics processes or distribution structures. Contributions are assigned the performance dimension, if they optimize logistics or operations processes in omni-channel retailing, analyze criteria for success, strive for cost or time savings. The last dimension grocery is specific to contributions setting a clear and absolute focus on grocery retailing. Contributions without this dimension also include the non-food sector, but clearly distinguish between food and non-food findings.

(1) Conceptualization: The first dimension is assigned to six of the identified contributions. De Koster (2002) discusses distribution structures to fulfill orders for HD either in distribution centers or stores. Hübner et al. (2016b) focus on logistics planning for the order fulfillment and the last mile. A framework is developed structuring omni-channel designs influenced by country, retailer and customer specifics. Focusing on the implementation of an omni-channel approach, Marchet et al. (2018) analyze how logistics variables should be set in the four areas: delivery service, distribution setting, fulfillment strategy and return management. Wollenburg et al. (2018b) develop distribution networks designs for omni-channel grocery retailing. The designs are mainly distinguished by the picking location, which are the stores, a dedicated online distribution cen-

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ter, or an integrated distribution center for all orders. A further study analyzes the configuration of these distribution centers as picking is the most time- and resource-intensive step of fulfilling an online grocery order (Eriksson et al., 2019). Buldeo Rai et al. (2019) examine outsourcing concepts and conclude that grocery retailers keep critical steps in-house.

(2) Performance: Eleven contributions strive to improve the omni-channel logistics and determine characteristics of a successful omni-channel concept. Thereby, the use and leverage of existing B&M structures and processes play a key role. Retailers achieve a competitive advantage by linking the online business and the store network thence, enabling a large geographic penetration and a short delivery time (Mkansi and Nsakanda, 2021). Eriksson et al. (2022) show capabilities of successful omni-channel grocery retailer, such as a joint management or automated distribution centers. Along with product availability, a short delivery time is one of the key logistical success factors for the click-and-collect (C&C) delivery mode in grocery retailing (Colla and Lapoule, 2012). The other contributions apply quantitative approaches mainly striving to minimize picking or last-mile costs of omni-channel grocery retailing. The location-routing problem from Aksen and Altinkemer (2008) thereby supports the decision of which B&M store should serve C&C customers. Likewise, Rasini et al. (2021) investigate the selection of stores for picking online orders and the determination of the delivery zone. A model for allocating online orders to stores for the store-based picking is also presented by Vazquez-Noguerol et al. (2022). The model minimizes picking and delivery costs and consolidates workloads. Optimization strategies for in-store picking and packing are provided by Pietri et al. (2021). Seghezzi et al. (2022) present an in-store picking approach for online orders, which includes a dedicated back store area as a small online warehouse. This approach combines the advantages of store and warehouse picking achieving time benefits comparing to classic in-store picking concept.

When the online demand volume increases, retailers often start picking in a dedicated online distribution center and deliver the picked orders to their stores. Then, orders are delivered to the stores by traditional distribution centers for store customers and by online warehouses for the pick-up points. The approach of

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Dethlefs et al. (2022) includes the B&M store and distribution center network for the online order fulfillment and achieves costs savings compared to sole picking in distribution centers or only in store. For saving transport costs from distribution centers to stores, Paul et al. (2019) present an approach for the shared capacity routing problem in the grocery omni-channel retailing. In addition to use the retailer's resources, the collaboration of grocery retailers in the last mile enables additional tour and route savings (Aktas et al., 2021).

(3) Sole grocery: The majority of the selected contributions relate exclusively to grocery retailing. Two contributions emphasize the differences between grocery and non-food retailing. Short delivery times are even more in demand in the grocery retailing than in the non-food sector leading to a decentralized picking network. Consequently, the level of automation in the grocery sector is lower than in the non-food sector, as investments in automation technology would have to be made at many sites (Marchet et al., 2018). Moreover, differences in outsourcing activities between grocery and non-food retailers are emerging. Grocery retailers tend to keep the critical processes of order fulfillment and last mile in-house. Non-food retailers predominantly use hybrid strategies for fulfillment and outsource last mile transport as HD or parcel deliveries (Buldeo Rai et al., 2019).

1.1.4 Material evaluation

The descriptive analysis and creation of categories enable to evaluate the existing literature and to identify issues for further research. The same three categories are used for the material evaluation as previously used for the descriptive analysis.

(1) Conceptualization: Overviews, like Hübner et al. (2016b), are developed structuring the omni-channel distribution and demonstrate different fulfillment and last mile options. The various execution concepts still need to be analyzed by focusing on the grocery specifics. In addition, practical cases could enrich the literature as grocery omni-channel retailing is still in an early stage and is

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dynamically changing. Moreover, in-depth research for logistics area could be added as traditional B&M concepts need to be modified (Eriksson et al., 2019).

(2) Performance: Optimization approaches are developed focusing on specific problems, mainly picking or last mile. However, few articles meet all three search criteria, as the grocery focus is lacking (see, e.g., Abdulkader et al. (2018) or Gao and Su (2017)), or the research is conducted from an online retailer perspective (see, e.g., Boyer et al. (2009)). Since 2019, research has increasingly involved existing resources, such as stores, for solving current challenges and enhancing the grocery omni-channel retailing. The allocation of online orders or delivery zones to existing stores and the optimization of in-store picking routes are increasingly being considered. In addition to cost optimization, the challenge of a short delivery time and ensuring the cold chain are addressed.

(3) Sole grocery: The omni-channel retailing is often examined across divers industries. A few studies consider grocery and non-food retailing and emphasize the differences between them (see, e.g., Buldeo Rai et al. (2019)). Results from non-food omni-channel research is not automatically valid for the grocery omni-channel retailing (Eriksson et al., 2019). The specifics of grocery retailing prevent the transfer of the previously dominant non-food literature (Wollenburg et al., 2018b). That is why a separate analysis of the grocery retailing could be useful (Hübner et al., 2016c). Up to now, grocery retailing is often analyzed for the online issue such as online fulfillment issues or last mile delivery options. However, only a small amount of contributions focus solely on grocery retailing in an omni-channel context, as the implementation of the omni-channel concept is at an early stage.

Researchers and retailers are increasingly aware of the importance of logistics for omni-channel retailing (Buldeo Rai et al., 2019; Raza and Govindaluri, 2021). As mentioned above, the identified papers are mainly conducted in an European context. However, omni-channel research without industry selection is mainly carried out in Europe and North America to a comparable proportion (Galipoglu et al., 2018). As shown in the paper selection, omni-channel research in economic journals focuses often on marketing and strategic issues support-

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ing statements of Eriksson et al. (2019) or Galipoglu et al. (2018), for example. This review confirms the literature reports that the omni-channel research shows gaps regarding logistics processes (see, e.g., Cai and Lo (2020); Galipoglu et al. (2018) or Melacini et al. (2018)). On top, the development in logistics from multi- to omni-channel retailing needs to be explored in more detail and ongoing discussions, e.g. on last mile innovations, are lacking the retailers perspective (Hänninen et al., 2021). Furthermore, studies linking contemporary trends and omni-channel retailing are needed (Raza and Govindaluri, 2021). The shift to omni-channel retailing is changing the interaction between all actors of the supply chain. Consequently, the retail environment and conditions are modifying. This affects every player in the grocery retail, including traditional B&M retailers. In the face of change, new issues and challenges are also emerging for the traditional B&M logistics.

1.2 Aim of thesis and research questions

The present dissertation strives to enrich the research in the field of omni-channel grocery retail logistics. Thereby, the dissertation contains three studies, which are dedicated to three problems in grocery retail logistics. The first study aims to enrich the research with an in-depth analysis of omni-channel concepts from practical cases of European grocery retailers. In doing so, the commonalities and differences of the logistics processes will be worked out. The following research question results:

How do grocery retailers implement the omni-channel concept logistically, especially with regard to application provisioning and last mile design?

Grocery retailing faces the challenge of fluctuating demand in public holiday seasons. The public holidays go along with volume peaks, especially during the Christmas time and Easter. In addition, retailers have at least one day less through the bank holiday to satisfy the demand and to handle the increased volume in the logistics processes. Adjustments of logistics processes are required.

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The aim of the second study is therefore to close the gap in the literature of the public holiday challenges from a logistics perspective. The research question is formulated as follows:

How do grocery retailers cope with public holidays in the operational logistics?

An extreme peak time appeared in spring 2020 with the occurrence of the Covid-19 pandemic in Germany. After the sudden hoarding of non-perishable groceries, customers tried to minimize contacts and tested the online services of the grocery retailers. These situation leads to the following research question:

What effects has the Covid-19 pandemic had on the operational logistics of grocery retailing and how do grocery retailers modify their supply chain operations in the post-Covid-19 era?

1.3 Chapter outline

Three contributions form the main part of this cumulative dissertation. The first one is dedicated to distribution concepts for omni-channel grocery retailers and is presented in Chapter 2. Subsequently, Chapter 3 discusses operational planning and execution of public holiday seasons. The third contribution, forming Chapter 4, analyzes the effects of the Covid-19 pandemic on the grocery retailing. Finally, the discussion and conclusion of Chapter 5 close the dissertation.

Chapter 2: Distribution in omni-channel grocery retailing: An analysis of concepts realized

The share of online business has been steadily increasing in grocery retailing in recent years. Thus, pure online retailers are entering grocery markets. To remain competitive in the future, originally B&M retailers are developing online services, such as a C&C option or a HD service.

The first paper presents possible distribution concepts for existing B&M retailers moving to omni-channel retailing and leveraging their existing structures. To il-

illustrate the benefits of different distribution concepts, a multiple case study was conducted with European grocery retailers. The focus is on the following components of distribution concepts: assortment range, inventory setting, picking system and last mile application.

Chapter 3: Operational planning for public holidays in grocery retailing – Managing the grocery retail rush

Recurring peak times in the grocery retailing are during public holiday periods such as the Christmas season or Easter. The public holiday constellations change every year, as some public holidays have a flexible calendar date, and those with a fixed date are subject to a weekday change. On top, demand increases during this time, which is why holidays seasons are challenging for the operational planning.

The second contribution of this thesis analyzes the public holiday challenge for operational planning and process steering. The explorative study was conducted in the German grocery retail sector influenced by a multitude of public holidays. In the focus of consideration are challenges and measures of demand planning and disposition, warehouse management, and transportation management.

Chapter 4: Challenges and opportunities in disruptive times of grocery retailing: Lessons learned from the Covid-19 pandemic

In spring of 2020, German grocery retail faced extremely high demand on an unprecedented scale due to the outbreak of Covid-19 pandemic. Great uncertainty has dominated, which required immediate control measures in the areas of operations and logistics.

The third contribution presents the early impact of the pandemic on the planning and execution areas of demand planning and order dispatching, store management, transport management, warehouse management and procurement. Building on this experience, the weaknesses of the standard business revealed in the first year of the pandemic are identified. Subsequently, the long-term development of grocery retail operations and the lessons-learned after a two-year review are discussed and a direction for grocery retailers to remain competitive in the future is given.

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Bibliographic information

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Author's contribution

Alexander Hübner conceptualized the study design, supervised the work, assisted with data analysis, and edited the manuscript.

Heinrich Kuhn assisted with the design of the study, assisted with data interpretation, edited and critically reviewed the manuscript.

Andreas Holzapfel assisted with the design of the study, assisted with data interpretation, edited and critically reviewed the manuscript.

Elisabeth Obermair conducted the literature search, performed the data collection, analysis, and interpretation, and edited the manuscript.

Abstract

The advent of grocery sales via online channels means that former bricks-and-mortar retailers need to construct efficient but also customer-oriented omni-channel distribution concepts if they want to compete online. As the general understanding of such bricks-and-clicks logistics systems for grocery is still limited, the purpose of this chapter is to analyze the distribution concepts used to serve customers across channels and their components. We analyze warehousing, picking, internal transportation, and last-mile delivery systems. Bricks-and-mortar grocery retailers are leveraging their existing logistics structures to fulfill online orders.

Our qualitative analysis of different design options will support the decisions of retailers developing distribution concepts for serving customers across channels. This chapter highlights the internal and external factors that drive decision making for omni-channel distribution for grocery retailers that were previously store based. We show that logistics networks are mostly determined by the question of where to split case packs into customer units. Furthermore, in non-food logistics channel integration is mostly seen as beneficial, but in grocery retailing this depends heavily on product, market, and retailer specifics. In doing this, we build a contingency and configuration theory of omni-channel grocery distribution concept design, illustrated by practical cases.

Keywords

Food retailing, Inventory, Last-mile delivery, Picking, Networks, Multiple case study

2.1 Introduction

Sales in online grocery retailing is growing across all countries in North America, Asia as well as Europe. In Europe, the USA and China, for example, online sales of food and beverages are expected to grow by an average of between 10 and 18% respectively per year from 2018 to 2021 (Statista, 2018a). In the United States a recent study shows that 41% of customers have already bought groceries online. A total of 21% had purchased groceries online within the previous 30 days. Those consumers buy 16% of their weekly grocery shopping online (BrickMeetsClick, 2016). The picture in Europe, however, is quite ambiguous. The Netherlands, France and particularly Great Britain have a considerable online share. In Germany on the other hand, the share of online food sales is still on a low level (Statista, 2018b). Nevertheless, the online grocery trade will significantly increase in the future and shift ever more into the focus of business development strategies of grocery retailers. Pure online grocers, such as Amazon Fresh, Ocado (Great Britain) and Picnic (Netherlands), are also driving this development. However, the global food retailing is still dominated by classical B&M stores, which currently still account for approx. 97% of all grocery sales. Traditional stationary food retailers, e.g., Walmart (USA), Tesco (Great Britain), Carrefour (France), or Rewe (Germany), are already intensively involved in online business. These retailers usually operate a dense network of B&M stores, representing a significant competitive advantage over pure online food retailers and offering the opportunity to rapidly develop into an omni-channel business model by establishing an online channel. Omni-channel retailing will therefore become particularly important in the grocery sector.

The distribution of online ordered groceries raises several difficulties. First of all, it significantly influences cost effectiveness (e.g., Fernie and Sparks, 2014; Agatz et al., 2008). Lawrence and Douglas (2001) found out that a lot of pure online grocers failed because of the so-called “killer costs” for fulfillment. Most retailers selling groceries via an online channel struggle to achieve profitability. Furthermore, the expectations of online customers are high as they demand the availability of groceries anywhere and at any time (Fernie and Sparks, 2014).

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Additionally, the willingness to pay higher prices than in stores or to pay delivery costs is limited (Boyer and Hult, 2005; Colla and Lapoule, 2012). Fulfillment costs are higher in online grocery retailing than in any other e-commerce segment because of two characteristics. First, the average number of items per basket is significantly higher at around 60-80 articles. Second, the maintenance of the different temperature zones of groceries during these processes is remarkable (Ferne and Sparks, 2014). The success of an omni-channel retailer is therefore strongly connected to the effectiveness of its logistics processes (Murfield et al., 2017).

Traditional B&M retailers that have started to sell through an online channel are trying to use the synergies of multiple channels to decrease costs. They can benefit from the pooling effects of sharing the inventory or achieving greater purchasing power (Agatz et al., 2008). However, logistics literature mostly focuses on online grocery fulfillment (e.g., Teller et al., 2006; Grant et al., 2014) and cross-channel fulfillment for non-food retailing (e.g., Agatz et al., 2008; Gallino and Moreno, 2014; Hübner et al., 2015, 2016a; Ishfaq et al., 2016), but only on cross-channel grocery retailers to a very limited degree (e.g., Colla and Lapoule, 2012). Most retailers are merging their channels at least to some extent (Hübner et al., 2016c). The question arises as to whether this is always beneficial, especially if this applies for all retail categories, and to what extent.

This chapter analyzes the logistics networks of omni-channel grocery retailers. These are retailers that offer their products not just in B&M stores, but also online via “bricks-and-clicks.” Focusing on the product flow, the products can be picked up at the store, at pick-up stations, or delivered to the customer’s home. Enabling the different delivery and pick-up modes across channels is a recent phenomenon, and is realized across markets in quite different ways, particularly in grocery retailing. German B&M retailers, for example, mostly supply their currently small volume of online orders via their existing store outlets, whereas most Dutch and British retailers fulfill HD via specialized online distribution centers (Hübner et al., 2016b). In France, the number of drive-through stations for the pick-up of online grocery orders is twice as much as the number of hypermarkets. Nevertheless, retailers may operate all types of these networks from

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isolated product flows – where direct-to-customer shipments and store supply are operated independently – to unified systems with comprehensively conflated front- and back-end logistics. Bricks-and-clicks retailers therefore need to address the question of how to operate logistics networks to serve customers across channels.

Such logistics networks that enable bulk and single unit picking and delivery are more costly than traditional store fulfillment with bulk deliveries to stores, where customers themselves are responsible for order picking at the store. In grocery retailing, differing temperature zones, orders with multiple items, higher waste due to perishable inventories and rapid delivery requirements make logistics more complex than for non-food. Innovative logistics concepts need to fulfill customer expectations particularly in terms of high delivery speed, high product availability and low delivery costs, while retailers need to consider the upside potential of new market segments, but also manage their own costs and complexity arising from different channels and concept options. B&M grocers need to find answers to how product flows for the fulfillment of online orders can be organized within their existing network or in a separate distribution channel. This raises the question of how retailers can leverage the dense store network to achieve competitive advantage.

A multiple case study approach with grocery retailers from different European countries is used to understand the advantages of different network, picking and last-mile applications. The data and findings are partially based on preceding studies like Hübner et al. (2015; 2016b,c), and Wollenburg et al. (2018b). In this chapter, we provide insights into the context of omni-channel grocery retailing (see Section 2.2) and describe the main logistics areas of omni-channel grocery retailing (see Section 2.3). Section 2.4 then develops a framework for last-mile logistics, picking systems and network configurations. It will reveal the reasons why retailers use specific omni-channel distribution concepts. The key findings are discussed in the final section.

2.2 Terminology and general insights

Omni-channel vs. multi-channel. Many different expressions have been developed for retailing via multiple channels with “bricks-and-clicks.” Terms encountered in practice include “multi-channel,” “cross-channel” or “omni-channel.” It is problematic that varying spellings and understandings of these expressions exist. Multi-channel retailing includes selling products or services through more than one channel (Beck and Rygl, 2015). A customer could choose whether to receive products in a physical store or through HD. There is no link between the channels, neither from an operational, logistics nor consumer perspective (Hübner et al., 2016b). An omni-channel strategy is a more advanced approach. In omni-channel retailing, neither the customer nor the retailer distinguishes between physical store and the Internet channel anymore (Brynjolfsson et al., 2013; Bell et al., 2014; Verhoef et al., 2015). A retailer provides its products or services through various channels as for instance via physical stores, catalogs, telephone or online shops. There is only one common interface to the customer (Wilding, 2013; Beck and Rygl, 2015). In the context of logistics, omni-channel retailers apply information exchange, joint operations, warehousing and inventories across channels, which leads to a conflation of the fulfillment processes (Hübner et al., 2016c). The logistics interface is the same for all channels. Well-organized distribution centers, the logistics network and omni-channel visibility to the customer are examples for building the basis of an omni-channel strategy (Saghiri et al., 2017). The fulfillment of retail orders across channels is based on a combination of existing B&M concepts, online fulfillment concepts and new options that arise from the joint fulfillment of both channels.

Online food and grocery market. Currently online food sales as a share of total food sales is quite moderate. Online sales involve an average of approximately 2.9% in the USA, 2.5% in China, and 2.7% in Europe (Statista, 2018b). However, the actual growth rate is significant and quite noticeable. The online sales of food and beverages are actually growing by 13.9%, 18.0% and 9.7% per year (compound annual growth rate, CAGR) in the USA, China and Europe, respectively (Statista, 2018a). In the future, the online share of food

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sales will therefore considerably increase, and is forecast at 3.6% in the USA, 3.4% in China and 3.7% in Europe in 2021 (Statista, 2018b) Europe, however, presents a quite heterogeneous picture. Germany exhibits a relatively low online share of 1.1% in 2018, whereas, the Netherlands, France and particularly Great Britain display a considerable online share of 2.6%, 4.1% and 7.4%, respectively (Statista, 2018b). In Germany, the situation in the online food retailing is rather unfavorable since the cities have a very high density of stationary grocery stores. For German customers, online shopping is therefore often more complicated than a quick visit to one of the many B&M stores in the immediate neighborhood. Furthermore, most German food retailers only offer online shopping in urban areas, while rural areas generally remain excluded, although the latter would in principle have a greater demand potential per inhabitant. On the other hand, the situation is very different in Great Britain and other European countries, such as France and the Netherlands. Great Britain, for example, which is considered a pioneer of the online grocery retail in Europe, has a significant share in online grocery sales (Statista, 2018b). The B&M retailers, especially the “Big Four” (Tesco, Asda, Sainsbury’s and Morrisons), have been investing heavily in expanding their online business since the early 2000s. The traders attract their customers with relatively low delivery fees, same-day attended HDs and relatively exact and compact delivery time slots, sometimes of less than one hour. It is therefore expected that food will overtake consumer electronics in online sales in 2018, making it the second largest online category in Great Britain after apparel (Forrester, 2014). France, for example, also has a relative substantial market share in online food business due to the special situation of a high proportion of dual-income households and a significantly lower density of grocery stores compared to Germany.

The expected growth for Europe is quite considerable. A market share in online food trade of almost 10% is expected for Great Britain in 2021. This corresponds to online sales of approximately EUR 20 billion in 2021 (Phillips and Vasquez-Nicholson, 2016). However, a market share of 10-12% is in general considered as the market saturation limit in online food sales. France, the Netherlands and Germany are still far behind this saturation level. In 2021 a market share in

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online food sales of 5.2%, 3.5%, and 1.7% is expected for these countries, respectively. Even in Germany, where the share of online sales in grocery products (food, drinks and personal care products) is currently below 2%, the online share is expected to increase significantly in the future. More than half of German consumers can already imagine buying food online (Wollenburg et al., 2018b).

Challenges in grocery retailing. Grocery retailing has some particularities that impact the distribution systems for fulfillment in both online and offline channels. First of all, grocery products are stored and transported in different temperature zones (e.g., ambient, fresh and deep-frozen). Retailers need to manage up to five different temperature zones during transport due to legal and quality regulations. Second, fresh products have a very short life cycle and are practically non-returnable due to high costs and quality regulations. Third, grocery shoppers visit stores frequently and expect to receive their goods on the same day. For HD it means that they expect delivery on the same day and within a particular time slot. Fourth, most retailers (at least in major European markets) operate with dense store and warehouse networks. Finally, the profitability in grocery retailing is usually low. Food retailers often operate with 2-3% margins and logistics costs amount to approximately 15% of sales. This all needs to be reflected when designing the logistics system of an omni-channel grocery retailer.

2.3 **Logistics areas in grocery retailing**

In general, retail logistics networks – in comparison to other logistics networks – have special characteristics in their distribution structures (e.g., number of delivery points, multiple distribution centers, high picking costs related to turnover). In the following, we explore the main differences between B&M and online grocery order fulfillment. We focus on the areas of network design, picking and last-mile delivery. We will first explain the general setting for all areas, and then describe the specific requirement for each channel separately.

2.3.1 Logistics networks

The logistics network of a grocery retailer defines the location of the facilities, i.e., distribution centers, transshipment points and stores. In addition, it defines the transportation strategies between these facilities as well as the transportation strategies from suppliers to these facilities and from these facilities to final customers, respectively. It therefore frames all planning aspects related to long-term network configuration, e.g., sizing the number of distribution centers and transshipment points, or defining functionalities and number of layers of distribution centers, and which distribution center holds which products. Retailers use their distribution centers for inventory holding and picking, but they can additionally serve for cross-docking. Furthermore, storage constraints (e.g., best-before issues) and transport restrictions (e.g., arrival before store opening) allow only limited distances between stores and the end consumer.

B&M networks. A traditional B&M grocery retailer has regional and national distribution centers, where around 85% of the products are received. The remaining share is delivered directly by the suppliers to the stores (Kuhn and Sternbeck, 2013). In grocery retail logistics networks usually a number of central distribution centers store slow-moving items (Hübner et al., 2013) in large facilities with a broad range of assortments, whereas multiple regional distribution centers mostly store fast-moving items and items with short transportation lead time requirements (e.g., fresh produce) (Holzapfel et al., 2018). The network is determined by size, number and type of distribution center. Internal consolidation of orders can take place when items from central distribution centers are cross-docked and bundled in a regional distribution centers for further transportation (Kuhn and Sternbeck, 2013). Items are usually stocked in case packs or in a larger-scale unit (e.g., a pallet).

The minimum transportation unit for store supplies is a pallet or roll cage for most items. After goods have been picked on transportation units, haulage is carried out by temperature-specific trucks (or temperature-specific compartments of a truck) that deliver orders to a store from once per week (i.e., slow-movers) to a couple of times per day (i.e., ultra-fresh grocery items). Repetitive deliv-

ery patterns are applied to facilitate planning in other subsystems (Holzapfel et al., 2016; Sternbeck and Kuhn, 2014). Regional distribution centers may serve as transshipment points for central distribution center shipments. Further transshipment points (e.g., for cross-docking) may be also applied. There is an interdependence between routing and warehouse location decisions that determines a logistics network as well. Thus, the main influencing factors include the number of stores, store density, delivery patterns, and whether or not transshipment points are used.

Online networks. A pure online retailer fulfills from dark stores or from online distribution centers that are designed solely for online order picking (de Koster et al., 2002; Hübner et al., 2016b). Dark stores are built similar to a store, but not open for other customers. Pickers fulfill customer orders by taking items from the shelves that are supplied regularly from a central warehouse or directly from suppliers. Dark stores and online distribution centers are built close to customers to shorten the transportation lead time (Hays et al., 2005). In both options, case packs are divided into (and stocked in) customer units. We term this “break-open point,” i.e., the point where case packs from suppliers are “broken” and divided into customer units for the first time (Broekmeulen et al., 2017). It determines in which subsystem of the supply chain logistics costs increase as products are no longer handled together (i.e., more efficiently) in a larger packaging unit. For online orders the only internal transportation occurs when retailers have central distribution centers and transport items from different temperature zones to online distribution centers for further picking and distribution.

2.3.2 Warehousing and picking

After the receipt of products from suppliers or other distribution centers, items are stored, picked, and distributed in different temperature zones. Retailers receive products in case packs, i.e., outer packs (secondary packaging), from their suppliers, but sell these products in customer units, i.e., eaches (primary pack-

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aging), to their customers. The suppliers' case pack facilitates the handling of multiple customer units in the supply chain and protects the products during picking and transportation (Broekmeulen et al., 2017; Wensing et al., 2018). These factors impact network design and lead to different cost structures, i.e., inventory holding costs in distribution centers, facility location costs and handling costs.

In grocery retailing, order picking is very cost intensive since it accounts for about 25% of the total supply chain costs. Picking is the process where different items for store and customer orders are compiled. One significant factor is the labor for manual order fulfillment. Minimizing the travel distance of pickers and consolidation effort of orders is the primary objective. Product variety and availability targets throughout the network are important variables in determining picking costs, which in the end also influence the network type. Because grocery products have differing temperature requirements, grocery retailers need to operate separate facilities by temperature zone. Additionally, frozen, chilled and ambient products need to be separated when picking groceries, and ensuring that the correct temperature is kept further complicates the entire process. The picking procedure needs to simultaneously achieve low costs, high accuracy and high velocity.

Picking for the B&M channel. Store orders come in much larger quantities than online orders and are processed in larger entities (i.e., case packs). Thus, it is a central question for retailers to what extent it is advantageous to unpack or bundle case packs to create order packaging units for the stores (Kuhn and Sternbeck, 2013). A picker takes an entire case pack from a storage area and puts it on a transportation unit (e.g., pallet or roll cage). Usually each transportation unit equals one picking job and contains 15 different items on average, i.e., a picker has an average of 15 different items to pick per job. Larger quantities than case packs (e.g., entire pallets) are only picked for bulky items or if stores display items on pallets. Under certain circumstances, e.g., for low-volume high-value products, a B&M retailer removes the secondary packaging at the distribution center and then uses reusable boxes for transportation. The break-open point is in the store for almost all items. The consolidation of items from various

temperature zones takes place either in the distribution center (if stores are delivered with multi-temperature vehicles (Hübner and Ostermeier, 2019)) or in the store.

Picking for the online channel. In online grocery retailing the unpacking has to be done, i.e., the secondary packaging removed, before customer orders are picked. In a first stage, pallets containing items of one product type are often broken up into case packs and then in a second stage case packs are further broken up into customer units. Online picking is also more complex because the orders consist of multiple different items (Agatz et al., 2008). Each online order contains from 60-80 different items (Fernie and Sparks, 2014). After picking, the order has to be consolidated (if split up into different picking jobs), packed and sorted by delivery region before the distribution can start. The final consolidation of an order from different temperature zones is performed by vehicle drivers on the customer's doorstep.

2.3.3 Last-mile delivery

Last-mile delivery defines the delivery of online orders to customers and is therefore only relevant for online retailers. After picking, online grocery retailers distribute their products from online distribution center with the help of logistics service providers or with their own fleet. The transportation vehicles need to either contain multiple compartments or be equipped with isolated boxes to transport products from different temperature zones. Basic differences in HD concepts are attended HD and unattended HD. This describes whether a customer needs to be at home when goods are delivered to the door or not. It impacts the degree of freedom in terms of delivery frequency and routing (Hübner et al., 2016b).

2.4 Distribution concepts in omni-channel retailing

The upcoming section analyzes the distribution concepts of omni-channel grocery retailers. The structure (see Figure 2.1) is oriented towards the main areas (2.4.1) assortment and inventory setting, (2.4.2) last-mile configuration, and (2.4.3) picking system. The three components together constitute the basics for distribution network design (2.4.4), which is analyzed at the end of this section.

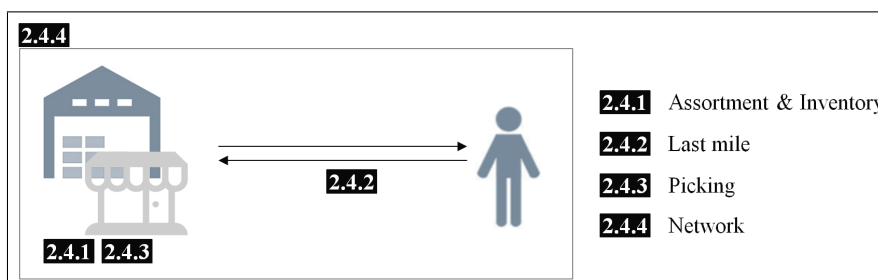


Figure 2.1: Distribution concepts in omni-channel retailing

2.4.1 Assortment and inventory concepts

Theoretically, a retailer could offer an unlimited number of articles in its online shop. However, the decision about the online assortment as part of inventory management has a strong impact on the picking system, location and network structure. Generally, we differentiate whether a retailer provides a smaller or larger assortment online than in the stores.

(ii) Smaller online assortment. When starting an online channel, retailers mostly offer a smaller assortment range because the online store is tailored to regional assortments and to availability in the fulfillment center. Consequently, the customer's address or choice of pick-up location influences the product range of the web shop. The customer log-in with zip code or its location is determined automatically by the Internet protocol. Moreover, retailers eliminate products

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from their online assortment that are too sensitive to temperature differences or too bulky for the online business.

A Portuguese retailer does not provide potted herbs online anymore as they had a high return rate of 30%. The cooling and handling system during the last-mile delivery was critical. An Austrian retailer excludes large non-food articles due to lack of space in its delivery vans.

Last-mile configuration therefore determines the product range. Considering the network design, the decision to hold a smaller online assortment entails the distribution of regional and fresh products via regional distribution centers. Retailers choosing the assortment as described are, for example, Asda (Great Britain), Carrefour (France), Rewe (Germany) or Tesco (Great Britain).

(ii) Larger online assortment. The majority of retailers strive to provide a larger assortment online than in their stores, where the assortment size is limited by shelf space. As a result, they increase the attractiveness of the online channel and strengthen their competitiveness. Omni-channel retailers offering an extensive online assortment often operate an online distribution center as it provides space and enables them to deal with a higher number of items than in stores. Such a concept is used by the Dutch retailer Jumbo, which operates several online distribution centers, where it stores all products for every online customer in the country. Equally, there are retailers offering only certain product categories online, e.g., non-food such as wine, as a virtual shelf expansion. Distribution does not require temperature control and is managed by central distribution centers. Typical examples represent the German retailers Aldi and Lidl, which have a non-food assortment in their online shops.

2.4.2 Last-mile delivery concepts

We start out by describing the various building blocks of omni-channel grocery distribution from the consumer perspective. The first building block is therefore concerned with distribution on the last mile. The last mile is of particular

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importance for retailers as the cost of last-mile delivery accounts for up to 50% of total distribution costs (Hübner et al., 2014). The characteristics are denoted as delivery mode and time, and consist of various design parameters (see Figure 2.2), which are further specified in the following (Hübner et al., 2016b).

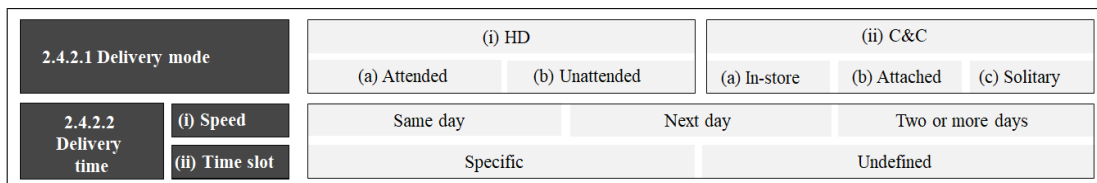


Figure 2.2: Design parameters for last-mile distribution in omni-channel retailing (Hübner et al., 2016b)

2.4.2.1 Delivery mode

A decision about the delivery mode depends to a large extent on the geographic situation. The relative efficiency of different models varies depending on the population density as well as local competition. Apart from logistics aspects, delivery is the only situation where an online customer comes into personal contact with the retailer. Delivery mode thus plays an important role in terms of customer relationship management and channel selection. Alternative delivery modes and their variants are discussed in the following. The predominant delivery concepts of (i) attended and (ii) unattended HD and (iii) C&C will be analyzed. As retailers are currently assessing further last-mile solutions, we mention the concept of crowdsourced shipping and the milkrun system as further innovative examples.

(i-a) Attended HD. Attended HD means that the customer has to be at the point of reception within a selected time frame to accept a delivery. This concept is used for HD of grocery goods across Europe, regardless of market proliferation, e.g., in Great Britain, the Netherlands or Germany. In most countries, attended HD accounts for the largest share of last-mile delivery. Whereas in Great Britain, Tesco mainly fulfills its online orders with attended HD, it is currently the only

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delivery channel used by Rewe in Germany.

However, home attendance creates complexity for the retailers and customers: On the one hand, the customer is under constraint to wait for his order to be delivered, while on the other hand, vehicle routing becomes more complex due to customers' time restrictions. Retailers' objectives include maximizing vehicle utilization and minimizing transportation costs, while maintaining a certain level of customer service and satisfaction rates. This requires dynamically assigning delivery time slots as new orders arrive as well as dynamically creating and adjusting delivery routes. If the customer is not available for order reception within the assigned time, the truck returns without fulfillment. This results not only in additional expenses for transportation and handling, but also in storing of the undelivered goods. Moreover, the retailer has to set a new date for delivery and complete an additional tour. Some retailers therefore charge additional fees if the customer is not able to receive the delivery in the agreed time slot.

An Austrian retailer offers an attended HD service only in selected areas with a surrounding area of 60 kilometers. They charge around EUR 5.00 for a delivery to the customer's doorstep and it is free for a basket value of EUR 100.00 or more. Before completing an online order, the customer chooses a two hours delivery time slot between Monday and Saturday from 10 am to 9 pm. The retailer uses a van with two compartments for different temperature zones. The rear section is cooled down to 4 degree Celsius, whereas the front is kept at a temperature around 15 degree Celsius. Unloading of customer orders can be done from the side of the van.

(i-b) Unattended HD. Unattended HD enables grocers to deliver online orders regardless of whether the customer is at home or not. The shopping basket is placed in front of the customer's home to be collected upon arrival. Common solutions for unattended reception are delivery boxes, reception boxes, and shared reception boxes. From a logistics point of view, the latter can be seen as a hybrid form between unattended delivery and C&C. The customer has to drive to the shared reception box and collect the purchases. But for the retailer it has the character of an unattended HD model with the same planning and coordination expenses.

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The main concern of the unattended model is to ensure safe and secure delivery so that the temperature chain is maintained at all times and it is ensured that the goods are delivered specifically to the buyer. From a logistics point of view, unattended reception eliminates tight time slots and capacity problems resulting from uneven demand during working hours. As a result, demand peaks are evened out. Delivery trucks can cover shorter distances as the need to visit different geographical regions is reduced to a minimum. Unattended reception shortens the working hours for the distributor. Furthermore, it eliminates the costs of redelivering if customers are not at home during their selected delivery slot.

The Swiss pioneer LeShop mainly fulfills its orders using cooled delivery boxes, making it possible to drop off twice as many orders per shift as an average online grocer could fulfill with attended delivery but leaving it with initial costs for buying the boxes and the additional effort of collecting them afterwards.

The cost of delivery can be reduced by up to 40% compared to attended HD with a reception box for unattended HD (Kämäräinen et al., 2001a). The applicability of unattended HD, however, highly depends on the respective region or country. In Switzerland, for example, an unattended delivery model raises no concern for theft due to the in general high GDP. In some regions of Great Britain, however, potential theft of delivery boxes would hinder this model.

(ii) C&C. C&C is the second dominant delivery mode in omni-channel grocery retailing. The development of online grocery sales in France is mainly driven by the installation of drive-through stations, whereas only a limited number of HD supply systems have been established so far. Even in countries with a strong HD grocery channel, such as Great Britain, C&C, which accounts for less than one in five online grocery purchases, is expected to grow significantly over the next five years (IGD, 2014). The customer can pick up the order at his convenience. While the obvious advantage of C&C is that the customer bears the full costs of fulfillment on the last mile, reducing logistics costs by up to 70%, the retailer still has to deal with a number of other challenges related to product availability and the picking process.

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In a C&C environment the pick-up station can be realized in three main variants: (a) a pick-up point in-store, (b) a pick-up point that is attached to a store, or (c) a solitary pick-up station at another location.

(ii-a) Pick-up station in-store. A collection point located in-store is often the ad hoc solution when a retailer wants to enter omni-channel retailing quickly at low initial cost. In this case a separate booth is installed inside a store, from which customers can pick up their online orders. An in-store pick-up station means that the retailer can continue to use its existing assets without major changes. From the customer's point of view, in-store collection points can be less convenient than other fulfillment and delivery solutions as the customer still has to drive to the store and pick up the order. The only thing a customer saves is the time spent on picking goods. From the retailer's perspective, in-store pick-ups offer additional possibilities to cross-sell products. In combination with in-store picking of online orders, this option becomes more attractive in terms of investment costs.

A Swiss retailer has included their in-store pick-up points in the kiosk at its store entrances, where (for example) flowers are sold. The online orders are stored in transport boxes using a shelf system, maintaining the desired temperature. The orders picked are delivered from an online distribution center to the stores by a third party. When a customer arrives at the pick-up station, an employee scans his/her bar code and takes the paper bags out of the appropriate boxes. The whole process is completed in under five minutes.

(ii-b) Pick-up station attached to a store. The pick-up point can also be attached to but not inside the store. Generally, the advantages and disadvantages are similar to the in-store solution. A further advantage is that an attached solution mainly offers drive-through opportunities. Furthermore, this costs less to build than a solitary drive-through station.

An Austrian retailer locates pick-up points in the parking spaces of their stores. A station consists of numerous temperature controlled boxes. An online order including products from different temperature zones is deposited in several boxes. From a customer perspective, the C&C service starts online with the

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selection of products, a pick-up station and a time slot. At the end of the order process, the customer receives a code for collection. When the customer arrives at the pick-up station, he scans in the bar code or enters a code on a touch screen to unlock one or several customer-specific boxes. The pick-up stations are completely self-service representing a huge advantage.

(ii-c) Solitary pick-up station. A solitary drive-through station combines a small warehouse from where the online orders are picked, and a pick-up station. The stations are independent from other stores and are supplied directly and separately from distribution centers. The direct supply of solitary pick-up points increases logistics costs with the additional shipping location, but simplifies demand planning and inventory control compared to an attached solution. Grocers with a low-density outlet network can expand their market coverage with solitary drive-through stations. However, setting up a solitary station requires investments. The setup costs for solitary drive-through stations in Europe range from EUR 2 to EUR 5 million and more, depending on the facilities and layout. The capacity of a medium-sized solitary drive-through station is around 1,000 orders per week, with a maximum of 170 orders per day. Despite higher costs, it reduces the cannibalization of in-store sales compared to an in-store or attached solution, where cannibalization can be between 10-30% of in-store sales (Colla and Lapoule, 2012).

A Dutch retailer provides standalone pick-up stations located on main roads so that they are easy to reach. When customers arrive, they scan in the bar code of their order. The staff select the corresponding boxes and hand the products over to the customer – a procedure that requires three to eight minutes in all.

(iii) Advanced concepts. Besides the above-mentioned options, crowdsourced shipping and the milkrun concept are further innovative HD concepts. Crowdsourced shipping applies the concept of crowdsourcing to logistics by turning the man/woman on the street into couriers (McKinnon, 2016). These individuals can be shoppers who are already available in-store fulfilling their own requirements for grocery goods, people who are already traveling, or dedicated professional or non-professional drivers who are willing to transport goods to

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other customers' homes. The accruing marginal costs are generally comparatively low. Crowdsourced shipping thus offers a chance to reduce costs, increase the speed of delivery, and may at the same time curb the environmental impact. This makes it a promising concept to master some of the challenges that arise in last-mile delivery, and entails mutual benefit (Estellés-Arolas and de Guevara, 2012). Online retailers such as Amazon, i.e., Amazon Flex, already use crowdsourced shipping to deliver packages to their customers. However, this approach still faces many legal hurdles as such deliveries may not be as reliable as corporate service providers in terms of theft, fraud or issues to maintain the cooled temperature chain. This approach is still in its infancy and its practicability is uncertain, but crowdsourced shipping has some potential to save last-mile delivery costs.

Walmart has piloted crowdsourced shipping since 2013. To enable same-day delivery, the retailer lets customers cover the last mile for other shoppers. In return, Walmart then offers a discount. Shopwings in Germany and MyWays in Sweden apply a similar service.

Operating customer delivery tours on a regular basis – like a public transport system or a milkrun system – is an additional concept that certainly reduces delivery costs but requires a critical mass of customers in the same residential area who regularly order grocery products online.

Picnic, a Dutch grocery online retailer, optimizes its last-mile costs by using the milkrun concept. Each street is visited just once a day by the so-called “runners.” A mobile app displays the day’s routing and the current location of the delivery van. Customers know its exact arrival time. Picnic provides its services only in selected streets in densely populated areas (although the area is expanding every day).

2.4.2.2 Delivery time

Delivery time plays an important role in terms of customer convenience, service and satisfaction. The goal is to minimize the time that customers wait to receive

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a delivery while meeting the customer's desired time slot. The delivery time therefore needs to address two issues: overall delivery speed and the time window. The former is segmented into same day, next day, or two or more days. The latter distinguishes between a specific time slot and an undefined time slot during the day of delivery. Each concept includes different logistics approaches and hurdles.

(i) Speed. Same-day delivery presents great logistics challenges in terms of cost and planning complexity. Customers' willingness to pay for the service even in the grocery business is low, but necessary, as customers often buy grocery for their daily requirements. Next-day delivery is still a complex undertaking but less costly as it offers more possibilities to use synergy effects when fulfilling customer orders. As customer satisfaction and days until delivery after ordering are negatively correlated, a grocer should not expect customer satisfaction to be high when customers receive their groceries more than one day after the order, especially for fresh produce.

At an Austrian retailer, around 70% of customers choose same-day delivery, which is available for all orders confirmed by noon. If an order is placed before midnight, it will be delivered the next morning. Of the remaining 30%, around 90% require their order within three days. The short time between ordering and delivering is challenging for the Austrian retailer as it complicates the forecast. Nevertheless, it is successful in delivering the right products within the time slots arranged, significantly influencing customer satisfaction and competitiveness.

(ii) Time slots. If a retailer offers a specific delivery window, the assumption is implied that small delivery windows will produce the highest customer satisfaction. Challenges include displaying the latest updated information for available time slots online. High demand for certain time slots, travel time uncertainties for the trucks and narrow time slots complicate on-time delivery. The more precisely the customer can monitor or select the desired time slot, the higher the cost for retailers.

A Portuguese retailer, for instance, charges EUR 1.00 more for a two hours time window instead of a four hours time slot for its HD.

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By pricing the time slots differently, retailers can create better, more cost-effective schedules. In terms of capacity management and delivery efficiency, it is useful to balance demand during prime time by charging a demand-based delivery fee – for morning and evening rush-hour times to avoid traffic congestion, for example. The difference between an order delivered during off-peak compared to on-peak hours can be 2.5 times higher in terms of cost per order (Hays et al., 2005).

A Dutch retailer uses a demand-based fee for its C&C service striving to balance the volume between days and time slots. Tuesday and Wednesday represent the cheapest days, with a fee of EUR 1.00. Customers' preferred time slots, however, are between 4 pm and 8 pm, as customers attempt to connect their shopping with their way home from work. The charge is therefore up to EUR 3.50.

As an incentive, delivery fees could be lowered if a customer chooses the same time slot for a HD service as another customer from the same neighborhood. Furthermore, the delivery windows themselves could be limited, e.g. 5-10 pm only, minimizing the time spent in traffic jams during rush hour in the morning and higher utilization due to deliveries that are better streamlined. In contrast, undefined delivery slots require less planning effort but imply lower customer satisfaction. Together with unattended delivery, an unspecific window achieves significant cost savings, as it enables routes and schedules to be optimized and therefore increases delivery efficiency. A longer time slot of one to three hours will lead to significant cost reductions. In general, the more control the customer has over the time for HD, the higher the costs.

Even without a financial incentive, Ocado combines delivery routes by using a "green van" flag in their online system. This allows a customer to see when a delivery truck is already going in their direction, and to choose this time slot, thus reducing Ocado's driving time and also the fuel required for delivery, which adds an element of environmental consciousness to the interaction.

2.4.3 Picking concepts

The large shopping baskets complicate the picking and packing procedure. The picking concepts applied in omni-channel grocery retailing can be differentiated by the location where the picking of orders is executed. Three options are analyzed in the following: (i) in-store picking, (ii) picking at an online distribution center, and (iii) picking at an integrated central distribution center.

(i) In-store picking. In this case, the picking of online orders is done by merchandisers who collect the groceries directly from the retail shelves. Retailers have to decide at which store to fulfill a customer's order. The retailer has to consider the tradeoff between picking efficiency in each store and delivery distances, delivery times, and delivery costs to decide at what outlet the online order should be picked and delivered.

An Austrian retailer organizes its in-store picking procedure by separating its stores into picking zones such as dry assortment, bakery products, meat, fast movers, frozen or chilled articles. Besides temperature requirements the zones are mainly influenced by the store organization, which aspires to provide the best shopping experience for a store customer. A conveyor with four boxes, in which paper bags are placed, is used for the picking. The merchandiser scans the bar codes of the boxes and the bar codes of their positions on the conveyor with a manual scanning device. The system automatically assigns an online order to a box, and four online orders are managed simultaneously in one picking zone. The tour is calculated by the system, and the scanner displays key information. Once the products have been collected, the merchandiser scans each of them separately and ensures that the best before date ends after a given date that appears on the scanner display. After putting the articles in a particular box, the correct allocation of the products to the box is confirmed by scanning the box. After finishing a tour the conveyors are collected in the backroom, where frozen and chilled products are put into insulated boxes to make sure they are cooled.

Many retailers use in-store picking as an entry model because it allows them to offer a full product range within the existing structures, enabling them to

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expand fast without investing in new logistics facilities while future demand is still uncertain. In this type no additional online distribution center is necessary, so no investment costs in new warehouse locations and no additional inventory are incurred. Moreover, the identical assortment for online and store channel leads to joint storage of online and store products in the distribution centers and therefore no additional space requirements for additional online items. However, the picking operation is expensive when conducted in stores because space restrictions limit the e-fulfillment. The picking of case packs on pallets in central and regional distribution center allows high operational distribution center efficiency. However, this is countered by the additional picking step and low picking efficiency in-store as the stores are not designed for order picking. Competition on products between online orders and store customers in store is another disadvantage of in-store picking. This out-of-stock risk pushes up demand planning costs and requires higher (online) safety stock. Professional order pickers and regular customers can get in each other's way. As a result, retailers claim that this concept is only appropriate if the online sales share is below 5%. Moreover, it is difficult to provide availability information to the online channel.

Tesco (Great Britain) started its online operations by using the existing store network and picked orders in-store. After growing in scale they shifted to picking orders from dedicated online distribution centers. A Portuguese retailer shifts from in-store picking to online distribution centers picking as soon as the share of online sales reaches 20% of total store sales.

In-store picking requires a joint forecast of store and online demand, which is generally more complex than independent forecasts. Purchasing patterns are not the same for online and store channel customers, which can lead to a mismatch of store replenishment forecasts and inventory holding. In addition, low service levels in store can lead to a lot of product replacements. This is especially relevant in grocery retailing as an order usually contains multiple items per order, so a customer order can rarely be supplied without replacements for missing items. In non-food retail a basket contains two to three different items on average. In contrast, the basket size covers approximately 60-80 items in food retailing (Ferne and Sparks, 2014). Nevertheless, customers mostly accept substitutes of the

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desired product if the product is currently unavailable. This is true for ambient food in over 90% of all cases.

(ii) Picking at online distribution center. In this case the omni-channel retailer uses separate picking locations for online orders. There are some advantages of picking at an online distribution center. First, in contrast to in-store picking, order picking can be conducted more efficiently here as the distribution center is especially designed for picking online orders and it is easier to scale up for larger volumes. This also makes it possible to use efficient warehouse configurations such as differentiation into channel-specific slow and fast movers. Second, because online distribution centers only stock inventory for the online channel, it is simpler to provide information on product availability to web shoppers. In the case of online distribution center inventory holding, customers benefit from longer best before dates on products ordered online because the goods do not have to be kept in-store, and service levels due to inventory pooling effects in the online distribution centers are usually higher than in-store.

A Dutch retailer fulfills its online orders from an online distribution center organized similarly to a hypermarket, where the products are stored in customer units. The online distribution center is divided into zones according to temperature ranges, article volume and value. Plastic boxes and isolated Styrofoam boxes cooled with dry ice are used depending on the zone. Additionally, loose, frozen and high-value items are packed in plastic bags first. After the picking process, the bins are collected at a consolidation point.

On the downside, an online distribution center incurs extra costs as an additional location needs to be supplied by contractors. The high initial costs for setting up online distribution centers require a certain online order volume to amortize the fixed costs. Another cost factor is duplicated inventory holding to serve online orders in store for pick-up and in online distribution centers for HD. In addition, virtual shelf extension is not possible for all online orders. The store assortment limits the online assortment because pick-up orders are fulfilled from store shelves. The assortment offered online can only be tailored automatically according to the order fulfillment location in a second step if retailers retrieve the

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delivery information (i.e., order for HD or order for pick-up) from the customer in a first step of the purchasing process. Customers who order for HD may see a larger assortment than customers who order for pick-up. Furthermore, because the picking processes for HD orders are specialized in online distribution centers, more efficient picking of customer units can be accomplished here than in a store.

(iii) Picking at integrated central distribution centers. This integrated option for home and store delivery requires more comprehensive processes. Omni-channel grocery retailers can integrate online orders into the picking processes of their regular stores to further utilize existing assets. Completely integrated distribution centers have a number of prerequisites if they are to be operated efficiently. First of all, they are beneficial in markets with a dense customer population and expensive rental fees that foster a greater number of small store formats. Second, the order sizes and delivery windows for stores and customers should be close. Finally, a high online order volume is required to accommodate the changes in the warehouses. This all requires design adjustments to prepare locations for efficient online order picking.

In Great Britain grocers are thinking about setting up integrated central distribution centers in specific regions like London where the city center is congested with a dense population for HD. The assortment range is reduced (e.g., by 11% at Tesco, 6% at ASDA, 4% at Sainsbury's) to support smaller store formats (IRI, 2015), and supermarkets and hypermarkets are remodeled as convenience stores (e.g., Carrefour Express, Sainsbury's Local, Tesco Express). In emerging markets convenience stores or nanostores are already the standard store format. Here case packs are unpacked at a distribution center level and products are mostly delivered to the stores in small unit sizes (see, e.g., Albán et al., 2015).

The integration is usually applied by retailers that have already been operating their online grocery channel for some time. With the integration of a warehouse, more complex picking systems are needed at the location to master store-order and customer-order picking. However, there are also advantages, such as short-term allocation decisions and synergies via joint deliveries from the supplier. Experts report that this is operationally effective and, depending on the total

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online volume, more cost efficient than other models, i.e., a single pick is cheaper in a warehouse than in a store. In a central distribution center, a consolidated inventory leads to higher turnover, lower inventory costs and requires fewer links in the supply chain. Inbound transportation costs are lower since deliveries are made to a single location in larger volumes. But the cost advantages from centralization do not come into effect due to higher delivery costs with a longer last mile to the customer. Nevertheless, the largest online grocer Ocado operates two centralized warehouses in Great Britain. However, to be able to deliver to 70% of the British population, Ocado has to use an additional hub and spoke network.

Retailers can offer a large assortment online for pick-up (or HD) that is stored in integrated distribution centers with a high service level. The joint inventory allows pooling effects for online and store items. It is also possible to replenish convenience stores in a demand-actuated manner in customer units, which reduces the waste in stores. However, for items such as ambient food it is very expensive to unpack and store everything in customer units rather than in case packs for store replenishment. Investments are necessary to rebuild regional distribution centers or build new online distribution centers and set up the associated picking processes to fulfill small order sizes. On top of this, distribution center picking in customer units – also for stores – reduces picking efficiency. For internal transportation and on the last mile to the customer, only one kind of multi-compartment vehicle is necessary that can fulfill HD, pick-up and convenience store orders. Transportation costs per unit for store delivery are higher due to greater delivery frequency and small-volume deliveries. Delivery times for stores and customers also differ. Stores are usually replenished in the morning while customers want their products delivered in the evening. The joint transportation of products is therefore only possible for small stores where store replenishment fits into smaller vehicles and store and customer delivery times match each other (e.g., early delivery of convenience stores and afterwards a two-hour time slot for delivery to customers near the store). In this case it may be possible to achieve higher store delivery frequency.

2.4.4 Network concepts

The different delivery, picking and assortment concepts ultimately constitute the distribution network designs. We summarize the network configurations in the following. In omni-channel grocery retailing three configurations can be distinguished (Wollenburg et al., 2018b). In the first configuration, denoted “store fulfillment,” online orders are mostly fulfilled via traditional B&M logistics networks. The configuration therefore abstains from establishing a separate online distribution center for online order fulfillment. The second network configuration, denoted “online distribution center fulfillment,” is characterized by the availability of an independent online distribution center that fulfills at least a significant share of all online orders. In the third network configuration, denoted “integrated distribution center,” all orders are fulfilled from one channel-integrated distribution center. Figure 2.3 outlines all three network configurations.

In Figure 2.3, goods flows are symbolized by arrows, which are solid for flows in case units and dotted for flows in customer units. A triangle shows a distribution center and its specification is marked by different colors. Finally, stores and pick-up points are shown by labeled rectangles.

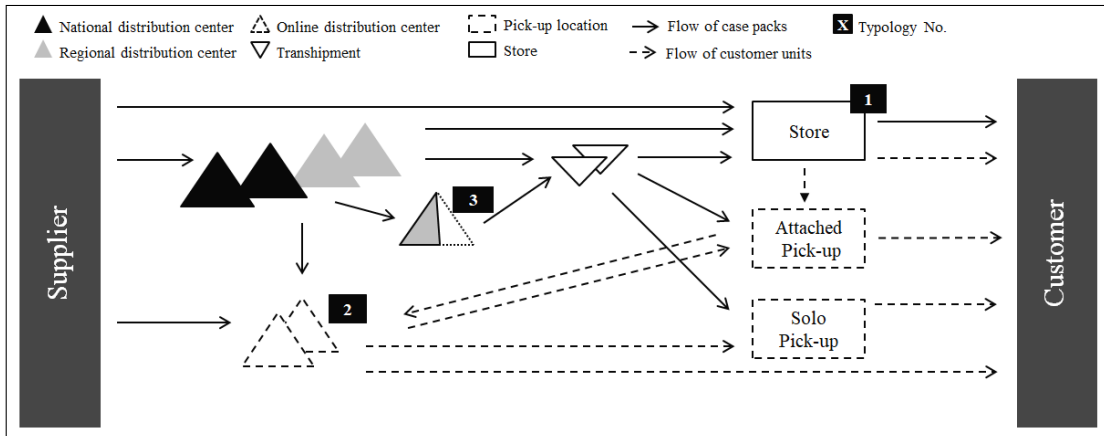


Figure 2.3: Main network configurations in omni-channel grocery retailing

2.4.4.1 Store fulfillment concept

A network configuration based on the concept of “store fulfillment” uses the traditional structures of a B&M grocer, as stores and pick-up points are supplied via existing networks. A separate online distribution center does not exist. All online orders are exclusively supplied via stores or pick-up points. In this type of network, case packs are broken into customer units as late as possible in the supply chain, allowing a long continuing common flow of goods. Customers can choose whether they either pick up online orders from a pick-up point that is attached to a store or have their orders delivered to their home. In both cases orders are picked at the store. The flow of goods goes from the supplier across different temperature and category-specific distribution centers and transshipment points via stores to the customer. Case packs are divided for the first time at the break-open point (i.e., “broken open”) into customer units, and from there everything is processed on a customer unit basis. With this type, the break-open point is at the store.

Suppliers mostly deliver goods to central and regional distribution centers on pallets, and via transshipment points to stores in different temperature zones. Slow-moving products are stored in central distribution centers and fast-moving products are stored in regional distribution centers, which are generally located closer to the stores. Store orders are picked in central and regional distribution centers and online orders in stores. Picking for stores is done in large quantities in distribution centers and at case pack level. Afterwards, the retailer delivers goods from the distribution centers to the stores in different temperature zones on pallets for store replenishment. Here, the case packs are divided into customer units and online orders are picked from store shelves by store employees in a defined picking procedure. Retailers can either only offer pick-up of products from the store or additionally offer HD with delivery vehicles from the store. The final consolidation of an order across temperature zones is conducted when customers pick up the order from the associated pick-up station or via HD when the driver reaches the customer’s doorstep.

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At the internal (temperature-specific) transportation between distribution centers and stores, stores can still be supplied using efficient transportation loads. No additional costs are required for internal transportation flows of online orders (e.g., from central and regional distribution center to an online distribution center). Furthermore, the high number of shipment locations (i.e., stores instead of online distribution centers) results in lower transportation costs on the last mile and shorter delivery lead times to the customer. Shipment of last-mile deliveries from a high number of decentralized locations (i.e., stores) results in higher capacity investments for vehicles as there are only very limited pooling effects available across last-mile operations as each store needs to operate its own fleet. Grocery retailers prefer to keep last-mile delivery within the company as the handling of grocery items and the final delivery and handover of items is seen as a delicate procedure by customers. Omni-channel grocery retailers therefore often invest in their own fleets for last-mile delivery.

An Austrian retailer applies the store-fulfillment concept described (see Figure 2.4). Suppliers deliver directly to regional distribution centers, from where stores are served using case packs. The pallets are divided into customer units at the stores. There is no separation of the stock between channels due to the use of an in-store picking concept – neither in the distribution centers nor in the stores. The goods flow from the stores to customers is symbolized in dotted arrows representing customer units. Besides shopping at a store, the Austrian retailer provides HD and pick-up stations served by its own multi-compartment vans.

The store-fulfillment concept allows fast market coverage for grocers with a dense store network. For example, in Germany and Austria more than double the grocery stores per one million inhabitants are available compared to France or Great Britain. This means that no additional pick-up points are necessary throughout the country due to the high density of outlets. As a result, in France and Great Britain grocery stores are larger and also further outside the city centers than in Germany and Austria (Nielsen, 2015).

From a market perspective this type is therefore best suited to regions where a broad customer base can be approached from stores within a short distance

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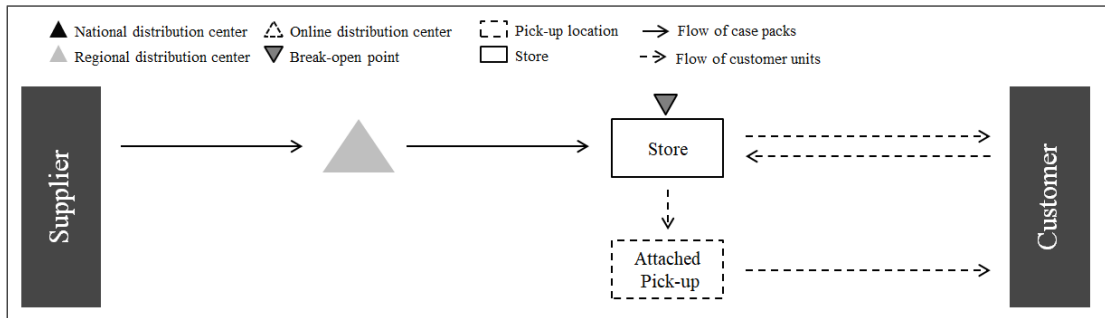


Figure 2.4: Network type based on the store fulfillment concept – Austrian retailer

and online volume is low. Furthermore, the structure is especially suited for and used by cooperative organizations where every owner knows their local customers best and where there is only limited interest in a central and mutual online distribution center sharing investment costs. However, cooperative organizational structures limit the speed of implementing new network designs.

2.4.4.2 Online distribution center fulfillment concept

In the second configuration an online distribution center is introduced to fulfill all or parts of online orders. The online distribution center may be used solely for HD orders (type [2.1]), for all online orders including the supply of pick-ups (type [2.2]), or for specific parts of an online order, whereby some product categories are added from stores (type [2.3]). In any case, case packs are divided into customer units earlier in the supply chain, i.e., mostly at the online distribution centers, compared to the store fulfillment concept.

Type [2.1]: Online distribution center for HD. One or more online distribution centers are introduced to fulfill all HD orders, while pick-up orders are still fulfilled from stores. Suppliers deliver directly to these online distribution centers, which are usually smaller than central and regional distribution centers. Online distribution centers are additionally replenished from central and regional distribution centers like a B&M store using case packs, which are bro-

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ken up and then stocked in customer units. Picking of online orders in customer units is completed here for HD. Multiple orders are stored in boxes of different temperatures and delivered in small vehicles, where the final order is assembled at the customer's home. Online orders for pick-up are still picked from store shelves and made available afterwards at the attached pick-up station. Unlike central warehouse systems, the transportation costs from storage to customer are generally lower in decentralized online distribution centers as the distance to a customer's home is shorter. In addition, delivery time accuracy can be improved, again enhancing customer satisfaction.

On the last mile to customers, the capacity of delivery systems can be better utilized by capturing bundling effects across orders because the online distribution center serves a larger delivery area than a single store. These bundling effects may make it possible to uphold time windows for HD reserved by customers more economically using online distribution centers. However, delivery may ultimately involve greater transportation distances and longer lead times because stores are closer to customers' homes.

A higher number of online distribution centers allow shorter transportation distances to customers. Nevertheless, the distances will usually be longer than delivery from stores. A tradeoff exists regarding centralization of the online distribution center accompanied by pooling effects and decentralization, where the proximity to customers and possible delivery of regional products has to be carefully considered, especially when regional differences of customers exist regarding product variety and affinity towards the products. When online order volume is low, central and larger online distribution centers are appropriate especially on scattered markets, whereas decentralized and smaller online distribution centers should be set up in markets where big cities with a lot of potential customers can be approached within short distances.

A Portuguese retailer focuses on big cities with high population density for their HD. They supply 30% of the country but 70% of the population with fresh online products. They typically start serving a region by providing online services with in-store picking. After they have grown in scale they shift to picking orders from a dedicated online distribution center.

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Tesco (Great Britain) has established nearby superstores, so-called “dot com only stores,” sometimes called “dark stores,” which are regional distribution centers that only fulfill orders placed online as soon as online demand is sufficiently high. In doing so, they are copying the Migros model, which has always sold online orders through specialized online distribution centers. Tesco now operates six of these online distribution centers in Great Britain, supplying 50% of the total online grocery market in Great Britain through this network.

Type [2.2]: Online distribution center for all online orders. In type [2.2] all online orders, i.e., pick-up and HD, are fulfilled from online distribution centers. This type is similar to type [2.1] in terms of most of the operational practices. The major difference is that the online distribution center also supplies all pick-up stations with online orders that are picked in customer units and transported in boxes. Multiple online orders are hence transported in boxes from different temperature zones to the various pick-up points, i.e., attached and solo pick-up, and to customers’ homes. Stores do not supply any online orders anymore.

Figure 2.5 below depicts a Swiss retailer that fulfills all online orders in online distribution centers. The logistics network of the traditional B&M business and the online channel are independent except for one connection: medium- and slow-moving products are shipped from a national central distribution center belonging to the retailer to the online distribution centers. Slow-moving articles are, however, delivered directly by the suppliers to the online distribution centers. There, case packs are divided into customer units, at which point customer orders can be picked. The last mile to the customer’s doorstep or pick-up station is covered by a fleet of their own, except orders for customers living in remote mountainous areas. For efficiency reasons these orders are taken by a service provider, which collects the orders from the online distribution centers.

Because inventory for all online orders is now stored in the online distribution center, only one stock for online items is necessary, thereby eliminating inventory holding of online items in multiple locations, i.e., stores. This increases service levels. The online channel can also provide a virtual shelf extension, offering

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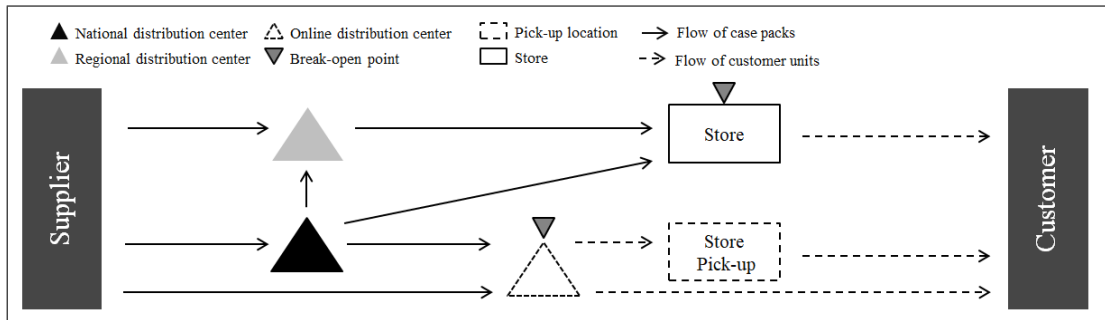


Figure 2.5: Network type [2.2] based on the online distribution center concept – Swiss retailer

an enlarged assortment online. There is no interaction of store customers and pickers in the store anymore. Retailers benefit from the learning and pooling effects of specialized picking for all online orders in the online distribution center. Despite the fact that picking in store for attached pick-up points increases picking costs (see type [2.1]), this decreases internal transportation costs. This is vice versa for the picking of every online order in the online distribution center, which has a positive effect on picking costs and a negative effect on transportation costs. The question is therefore whether picking efficiency in the online distribution center compensates for another intermediate transportation and processing step in the logistics network, i.e., regional distribution center to online distribution center to store/pick-up instead of regional distribution center to store/pick-up.

Type [2.3]: Online distribution center with hybrid order fulfillment. In this type orders are fulfilled from both online distribution centers and stores depending on the content of the online order. Warehousing in central and regional distribution centers and online distribution centers is the same as in type [2.1], and online orders are picked in online distribution centers and stores. The majority of products sold online are picked from online distribution centers, whereas the remainder are added from stores. Ultra-fresh products in particular, e.g., unpacked fish, meat or fresh bakery goods, are picked in stores because stores are already directly supplied with this commodity group. A broad assortment range, including ultra-fresh products, can therefore be offered online.

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The online distribution center of a Portuguese retailer contains 5,000-7,000 fast-movers representing approximately 85% of products sold online. The remaining 15% come from the stores, especially counter products like fresh meat and fish. For the final assembly of an order, the products are transported from the online distribution center to the store or the other way round depending on where the customer lives. For the implementation of this hybrid network type the Portuguese retailer locates its online distribution center to the neighborhood of a store, making the transport distance for picked ultra-fresh products as short as possible. The online distribution center receives all other products from suppliers, central and regional distribution centers in case packs. They are divided into customer units in the online distribution center before picking starts. The finished online orders are delivered to the customer's home by a proprietary fleet, or to the in-store pick-up station. Figure 2.6 visualizes the network type established.

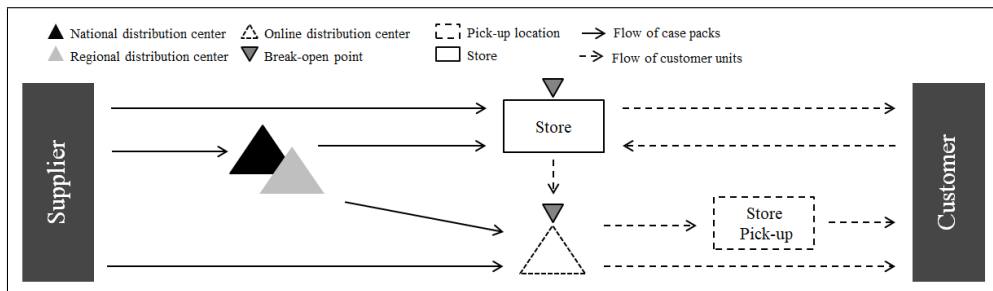


Figure 2.6: Network type [2.3] based on the online distribution center concept – Portuguese retailer

This hybrid solution can achieve inventory pooling effects between stores and the online distribution center, leading to high service levels. There is no need for additional inventory holding of ultra-fresh products in online distribution centers because those products can be added to online orders from the stores. This significantly reduces the waste for this product category. A broad assortment including ultra-fresh products can be offered online and stored partly in store and partly in the online distribution center. In addition to the remaining disadvantages of in-store picking, more repacking and repicking of customer units is necessary because of the two different picking locations for online orders. Transportation costs are also higher because of the additional transportation between

the online distribution center and stores. This logistics network can be used especially in markets with a high population and store density, where the stores can serve as hubs for last-mile deliveries. The hybrid approach is also meaningful in markets where customers do not buy prepackaged meat, fish or cheese, and also want ultra-fresh products online. In the future it should therefore be viable to store and pick most products – approximately 80% – outside big cities in a highly automated manner. Afterwards these products are brought to a store or dedicated pick-up station in the cities and the remaining 20% of an order, for example, meat, fish or bakery goods, can be added directly from the store.

2.4.4.3 Integrated online distribution center concept

The integrated distribution center concept integrates regional distribution centers and online distribution centers for fulfillment of all online and store orders. This may be a future scenario for some retailers, but it is already an existing solution in certain settings and for certain regions, such as big cities and retailers with small store formats, e.g., convenience stores, mom-and-pop stores, nano-stores, etc. The supply of super- and hypermarkets is therefore not considered in this type.

After products have been received from suppliers and central distribution centers, all items are stored on a customer unit basis and not in case packs in an integrated distribution center that supplies convenience stores, pick-ups and customers directly. Store and customer orders are picked in parallel or sequentially from the same inventory. Convenience stores, for example, have a selected assortment range focusing on the presentation of specific grocery products (e.g., ultra-fresh products).

A German retailer serving convenience stores at gasoline stations that also serve as pick-up stations has joint warehousing and transportation for both channels.

2.5 Conclusions and future trends

The online grocery trade is significantly increasing all over the world. Nevertheless, the classical B&M business still has a significant market share, and this will continue to be the case in the future. The omni-channel business concept will therefore become particularly important in the grocery sector, and will become ever more central to the business development strategies of grocery retailers.

Grocery retailers need a consistent strategy when developing their omni-channel business model, which can be derived from the distribution and network concepts described above (see Section 2.4 and Wollenburg et al., 2018b). In a first phase, it is mainly B&M structures that are used for the fulfillment of all channels. The product flows of store, HD as well as pick-up orders are kept together as long as possible, i.e., applying the store fulfillment concept. In a second phase, channels are separated by opening one or several online distribution centers for the fulfillment of this particular channel, i.e., developing the online distribution center fulfillment concept. In a third phase, when online volume accounts for a significant share of sales, retailers reconsider merging online and B&M logistics. Certain store types, e.g., convenience stores, can be supplied together with online customers, as described by the integrated distribution center concept. The development from phase 1 to phase 3 is accompanied by increasing logistics capabilities and thus efficiencies. While a general development from phase 1 to phase 3 can be observed, this does not necessarily mean that all omni-channel grocery retailers will necessarily develop from the store fulfillment concept to an integrated distribution center concept, or pass through all phases in their development cycle.

Retailers also need to synchronize their designated distribution concept with their marketing strategy. Retail logistics is no longer just about building the bridge between warehouses and stores. Retailers' logistics system are increasingly having direct contact with customers and influencing customer services, which has a huge potential impact on future sales. With this in mind, distribution concepts should not just be planned based on logistics parameters such as

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cost savings, transportation distances or operational synergies (see, e.g., Piotrowicz and Cuthbertson, 2014), but also from the viewpoint of product, customer and market characteristics (see, e.g., Rao et al., 2009).

Offering additional fulfillment options is costly but allows the enhancement of customer services via cross-channel substitutions and faster deliveries. Retailers can leverage these integrated systems to improve return on investment as well as customer services. Customers' channel choice can, however, be influenced by steering customers to the appropriate channel saving costs, achieving additional sales and/or developing single-channel customers into omni-channel customers. Omni-channel customers are in general known for being more profitable and more loyal than single-channel customers (Wollenburg et al., 2018a).

In the future new concepts will be available that need to be examined and potentially integrated into retailer's omni-channel distribution model. One challenge will certainly be revealed in the area of the "sharing economy," where private or commercial providers offer their services via online platforms. In line with Airbnb's or Uber's people-to-people business model, there will be similar models available in the future that can be used to improve customer benefits and/or reduce costs in omni-channel grocery distribution. Crowdsourced transport services may then undertake the last mile of order fulfillment for online customers as well as for classical store customers (Castillo et al., 2018). These concepts could also enrich the classical B&M business if, for example, customers who shop in-store deliver products for other customers. This could enable B&M retailers to achieve additional sales and/or save delivery costs. These innovations are possibilities for realizing effective and at the same time cost-efficient same-day HD of grocery products.

A delivery concept revealing great economical potential in the future is if attended as well as unattended HD tours are performed on fixed routes and at regular times, similar to milk runs or public transport. Under these circumstances autonomous delivery vehicles would be a conceivable evolutionary step since the routes are mostly predefined and repeated on a regular basis. Further technological advances may include automated pickup and handover to

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customers of the boxes with robotic arms. Up to now, rural areas have generally been excluded from online grocery retailing because of the unfavorable cost-benefit ratio in these regions. However, in the future drones are potentially an alternative or complement to traditional HDs by vehicles. The idea is currently attracting considerable attention from major retailers and service providers, such as Amazon, UPS, Google, DHL, and Walmart as well as several startups. Hybrid truck-drone delivery systems could be a particularly interesting option in the context of grocery retailing, where several truck-based drones could make deliveries simultaneously with vehicles. Our network types and logistics areas identified for omni-channel grocery distribution can serve as framework and starting point for the application of further innovations.

3 Operational planning for public holidays in grocery retailing – Managing the grocery retail rush.

Bibliographic information

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Author's contribution

Elisabeth Obermair conducted the data collection, reviewed the literature, conceptualized the study design, performed the data analysis, drafted and reviewed the manuscript.

Andreas Holzapfel conceptualized and drafted the manuscript, supported the study design and the analysis of results.

Heinrich Kuhn supported the study design and the data analysis, reviewed and critically edited the manuscript.

Abstract

Public holiday weeks cause specific challenges in grocery retailing as sales are raising and working days for logistics processes are reduced. The paper analyzes the operational planning challenges and solutions for demand planning and disposition as well as for warehouse and transportation management of grocery retailers in public holiday seasons. A total of 22 top managers representing 20 sales lines of 17 of the top 30 grocery retailers in Germany participated in the study. Semi-structured, face-to-face interviews with logistics managers were conducted and analyzed. Uncertainties and missing resources can be identified as the two main challenges of public holiday seasons in grocery retailing. Retailers implement numerous measures that can be summarized in three categories, i.e., the adjustment of workload profiles, the adaptation of resources and modifying processes. Literature has so far considered public holidays only to a limited extent, e.g., as a parameter in forecasting models or for the application of marketing instruments. This study is the first developing a framework and providing insights into operational planning in grocery retailing.

Keywords:

Grocery retail, Public holiday, Operations, Logistics planning

3.1 Introduction

In retailing, demand fluctuates during the week, the year and especially around holidays (Ehrenthal et al., 2014). Public holiday seasons are associated with an increase in revenue and play a major role for the annual performance. Therefore, retailers offer a multitude of promotional articles in holiday seasons to improve their sales (Qiu and Wenqing, 2016). Moreover, instore sales per day increase during public holiday periods because customers have one or several days less for their purchases. This especially applies to grocery retailing as shown in Figure 3.1 using the example of Germany in 2021 and 2022. The figure shows that sales increase noticeably at the end of the year. In calendar week 51/2021, the grocery retailers' turnovers increased by 50% compared to an average week of the same year (Lebensmittel Zeitung, 2022). Consumers bought their groceries for the Christmas holidays, when the stores are closed for at least two days.

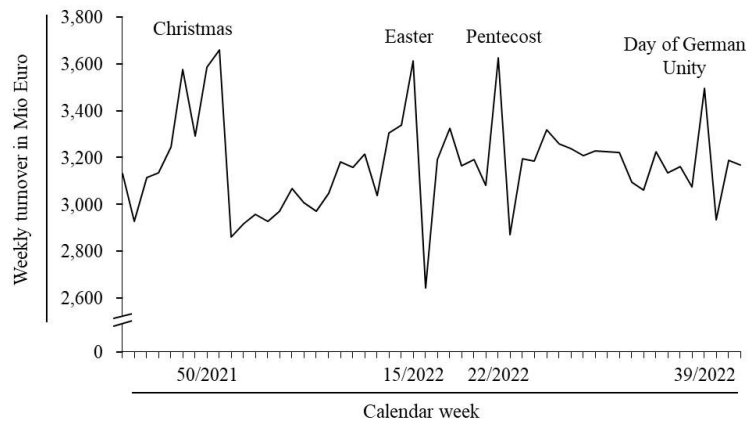


Figure 3.1: Total sales of the German grocery retail per week (Lebensmittel Zeitung, 2022)

Besides sales effects, public holidays are also affecting retail operation processes. For instance in Germany, employees are not permitted to work on public holidays besides a few occupational groups such as emergency services. As a result, less time is available to perform the necessary logistical processes, but the same or even higher volumes than in average weeks have to be handled.

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Additionally, calendar effects change the holiday constellations every year, as several public holidays have a flexible calendar date and the ones with a fixed date are subject to weekday changes. This further challenges operational planning as historical references are often missing. Consequently, logistics plans must be updated every year resulting in a considerable additional effort. For example, during the Christmas week, several working days are omitted. This means that several delivery days are omitted and some stores can be supplied less frequently than usual due to limited transport capacity. In addition, before Christmas and New Year's Eve a large number of additional seasonal items have to be integrated into the supply chain processes. Moreover, planning is complicated by a lack of forecast data because the available weekdays for sale vary from year to year. The changing weekday constellation of the Christmas public holidays leads to a total of seven different Christmas constellations. Sales figures from the year with the same constellation are therefore considerably out of date. The aforementioned challenges are even greater for the Easter holidays, which can be shifted by several weeks during the year. Previous year's values cannot be carried over as the weather strongly influences the consumer behavior on a free day in spring.

In addition, some countries (e.g., Germany) have different public holiday regulations within the country, which further complicates logistics planning and operations. In the event that the distribution center is affected by a public holiday but the associated stores are (partially) not, separate delivery schedules must be created for the affected stores. In addition, these stores – if located near the state border – experience additional demand due to the holiday-shopping behavior of neighboring states celebrating a holiday. Open stores in neighboring states need sufficient stock to compensate for potential delivery shortfalls and additional demand. If replenishment authority lies with the stores, store employees must adjust their orders accordingly. These volumes accumulate in the upstream distribution centers, resulting in additional peaks.

In what follows, we refer to all the logistical and operational planning challenges in grocery retailing just mentioned as the “public holiday challenge.” Given this challenging planning conditions, a careful planning of operations for public hol-

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iday seasons is essential as retailers have to cover significant operational efforts and logistics costs (Holzapfel et al., 2016). Although there are various contributions on retail logistics and operations planning, pertinent literature so far misses a comprehensive analysis of logistics and operations challenges and suitable measures for the public holiday challenge. There are some contributions on demand planning and forecasting for high demand seasons (see, e.g., Dharmawardane et al. (2021) or Dreyer et al. (2018)) and general approaches for handling workload peaks in warehousing and transportation are presented (see, e.g., van Gils et al. (2017); Wilding and Juriado (2004) or Wruck et al. (2017)). However, the question remains open whether these general suggestions can be directly transferred given the specifics of the public holiday challenge outlined above. Additionally, retail practice urges for a systematization and structured decision support for the public holiday challenge, as we have found in pre-discussions with managers involved in logistics and operations decision making in grocery retailers. So far the various challenges are typically solved without a structured planning concept.

Thus, our aim is to identify and systematize the fields of action as well as the solution approaches of grocery retailers before and after holidays by means of an exploratory study, providing guidance on which logistics and operational measures are proven to be adequate under which conditions. We thereby contribute to literature with a first systematization and challenge-solution-framework for the public holiday challenge in grocery retailing, while retail practice can use our findings to develop their company-specific public holiday planning concept in a structured manner based on best-practices in the sector.

The remainder of the paper is organized as follows. Section [3.2](#) reviews existing contributions in the research field and formulates and motivates the research questions for our exploratory study. Section [3.3](#) then details the methodology used. Section [3.4](#) then presents the empirical findings of our study. Afterwards, Section [3.5](#) discusses these findings in the light of literature and demonstrates the practical implications. Finally, Section [3.6](#) summarizes the main results and indicates future research areas.

3.2 Related literature

The public holiday challenges in grocery retailing influence planning and fulfillment activities at different temporal levels and in different functional areas. The aim of this section is to identify the planning areas that are particularly affected by public holiday effects. These areas form the central focus of our study. For the planning areas considered to be particularly relevant, we then examine to what extent proposals for solutions to the public holiday problem have already been developed and presented in the associated literature. Based on this we then derive our research questions.

Supply chain planning is an intensively researched area (see, e.g., Stadler et al. (2015)). A distinction is made between three levels, depending on the temporal horizon: long-term, mid-term and short-term planning. Long-term planning makes strategic decisions that are valid for several years, such as the design of the supply chain. Mid-term planning covers the planning horizon of the next 6 to 24 months and plans the rough framework of operations in terms of volumes and resources. Seasonal fluctuations are taken into account here. Short-term planning involves decisions for a few days up to several weeks. The majority of authors describes mid- and short-term planning as operational planning area with decisions that are highly interconnected (Fleischmann et al., 2015). Given the time horizon of public holiday planning that has to be executed year by year for the different events, we focus on such operational planning tasks in the following portrayal of pertinent literature.

Beside the temporal component, grocery retail planning can be divided into functional planning areas: procurement, warehousing, distribution, outlet, and sales (Hübner et al., 2013). While generally all of these planning areas have to be considered when arranging the retail business before public holidays, we focus in the following on mid-term sales planning (demand planning and disposition) and mid- and short-term planning problems in the areas of warehousing and distribution. We exclude procurement and outlet planning in our study because warehousing serves as a central buffer between suppliers and stores in grocery retailing and specific mid- and short-term activities resulting from the holiday

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effects primarily involve warehouse- and transport-related activities in addition to demand planning and disposition. This focus is also justified as these planning areas are typically seen as most critical elements of public holiday logistics and operations planning, as we have found through a preliminary study which we have conducted with experts in grocery retail supply chain management to streamline our study and to promote practical relevance (see Section 3.3.4). Figure 3.2 depicts the retail supply chain planning matrix according to Hübner et al. (2013) and highlights the planning areas, which we focus on.

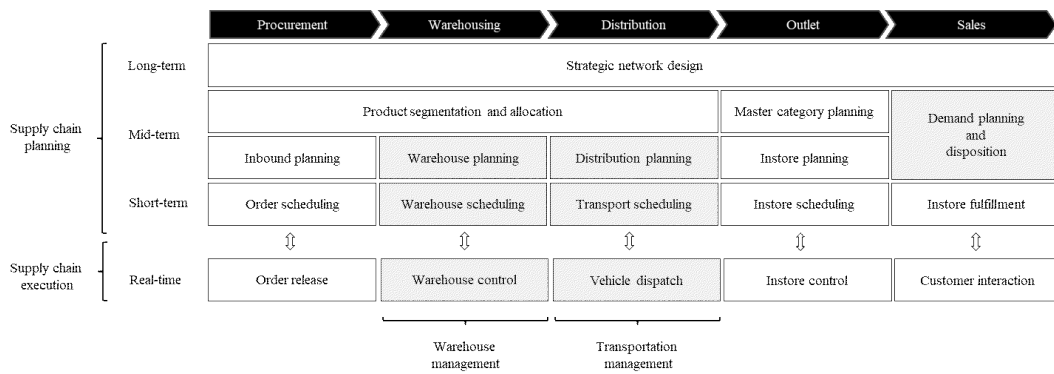


Figure 3.2: Retail supply chain planning and execution framework (adapted from Hübner et al. (2013); Meyr et al. (2015))

In the domain of mid-term sales planning, Fildes et al. (2022) present an overview of the retail forecasting literature and practice including store ordering. They analyze parameters of operational forecasting, which highly influence demand per stock keeping unit and store order. The demand for each item is usually calculated on a weekly or daily basis including short-term special influences. Automated store ordering systems are implemented considering individual inventory and logistics settings of each store (van Donselaar et al., 2010). Consequently, forecasting in grocery retailing requires high computing capacities and error monitoring should be focused on an operational level (Dharmawardane et al., 2021). Nowadays, choosing the right settings is ever more challenging due to shorter product life cycles and increasing assortments (Dekker et al., 2004). It is essential to understand the demand development and fluctuation of the assortment, as the calculations performed determine the order quantities

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and delivery times per store (Kembro et al., 2018). The exceptional demand peaks, which can be observed in public holiday seasons, are mentioned in several contributions in the literature. Dharmawardane et al. (2021) for example highlight that exceptional demand peaks are highly influenced by promotions, sales events or the weather in retailing. In this context, Alftan et al. (2015) mention that a centralization of the forecasting activities is useful for bundling information and handling the complexity of the high amount of parameters necessary. Nevertheless, Dreyer et al. (2018) pinpoint that operational forecasting can be considerably improved by analyzing promotional events, increasing the knowledge about such events. Transferred to public holiday planning, this shows the need for a deeper analysis of the challenges and circumstances of the individual holidays to be able to develop adequate solution procedures for demand planning in the respective selling seasons.

Demand planning in turn directly impacts warehouse management defining the volumes that need to be handled and thus personnel and storage capacity requirements in the distribution centers. An overview of warehouse operations problems is given by Gu et al. (2007). The focus in this domain is mainly on order picking and storage, such as the design of order picking systems (see, e.g., van Gils et al. (2018)). For picking, orders have to be sequenced and aligned to shifts enabling personnel scheduling (van Gils et al., 2018). Manual picking processes dominate in grocery retailing, because of the demand seasonality, the variability in product shape and the high investment costs of automation solutions (Petersen and Aase, 2004). Storage location and assignment planning is linked to the routing of order picking, which influences picking times and costs. Operational warehouse management revises and improves the corresponding planning activities. Its effort highly depends on the complexity of the activities (Faber et al., 2013). For managing peak loads at the warehouses pertinent literature suggests balancing the volume according to the capabilities. On the one hand, the volume can be moved according to the available resources. On the other hand, the resources can be adjusted to the volume. Personnel scheduling and labor flexibility approaches are focused as main tools (Porto et al., 2019). Further on, pertinent literature frequently elaborates on the decision making process for

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the use of external workers when managing peak loads in warehouses (Wruck et al., 2017). However, so far there are no contributions explicitly investigating the specific conditions and corresponding solution concepts for warehouse management during public holiday seasons. As mentioned in the introduction, there are several additional factors that complicate operational planning in these seasons, besides the pure workload peaks. Thus, it is relevant to investigate the corresponding consequences for warehousing and to analyze which of the concepts that are generally suggested for handling peak loads are suitable under which conditions.

Similar conclusions can be drawn when investigating literature in the transport domain. Operational transportation planning captures the transport between distribution centers and stores and is forced to meet the high requirements of both adjacent subsystems (Hübner et al., 2013). It consists of delivery mode planning, product-warehouse allocation, transportation mode selection, and delivery pattern definition. The correlations of the aforementioned topics are discussed by Martins et al. (2018). More in-depth insights for grocery retailing are provided by Holzapfel et al. (2018) presenting a planning concept for product allocation decisions, and Holzapfel et al. (2016) as well as Frank et al. (2021) optimizing store delivery patterns. The latter affects vehicle routing striving for high vehicle utilization and minimizing driving distance and stop costs. The interface between transportation and store operation is analyzed by Kuhn and Sternbeck (2013). The packaging unit, the store delivery pattern, the lead time for store orders, delivery time windows as well as the sequence load carrier are identified as main parameters and their mutual dependencies as well as effects on the store and transport are analyzed. However, so far it remains unclear how peak seasons like the ones before public holidays impact these planning tasks and which strategies exist to handle peak volumes in transportation, given the general transportation capacity and driver shortage. Pertinent literature notes that retailers usually purchase transport capacity from third parties to manage such peaks (Wilding and Juriado, 2004), but the question remains open how this decision is integrated in the operational planning concepts and which other strategies exist.

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Summarizing the findings from our literature review, there are numerous existing contributions presenting planning concepts for the standard business in retailing. There are also some contributions that provide general solution approaches for handling demand and workload peaks. However, contributions that explicitly investigate the circumstances and special characteristics of the planning situation before public holidays are missing so far. Investigating these aspects will help to provide a more concrete challenge-solution framework for the different planning tasks in operational planning for public holiday seasons. Moreover, retail practice that also misses a structured planning concept for these periods, could benefit from clear insights which solution possibilities exist for the diverse challenges and which approaches have been proven to be adequate under which conditions. In the light of this background, we can formulate the following research questions:

- Research question 3.1: How do grocery retailers deal with the public holiday challenge in logistics operations, and why are specific strategies applied?
- Research question 3.2: How do context specifics in the problem settings influence their solutions?

3.3 Methodology

For answering the research questions, we have chosen an exploratory qualitative research study. Such a study is appropriate for uncovering such unstudied research areas as data from practice enrich the theoretical findings (Flynn et al., 1990; Stebbins, 2001).

3.3.1 Research framework

Qualitative research is useful for studying “how” and “why” research questions as in our case (Pratt, 2009). Using an exploratory study, we follow the grounded theory approach and develop generalizable results out of empirical

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data (Glaser and Strauss, 1967). The methodology follows the typical structure for exploratory studies in the logistics domain using semi-structured expert interviews as portrayed in Voss et al. (2002), and has been also applied in further studies in retail logistics and operations management (see Hübner et al. (2015); Kuhn and Sternbeck (2013) or Upadhyay et al. (2022)).

In a preliminary study, three interviews were conducted with experts from retail logistics and relevant literature on logistics in grocery retailing was examined with regard to the public holiday challenge. The interviews lasted 60 minutes and were conducted personally with two interviewers. After these preliminary interviews the operational processes of an average week without public holidays were outlined and the terminology “public holiday challenge” was clarified. All planning areas in retail logistics (see Figure 3.2) were systematically queried and the influence of holidays as well as the challenges were asked. The planning areas were thereby structured in procurement, warehousing, distribution, outlet and sales, as commonly applied in retail logistics research (see, e.g., Kuhn and Sternbeck (2013); Hübner et al. (2015) or Dreyer et al. (2018)). With the help of the pre-study and our literature review, we identified the mid- and short-term planning levels as well as the retail business functions demand planning, warehousing and distribution as most affected areas. We decided to focus our study on these issues to limit the scope and to capture the respective problems in detail. In-store logistics was considered, in case being directly connected with another issue of the focus areas, as most retailers organize instore logistics in separate divisions and thus additional interview partners would have been necessary. The insights gathered from the preliminary interviews and literature research were used as a structural basis for developing an interview guideline.

3.3.2 Target group

Grocery retailing is characterized by country-specific patterns and shopping behaviors (Hübner et al., 2016b). Creating an unified context and achieving in-depth insights, the focus of the study is on the German grocery market (Voss

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et al., 2002). The German market shows specific characteristics compared to other European countries or, for example, the USA. Germany has a large number of public holidays on which work is generally prohibited. This also applies on Sundays, when the stores are closed and no logistical processes can take place. In addition, the constellation of public holidays changes in terms of calendar and/or working day and may differ in the federal states within Germany. These parameters limit retailers and face them with a particular challenge. The unified context, i.e., the German grocery market, enabled us to compare the participating companies and to evaluate the representativeness of the recorded data. The 30 top-selling grocery retailers in Germany were the target group of our study (see LZ Retailytics (2018)).

In total 20 sales lines of 17 of the top 30 German grocery retailers took part in the study, resulting in a participation rate of 57%. This high response rate demonstrates the importance of the topic. The participating sales lines cover around 70% of the market volume, which supports the external validity and strengthens the representativity of the study (Bryman and Bell, 2015). Table 3.1 shows that our study involves all sales formats and a large variety of company sizes.

Table 3.1: Overview of participating companies and interviewees

Sales format	Full-range provider	Discounter	Wholesaler	Specialized retailer
Number of participants	10	5	3	2
Number of stores	<= 500]500; 1,000]	>1,500	
Number of participants	10	4	6	
Position of interviewee	Board member	Division manager	Department manager	
Number of participants	2	9	11	

Within the companies, we selected the interviewees according to the criteria, that they have a holistic view of the logistics structures and processes of their company (Manuj and Pohlen, 2012). This enables them to assess the public holiday challenge across all areas considered. Therefore, all interviewees have an overall responsibility for logistics and supply chain management within their company. In total 22 top managers were interviewed. Table 3.1 summarizes their positions.

3.3.3 Protocols

For our exploratory study, we designed an interview guideline with a flexible order of questions as suggested by Manuj and Pohlen (2012). The objective was to create an open conversation with free answers. This should establish the necessary level of trust. Our interview guideline was tested in a pre-test interview to check how the questions are interpreted and to strengthen the validity and reliability (Flynn et al., 1990). Moreover, the interview guideline was continuously modified during the data collection to improve our growing insights of the challenges studied (Manuj and Pohlen, 2012). Prior to interviewing, each interviewee received an overview of the questions to enable preparation. This overview can be found in the appendix.

3.3.4 Data collection

Data of the study were collected by conducting semi-structured, face-to-face interviews with logistics experts following a multi-step research design (Manuj and Pohlen, 2012). It is an effective way of obtaining in-depth information. The same two interviewers conducted all interviews at the retailers' offices, except two interviews, which were conducted by telephone because of time reasons. The average interview duration was 72 minutes. We wrote field notes during the interviews and compared and discussed them directly afterwards to check the right understanding and to achieve internal reliability (Bryman and Bell, 2015).

After a first round of invitations nine of the top 30 grocery retailers in Germany participated in the study. As we gained more insights after the analysis of each interview and noticed that there are substantial differences in processes, structures and solutions between sales formats, we decided to proceed and to investigate each sales line of the retailers separately. Additionally, we sent a reminder to the retailers already invited. Another six participants were gained. The analysis and coding of the last interviews of this group further enriched our findings only to a limited extend. However, to insure reaching the saturation

level (Glaser and Strauss, 1967), we sent out a third round of invitations to those retailers that had not answered so far. Two additional retailers participated, but we could not add any new code or category to our analysis. Thus, we reached the theoretical saturation level after a period of six months, and stopped the data collection.

3.3.5 Data analysis

The data analysis follows grounded theory, in which theory should be built by developing categories and using a constant comparative approach (Glaser and Strauss, 1967; Manuj and Pohlen, 2012). For this aim, an inductive analysis was applied by formulating abstract groups and assigning the data to them (Gephart, 2004). By coding the data, we built substantive categories as the categories are “descriptive” (Maxwell, 2008). The coding was done by two researchers using the qualitative computer analysis program MAXQDA and working independently to reach internal reliability (Bryman and Bell, 2015). Thereby, each code was assigned to a phrase of the interview notes such that the codes could be compared and discussed in the research team. This was done in regular meetings. There we also analyzed, whether and which new insights were gained from the respective interviews. Data were conducted and coded until the theoretical saturation was reached as described above (Glaser and Strauss, 1967).

For structuring the data, we used the Gioia method (Gioia et al., 2012). Thereof, 944 relevant phrases resulted, which we assigned to codes. Finding similarities between the codes, we built 332 first order categories. In the next step, the first order categories were classified in 97 second order categories to get the more generic dimensions. They depict the single sub-problems and the solution activities of the retailers facing the public holiday challenge.

3.4 Empirical findings

This section presents the main findings of our study. It focuses on demand planning and disposition (Section 3.4.1), warehouse management (Section 3.4.2) and transportation management (Section 3.4.3).

3.4.1 Demand planning and disposition

Demand forecasting plays a major role as it affects all further planning areas. It is essential for the availability of goods in stores and thus for sales optimization before public holidays. Transparency about forecasting accuracy in public holiday seasons is not always available and varies greatly between the retailers interviewed. While some retailers report forecast accuracies of only 35% in public holiday seasons, others manage to produce quite accurate forecasts, with only 5% average deviation.

3.4.1.1 Holiday logistics challenges

Three main challenges emerge from our analysis. There is a high additional effort for manually adapting forecasts. This effort is further increased by the weather influencing the shopping behavior. Finally, short-term ordering behavior by the stores disturbs smooth disposition planning.

Manual forecasting effort. Public holidays require a separate forecasting process, which comes along with additional manual calculation and adaptation effort. This is reported as a special challenge by 25% of the participating retailers. Many retailers have problems to implement seasonal effects in their IT systems or the complexity of the forecasting systems would not stay manageable. Consequently, manual planning of public holiday weeks is necessary, which is time-consuming. Previous or comparison years' values can often only serve as a starting point for public holiday forecasts due to a large number of changing or unknown parameters, e.g., the increasing number of stores, the overlap with

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school holidays that changes year by year, or the offers of competitors which are only limited predictable. Additionally, more promotional articles than usual are offered in public holiday seasons and there is a considerable number of product innovations every year. Forecasting for these new products is difficult since historical data are missing.

Forecasting demand for public holidays is very time consuming. We work availability-oriented, what means that the availability of products in the stores is more important than a possible loss, if we have to throw away surplus goods. [Discounter 2, Department manager].

Weather influences on shopping behavior. The weather forecast is crucial for how customers plan their free days and thus their holiday purchases. Previous years' sales therefore cannot generally serve as a meaningful basis. In addition, weather forecasts are not included in automated demand planning processes at most retailers. As a consequence, the weather forecast has to be considered by short-term manual adjustments. This explains why approximately 35% of the grocery retailers indicate that the weather volatility noticeably complicates demand planning in holiday seasons.

Forecasting demand for public holiday seasons is very complex. Precise planning is often only possible at short notice because of the weather. [Wholesaler 1, Division manager].

Short-term ordering behavior. Weather volatility and little long-term planning effort lead to short-term ordering by store managers. This ordering practice is known to be a major factor causing out-of-stock situations (Moussaoui et al., 2016). 25% of the retailers indicate short-term ordering behavior of their store managers as a special challenge for the holiday season disposition. However, several retailers allow their store managers very short ordering times on a regular basis, even before public holidays, to achieve high customer service levels. This requires high stock levels and flexible personnel resources in the distribution center.

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80% of our stores reorder before public holidays, what is possible at short notice for the next day. [Full-range provider 2, Division manager].

3.4.1.2 Solution concepts

Grocery retailers differentiate between the standard assortment and promotional products when developing forecasting solutions for public holiday seasons. The standard assortment includes all regular and seasonal articles, such as baking ingredients during the Christmas season. Promotional items are listed for a certain period of time such as chocolate eggs before the Easter holidays. Moreover, retailers declare regular products that are included in advertising campaigns during the holiday season as promotional items. For both the standard assortment and promotional articles dedicated solution concepts exist.

Standard assortment. Basic store order proposals for the standard assortment for public holiday weeks are generated by IT systems at all interviewed retailers, as rich data sets from standard weeks are available. For two thirds of the participants, the proposals are based on the previous year's figures, as these are assessed as most meaningful. The remaining retailers include further past values or use data from the year with the same weekday constellation of the holidays.

The IT system considers the calendar constellation of public holidays. For example, the sales before a public holiday at the beginning of a month are higher as the customers have more money available. [Discounter 1, Department manager].

Half of the retailers mostly rely on these automatically generated order proposals, thus stores should maintain their stocks carefully. This automated procedure is, however, not applicable for the complete standard assortment. It is particularly difficult for goods sold by weight, such as fruits. The other half of the retailers apply manual approaches to forecast their standard assortment in public holiday seasons. This means order proposals by the IT system are fundamentally revised manually as an accurate parameterization of the system gets too complicated and the results are too imprecise. 50% of this group of retailers

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centrally quantifies these figures and pushes the associated product volumes into the stores without consulting store managers. Working at capacity limits and the high complexity of logistics processes during the holiday business are reasons why short-time orders of store managers are banned. In addition, high coordination effort results. Nevertheless, the other half of retailers explicitly bases their predictions on the experience of store managers because of their knowledge of local customer behavior.

Store employees use an action planner to plan the seasonal articles, especially for the dry assortment. They decide when they want to reach the maximum storage and how they can avoid large order quantities. [Discounter 2, Department manager].

To limit the forecasting effort, some retailers define a limited number of critical articles that have a major impact on sales or that have caused problems in previous years. Only for these products, they adjust the system proposals manually.

We define corner articles. That are around 300-500 products out of 100,000. The automated forecasts for these corner articles need to be modified manually. We are therefore contacting the stores and plan the stockpiling. [Full-range provider 10, Division manager].

Promotional articles. Retailers organize demand planning and allocation of promotional items quite differently, i.e., centrally or decentrally. 40% of the interviewed retailers, among them 80% discounters, have centralized the forecasting of promotional articles. Centralization leads to a more efficient and precise forecasting process as central marketing initiatives and long supply times could be better incorporated. The latter one is especially relevant because non-food import products are mostly ordered up to one year in advance. In addition, several manufacturers only produce on demand. The responsibility for these tasks varies between the retailers interviewed.

Promotional articles are allocated by the logistics department as centralization is easier and enables a better disposition for the sales department. [Discounter 1, Division manager].

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60% of the retailers rely on a decentralized demand planning and allocation of promotional articles. The sales department makes a pre-selection and the store managers order their desired quantities. They use advance inquiries to avoid short-term orders and to be able to place the orders early at the manufacturers, thus increasing the chance of receiving the delivery in time. Additionally, the order lead times for the stores for promotional articles are extended depending on the merchandise category to be able to handle the order volume fluctuations due to the decentralized disposition.

Summary. In holiday seasons, retailers predict and dispose regular and promotional products quite differently. Regular products are forecasted and replenished by data-driven approaches, if appropriate past-data are available. Alternatively, critical products of the standard assortment that feature high demand volatility are manually disposed. Promotional non-food articles are mostly forecasted and disposed on a centralized level in particular if these articles are sourced from afar. Retailers apply decentralized forecasting and disposition systems, if local consumer behavior gains significance.

3.4.2 Warehouse management

The grocery retailers interviewed distribute on average of 81% of the entire product volume sold via their own distribution centers. 50% of the retailers handle at least 95% of their product volume via distribution centers. This gives warehouse management a special significance.

3.4.2.1 Holiday logistics challenges

Three main issues challenge warehouse management in public holiday seasons: overutilization, delayed incoming goods, and shortage of appropriately skilled employees.

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Overutilization. In public holiday seasons the warehouses are running at their capacity limits. 65% of retailers report that warehouses actually are over capacity. Goods, for example, are already stored in the corridors. Especially for full-range providers this problem is prevalent due to their broad assortment. Running over capacity causes several safety and performance issues in distribution centers. Pallets stored in the corridors increase the risk of accidents and blocking situations as pickers and forklift drivers move in the same corridors. The high amount of employees working simultaneously in addition causes a shortage of warehouse utilities. Moreover, picking ways increase as pallets with the same goods are distributed over several corridors due to missing storage spaces. Furthermore, the high amount of promotional items in public holiday seasons causes additional performance issues as their handling is not as trained and efficient as for standard items. Thus, a considerable amount of extra hours has to be planned, which further increases capacity utilization.

Forklift drivers and order pickers are in each other's way. [...] A doubled number of employees in the warehouse does therefore not mean a doubled output, but rather a loss of performance per employee and an increase of stress level for everybody. [Full-range provider 5, Division manager].

Delayed incoming goods. Delivery delays of incoming goods are common before public holidays for several reasons. The high order volumes are challenging for the suppliers and they therefore often struggle to manage the respective production volume in time. Delays are further caused by scarce transportation capacities. In addition, traffic jams around holidays postpone deliveries. Delayed deliveries are especially critical, if fresh products or items with large order volumes are affected.

Shortage of skilled employees. A significant amount of retailers interviewed (35%) emphasizes a shortage of skilled employees in public holiday seasons. However, a sufficiently large employee base is necessary to handle the increased volumes and the high number of additional promotional articles. Furthermore, the pressure in distribution centers before public holidays is high and error-free work is particularly important. Thus, skilled and experienced employees are required.

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Permanent employees alone are, however, typically not sufficient to handle the peaks. Thus, additional temporary workers are necessary. Their availability is, however, limited as temporary employment agencies are just as affected by skill shortage as the retailers.

3.4.2.2 Solution concepts

Grocery retailers apply spatial, organizational and personnel measures, and they adjust workload profiles to handle the warehouse challenges occurring in public holiday seasons.

Spatial and organizational measures. Seasonal and promotional items require considerably additional effort in warehouses. The majority of retailers interviewed (80%) separates promotional articles spatially from the regular assortment. They place these items in separate locations within the warehouse or even use additional warehouses for distributing. Experienced workers are responsible for picking and packing as often special handling is required and promotional displays have to be built.

We do not try to pick the promotional items for the holiday business together with the everyday business. They are separated in time and space. For example last year, a single, very experienced employee has exclusively picked and packed the displays for Christmas on our warehouse gallery from October to December. [Wholesaler 1, Division manager].

To handle the additional volumes of regular items in holiday seasons, retailers create buffer locations or separated areas at the warehouses as far as possible. From an organizational point of view, warehouse planning prioritizes outgoing product flows as a continuous store delivery is necessary to ensure the availability of goods.

On the inbound side, a close cooperation with suppliers enables just-in-time deliveries, which in turn saves storage room in the distribution center. A good supplier relationship further helps to reduce the risk of delivery failures. Several retailers foster better supplier relations by paying a higher purchasing price

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to suppliers in public holiday seasons. Additionally, small suppliers with little market power struggling with missing transport capacities, are supported by the retailers organizing the respective deliveries.

Personnel measures. Retailers try to match personnel capacity to demand as close as possible. More than half of the retailers interviewed plan by default a build up of overtime before public holidays. This is enabled by flexible working time models. Shifts are extended up to ten hours and additional shifts are added, for example in the night or on Saturday. Weekend work is generally organized on a voluntary basis at most retailers and mainly the best-before-date-critical product groups are picked.

Employees have ten hours days. This is agreed with the workers' council already in August for Christmas, for example. [Full-range provider 5, Division manager].

Retailers announce a ban on taking leave in peak seasons to guarantee that the maximum number of permanent employees is available at these times. They only approve vacation inquiries in exceptional cases. Nevertheless, retailers prioritize employee friendly solutions and offer further benefits to avoid employee fluctuations in times of skill shortage and enhance their attractiveness for new potential employees. For example, retailers announce staff schedules early and establish company kindergartens.

Especially before Christmas, there are holiday quotas. However, we try to release employees with children, who rely on the vacation times, over the busy days, as well. [Discounter 3, Department manager].

Especially, before holidays with more than one day free, e.g., Christmas or Easter, the own personnel resources, however, might be insufficient to handle the additional volumes. In these cases retailers contract temporal workers.

At Christmas and Easter, we have ban of leaves, recruit high school college students and the shifts start at 5 am instead of 6 am. [Discounter 2, Department manager].

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Adjustment of load profiles. Shifting the workload to less busy periods is in addition to the measures named before another key concept to respond to the peak load in the holiday season. On a mid-term planning level retailers use pre-picking and stockpiling at the stores to balance distribution center workloads. For example, retailers begin to build up the holiday ambient assortment for Christmas already in September/October. Before single holidays, picking and deliveries of the ambient assortment are only adjusted up to four weeks in advance. Within the ambient assortment, slow-moving items with a low value density are considered first, followed by fast-moving items and items with a high value density. The delivery volumes of perishables, however, are increased just one or two days before public holidays. Moreover, 40% of the retailers interviewed move promotion campaigns into less busy times.

The purchasing department determines for which key articles the stock ranges are adjusted because of the financial commitment. 15,000 pallets could be handled four weeks earlier at Christmas. [Full-range provider 9, Board manager].

Short-term, 85% of the retailers switch orders in shifts with free capacities. More than half of the retailers pick orders in an earlier shift to balance the capacity load, especially for the ambient assortment. The pre-picked orders are stored in the distribution center or in trailers until delivery.

Trailers are pre-loaded although it is not yet clear which service provider will actually drive the tour. The trailer is then parked in the yard. [Specialized retailer 2, Department manager].

Additionally, 10% of the retailers pick fresh products, fruits and vegetables on Sunday, in the night or on the public holiday itself. This facilitates goods processing, but results in significantly higher personnel costs and is regulated strictly by law.

Summary. Most solution concepts presented especially target the main challenge of warehouse management, which is the capacity shortage. Delivery delays are faced by stockpiling and cooperations with suppliers, while the skill shortage is tackled by providing attractive staff benefits. Generally, a close cooperation

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with sales and purchasing departments as well as stores and suppliers facilitates adequate warehouse operations in public holiday seasons and offers opportunities to balance capacities.

3.4.3 Transportation management

Transportation between distribution centers and stores significantly contributes to total logistics costs in grocery retailing (Holzapfel et al., 2016). Retailers, however, organize their transportation processes quite differently. 40% of the interviewed retailers outsource the transport to one or more long-term contracted third parties. 20% of the retailers operate an own fleet to reduce the risk of delivery failures. The remaining retailers (40%) manage on average half of their transport volumes themselves and subcontract the remaining share.

3.4.3.1 Holiday logistics challenges

The general lack of drivers constitutes a big challenge for transportation management already in standard weeks. The high additional volumes in public holiday seasons and the omission of delivery days due to the holidays as well as frequent traffic jams challenge transportation management further. Therefore, it is not surprising that the lack of transportation capacity, driver shortage and the complexity of transportation tour planning are the top challenges named by the participating retailers.

Lack of transportation capacity. Free transport capacity is rather limited in Europe and especially in Germany. In public holiday seasons this limitation gets particularly relevant. The demand increases and fewer delivery days are available. Consequently, the daily transport volumes substantially increase. Half of the retailers interviewed name the lack of transportation capacity as the greatest challenge in public holiday seasons.

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The greatest challenge are the missing transport capacities in public holiday weeks. This problem [...] affects the entire supply chain. It cannot be solved ad hoc as we have of course optimized our plans in the past, too. [Full-range provider 8, Division manager].

Frequent traffic jams additionally restrict the usage of transportation capacities. Delivery tours last longer and fluctuate more in those times.

Truck drivers for the afternoon/night tour have to wait in the distribution centers at the beginning of their shift if the trucks from the morning tour are stuck in traffic jams. [Discounter 2, Department manager].

Shortage of drivers. Many German retailers work with employees from Eastern Europe to face the general shortage of drivers. These employees, however, have general agreements to visit their home countries on the bridging days around public holidays. Retailers provide these benefits to gain drivers' company loyalty. This commitment, however, increases the shortage of drivers especially around public holidays. In addition, drivers' salaries increase along with driver shortage, which is a great challenge in grocery retailing due to the comparatively low profit margins.

We need a solution for the transport. We cannot continue like this as there is hardly any capacity left. Truck drivers are already attracted with a premium of EUR 3,000-5,000. [Full-range provider 8, Division manager].

Complexity of holiday tour planning. One quarter of the retailers emphasize the effort for designing special delivery tour plans around public holidays. Stores are often unable to process the increasing volumes at the delivery days as they do not have enough storage space and/or employees to receive the goods. Delivery quantities and frequencies therefore have to be aligned on each other.

Tour adjustments are a big challenge. In total, no delivery day should be canceled; only those deliveries that lie on the holiday itself should be postponed. This is difficult and must be planned in the long-term. [Full-range provider 7, Department manager].

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Moreover, tour time fluctuations are more likely around public holidays due to the intense traffic volume and thus, tour planning gets further complex. Various retailers also note in this context that the compliance to the working time act is challenging in those situations. Driving times and rest periods for drivers are defined by law. Thus, on the one hand, tour planning has to include time buffers for traffic jams. On the other side, the grocery retailers have to ensure a high utilization of their resources due to the lack of transportation capacity and drivers. Driving bans on Sundays and public holidays as well as local restrictions on night deliveries, vehicle weights, and store access times additionally complicate the building of feasible delivery tours.

One of the biggest challenges is the high complexity of the creation of delivery plans. Under consideration of the public holidays and all the other limiting factors, we try to balance the peaks and to work within capacities. [Specialized retailer 1, Division manager].

The federal structure of Germany further complicates delivery tour planning. It may happen that a distribution center is closed and some of its associated stores are open because they are located in a state not having a public holiday, and vice versa.

3.4.3.2 Solution concepts

The retailers interviewed adapt transportation capacities and adjust delivery schedules to respond to the challenges in public holiday seasons.

Adapting capacities. 45% of the retailers interviewed plan more trucks and tours for the public holiday business. Regular tours are separated to more vehicles or the same tours are run multiple times. Thus, retailers plan for an increased capacity usage but assume a higher volatility of its usage. 75% of the retailers without an own fleet reserve additional transportation capacities early in advance at their third party providers, or they mention this additional option in the annual contracts. This ensures an equivalent price for the potentially additional capacity required. Half of these retailers make a tight calculation to

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limit the risk of overbooking and buy additional capacities on the spot market. However, before public holidays prices can even increase up to 50-60% compared to standard weeks.

We reserve trucks before public holidays as it is hard to get anything on the daily market. But if we have booked too much, then high costs arise. For example, Easter 2018, we had ten trucks for three weeks too much due to an incorrect forecast. [Full-range provider 9, Board member].

Retailers operating their own fleet typically avoid to make recourse to spot markets. They apply different measures to ensure sufficient capacity in public holiday seasons. They, for example, switch capacities between delivery regions, or they offer their drivers special benefits, like luxuriously equipped trucks or company kindergartens to foster drivers' loyalty.

Adjustment of delivery schedules. Besides capacity measures, retailers adapt their delivery schedules in various ways to manage increasing transportation workload during public holiday seasons. In most cases they increase the tour density compared to standard weeks to save capacity. Thereby, 35% of the participating retailers adapt the designed tours of their systems, while nearly half of the retailers (45%) manually elaborate their special tour plans on the basis of predefined standard tours. The remaining 20% of the participants outsource the tour planning to third parties. Retailers operating with a heterogeneous store structure classify their stores according to size and number of delivery days. They then apply homogeneous adaption strategies to all stores of one category.

Store groups are created that have the same delivery days, such as Monday, Wednesday and Friday. We decide for the whole group, whether a delivery day should be canceled or not. [Full-range provider 4, Department manager].

Retailers increase night deliveries to those stores, which are equipped with non-personnel storage rooms. This avoids traffic jams and saves capacity during the day shift. Furthermore, 25% of the retailers interviewed extend delivery time windows to increase the flexibility for tour planning. Nevertheless, most retailers have to increase the number of delivery days to handle the additional volume,

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or they have to switch the regular delivery day because this just constitutes the public holiday. In the latter case, retailers move all delivery days in the week before a holiday one day onwards (pre-delivery), or all deliveries after the public holiday one day backwards (subsequent delivery).

Furthermore, 35% of the participants emphasize that they adjust tour plans already many weeks before a public holiday. This enables pre-deliveries, ensuring the product availability in the stores while balancing capacity peaks. The increased delivery volumes can therefore be spread over several deliveries. Moreover, transport capacity in the public holiday week is then available for prioritized product groups like fruits and vegetables. As these adjustments directly affect store management, stores have to be involved or at least informed timely. However, 20% of the retailers (full-range providers and discounters) emphasize that stores are not involved in pre-delivery decisions because of complexity reasons. Finally, there are several full-range providers that increase direct deliveries from the suppliers to the stores at Christmas or Easter seasons. This is done particularly for promotional items and displays that would lead to high extra capacity requirements at the retailer. Thus, transportation is outsourced to the suppliers and the retailers save scarce capacity.

Summary. Retailers apply several measures to manage the additional transportation volume and the missing delivery days in public holiday seasons. They increase transportation capacities and adapt their tour plans in many ways. In addition, they pre-deliver stores, apply night deliveries and extend delivery time windows to be able to use the standard tours as far as possible.

3.5 Discussion

Our study discloses two main reasons that cause particular challenges in grocery retailing within public holiday seasons, i.e., uncertainties and missing resources. In addition, we find that retailers take up these challenges by a diverse set of measures, which can be categorized into three main approaches, i.e., adjustment of workload profiles, adaptation of resources, and modifying processes and orga-

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nization. Figure 3.3 lists the main challenges and measures, and it additionally shows which measures are used by the retailers to face one or more of the individual challenges.

In the further course of this section, we compare the main challenges and solution approaches detected with the results already available in literature. Additionally, we portray the links between the planning areas and derive the managerial implications of our findings. In doing so, we highlight the theoretical and practical contribution of our study.

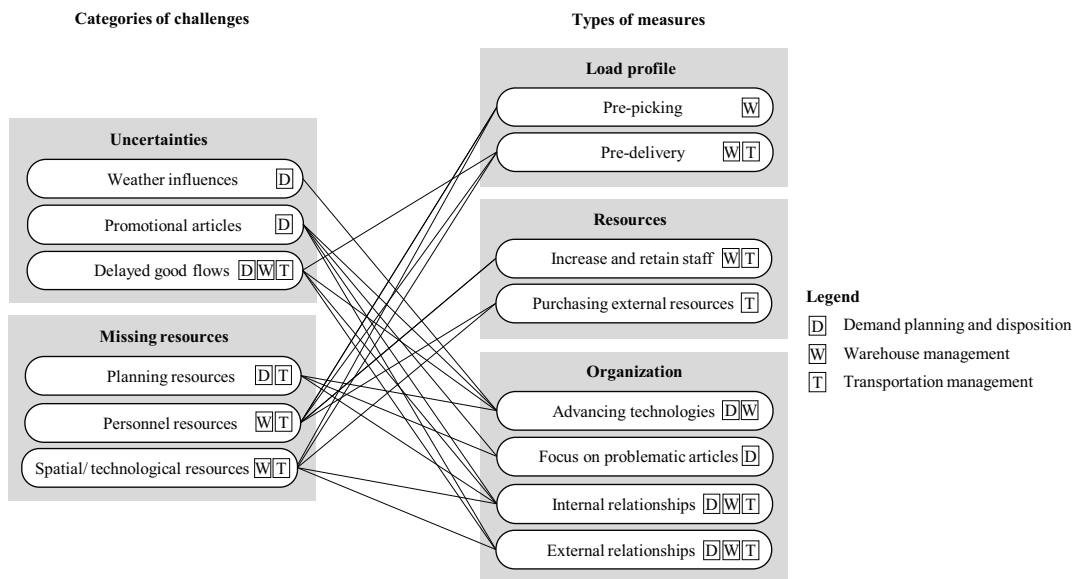


Figure 3.3: Categories of challenges and types of measures identified

3.5.1 Holiday logistics challenges in the light of literature

Uncertainties. As known from previous contributions in literature demand generally fluctuates due to uncontrollable uncertainties such as the weather, short-term orders or promotional articles (Taylor and Fearne, 2009). System and physical inventory figures vary on average by 35% (Moussaoui et al., 2016). Several retailers report for example sales peaks of additional 50% per day.

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The literature develops demand forecasting models considering public holidays or the weather as external parameters (see, e.g., Gur Ali and Pinar (2016)). However, the influence of the weather on the demand before public holidays in grocery retailing has not yet been analyzed. Furthermore, scientific papers mostly classify public holidays and shopping events, e.g., “back to school,” as one group. Thus, public holidays are studied with regard to promotional items and their pricing from a marketing perspective (see, e.g., Qiu and Wenqing (2016)). According to Taylor and Fearne (2009), fluctuation of food demand is more often caused by advertising activity than by seasonality or weather conditions. Nevertheless, we show that the seasonality and the current weather situation leads to less accurate forecasts around public holidays – especially for promotional articles. Our study also shows that the respective weekday constellation highly influences customer shopping behavior and has to be considered when forecasting public holiday demand.

Uncertainties in public holiday seasons also effect logistics planning. Henao et al. (2015) already note that employing the actual number of employees required is difficult when volume fluctuates. Our study confirms this finding and adds that this also is valid when reserving transportation capacities. Transportation capacities, however, have to be contracted long-term or otherwise have to be bought at considerable higher prices on the spot market.

The transport capacities required are not only influenced by an increased holiday demand but also by intense traffic in public holiday seasons. During these periods, delivery times fluctuate and deliveries from suppliers are delayed. In grocery retailing these delays are generally frequent and considerably impact the operating profit (Sanchez-Rodrigues et al., 2010).

Missing resources. Our study shows that all logistics subsystems work on their capacity limits. The general skill shortage further increases this challenge, which is well-known in the logistics sector (Dubey et al., 2018). Recruiting and retaining qualified staff for warehouse operations and transportation gets increasingly demanding (Min and Lambert, 2002; Min, 2007). Skill shortage becomes particularly apparent in public holiday seasons when additional volumes have to be handled and further tasks have to be fulfilled under great time pressure.

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Delivery capacities could be enlarged by shortening the delivery tours and increasing the utilization of trucks (see, e.g., Piecyk and McKinnon (2010)). This is, however, hard to manage due to increased traffic density, regulatory limitations and the already increased delivery volume in public holiday seasons. Our study also shows that the limited space in the warehouses and the lack of warehouse utilities leads to additional challenges in these periods.

The challenges associated with holidays share some similarities with situations considered in the literature on supply chain risk and resilience (Ivanov, 2021b). Disruptions of the standard business with demand peaks and capacity shortages were recently observable during the Covid-19 pandemic in retailing and especially in grocery retailing (see, e.g., Delasay et al. (2022); Schleper et al. (2021)). The literature on supply chain risk management mainly distinguishes four types of uncertainties and risks (Ivanov, 2021b; Klibi et al., 2010). First, random uncertainties, e.g., demand, price, and cost variation risks, which can be modeled and quantified using random variables with predictable probability distributions. Second, hazard uncertainty, i.e., the risk of an unusual event with a strong impact on one or more business functions, e.g., the loss of a key supplier. Third, deep uncertainty, i.e., a severe disruption risk, such as a natural disaster in a major supply and/or demand region. Fourth, a super-disruption event, i.e., a long-lasting crisis that affects multiple industries and impacts supply, production, demand, and logistics simultaneously, e.g., the Covid-19 pandemic. However, in contrast to the above-mentioned situations, the respective events and most of the influencing factors (weather, weekday constellation, etc.) are known in advance in the case of the public holiday challenge. Thus, the demand patterns of the respective peak periods as well as the respective availability of capacities and personnel can potentially be predicted relatively accurately. Compared to the situations and measures discussed in supply chain risk and resilience literature, a specific and detailed plan can be created for each situation considered. The greatest challenge here is to balance the extremely tight transportation capacities, the very limited availability of personnel, and the highly limited storage space in warehouses and outlets.

3.5.2 Holiday logistics solutions in the light of literature

Load profile. Retailers shift workload in less utilized periods to balance the workload. That includes adjustments of delivery days, pre-picking and pre-delivery. These measures generally increase the in-store inventory level, even several weeks before public holidays. Inventory holding costs in grocery retailing, however, are typically less relevant than handling costs (van Donselaar et al., 2010). The retailers interviewed verify these observations. They intensively apply these measures, especially in Christmas and Easter business.

In grocery retailing workload balancing in the warehouse is commonly applied to smooth weekly seasonality (see, e.g., Vanheusden et al. (2020)). For public holiday seasons, balancing measures, however, have to be planned and executed over a longer period of time, to be able to smooth the exceptional workload peaks. According to Rogerson and Santén (2017), balancing the transport volume in grocery retailing should be achieved by several actions like adjustments of the deliveries and order sizes. For standard weeks, this can be done using IT systems and mathematical models (see, e.g., Holzapfel et al. (2016)). In public holiday weeks, however, many exceptional circumstances have to be considered and thus, tour planning is largely adapted manually.

Resources. According to van Gils et al. (2017), personnel resources are the main tool to handle seasonal fluctuations in warehouse operations. Similarly, personnel resources play a major role to handle seasonal transportation. Due to the problem of driver shortage, Min and Lambert (2002) identify factors increasing the satisfaction of drivers such as a competitive pay or the comfort of the truck. Motivation factors for warehouse staff include job satisfaction or a family-friendly working environment (Min, 2007). Our interviewees confirm these literature reports. The retailers also offer employee-friendly working conditions and award their employees numerous benefits.

Wilding and Juriado (2004) note that retailers purchase external resources such as transport capacity from third parties if own resources are exhausted in public holiday seasons. Retailers apply this hybrid model to save costs and simultaneously assuring a certain degree of flexibility. Our study, however, shows that

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most retailers interviewed prefer to maintain the responsibility for picking and delivery. They therefore establish long-term contracts with service providers that mostly allow flexible and short-term adaptations of resources required. Purchasing on spot markets is only considered as final possibility.

Organization. In the domain of organizational measures, automation plays a prominent role. Advanced forecasting technologies are becoming increasingly important for all logistics planning issues in grocery retailing. Accurate forecasts improve warehouse capacity management, workload balancing, and transport planning (Kim et al., 2018). Most retailers interviewed, however, struggle to apply automated forecasting techniques during public holiday seasons because of less suitable models and/or missing data. Retailers therefore manually adapt system-generated forecasts with great effort to improve forecast accuracy. Ehrenthal et al. (2014) already found that benefits can be generated when forecasts distinct between weekday and weekend figures. In addition, retailers should use data that depend on the planning horizon (Williams and Waller, 2010). Our findings further indicate that weather forecasts, weekday constellations of holidays, and the stage of the selling seasons should be considered.

Furthermore, a higher degree of automation is becoming even more important for warehouse operations due to the lack of qualified personnel. The literature analyzes suitable robotics solutions supporting picking and packing (see, e.g., Azadeh et al. (2019)). Our findings further indicate that retailers that apply automated warehousing systems face similar challenges as their competitors, as automated systems so far are designed to work continuously at high utilization. That means, peaks in public holiday seasons can only be handled manually even though highly automated systems are available. Nevertheless, the grocery retailers interviewed see automation as an appropriate solution approach for the future.

Limiting the planning effort, retailers focus on pre-defined product groups during the disposition. Selection criteria are, for example, the extent of volatility due to their position in the store layout or little available data. Building product groups simplifies the forecasting process or enables forecasting for new products. This procedure in retail practice identified within our study is also suggested by several

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research papers. For example, Dekker et al. (2004) classify products with similar seasonal patterns for forecasting. Moreover, retailers collaborate with up- and downstream supply chain actors to manage the public holiday challenge. Several papers analyze the pros and cons of retailer and supplier collaborations (see, e.g., Teller et al. (2016)). In our study we concrete the capability of retailer-supplier cooperation and show areas of application. A close supplier relationship for example reduces delivery failures and enables just-in-time deliveries that reduce the storage capacity required in the distribution center. In addition, retailers can support small suppliers with transport capacity in public holiday seasons. Alftan et al. (2015) suggest collaborative forecasting for critical products in grocery retailing. Sharing sales and inventory figures is considered to be especially effective. We find that centralizing the planning tasks for the holiday business enhances the forecast quality at various retailers as all information is pooled and a central unit communicates with the supply chain partners.

Besides external cooperation, a harmonization of public holiday season plans of the different departments of a retailer (e.g., purchasing, logistics, marketing, sales) is required to allow efficient and effective public holiday operations. Collaboration of departments and the alignment of their planning is complex but improves the performance of logistics processes, resulting in less uncertainties, lower inventory levels or a higher availability (Dreyer et al., 2018). Although the participating retailers agree that close communication between departments is necessary, the implementation of measures is not generally executed in a collaborative way because of complexity reasons.

Again some of the approaches relevant for addressing the challenges associated with public holiday seasons show similarities to the approaches developed in the context of supply chain risk and resilience management that were recently particularly relevant to approach Covid-19 impacts in (grocery) retailing (see, e.g., Schleper et al. (2021) and Delasay et al. (2022)). Proactive and reactive (adaptation and recovery) measures can be taken to address these risks (Ivanov, 2021c). The proposed proactive measures, i.e., creating flexibility or redundancy (see, e.g., Obermair et al. (2022)), show strong similarities to the approaches relevant to addressing the public holiday challenges. While these measures create

general conditions for higher responsiveness, solution concepts for public holiday planning comprise additional mid-term capacity balancing elements that further relax workload in the peak seasons.

3.5.3 Managerial implications

The sales divisions involved in the exploratory study cover around 80% of total market sales in German grocery retailing. This confirms the high relevance of the holiday issue in practice. 81% of study participants identify the Christmas season as one of the major challenges in grocery logistics. Due to the ban on working on public holidays and therefore the missing days for logistics, the typical concepts are not enough to handle all volume fluctuations in public holiday seasons. Therefore, additional, dedicated measures are necessary. Our study categorizes the solution approaches on a higher level and therefore highlights the links between all explored areas. The key to overcome the challenges in demand planning are IT systems. Data maintenance is therefore a decisive factor for forecasting quality. In addition, centralization of demand planning can be an efficient possibility for retailers as costs of separate planning of promotional items before public holidays can be kept to a minimum. Short-term reordering by stores can be avoided, as store-specific demand peaks can be predicted more accurately. Without short-term reorders, capacity requirements in the warehouse can be balanced on a mid-term basis by pre-picking and pre-delivery to the stores. Retailers may initiate these processes several weeks before the respective holiday seasons. This measure leads to an increase in inventory in stores, but frees up capacities in the distribution centers and transportation that are highly needed to deliver perishable groceries, fast moving, and high-value items during the public holiday weeks. Enabling this pre-working, extensive modifications of transportation tours are made that however pay off as transport capacities can be reserved on a reliable planning basis in advance which is relevant to overcome possible short-term transportation capacity scarcity or high costs on the spot market. Additionally, the early build-up of stock in the stores also balances the volume for refilling shelves and thus the tight and costly in-

store personnel capacity. However, the measures taken to reduce peak demand are generally not sufficient to satisfy the additional volume that occurs during public holiday weeks completely on a mid-term basis. Moreover, the balancing measures cannot be applied for perishable groceries, and are not efficient and cost-optimal for fast moving and high value items. Consequently, retailers need to expand their capacities in the distribution centers, transport and stores, and retain qualified staff, whose experience is highly demanded in the operationally complex and stressful peak seasons. Due to the scarcity of adequate personnel resources, retailers should offer an attractive working environment to avoid personnel fluctuation.

3.6 Conclusion and further areas of research

Conclusion. Grocery retailers have to deal with the public holiday challenge several times per year. Nevertheless, literature so far only considered public holidays in a very general way and analyzed the corresponding logistics processes to a very limited extent. The present study provides insights into the operational planning issues in public holiday seasons. We analyze challenges and solution approaches of German grocery retailers for public holiday seasons, focusing on demand planning and disposition, warehouse management, and transportation management. Uncertainties and a shortage of resources mainly involve the challenges of public holiday seasons in grocery retailing. Retailers take up these challenges by a divers set of measures, which can be assigned to three general solution approaches: adjustment of workload profiles, adaptation of resources, and modifying organizations. Our findings disclose that retailers simultaneously adapt multiple processes in quite different logistics areas within public holiday seasons. This reveals the complexity and the interdependence of the occurring planning tasks. Until now the literature has not discussed this with comparable extent. Theory on retail operations management benefits from the structured overview on the divers challenges, their drivers and context-specifics, and the sets of solution concepts and their application conditions in retail practice. Retail

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practice on the other side benefits from our comprehensive overview of solution approaches proven to be adequate in the light of the individual challenges, which allows to rethink own approaches used. Retailers can thus leverage our findings to adequately develop public holiday logistics planning considering specific contexts. Our study shows that almost all retailers have room for considerable improvements.

Further research. Our study provides useful insights for research and practice of operational logistics planning and execution in grocery retailing. Nevertheless, there are numerous possibilities for future research.

- (1) While we have focused on mid- and short-term planning problems, future research may consider decisions with a longer planning horizon. A further study might address for example assortment or promotion planning and their respective implications for balancing volume peaks in the supply chain in public holiday seasons.
- (2) Further research could include the perspective of the upstream supply chain partners such as the suppliers and manufacturers. As noted in our findings section, there are numerous potentials for collaboration that can be further detailed and their impact on the companies' performance could be analyzed.
- (3) Future research could focus on how automation techniques can support warehouse and transportation processes to compensate the general skill shortage.
- (4) Our study focuses on the German grocery market. Although we consider the findings as rather generic, future research could analyze other markets and compare the results to our findings.
- (5) Finally, future work can explore similar questions in other retail branches.

4 Challenges and measures in disruptive times: Lessons learned for grocery retailing from the Covid-19 pandemic

Bibliographic information

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Author's contribution

Elisabeth Obermair reviewed the literature, supported the study design, conducted the data collection and analysis, drafted and reviewed manuscript.

Andreas Holzapfel supported the conception and execution of the study, interpreted the results, edited and critical review the manuscript.

Heinrich Kuhn supported the conception and execution of the study, interpreted the results, edited and critical review the manuscript.

Michael Sternbeck supported the data collection and interpretation, edited and critical review the manuscript.

Abstract

Purpose. The 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. The aim of our case studies is to explore how grocery retailers could better deal with potential future disruptive times and to derive propositions about the developments of German grocery retail operations triggered by the pandemic.

Design/methodology/approach. 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.

Findings. Our contribution highlights the early impact of the pandemic on grocery retail SCs 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 propositions for the development trends.

Originality/value. 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.

Research limitations/implications. The results achieved should be contrasted with comparable studies in other countries to identify differences and commonalities of retail management approaches and limitations in disruptive times.

Keywords

Grocery retail, Covid-19, Operations, Logistics planning, Case study

4.1 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 (van Hoek, 2020). 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 (Dolgui and Ivanov, 2021). Grocery retailing in particular has faced huge uncertainties during the pandemic. As the disruptions influenced the well-being of society, the pressure on retailers has been high (Ahlqvist et al., 2020). 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 stricter regulations were announced by the government and new infection waves evolved creating a bullwhip-effect in the supply chain (see, e.g., Nikolopoulos et al., (2020)).

Additionally, demand in B&M 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 (Eriksson and Stenius, 2020). This has a direct impact on the transport market as the number of new infections influences the demand for non-cooled transport capacity (Loske, 2020), which highlights the interconnection between the sales development and supply chain challenges, as an example.

This paper aims to address these challenges via a multiple case study focusing on the lasting impact on grocery retail logistics and the new developments that have been triggered. The remainder of this paper is organized as follows. First, Section 4.2 briefly reviews the relevant literature and formulates the research questions of the study. Section 4.3 and 4.4 then detail the research design and the cases investigated. Section 4.5 outlines the early impact of the pandemic on grocery retail supply chains in the initial phase of the pandemic. Section 4.6 then identifies the weaknesses of the standard business revealed in the first year of the pandemic. Afterwards, Section 4.7 discusses the long-term development of grocery retail logistics after a two-year review in light of pertinent literature. Fi-

nally, Section 4.8 concludes the paper by summarizing the results and proposing areas for future research.

4.2 Literature review

We consider several aspects of grocery retailing (Hübner et al., 2013), retail logistics and operations (Frank et al., 2021), online retailing (Wollenburg et al., 2018b), omni-channel retailing (Gallino and Moreno-Garcia, 2018) and supply chain risk and resilience (Ivanov, 2021c). We advise interested readers to consult the references mentioned due to space limitations, and concentrate our review on Covid-19 impact on the retail industry (Schleper et al., 2021), particularly on the grocery sector (Delasay et al., 2022).

The global pandemic is a so-called “super-disruption event” affecting the supply chain over an extensive time horizon, while its duration is not immediately foreseeable (Ivanov, 2021a). Respective contributions in literature consider the impact of the pandemic (Ivanov, 2020) or examine the adaptive behaviors of supply chains during the pandemic (Ivanov, 2021b). The impact of the pandemic has received considerable attention in operations management research (e.g., Chowdhury et al. (2021); Gunessee and Subramanian (2020); Golan et al. (2020); Micheli et al. (2021); Queiroz et al. (2020) or Verma and Gustafsson (2020)), and several papers investigate opportunities to mitigate the disruption it has caused and increase the resilience of supply chains in the face of future disruptions (e.g., Chowdhury et al. (2020); Lorentz et al. (2021); Münch and Hartmann (2022); Nikookar and Yanadori (2022); Paul and Chowdhury (2020); Sodhi et al. (2021) or van Hoek and Dobrzykowski (2021)).

In addition, papers underline the importance of resilient supply chains using simulation models (e.g., Dolgui and Ivanov (2021); Singh et al. (2021) or Ivanov and Dolgui (2020)). Moreover, the growing importance of risk management and visibility in supply chains is mentioned as an impact of the pandemic (e.g., Finkenstadt and Handfield (2021); Handfield et al. (2020) and van Hoek and

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Loseby (2021)). In addition, Xiong et al. (2021) verify that new technologies can mitigate negative impacts of the pandemic, particularly in complex supply chains.

Some contributions already refer to the retail market, e.g., Schleper et al. (2021), who highlight the changes to retail operations and supply chain management that the pandemic has brought about, and suggest research gaps. Similarly, Pantano et al. (2020) identify the critical retail areas in the era of the pandemic. The perception of the company in society, agile management, the means of communication and the focus on consumers need to be revised. Moreover, Saarinen et al. (2020) analyze changes in the food supply chain and define agile planning as an essential feature of resilient supply chains, while Raassens et al. (2021) analyze crisis management strategies for supply chains of food service firms at the beginning of the pandemic. 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.

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. We therefore formulate the following three research questions:

- Research question 4.1: What effects has the crisis had on operational logistics in grocery retailing? Why have these effects been challenging?
- Research question 4.2: What are the main areas of development in grocery logistics resulting from the weaknesses identified during the pandemic?
- Research question 4.3: How are grocery retailers modifying their supply chain operations in the post-Covid-19 era?

4.3 Methodology

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

4.3.1 Research method

We chose a qualitative research approach and applied an embedded multiple case study according to Yin (2018) that is appropriate to answer the “why” and “how” research questions that have already been formulated, and to explore a “real-world phenomenon” such as the pandemic in grocery retailing (see Hohenstein (2022) or van Hoek (2020) for further Covid-19 publications with case studies approaches). Enhancing the external validity, we decided to develop a multiple instead of a single case study design (Voss et al., 2002). The design is guided by the quality criteria of transferability, truth-value, and traceability to ensure high-quality (da Mota Petrosa et al., 2012).

4.3.2 Defining and bounding the cases

We defined the German grocery retail market as the focus area for our 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 our 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 our units of analysis to develop a clear focus (Yin, 2018). We oriented ourselves around the short-term operational planning areas of the planning framework for grocery

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retailing by Hübner et al. (2013), 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 (Yin, 2018). We made our inquiries among leading grocery retailers as few players dominate the German market, and we ensured that all prevalent sales formats were covered by our selection.

4.3.3 Data collection

Multiple sources of data were used to strengthen construct validity (Yin, 2018). We collected data from databases such as those of the European Retail Institute (EHI), which published several retail surveys (e.g., EHI Retail Institute (2020)) and sales data (e.g., Lebensmittel Zeitung (2020)). 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 (Yin, 2018). We set up three rounds of interviews to answer our research questions. The results are reported within the following sections of the paper. Figure [4.1](#) displays an overview of interview rounds and the paper structure. There are 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 (Voss et al., 2002). All the interviews were then conducted via video calls and lasted 60 minutes on average.

The first interview guideline was organized in six parts: introduction, the challenges within the four units of analysis (see Research question 4.1) and the post-Covid-19 outlook (see Research question 4.2). The design was still open

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and flexible to give the interviewee the opportunity to report freely (Yin, 2018). After piloting the interview protocol in a test interview with a retailer (Voss et al., 2002), we conducted six interviews from mid-August until mid-September 2020.

After analyzing the interviews, we were able to systemize 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 Research questions 4.2 and 4.3). 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, we conducted a third round of interviews with managers of our case companies in February and March 2022.

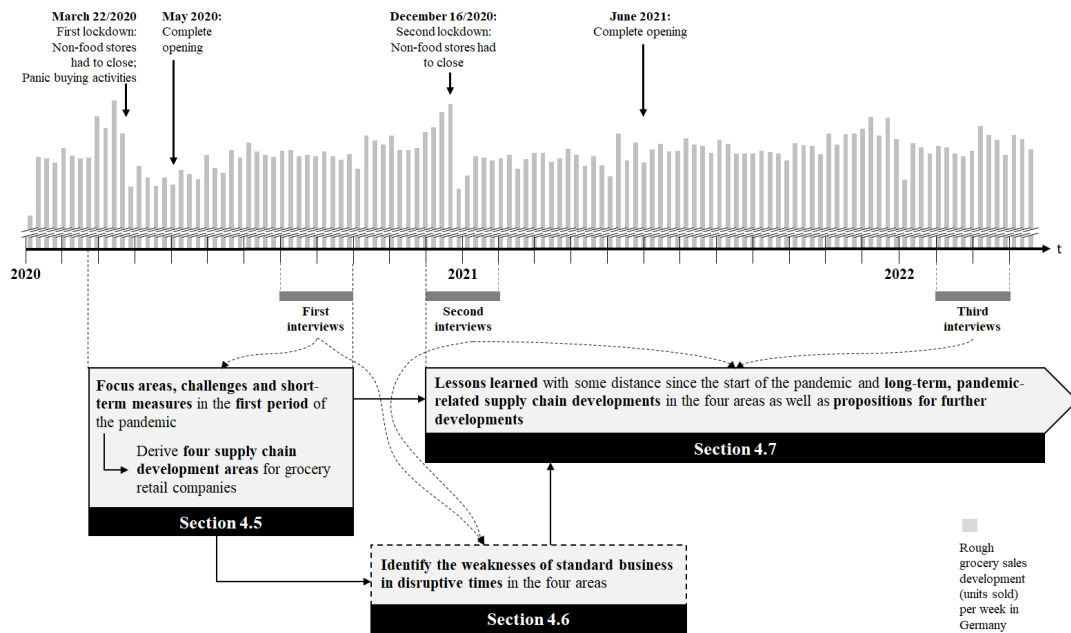


Figure 4.1: Sequence of interviews and structure of the paper

4.3.4 Data analysis

We followed an inductive strategy for the case study analysis. Open, axial, and selective coding was applied as we assigned codes to the data, grouped them and focused next on the relevant categories (Corbin and Strauss, 1990). The coding was done using the qualitative computer data software MAXQDA (Yin, 2018; da Mota Petrosa et al., 2012). We first considered each case separately to understand the retailer-specific situation (Voss et al., 2002). After coding each case, we went through the codes again and built more abstract groups summarizing specific retailer examples (da Mota Petrosa et al., 2012). Next, we applied the cross-case synthesis from an inductive perspective (Yin, 2018). 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. We repeated this process after each round of interviews. Coding, categorization and synthesis both, within and across the cases, give us deep insights into the case companies and helped us derive our findings. Our interviewees reviewed our findings and discussed them with us in order to validate the findings and fulfill the refutation criteria (Yin, 2018; da Mota Petrosa et al., 2012).

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 within the following section and refer to challenges and measures observed. We also present development strategies pursued by the specific companies within our results sections (see Section 4.6 and 4.7).

4.4 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 4.1). The first case company is one of the market leaders. The full-range provider operates

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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 HD and C&C services. The retailer has expanded its HD capacity during the pandemic, and has opened additional pickup stations. Its sales in the online channel have been growing in double digits since the start of the pandemic.

The second case company is represented by a large discounter with 3,000-5,000 stores in Germany. It 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.

The third case company is a hypermarket with fewer than 500 stores. An online service had not been established until the pandemic. An in-store pickup service was rolled out in 2020 due to consumer demand. The number of pickup stations has continuously expanded but is still small, and the hypermarket generates an almost negligible amount of revenue with them.

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.

Case company five is an organic supermarket with fewer than 500 stores. The sales peak of 300% was reached in calendar week 12 in 2020, which subsequently leveled off. It does not operate an online store, but its ambient and non-food products can be ordered by consumers from partner retailers. The case company has begun a cooperation with an e-grocery delivery service provider, and tests for a HD service are planned for the second quarter of 2022.

The sixth case is a leading drugstore with more than 2,000 stores in Germany, where pickup services are also offered. In addition, HD of online orders is possible via CEP service providers. The company experienced significant sales peaks

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when lockdowns were announced. 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.

Table 4.1: Overview of cases

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

4.5 Short-term challenges and measures in the initial phase of the pandemic

In the first round of interviews we investigated areas of particular focus for retailers at the start of the pandemic. In the following, the challenges and measures are presented from a shelf-back perspective (Kuhn and Sternbeck, 2013), 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 able to properly 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. 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. For example, store managers of the full-range provider ordered full-truck-loads of toilet paper. As a result, most retailers surveyed froze their

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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.

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 were required as a result. Besides refilling shelves, store employees had to serve a large number of unsettled customers and implement a variety of hygiene measures. 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 pasta. In addition, extremely extended store delivery times, spontaneous deliveries, continuous refilling of the shelves and additional employees were intended to ensure product availability.

Transport management. In transportation, panic buying caused an increased demand for transport capacity for store deliveries and HD. The discounter acquired transport capacity and drivers available from other industries, some of which were 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. 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.

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. The organic supermarket used employees from other departments and several retailers engaged temporary staff to cope with volume peaks in distribution centers. They

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were untrained and thus less efficient. The wholesaler stood out from the other retailers because of the volume drops in the gastronomy and hotel industry. It cuts 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.

Procurement. The rapid increase in demand led to the limited availability of hoarded articles at both the retail and supplier level. For example, the hypermarket mentioned that the pasta manufacturers reached their capacity limits at short notice, and canned tomatoes could not be replenished because production is seasonal. Moreover, the tightly knit German grocery market complicated the acquisition of new procurement channels or suppliers, whose one-time deliveries had to be aligned. 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 established new short-term procurement channels in cooperation with suppliers that shifted production capacity from products for large commercial customers that were shut down, e.g., cruise ships or hotels. Centralized management was therefore advantageous for procurement as it improved internal and external communication.

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Table 4.2: Challenges and measures taken by grocery retailing in the initial phase of the pandemic

Area	Challenges	Measures
Demand planning and order dispatching	High manual workload (4), Distribution of scarce products (3)	Centralized and fair distribution of scarce products (5), Focus on critical products (4)
Store management	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)
Transport management	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)
Warehouse management	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)
Procurement	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)

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

Summary and outlook. Table 4.2 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). Reflecting on the challenges and measures as well as based on the outlook provided by the retailers, we can systematize the weaknesses of grocery retail operations uncovered by the pandemic as well as the future developments into the following four development areas:

1. Behavioral demand planning and order dispatching
2. Agile supply chain management
3. Transparency in the supply chain
4. Development of online business

4.6 Weaknesses of standard business

We explored the weaknesses of the standard business in grocery retail operations in more detail focusing on the four development areas identified within a second round of interviews. “Standard business” in this case describes the way processes are planned and executed in non-crisis periods.

4.6.1 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 determined that basic 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 automatically equitable distribution. The full-range provider highlighted the lack of sensible maximum order limits in the systems, as irrational orders from store managers were accepted. 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. The conclusion to be drawn is that human behavior influenced order sizing in the disruptive times. The full-range provider explained that during the pandemic, the irrational behavior and overreaction of store managers also had an impact on staff at headquarters, who had to determine final order quantities by differentiating between system-generated order sizes and manual adjustments. At the discounter, the pandemic additionally revealed that only a few employees had critical knowledge of systems and internal company processes. As a result, the workload was difficult to distribute.

4.6.2 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 reduced 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 reduced to increase 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. Furthermore, the grocery industry in Germany has invested in highly automated storage and picking systems that are not easily scalable. The discounter stated for example that the long battery charging times of the warehouse aids, such as industrial floor vehicles or pick-by-voice devices, limited the introduction of additional shifts or the use of more employees during the pandemic. 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.

4.6.3 Transparent supply chain

Grocery retail supply chains lacked data availability, analysis and sharing for complete 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. For example, the organic supermarket was not able to analyze the data in real time and the hypermarket lacked adequate

data granularity to view the current inventory of the stores. 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 a being adequately reflected in databases. The potential of machine learning 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.

4.6.4 Development of online business

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 (Piroth et al., 2020). 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 full-range provider stated that they experienced a shortage of picking boxes and delivery vans, for example. The drugstore used in-store picking in many stores to respond more flexibly to significant capacity effects. However, most companies reported that the 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.

4.7 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 to derive propositions.

4.7.1 Behavioral demand planning and order dispatching

4.7.1.1 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 follow a decentralized responsibility concept in general, 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 apply an integrative supply chain perspective. The hypermarket changes the store supply of critical products from pull-based

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orders to a fully centralized push system by centrally assigning the available quantities to the outlets.

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 delivery schedule with 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. 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.

The parameterization of the store ordering system is of central importance since it controls instore 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. 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.

4.7.1.2 Discussion and propositions

ASO systems had already undergone significant developments in the years leading up to the pandemic to increase their resilience to supply chain risks (Avlijas et al., 2021). 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 (e.g., Ehrenthal et al., 2014). 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 (van Donselaar et al., 2010). Another is that previous studies show that store manager behavior has a positive impact on out-of-stocks (Aastrup and Kotzab, 2008). 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

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observations of Alftan et al. (2015), 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 (Gunessee and Subramanian, 2020). 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 (Modgil et al., 2021). 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 (Handfield et al., 2019).

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. 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 propositions can be derived from these observations.

Proposition 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.

Proposition 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.

4.7.2 Agile supply chain

4.7.2.1 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. The full-range provider speaks of demand fluctuations of up to 20% compared to the standard business that can be managed in a relatively smooth manner, while higher deviations have to be managed using special and more costly measures. 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 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

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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.

Extension of storage space and inventories. The need for additional storage space at the warehouses and higher safety stocks for critical products 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 5% of the picking capacities beyond the tight standard requirements, and the establishment of multi-purpose “break-out warehouses” with capacity to increase capacity flexibly and swiftly. The hypermarket highlights a similar strategy that relies on external rented overflow facilities. 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.

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.

4.7.2.2 Discussion and propositions

The tight market on the one hand and the high logistics costs for warehousing and delivery processes on the other have led to a high focus on logistics costs in practical and theoretical concepts for German grocery retailing (see, e.g., Hübner et al. (2013)). However, the challenges during the pandemic have mainly been caused by cost-optimized approaches. 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 (see, e.g., Do et al. (2021); Handfield et al. (2020); Patrucco and Kähkönen (2021) or Schatteman et al. (2020)). 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 (2021), who postulate that mass retail and the grocery sector have been among the branches with comparably good 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 (2021), who highlights that the experience gained during the pandemic is an especially 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, e.g., Rozhkov et al. (2022)). 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 capac-

ity. 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 (Ivanov, 2021c). 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 and stock. This is in line with other studies that highlight low inventory levels as a major risk in crises like the pandemic (see, e.g., Ivanov (2021b); Schatteman et al. (2020) or van Hoek (2021)). 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 instore (Kuhn and Sternbeck, 2013). Given these observations, we formulate the following two propositions regarding the development of supply chain agility due to Covid-19:

Proposition 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.

Proposition 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.

4.7.3 Transparent supply chain

4.7.3.1 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 (within the supply chain and operations functions) and vertical (between different organizational hierarchies)

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transparency in the supply chain to expand the monitoring options and enable faster responses in critical times.

Horizontal supply chain transparency. 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 that drill down to sales units and the store level. Similarly, the organic supermarket introduced an alert system that detects unusual sales at an early stage. 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 key performance indicator (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 application systems 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 figures that are updated daily, which they aim to extend using further information. The full-range provider, who previously operated the provision of POS data as a separate business model and only passed on this data to its suppliers for a not inconsequential 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 using advanced AI methods for demand forecasting. So far, for example, the distribution of scarce

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supply quantities has been performed manually, which tied up ten employees full time. 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.

Vertical supply chain transparency. 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 provider 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 end-to-end 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.

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).

4.7.3.2 Discussion and propositions

Our observations are in coherence with findings from literature before or at the beginning of the pandemic. Choi et al. (2020) for example note that investments in supply chain network transparency are necessary to be digitally prepared for future disruptions. Ivanov (2020) and Dolgui and Ivanov (2022) confirm this statement. In addition, close interorganizational relationships supported by shared and linked systems are required to achieve the desired transparency (Nor-

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rman and Wieland, 2020) and uncover hidden and invisible stock (Finkenstadt and Handfield, 2021). 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 (Saarinen et al., 2020).

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 propositions can be derived from these observations.

Proposition 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.

Proposition 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 toward 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.

4.7.4 Development of online business

4.7.4.1 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. 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% (Kamel et al., 2020). 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 an online store 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. To date, the online demand remains high at around 2,000 orders per week, which is limited by the available pickup 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 now account for a proportion of total sales that the retailer would have expected in five years without the pandemic. According to the companies surveyed, the importance of online retailing will continue to grow after the pandemic.

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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 HD systems. The retailer is benefitting from its B&M processes by picking instore and treating online orders as additional store customers. According to the hypermarket, the store pickup stations also solve the problem of substitute items. A customer can still be offered an alternative product during pickup, if a product is not available. 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. 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 HD. Interconnecting the logistics of online and B&M 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 HD. 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 pickup 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 pickup options are therefore becoming central objectives of grocery retailers.

4.7.4.2 Discussion and propositions

Several contributions in literature have already analyzed the changes in shopping behavior, which are assumed to have a lasting impact on grocery retailing

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(Eriksson and Stenius, 2020). The pandemic is increasing the acceptance of online and mobile shopping for groceries. However, 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 (Habib and Hamadneh, 2021). 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 pickup points in April 2020 than originally planned for the entire year (Dannenberg et al., 2020). 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 (Loderhose, 2021). 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 (HDE, 2021).

Regarding the delivery mode, in Germany it is mainly HD that is offered, or in combination with C&C concepts (Hübner et al., 2016b; Wollenburg et al., 2018b; von Viebahn et al., 2020; Piroth et al., 2020). However, it 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 (Lodni et al., 2021). 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 (Davies et al., 2019), and increasing sales under the pandemic conditions (Delasay et al., 2022). The aforementioned observations lead to the following propositions:

Proposition 7: The low profit margins, cost-sensitive consumers, and high store density in German grocery retail are driving large players to expand the lower-cost C&C delivery mode and to use B&M logistics processes to avoid large investments in HD.

Proposition 8: Grocery retailers can more flexibly absorb volume fluctuations in disruptive times with C&C, especially instore pickup stations, than with HD, thereby leveraging the store’s resources and infrastructure.

4.8 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 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 online channel. 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. We have discussed these findings in light of contributions from the relevant fields and formulated corresponding propositions.

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 propositions 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 propositions inductively derived based on the cases we examined can serve as a starting point for future research and the 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

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operations costs of procurement (e.g., Lyu et al. (2010)), warehousing (e.g., Boysen, et al (2021)), transport (e.g., Holzapfel et al. (2016)) and in-store operations (e.g., Kuhn and Sternbeck (2013)) of the B&M business. Numerous concepts have also been developed for the online business to minimize the two major cost blocks of picking and last-mile delivery (e.g., Wollenburg et al. (2018b)). 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 (Perera et al., 2020).

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.

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As outlined in Chapter [1](#), the research interest and the relevance of omni-channel grocery retailing increased over the last decade, was intensified by the Covid-19 pandemic, and continues rapidly to evolve driven by the progressive digitalization. The present work makes a contribution to this field of research and is dedicated to logistics issues in the grocery omni-channel retailing. The Section [5.1](#), a comparison of the public holiday study with the Covid-19 pandemic study is presented. Subsequently, the academic and managerial implications are demonstrated in Section [5.2](#), before closing the dissertation by acknowledging the research limitations.

5.1 Comparison of disruptive times

Disruptive times, like public holiday seasons, occur in grocery retailing. One objective of the presented dissertation is to recommend grocery retailers strategies to deal with disruptive times. Chapter [3](#) and [4](#), both analyze disruptive times of grocery retailing. Thus, it is worthwhile to compare the results of these two different studies and to be able to answer the following questions: Are there common findings in holiday planning and pandemic management? Are there insights, which can be applied to disruptive times in general? How does the management and control of the logistics measures and challenges differ? A comparison is possible for the common planning areas considered in both studies: disposition and demand planning, warehouse management and transport management. Thereby, the short-term reaction of the pandemic is compared to the public holiday planning, as data were collected specifically for these areas.

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Disposition and demand planning. Shopping behavior and thus demand around public holidays is strongly influenced by the weather, as customers plan their day off accordingly. Likewise, store managers adjust their orders at short notice according to the weather forecast. These adjustments cause a high manual effort in the head office. Similarly, the customer demand increased at the beginning of the pandemic. The sudden high demand caused a high workload for those in charge of disposition and demand planning. However, the distribution of scarce products and the product availability in particular was a challenge during the pandemic as demand planning has struggled. Therefore, grocery retailers apply different actions and strategies than in holiday seasons. During holidays, they roughly follow historical values and focus on products, for which demand has fluctuated in the past. During the pandemic, retailers made ad hoc efforts to distribute available products fairly.

Warehouse management. The public holidays and pandemic challenges are similar in the warehouse, although the magnitude differs. Grocery retailers face overload, delayed receipt of goods and shortage of skilled workers during public holiday seasons. Uncertain delivery quantities represent the main problem during the pandemic accompanied by delayed deliveries, lack of warehouse space and untrained temporary staff. During the pandemic, there was the added risk of a warehouse closure due to a Covid-19 outbreak, which was initially difficult to assess many retailers. In the case of public holidays, adjustment of load profiles, organizational and personnel measures are applied, whereas for the pandemic, the focus was primarily on personnel measures, such as additional shifts.

Transport management. The generally tight transport market in Germany leads to challenges during busy public holiday seasons. Lack of transport capacities and shortage of drivers significantly increase the complexity of tour planning. During the pandemic, in contrast, general circumstances in the transport market had changed, as other industries shortened their production and required less transport capacity. Border closures due to Covid-19 containment posed here the main problem. Consequently, the solution approaches differ. In public holiday seasons, retailers compensate the lack of capacity by mid-term planning, while rapid actions were required in the initial phase of the pandemic. Therefore, the

government adopted exemption regulations for the transportation, namely the permission for Sunday driving enabled one additional delivery day as an example.

The comparison of the insights from the studies reveals commonalities between the two disruptive situations. However, the focus and causes differ. Public holidays occur regularly, not in the same constellation, but they are known in advance. The pandemic confronted grocery retailers without preparation time and represented a new, exceptional situation. Therefore, public holiday seasons can be planned for the mid-term and experience values from the last years can be used for orientation. In contrast, the pandemic required short-term responses. In addition, health measures, like the creation and adherence to fixed work teams or the observance of distance rules, proved to be essential during the pandemic for retaining workforces. Moreover, the pandemic represented an issue of social interest, where government intervention dynamically adjusted the framework and created exemptions.

5.2 Research contribution

As mentioned in the Section [1.1](#), little research is done so far for the grocery omni-channel retailing from a logistics perspective. The presented research of Chapter [2](#), [3](#) and [4](#) enriches the findings in the field and contribute to two main issues: configurating an omni-channel network and dealing with disruptive times in grocery retailing. The findings have importance to both practitioners and academic research.

Academic implications. The presented dissertation contributes to the academic literature by presenting rich empirical studies of European, and in particular German grocery retailers from an omni-channel perspective. With the aid of qualitative approaches in-depth insights in grocery retail issues are generated. The findings reveal how omni-channel networks are designed in grocery retailing and differentiate among distinct network types. Differences to the further

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developed non-food retail are identified and influencing design parameters are mentioned in Chapter 2. Moreover, Chapter 3 highlights the need to identify and systematize the challenges during public holiday seasons. The study emphasizes the essential role of logistics during disruptive times and develops a set of solution approaches for them. Thereby, the comprehensive view covers several planning areas. These insights are enriched by analyzing the logistics challenges during the Covid-19 pandemic. The findings strengthen the understanding of the long-term implications of the Covid-19 pandemic and show development directions of grocery retail logistics (see Chapter 4). The results serve as a starting point for further research.

Managerial implications. Besides the contribution to the academic literature, the results of the studies presented offer a number of implications for practitioners. As mentioned earlier, the Covid-19 pandemic has accelerated developments in grocery retailing, making the omni-channel approach to continue to gain traction in grocery retail sector. Retail practitioners can use the highlighted networks types to guide the implementation and development of omni-channel logistic processes. The results of these studies could expand the knowledge of practitioners in how to design order picking, warehousing, internal transport and last mile. Practitioners can use the findings as a starting model for the further development of their own logistics processes in the direction of omni-channel retailing. In addition, the findings contribute to the general understanding of the challenges in disruptive times and the corresponding measures that have to be taken in order to mitigate the volatility and to ensure product availability. Logistics processes along the supply chain of a grocery retailer are included for improving holiday logistics planning or sudden peaks in demand. Likewise, the present dissertation provides guidance to grocery retailers to identify potential weaknesses in their standard processes. Practitioners can use the results and formulated propositions to equip their standard business for future requirements and support them by developing their supply chains.

5.3 Limitations and outlook

The three contributions have some limitations that provide room for further areas of research. The limited sample sizes cannot provide a sufficiently detailed view of the problems considered. These data could be further expanded in future studies by increasing the number of participants and/or by adding pure online retailers. Recently, in Germany, several start-ups entered the grocery market, operating different logistics networks and processes compared to the traditional large market players. Moreover, the results of the three studies are limited to European, especially German, grocery markets and their different characteristics and conditions created by government agencies at pandemic times. Future studies could analyze other national and international markets and compare the results with the presented ones. Then, the generality of the results to other grocery markets could be assessed.

In addition, the papers of the dissertation are written from the point of view of grocery retailers. However, the impact of all actors on the grocery supply chain is an intriguing one, which could be usefully explored in further research, as for example from a supplier perspective. As highlighted in the results, collaboration along the supply chain and more process transparency is required. More work will need to be done to determine the grocery omni-channel logistics processes in more detail and to find innovative solutions for the future requirements.

References

- Aastrup, J. and Kotzab, H. (2008). Analyzing out-of-stock in independent grocery stores: an empirical study. *International Journal of Retail & Logistics Management*, Vol. 37 No. 9, pp. 765–789.
- Abdulkader, M.M.S., Gajpal, Y. and ElMekkawy, T.Y. (2018). Vehicle routing problem in omni-channel retailing distribution systems. *International Journal of Production Economics*, Vol. 196, pp. 43–55.
- Agatz, N., Fleischmann, M. and van Nunen, J. (2008). E-fulfillment and multi-channel distribution – A review. *European Journal of Operational Research*, Vol. 187 No. 2, pp. 339–356.
- Ahlqvist, V., Norrman, A. and Jahre, M. (2020). Supply chain risk governance: Towards a conceptual multi-level framework. *Operations and Supply Chain Management: An International Journal*, Vol. 13 No. 4, pp. 382–395.
- Aksen, D. and Altinkemer, K. (2008). A location-routing problem for the conversion to the 'click-and-mortar' retailing: The static case. *European Journal of Operational Research*, Vol. 186 No. 2, pp. 554–575.
- Aktas, E., Bourlakis, M. and Zissis, D. (2021). Collaboration in the last mile: evidence from grocery deliveries. *International Journal of Logistics Research and Applications*, Vol. 24 No. 3, pp. 227–241.
- Albán, H.M.G., Cardona, O.C.S., Argueta, C.M. and Sarmiento, A.T. (2015). A cost-efficient method to optimize package size in emerging markets. *European Journal of Operational Research*, Vol. 241 No. 3, pp. 917–926.

References

- Alftan, A., Kaipia, R., Loikkanen, L. and Spens, K. (2015). Centralised grocery supply chain planning: Improved exception management. *International Journal of Physical Distribution & Logistics Management*, Vol. 45 No. 3, pp. 237–259
- Al-nawayseh, M.K., Alnabhan, M.M., Al-Debei, M.M. and Balachandran, W. (2013). An adaptive decision support system for last mile logistics in e-commerce. *International Journal of Decision Support System Technology*, Vol. 5 No. 1, pp. 40–65.
- Avlijas, G., Vukanovic Dumanovic, V. and Radunovic, M. (2021). Measuring the effects of automatic replenishment on product availability in retail stores. *Sustainability*, Vol. 13 No. 3, <https://doi.org/10.3390/su13031391>.
- Azadeh, K., de Koster, R.B.M. and Roy, D. (2019). Robotized and automated warehouse systems: Review and recent developments. *Transportation Science*, Vol. 53 No. 4, pp. 917–945.
- Beck, N. and Rygl, D. (2015). Categorization of multiple channel retailing in multi-, cross- and omni-channel retailing for retailers and retailing. *Journal of Retailing and Consumer Services*, Vol. 327, pp. 170–178.
- Bell, D.R., Gallino, S. and Moreno, A. (2014). How to win in an omnichannel world. *MIT Sloan Management Review*, Vol. 56 No. 1, pp. 45–53.
- Bernon, M., Cullen, J. and Gorst, J. (2016). Online retail returns management: Integration within an omni-channel distribution context. *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 6/7, pp. 584–605.
- Bijmolt, T.H.A., Broekhuis, M., de Leeuw, S., Hirche, C., Rooderkerk, R.P., Sousa, R. and Zhu, S. (2021). Challenges at the marketing-operations interface in omni-channel retail environments. *Journal of Business Research*, Vol. 122, pp. 864–874.

References

- Boyer, K. and Hult, T. (2005). Extending the supply chain: Integrating operations and marketing in the online grocery industry. *Journal of Operations Management*, Vol. 23 No. 6, pp. 642–661.
- Boyer, K., Hult, T. and Frohlich, M. (2003). An exploratory analysis of extended grocery supply chain operations and home delivery. *Integrated Manufacturing Systems*, Vol. 14 No. 8, pp. 652–663.
- Boyer, K., Prud'homme, A. and Chung, W. (2009). The last mile challenge: Evaluating the effects of customer density and delivery window patterns. *Journal of Business Logistics*, Vol. 30 No. 1, pp. 185–201.
- Boysen, N., de Koster, R. and Füssler, D. (2021). The forgotten sons: warehousing systems for brick-and-mortar retail chains. *European Journal of Operational Research*, Vol. 288 No. 2, pp. 361–381.
- BrickMeetsClick (2016). *How consumers are using online grocery*. Available at: www.brickmeetsclick.com (accessed at 20 Juli 2018).
- Broekmeulen, R.A., Sternbeck, M., van Donselaar, K.H. and Kuhn, H. (2017). Decision support for selecting the optimal product unpacking location in a retail supply chain. *European Journal of Operational Research*, Vol. 259 No. 1, pp. 84–99.
- Bryman, A. and Bell, E. (2015). *Business research methods*. Fourth edition. Oxford University Press, Oxford.
- Brynjolfsson, A., Hu, Y.J. and Rahman, M.S. (2013). Competing in the age of omnichannel retailing. *MIT Sloan Management Review*, Vol. 54 No. 4, pp. 23–29.
- Buldeo Rai, H., Verlinde, S., Macharis, C., Schoutteet, P. and Vanhaverbeke, L. (2019). Logistics outsourcing in omnichannel retail. State of practice and service recommendations. *International Journal of Physical Distribution & Logistics Management*, Vol. 49 No. 3, pp. 267–286.

References

- Burgos, D. and Ivanov, D. (2021). Food retail supply chain resilience and the Covid-19 pandemic: A digital twin-based impact analysis and improvement directions. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 152, <https://doi.org/10.1016/j.tre.2021.102412>.
- Cai, Y.J. and Lo, C.K. (2020). Omni-channel management in the new retailing era: a systematic review and future research agenda. *International Journal of Production Economics*, Vol. 229, <https://doi.org/10.1016/j.ijpe.2020.107729>.
- Castillo, V.E., Bell, J.E., Rose, W.J. and Rodrigues, A.M. (2018). Crowdsourcing last mile delivery: Strategic implications and future research directions. *Journal of Business Logistics*, Vol. 39 No. 1, pp. 7–25.
- Choi, T., Rogers, D. and Vakil, B. (2020). Coronavirus is a wake-up call for supply chain management. *Harvard Business Review*. Available at: <https://hbr.org/2020/03/coronavirus-is-a-wake-up-call-for-supply-chain-management> (accessed at 31 January 2021).
- Chowdhury, P., Paul, S., Kaisar, S. and Muktadir, M.A. (2021). Covid-19 pandemic related supply chain studies: A systematic review. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 148, pp. 102271.
- Chowdhury, M.T., Sarkar, A., Paul, S.K. and Muktadir, M.A. (2020). A case study on strategies to deal with the impacts of Covid-19 pandemic in the food and beverage industry. *Operations Management Research*, <https://doi.org/10.1007/s12063-020-00166-9>.
- Colla, E. and Lapoule, P. (2012). E-commerce. Exploring the critical success factors. *International Journal of Retail & Distribution Management*, Vol. 40 No. 11, pp. 842–864.
- Corbin, J. and Strauss, A. (1990). Grounded Theory Research: Procedures, Canons, and Evaluative Criteria. *Qualitative Sociology*, Vol. 13 No. 1, pp. 3–21.

References

- da Mota Petrosa, A., Näslund, D. and Jasmand, C. (2012). Logistics case study based research: Towards a higher quality. *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 3, pp. 275–295.
- Dannenber, P., Fuchs, N., Riedler, T. and Wiedemann, C. (2020). Digital transition by COVID-19 pandemic? The German food online retail. *Tijdschrift voor Economische en Sociale Geografie*, Vol. 111 No. 3, pp. 543–560.
- Davies, A., Dolega, L. and Arribas-Bel, D. (2019). Buy online collect in-store: exploring grocery click & collect using a national case study. *International Journal of Retail & Distribution Management*, Vol. 47 No. 3, pp. 278–291.
- de Borba, J.L.G., de Magalhães, M.R., Filgueiras, R.S. and Bouzon, M. (2020). Barriers in omnichannel retailing returns: a conceptual framework. *International Journal of Retail & Distribution Management*, Vol. 49 No. 1, pp. 121–143.
- Dekker, M., van Donselaar, K.H. and Ouwehand, P. (2004). How to use aggregation and combined forecasting to improve seasonal demand forecasts. *International Journal of Production Economics*, Vol. 90 No. 2, pp. 151–167.
- de Koster, R. (2002). Distribution structures for food home shopping. *International Journal of Physical Distribution & Logistics Management*, Vol. 32 No. 5, pp. 362–380.
- de Koster, R., Brito, M. and van de Vendel, M.A. (2002). Return handling: An exploratory study with nine retailer warehouses. *International Journal of Retail & Distribution Management*, Vol. 30 No. 8, pp. 407–421.
- Delasay, M., Jain, A. and Kumar, S. (2022). Impacts of the COVID-19 pandemic on grocery retail operations: An analytical model. *Production and Operations Management*, Vol. 31 No. 5, pp. 2237–2255.
- Dethlefs, C., Ostermeier, M. and Hübner, A. (2022). Rapid fulfillment of online orders in omnichannel grocery retailing. *EURO Journal on Transportation and Logistics*, Vol. 11, <https://doi.org/10.1016/j.ejtl.2022.100082>.

References

- Dharmawardane, C., Sillanpää, V. and Holmström, J. (2021). High-frequency forecasting for grocery point-of-sales: intervention in practice and theoretical implications for operational design. *Operations Management Research*, Vol. 14, pp. 38–60.
- Do, Q.N., Mishra, N., Wulandhari, N.B.I., Ramudhin, A., Sivrajah, U. and Milligan, G. (2021). Supply chain agility responding to unprecedented changes: empirical evidence from the UK food supply chain during COVID-19 crisis. *Supply Chain Management*, Vol. 26 No. 6, pp. 737–752.
- Dolgui, A. and Ivanov, D. (2021). Ripple effect and supply chain disruption management: new trends and research directions. *International Journal of Production Research*, Vol. 59 No. 1, pp. 102–109.
- Dolgui, A. and Ivanov, D. (2022). 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*, Vol. 60 No. 2, pp. 442–451.
- Dreyer, H.C., Kiil, K., Dukovska-Popovska, I. and Kaipia, R. (2018). Proposals for enhancing tactical planning in grocery retailing with S&OP. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 2, pp. 114–138.
- Dubey, R., Gunasekaran, A., Childe, S.J. and Papadopoulos, T. (2018). Skills needed in supply chain – human agency and social capital analysis in third party logistics. *Management Decision*, Vol. 56 No. 1, pp. 143–159.
- EHI Retail Institute (2020). *Auswirkungen der Corona Pandemie auf die Warendistribution im Handel*. Available at: <https://www.handelsdaten.de/deutschsprachiger-einzelhandel/handelslogistik-corona-pandemie-auswirkungen-warendistribution> (accessed at 31 January 2021).
- Ehrenthal, J., Honhon, D. and van Woensel, T. (2014). Demand seasonality in retail inventory management. *European Journal of Operational Research*, Vol. 238 No. 2, pp. 527–539.

References

- Eriksson, E., Norrman, A. and Kembro, J. (2019). Contextual adaptation of omnichannel grocery retailers' online fulfilment centres. *International Journal of Retail & Distribution Management*, Vol. 47 No. 12, pp. 1232–1250.
- Eriksson, E., Norrman, A. and Kembro, J. (2022). Understanding the transformation toward omnichannel logistics in grocery retail: a dynamic capabilities perspective. *International Journal of Retail & Distribution Management*, Vol. 50 No. 8/9, pp. 1095–1128.
- Eriksson, E. and Stenius, M. (2020). 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*, Vol. 8, pp. 1946–1961.
- Estellés-Arolas, E. and de Guevara, F.G.L. (2012). Towards an integrated crowdsourcing definition. *Journal of Information Science*, Vol. 38 No. 2, pp. 189–200.
- Faber, N., de Koster, R.B.M. and Smidts, A. (2013). Organizing warehouse management. *International Journal of Operations & Production Management*, Vol. 33 No. 9, pp. 1230–1256.
- Fernie, J. and Sparks, L. (2014). *Logistics and retail management. Emerging issues and new challenges in the retail supply chain*. Fourth edition. Kogan Page Limited, London.
- Fildes, R., Ma, S. and Kolassa, S. (2022). Retail forecasting: Research and practice. *International Journal of Forecasting*, Vol. 38, pp. 1283–1318.
- Finkenstadt, D.J. and Handfield, R. (2021). Blurry vision: supply chain visibility for personal protective equipment during COVID-19. *Journal of Purchasing and Supply Management*, Vol. 27 No. 3, <https://doi.org/10.1016/j.pursup.2021.100689>.

References

- Fleischmann, B., Meyr, H. and Wagner, M. (2015). Advanced planning. In: Stadler, H., Kilger, C. and Meyr, H. (Eds.), *Supply Chain Management and Advanced Planning*. Sixth edition. Springer, Berlin Heidelberg New York, pp. 71–95.
- Flynn, B., Sakakibara, S., Schroeder, R., Kimberly, A. and Flynn, J. (1990). Empirical research methods in operations management. *Journal of Operations Management*, Vol. 9 No. 2, pp. 250–284.
- Forrester (2014). *European online retail forecast: 2013 to 2018*. Available at: <https://www.forrester.com> (accessed on 20 June 2018).
- Frank, M., Ostermeier, M., Holzapfel, A., Hübner, A. and Kuhn, H. (2021). Optimizing routing and delivery patterns with multi-compartment vehicles. *European Journal of Operational Research*, Vol. 293 No. 2, pp. 495–510.
- Galipoglu, E., Kotzab, H., Teller, C., Hüseyinoglu, I.Ö.Z. and Pöppelbuß, J. (2018). Omni-channel retailing research – state of the art and intellectual foundation. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 4, pp. 365–390.
- Gallino, S. and Moreno-Garcia, A. (2014). Integration of online and offline channels in retail: The impact of sharing reliable inventory availability information. *Management Science*, Vol. 60 No. 6, pp. 1434–1451.
- Gallino, S. and Moreno-Garcia, A. (2018). *Operations in an omnichannel world*. Springer Nature Switzerland AG, Cham.
- Gao, F. and Su, X. (2017). Omnichannel retail operations with buy-online-and-pick-up-in-store. *Management Science*, Vol. 63 No. 8, pp. 2478–2492.
- Garcia Gomez, B., Gutierrez Arranz, A.M. and Gutierrez Cillan, J. (2012). Drivers of customer likelihood to join grocery retail loyalty programs. An analysis of reward programs and loyalty cards. *Journal of Retailing and Consumer Services*, Vol. 19 No. 5, pp. 492–500.

References

- Gerea, C., Gonzalez-Lopez, F. and Herskovic, V. (2021). Omnichannel customer experience and management: An integrative review and research agenda. *Sustainability*, Vol. 13 No. 5, <https://doi.org/10.3390/su13052824>.
- Gephart, R.P. (2004). Qualitative research and the academy of management journal. *Academy of Management Journal*, Vol. 47 No. 5, pp. 454–462.
- Gioia, D.A., Corley, K.G. and Hamilton, A.L. (2012). Seeking qualitative rigor in inductive research. *Organizational Research Methods*, Vol. 16, pp. 15–31.
- Glaser, B.G. and Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine de Gruyter, New York.
- Golan, M.S., Jernegan, L.H. and Linkov, I. (2020). 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*, Vol. 40, pp. 222–243.
- Grant, D., Fernie, J. and Schulz, B. (2014). Enablers and barriers in German online food retailing. *Supply Chain Forum: An International Journal*, Vol. 15 No. 3, pp. 4–11.
- Gunessee, S. and Subramanian, N. (2020). Ambiguity and its coping mechanisms in supply chains lessons from the Covid-19 pandemic and natural disasters. *International Journal of Operations & Production Management*, Vol. 40 No. 7/8, pp. 1201–1223.
- Gu, J., Goetschalckx, M. and McGinnis, L.F. (2007). Research on warehouse operation: A comprehensive review. *European Journal of Operational Research*, Vol. 177, pp. 1–27.
- Gur Ali, O. and Pinar, E. (2016). Multi-period-ahead forecasting with residual extrapolation and information sharing – utilizing a multitude of retail series. *International Journal of Forecasting*, Vol. 32 No. 2, pp. 502–517.

References

- Haas, Y. (2019). Developing a generic retail business model – a qualitative comparative study. *International Journal of Retail & Distribution Management*, Vol. 47 No. 19, pp. 1029–1056.
- Habib, S. and Hamadneh, N.N. (2021). Impact of perceived risk on consumers technology acceptance in online grocery adoption amid COVID-19 pandemic. *Sustainability*, Vol. 13 No. 18, <https://doi.org/10.3390/su131810221>.
- Hagberg, J., Sundstrom, M. and Egles-Zanden, N. (2016). The digitalization of retailing: an exploratory framework. *International Journal of Retail & Distribution Management*, Vol. 44 No. 7, pp. 694–712.
- Handfield, R., Graham, G. and Burns, L. (2020). Corona virus, tariffs, trade wars and supply chain evolutionary design. *International Journal of Operations & Production Management*, Vol. 40 No. 10, pp. 1649–1660.
- Handfield, R., Jeong, S. and Choi, T. (2019). Emerging procurement technologies: data analytics and cognitive analytics. *International Journal of Physical Distribution & Logistics Management*, Vol. 49 No. 10, pp. 972–1002.
- Hänninen, M., Kwan, S.K. and Mitronen, L. (2021). From the store to omnichannel retail: looking back over three decades of research. *The International Review of Retail, Distribution and Consumer Research*, Vol. 31 No. 1, pp. 1–35.
- Hays, T., Keskinocak, P. and López, V. (2005). Strategies and challenges of internet grocery retailing logistics. In: Pardalos, P.M., Hearn, D.W., Geunes, J., Akcali, E., Romeijn, H.E. and Shen, Z.J.M. (Eds.), *Applications of supply chain management and e-commerce research*. Springer, Boston, pp. 217–252.
- HDE (2021). *Online-monitor 2021*. Available at: https://einzelhandel.de/index.php?option=com_attachments&task=download&id=10572 (accessed at 26 May 2021).

References

- Henao, C.A., Murioz, J.C. and Ferrer, J.C. (2015). The impact of multi-skilling on personnel scheduling in the service sector: a retail industry case. *Journal of Operations Research Society*, Vol. 66 No. 12, pp. 1949–1959.
- Hohenstein, N.O. (2022). 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*, Vol. 33 No. 4, pp. 1336–1365.
- Holzapfel, A., Hübner, A., Kuhn, H. and Sternbeck, M. (2016). Delivery pattern and transportation planning in grocery retailing. *European Journal of Operational Research*, Vol. 252, pp. 54–68.
- Holzapfel, A., Kuhn, H. and Sternbeck, M. (2018). Product allocation to different types of distribution center in retail logistics networks. *European Journal of Operational Research*, Vol. 264 No. 3, pp. 948–966.
- Hübner, A., Hense, J. and Dethlefs, C. (2022). The revival of retail stores via omnichannel operations: A literature review and research framework. *European Journal of Operational Research*, Vol. 302 No. 3, pp. 799–818.
- Hübner, A., Holzapfel, A. and Kuhn, H. (2014). Structures and development paths for logistics and distribution systems in multi-channel retailing. In: Delfmann, W. and Wimmer, T. (Eds.), *Conference Papers of the 7th International Scientific Symposium on Logistics*. BVL International, Cologne, pp. 269–294.
- Hübner, A., Holzapfel, A. and Kuhn, H. (2015). Operations management in multi-channel retailing: an exploratory study. *Operations Management Research*, Vol. 8, pp. 84–100.
- Hübner, A., Holzapfel, A. and Kuhn, H. (2016a). Distribution channel in omnichannel retailing. *Business Research*, Vol. 9, pp. 255–296.

References

- Hübner, A., Kuhn, H. and Sternbeck, M. (2013). Demand and supply chain planning in grocery retail: An operations planning framework. *International Journal of Retail & Distribution Management*, Vol. 41 No. 7, pp. 512–530.
- Hübner, A., Kuhn, H. and Wollenburg, J. (2016b). Last mile fulfilment and distribution in omni-channel grocery retailing. A strategic planning framework. *International Journal of Retail & Distribution Management*, Vol. 44 No. 3, pp. 228–247.
- Hübner, A. and Ostermeier, M. (2019). A multi-compartment vehicle routing problem with loading and unloading costs. *Transportation Science*, Vol. 53 No. 1, pp. 282–300.
- Hübner, A., Wollenburg, J. and Holzapfel, A. (2016c). Retail logistics in the transition from multi-channel to omni-channel. *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 6/7, pp. 562–583.
- IGD (2014). *UK grocery retailing in July 2014*. Available at: <http://www.igd.com/ourexpertise/> (accessed 20 June 2018).
- Iglesias-Pradas, S., Acquila-Natale, E. and Del-Rio-Carazo, L. (2021). Omnichannel retailing: a tale of three sectors. *Economic Research-Ekonomska Istraživanja*, <https://doi.org/10.1080/1331677X.2021.1991825>.
- IRI (2015). *The changing face of retail*. Available at: www.iriworldwide.com/en-US/insights/Publications/Changing-Face-of-Retail (accessed 20 June 2018).
- Ishfaq, R., Defee, C.C., Gibson, B.J. and Uzma, R. (2016). Realignment of the physical distribution process in omni-channel fulfilment. *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 6/7, pp. 543–561.

References

- Ivanov, D. (2020). Viable supply chain model: integrating agility, resilience and sustainability perspectives – lessons from and thinking beyond the Covid-19 pandemic. *Annals of Operations Research*, <https://doi.org/10.1007/s10479-020-03640-6>.
- Ivanov, D. (2021a). Exiting the COVID-19 pandemic: after-shock risks and avoidance of disruption tails in supply chains. *Annals of Operations Research*, <https://doi.org/10.1007/s10479-021-04047-7>.
- Ivanov, D. (2021b). *Introduction to supply chain resilience. Management, Modelling, Technology*. Springer, Cham.
- Ivanov, D. (2021c). Supply chain viability and the COVID-19 pandemic: a conceptual and formal generalisation of four major adaptation strategies. *International Journal of Production Research*, Vol. 59 No. 12, pp. 3535–3552.
- Ivanov, D. and Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by Covid-19 outbreak. *International Journal of Production Research*, Vol. 58 No. 10, pp. 2904–2915.
- Kämäräinen, V. (2001). The reception box impact on home delivery efficiency in the e-grocery business. *International Journal of Physical Distribution & Logistics Management*, Vol. 31 No. 6, pp. 414–426.
- Kämäräinen, V., Saranen, J. and Holmström, J. (2001a). The reception box impact on home delivery efficiency in the e-grocery business. *International Journal of Physical Distribution & Logistics Management*, Vol. 31 No. 6, pp. 414–426.
- Kämäräinen, V., Smaros, J., Jaakola, T. and Holmström, J. (2001b). Cost-effectiveness in the e-grocery business. *International Journal of Retail & Distribution Management*, Vol. 29 No. 1, pp. 41–48.

References

- Kamel, M., de Montgolfier, J., Caine, S., Ringer, J. and Puzio, S. (2020). *How to ramp up online grocery – without breaking the bank*, Bain & Company, Inc., Boston. Available at: www.bain.com/globalassets/noindex/2020/bain_brief_how_to_ramp_up_online_grocery_without_breaking_the_bank.pdf (accessed at 27 May 2021).
- Kembro, J.H., Norrman, A. and Eriksson, E. (2018). Adapting warehouse operations and design to omni-channel logistics: A literature review and research agenda. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 9, pp. 890–912.
- Kim, Y.T., Dekker, R. and Heij, C. (2018). Improving warehouse labour efficiency by intentional forecast bias. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 1, pp. 93–110.
- Klepek, M. and Bauerová, R. (2020). Why do retail customers hesitate for shopping grocery online? *Technological and Economic Development of Economy*, Vol. 26 No. 6, pp. 1444–1462.
- Klibi, W., Martel, A. and Adel, G. (2010). The design of robust value-creating supply chain networks: A critical review. *European Journal of Operational Research*, Vol. 203 No. 2, pp. 283–293.
- Koistinen, K. and Järvinen, R. (2009). Consumer observations on channel choices – Competitive strategies in Finnish grocery retailing. *Journal of Retailing and Consumer Services*, Vol. 16 No. 4, pp. 260–270.
- Kuhn, H. and Sternbeck, M. (2013). Integrative retail logistics: An exploratory study. *Operations Management Research*, Vol. 6, pp. 2–18.
- Lawrence, R. and Douglas, T. (2001). Viewpoint: The decline and fall of internet grocery retailers. *International Journal of Retail & Distribution Management*, Vol. 29 No. 6, pp. 264–271.

References

- Lebensmittel Zeitung (2020). *Pozentuale Absatzentwicklung ausgewählter Food- und Nearfood-Sortimente im deutschen Lebensmitteleinzelhandel in den KW10/2020 bis KW20/2020*. Available at: <https://www.handelsdaten.de/lebensmittelhandel/lebensmitteleinzelhandel-absatzentwicklung-food-nearfood-sortimente-coronavirus> (accessed at 07 May 2020).
- Lebensmittel Zeitung (2022). *Wöchentlicher Umsatz im Lebensmitteleinzelhandel in Deutschland von KW 43/2021 bis KW 42/2022 (in Millionen Euro)*. Available at: <https://www.statista.com/statistik/daten/studie/579689/umfrage/woechentlicher-umsatz-im-lebensmitteleinzelhandel-in-deutschland/> (accessed at 19 November 2022).
- Lim, S.F.W., Jin, X. and Srari, J.S. (2018). Consumer-driven e-commerce. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 3, pp. 308–332.
- Loderhose, B. (2021). Angriff der Hastigen. *Lebensmittel Zeitung*, Vol. 9, pp. 29–30.
- Lodni, C., Najmaei, M. and Mansori, S. (2021). 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*, Vol. 3 No. 3, pp. 1–31.
- Lorentz, H., Laari, S., Meehan, J., Eßig, M. and Henke, M. (2021). An attention-based view of supply disruption risk management: balancing biased attentional processing for improved resilience in the COVID-19 context. *International Journal of Operations & Production Management*, Vol. 41 No. 13, pp. 152–177.
- Loske, D. (2020). The impact of Covid-19 on transport volume and freight capacity dynamics: An empirical analysis in German food retail logistics. *Transportation Research Interdisciplinary Perspectives*, Vol. 6, <https://doi.org/10.1016/j.trip.2020.100165>.

References

- Lyu, J., Ding, J. and Chen, P. (2010). Coordinating replenishment mechanisms in supply chain: From the collaborative supplier and store-level retailer perspective. *International Journal of Production Economics*, Vol. 123 No. 1, pp. 221–234.
- LZ Retailytics (2018). *Ranking Top 30 Lebensmittelhändler Deutschland 2018*. Available at: <https://www.lebensmittelzeitung.net/handel/Ranking-Top-30-Lebensmittelhandel-Deutschland-2018-134606> (accessed at 28 October 2018).
- Mahadevan, K. and Joshi, S. (2021). Omnichannel retailing: a bibliometric and network visualization analysis. *Benchmarking: An International Journal*, Vol. 29 No. 4, pp. 1113–1136.
- Manuj, I. and Pohlen, T.L. (2012). A reviewer’s guide to the grounded theory methodology in logistics and supply chain management research. *International Journal of Physical Distribution & Logistics Management*, Vol. 42 No. 8/9, pp. 784–803.
- Marchet, G., Melacini, M., Perotti, S., Rasini, M. and Tappia, E. (2018). Business logistics models in omni-channel: a classification framework and empirical analysis. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 4, pp. 439–464.
- Martins, S., Amorim, P. and Almada-Lobo, B. (2018). Delivery mode planning for distribution to brick-and-mortar retail stores: discussion and literature review. *Flexible Services and Manufacturing Journal*, Vol. 30, pp. 785–812.
- Maxwell, J.A. (2008). Designing a qualitative study. In: Bickman, L. and Rog, D.J. (Eds.), *The SAGE handbook of applied social research methods*. SAGE, Thousand Oaks, pp. 214–253.
- McKinnon, A.C. (2016). *Crowdshipping: A communal approach to reducing urban traffic levels?* Technical report, Kuehne Logistics University, Hamburg, <https://doi.org/10.13140/rg.2.2.20271.53925>.

References

- Melacini, M., Perotti, S., Rasini, M. and Tappia, E. (2018). E-fulfilment and distribution in omni-channel retailing: a systematic literature review. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 4, pp. 391–414.
- Meyr, H., Wagner, M. and Rohde, J. (2015). Structure of advanced planning systems. In: Stadler, H. and Kilger, C. (Eds.), *Supply Chain Management and Advanced Planning*. Springer, Berlin Heidelberg, pp. 99–106.
- Micheli, P., Johnson, M. and Godsell, J. (2021). How the Covid-19 pandemic has affected, and will affect, operations and supply chain management research and practice. *International Journal of Operations & Production Management*, Vol. 41 No. 6, pp. 773–780.
- Min, H. (2007). Examining sources of warehouse employee turnover. *International Journal of Physical Distribution & Logistics Management*, Vol. 37 No. 5, pp. 375–388.
- Min, H. and Lambert, T. (2002). Truck driver shortage revisited. *Transportation Journal*, Vol. 42 No. 2, pp. 5–16.
- Mkansi, M. and Nsakanda, A.L. (2021). Leveraging the physical network of stores in e-grocery order fulfilment for sustainable competitive advantage. *Research in Transportation Economics*, Vol. 87 No. 2, <https://doi.org/10.1016/j.retrec.2019.100786>.
- Modgil, S., Singh, R. K. and Hannibal, C. (2021). Artificial intelligence for supply chain resilience: learning from Covid-19. *The International Journal of Logistics Management*, Vol. 33 No. 4, pp. 1246–1268.
- Moussaoui, I., Williams, B.D., Hofer, C., Aloysius, J.A. and Waller, M.A. (2016). Drivers of retail on-shelf availability. *International Journal of Physical Distribution & Logistics Management*, Vol. 46 No. 5, pp. 516–535.

References

- Münch, C. and Hartmann, E. (2022). Transforming resilience in the context of a pandemic: results from a cross-industry case study exploring supply chain viability. *International Journal of Production Research*, <https://doi.org/10.1080/00207543.2022.2029610>.
- Murfield, M., Boone, C., Paige, R. and Rodney, T. (2017). Investigating logistics service quality in omni-channel retailing. *International Journal of Physical Distribution & Logistics Management*, Vol. 4 No. 4, pp. 263–296.
- Nielsen (2015). *Number of grocery stores per 1 million inhabitants in Europe*. Available at: www.nielsen.com (accessed 20 June 2018).
- Nikolopoulos, K., Punia, S., Schäfers, A., Tsinopoulos, C. and Vasilakis, C. (2020). Forecasting and planning during a pandemic: Covid-19 growth rates, supply chain disruptions, and governmental decisions. *European Journal of Operational Research*, Vol. 290 No. 1, pp. 99–115.
- Nikookar, E. and Yanadori, Y. (2022). Preparing supply chain for the next disruption beyond COVID-19: managerial antecedents of supply chain resilience. *International Journal of Operations & Production Management*, Vol. 42 No. 1, pp. 59–90.
- Norrman, A. and Wieland, A. (2020). The development of supply chain risk management over time: revisiting Ericsson. *International Journal of Physical Distribution & Logistics Management*, Vol. 50 No. 6, pp. 641–666.
- Obermair, E., Holzapfel, A., Kuhn, H. and Sternbeck, M. (2022). Challenges and measures in disruptive times: Lessons learned from the pandemic for grocery retailing operations. Working paper. Hochschule Geisenheim University, Germany.
- Olsson, J., Hellström, D. and Palsson, H. (2019). Framework of last mile logistics research: A systematic review of the literature. *Sustainability*, Vol. 11 No. 4, <https://doi.org/10.3390/su11247131>.

References

- Pantano, E., Pizzi, G., Scarpi, D. and Dennis, C. (2020). Competing during a pandemic? Retailers' up and downs during the Covid-19 outbreak. *Journal of Business Research*, Vol. 116, pp. 209–213.
- Patrucco, A.S. and Kähkönen, A.-K. (2021). Agility, adaptability, and alignment: new capabilities for PSM in a post-pandemic world. *Journal of Purchasing and Supply Management*, Vol. 27 No. 4, <https://doi.org/10.1016/j.pursup.2021.100719>.
- Paul, J., Agatz, N., Spliet, R. and de Koster, R. (2019). Shared capacity routing problem – An omni-channel retail study. *European Journal of Operational Research*, Vol. 273 No. 2, pp. 731–739.
- Paul, S.K. and Chowdhury, P. (2020). Strategies for managing the impacts of disruptions during Covid-19: an example of toilet paper. *Global Journal of Flexible Systems Management*, Vol. 21 No. 3, pp. 283–293.
- Perera, H.N., Fahimnia, B. and Tokar, T. (2020). Inventory and ordering decisions: a systematic review on research driven through behavioral experiments. *International Journal of Operations & Production Management*, Vol. 40 No. 7/8, pp. 997–1039.
- Petersen, C.G. and Aase, G. (2004). A comparison of picking, storage, and routing policies in manual order picking. *International Journal of Production Economics*, Vol. 92 No. 1, pp. 11–19.
- Phillips, S. and Vasquez-Nicholson, J. (2016). *Retail foods*. Technical report, GAIN Report, United Kingdom, <https://gain.fas.usda.gov>.
- Piecyk, M. and McKinnon, A.C. (2010). Forecasting the carbon footprint of road freight transport in 2020. *International Journal of Production Economics*, Vol. 128 No. 1, pp. 31–42.

References

- Pietri, N.O., Chou, X., Loske, D., Klumpp, M. and Montemanni, R. (2021). The buy-online-pick-up-in-store retailing model: Optimization strategies for in-store picking and packing. *Algorithms*, Vol. 14, <http://dx.doi.org/10.3390/a14120350>.
- Piotrowicz, W. and Cuthbertson, R. (2014). Introduction to the special issue information technology in retail: Toward omnichannel retailing. *International Journal of Electronic Commerce*, Vol. 18 No. 4, pp. 5–16.
- Piroth, P., Rüger-Muck, E. and Bruwer, J. (2020). Digitalisation in grocery retailing in Germany: an explorative study. *The International Review of Retail, Distribution and Consumer Research*, Vol. 30 No. 5, pp. 479–497.
- Porto, A., Henao, C., Lopez-Ospina, H. and Gonzalez, E. (2019). Hybrid flexibility strategy on personnel scheduling: Retail case study. *Computers Industrial Engineering*, Vol. 133, pp. 220–230.
- Pratt, M.G. (2009). From the editors for the lack of a boilerplate: Tips on writing up (and reviewing) qualitative research. *Academy of Management Journal*, Vol. 52 No. 5, pp. 856–862.
- Qiu, C. and Wenqing, Z. (2016). Managing long queues for holiday sales shopping. *Journal of Revenue and Pricing Management*, Vol. 15, pp. 52–65.
- Queiroz, M.M., Ivanov, D., Dolgui, A. and Wamba, S.F. (2020). 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*, <https://doi.org/10.1007/s10479-020-03685-7>.
- Raassens, N., Haans, H. and Mullick, S. (2021). 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. *The International Journal of Logistics Management*, Vol. 33 No. 3, pp. 877–900.

References

- Rao, S., Goldsby, T.J. and Iyengar, D. (2009). The marketing and logistics efficacy of online sales channels. *International Journal of Physical Distribution & Logistics Management*, Vol. 39 No. 2, pp. 106–130.
- Rasini, M., Tappia, E. and Melacini, M. (2021). E-fulfilment in grocery retailing: design insights for a store-based distribution system. *International Journal of Logistics Systems and Management*, Vol. 39 No. 4, pp. 470–490.
- Raza, S.A. and Govindaluri, S.M. (2021). Omni-channel retailing in supply chain: a systematic literature review. *Benchmarking: An International Journal*, Vol. 28 No. 9, pp. 2605–2635.
- Rodríguez García, M., González Romero, I., Bas, A. and Prado-Prado, J.C. (2021). E-grocery retailing: from value proposition to logistics strategy. *International Journal of Logistics Research and Applications*, Vol. 74 No. 6, pp. 1–20.
- Rogerson, S. and Santén, V. (2017). Shippers' opportunities to increase load factor: Managing imbalances between required and available capacity. *International Journal of Logistics Research and Applications*, Vol. 20 No. 6, pp. 581–603.
- Rozhkov, M., Ivanov, D., Blackhurst, J. and Nair, A. (2022). Adapting supply chain operations in anticipation of and during the COVID-19 pandemic. *Omega*, Vol. 110, <https://doi.org/10.1016/j.omega.2022.102635>.
- Saarinen, L., Loikkanen, L., Tanskanen, K., Kaipia, R., Tukkonen, S. and Holmström, J. (2020). Agile planning: Avoiding disaster in the grocery supply chain during Covid-19 crisis. *Aalto University publication series BUSINESS + ECONOMY*, <http://urn.fi/URN:ISBN:978-952-60-3960-2>.
- Saghiri, S., Wilding, R., Mena, C. and Bourlakis, M. (2017). Toward a three-dimensional framework for omni-channel channels. *Journal of Business Research*, Vol. 77, pp. 53–67.

References

- Sanchez-Rodrigues, V., Potter, A. and Naim, M. (2010). The impact of logistics uncertainty on sustainable transport operations. *International Journal of Physical Distribution & Logistics Management*, Vol. 40 No. 1/2, pp. 61–83.
- Schatteman, O., Woodhouse, D. and Terino, J. (2020). *Supply chain lessons from Covid-19: Time to refocus on resilience*, Bain & Company, Inc., Boston, MA. Available at: <https://www.bain.com/insights/supply-chain-lessons-from-covid-19/> (accessed at 15 May 2022).
- Schleper, M.C., Gold, S., Trautrim, A. and Baldock, D. (2021). Pandemic-induced knowledge gaps in operations and supply chain management: Covid-19's impacts on retailing. *International Journal of Operations & Production Management*, Vol. 41 No. 3, pp. 193–205.
- Seghezzi, A., Siragusa, C. and Mangiaracina, R. (2022). Enhancing in-store picking for e-grocery: an empirical-based model. *International Journal of Physical Distribution & Logistics Management*, Vol. 52 No. 4, pp. 301–323.
- Seuring, S. and Gold, S. (2012). Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management: An International Journal*, Vol. 17 No. 5, pp. 544–555.
- Singh, S., Kumar, R., Panchal, R. and Tiwari, M.K. (2021). Impact of Covid-19 on logistics systems and disruptions in food supply chain. *International Journal of Production Research*, Vol. 59 No. 7, pp. 1993–2008.
- Sodhi, M.S., Tang, C.S. and Willenson, E.T. (2021). Research opportunities in preparing supply chains of essential goods for future pandemics. *International Journal of Production Research*, <https://doi.org/10.1080/00207543.2021.1884310>.
- Stadler, H., Kilger, C. and Meyr, H. (2015). *Supply chain management and advanced planning*. Sixth edition. Springer, Berlin Heidelberg.
- Statista (2018a). *E-commerce report 2017 – Lebensmittel & Drogerie*. Available at: <https://de.statista.com/study/39179/> (accessed at 20 June 2018).

References

- Statista (2018b). *Statista consumer market outlook*. Available at: <https://de.statista.com/outlook/consumermarkets> (accessed at 20 June 2018).
- Statista (2022a). *Apparel – Germany*. Available at: <https://www.statista.com/outlook/cmo/apparel/germany> (accessed at 29 May 2022).
- Statista (2022b). *Consumer Electronics – Germany*. Available at: <https://www.statista.com/outlook/cmo/consumer-electronics/germany> (accessed at 29 May 2022).
- Statista (2022c). *Food – China*. Available at: <https://www.statista.com/outlook/cmo/food/china> (accessed at 29 May 2022).
- Statista (2022d). *Food – Europe*. Available at: <https://www.statista.com/outlook/cmo/food/europe> (accessed at 29 May 2022).
- Statista (2022e). *Food – France*. Available at: <https://www.statista.com/outlook/cmo/food/france> (accessed at 16 June 2022).
- Statista (2022f). *Food – Germany*. Available at: <https://www.statista.com/outlook/cmo/food/germany> (accessed at 29 May 2022).
- Statista (2022g). *Food – Netherlands*. Available at: <https://www.statista.com/outlook/cmo/food/netherlands> (accessed at 16 June 2022).
- Statista (2022h). *Food – United Kingdom*. Available at: <https://www.statista.com/outlook/cmo/food/united-kingdom> (accessed at 16 June 2022).
- Statista (2022i). *Food – Worldwide*. Available at: <https://www.statista.com/outlook/cmo/food/worldwide> (accessed at 29 May 2022).
- Stebbins, R.A. (2001). Exploratory research in the social sciences. *Sage University Papers on Qualitative Research Methods*. Vol. 48. SAGE Publications, Inc., Thousand Oaks.

References

- Sternbeck, M. and Kuhn, H. (2014). An integrative approach to determine store delivery patterns in grocery retailing. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 70, pp. 205–224.
- Taylor, D.H. and Fearne, A. (2009). Demand management in fresh food value chains: a framework for analysis and improvement. *Supply Chain Management: An International Journal*, Vol. 14 No. 5, pp. 379–392.
- Teller, C., Kotzab, H., Grant, D. and Holweg, C. (2016). The importance of key supplier relationship management in supply chain. *International Journal of Retail & Distribution Management*, Vol. 44 No. 2, pp. 109–123.
- Upadhyay, A., Hernandez, M. and Balodi, K. (2022). Disaster relief projects management: an exploratory study of critical success factors. *Operations Management Research*, <https://doi.org/10.1007/s12063-021-00246-4>.
- van Donselaar, K.H., Gaur, V., van Woensel, T., Broekmeulen, R.A. and Fransoo, J.C. (2010). Ordering behavior in retail stores and implications for automated replenishment. *Management Science*, Vol. 56 No. 5, pp. 766–784.
- van Gils, T., Ramaekers, K., Caris, A. and Cools, M. (2017). The use of time series forecasting in zone order picking systems to predict order pickers' workload. *International Journal of Production Research*, Vol. 55 No. 21, pp. 6380–6393.
- van Gils, T., Ramaekers, K., Caris, A. and de Koster, R.B.M. (2018). Designing efficient order picking systems by combining planning problems: State-of-the-art classification and review. *European Journal of Operational Research*, Vol. 267, pp. 1–15.
- Vanheusden, S., van Gils, T., Caris, A., Ramaekers, K. and Braekers, K. (2020). Operational workload balancing in manual order picking. *Computers & Industrial Engineering*, Vol. 141, <https://doi.org/10.1016/j.cie.2020.106269>.

References

- van Hoek, R. (2020). 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*, Vol. 40 No. 4, pp. 342–355.
- van Hoek, R. (2021). Exploring progress with supply chain risk management during the first year of the COVID-19 pandemic. *Logistics*, Vol. 5 No. 70, <https://doi.org/10.3390/logistics5040070>.
- van Hoek, R. and Dobrzykowski, D. (2021). Towards more balanced sourcing strategies – are supply chain risks caused by the COVID-19 pandemic driving reshoring considerations? *Supply Chain Management*, Vol. 26 No. 6, pp. 689–701.
- van Hoek, R. and Loseby, D. (2021). Beyond COVID-19 supply chain heroism, no dust settling yet – lessons learned at Rolls Royce about advancing risk management thinking. *International Journal of Operations & Production Management*, Vol. 41 No. 10, pp. 1579–1592.
- Vazquez-Noguerol, M., Comesãna-Benavides, J., Poler, R. and Prado-Prado, J.C. (2022). An optimisation approach for the e-grocery order picking and delivery problem. *Central European Journal of Operations Research*, Vol. 30, pp. 961–990.
- Verhoef, P.C., Kannan, P.K. and Inman, J.J. (2015). From multi-channel retailing to omni-channel retailing. *Journal of Retailing*, Vol. 91 No. 2, pp. 174–181.
- Verma, S. and Gustafsson, A. (2020). Investigating the emerging Covid-19 research trends in the field of business and management: A bibliometric analysis approach. *Journal of Business Research*, Vol. 118, pp. 253–261.
- von Viebahn, C., Landwehr, M. and Trott, M. (2020). *The future of grocery shopping? A taxonomy-based approach to classify e-grocery fulfillment concepts*. Available at: https://library.gito.de/oa_wi2020-j2.html (accessed at 16 March 2021).

References

- Voss, C., Tsikriktsis, N. and Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Production Management*, Vol. 22 No. 2, pp. 195–219.
- Wensing, T., Sternbeck, M. and Kuhn, H. (2018). Optimizing case-pack sizes in the bricks-and-mortar retail trade. *OR Spectrum*, Vol. 40, pp. 913–944.
- Wilding, R. (2013). Multichannel or omnichannel? *Logistics and Transport Focus*, Vol. 15 No. 10, pp. 44.
- Wilding, R. and Juriado, R. (2004). Customer perceptions on logistics outsourcing in the European consumer goods industry. *International Journal of Physical Distribution & Logistics Management*, Vol. 34 No. 8, pp. 628–644.
- Williams, B.D. and Waller, M.A. (2010). Creating order forecasts: Point-of-sale or order history? *Journal of Business Logistics*, Vol. 31 No. 2, pp. 231–251.
- Wollenburg, J. (2017). *Empirical studies in multi-channel and omni-channel retail operations and logistics*. Doctoral thesis, Catholic University Eichstätt-Ingolstadt, [urn:nbn:de:bvb:824-opus4-3528](https://nbn-resolving.org/urn:nbn:de:bvb:824-opus4-3528).
- Wollenburg, J., Holzapfel, A., Hübner, A. and Kuhn, H. (2018a). Configuring retail fulfillment processes for omnichannel customer steering. *International Journal of Electronic Commerce*, <https://doi.org/10.1080/10864415.2018.1485085>.
- Wollenburg, J., Hübner, A., Kuhn, H. and Trautrim, A. (2018b). From bricks-and-mortar to bricks-and-clicks – Logistics networks in omni-channel grocery retailing. *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 4, pp. 415–438.
- Wruck, S., Vis, I.F.A. and Boter, J. (2017). Risk control for staff planning in e-commerce warehouses. *International Journal of Production Research*, Vol. 55 No. 21, pp. 6453–6469.

References

- Xiong, Y., Lam, H.K.S., Kumar, A., Ngai, E.W.T., Xiu, C. and Wang, X. (2021). The mitigating role of blockchain-enabled supply chains during the Covid-19 pandemic. *International Journal of Operations & Production Management*, Vol. 41 No. 9, pp. 1495–1521.
- Yin, R.K. (2018). *Case study research and applications*. Sixth edition. SAGE Publications, Inc., Los Angeles.

Appendix

Overview of interview guideline of Chapter 3

Standard processes

- How does the distribution of the picking volume during a week look like?
- Which flows of goods are common between the suppliers and the stores?
- How often do you deliver each product category to the stores?

General insights on public holidays

- What are the major logistics challenges for grocery retailing before and after public holidays? Why are they challenging?
- Which planning areas are affected most by public holidays and why?
- How do public holidays influence the daily turnovers?

Disposition

- Which problems occur in forecasting and disposition of public holiday seasons? Why are they challenging?
- Are there specific solution approaches to face disposition challenges in public holiday seasons? How do these approaches look like and what are the reasons behind?
- How are public holidays parameterized in your forecasting system?
- How do you adjust order quantities before public holidays? Why?
- How is the shift of the demand if a public holiday leads to a missing sales day?
- How do store disposition processes, e.g., order times, change in public holiday seasons?

Appendix

Warehouse planning

- Which problems occur in the warehouse in public holiday seasons? Why are they challenging?
- Are there specific solution approaches to face challenges in warehousing in public holiday seasons? How do these approaches look like and what are the reasons behind?
- How are holiday specific articles integrated in the warehouses?
- How do you deal with the reduced amount of potential picking days in public holiday weeks?
- Why have you designed your warehouse operations like this?
- Do you use stockpiling and how do you organize this with the stores?

Transport planning

- Which problems occur in the transport domain in public holiday seasons?
- Are there specific solution approaches to face transportation challenges in public holiday seasons? How do these approaches look like and what are the reasons behind?
- How do you execute the transport planning in public holiday seasons?
- Do you adjust tour plans, delivery rhythms, ramp management, etc.? How do you do this?
- Why have you chosen these instruments?
- How are internal store processes changed due to transportation?