An exploration of the operations-marketing interface in the omni-channel context

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Declaration of authorship

I am the author of this thesis, and the work described therein was carried out by myself personally, except for chapter four where 20% of the work was carried out by other researchers. The co-authors supported with the design of methodology and presentation of data in journal format.

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I have learned a lot by completing the PhD journey. I am very proud to be a doctoral student at the University of Bath. I am a different person at the end of the journey than I was at the start. I have thoroughly enjoyed my time at IDO, I have always felt enormous support and encouragement from the IDO team.

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Thank you,

Stuart Milligan

Abstract

Over the past twenty years, the retail industry has experienced a paradigm shift that has shaped the market significantly. In attempts to grow sales and gain market share, retailers have enhanced their proposition to make shopping more convenient. Defined as omni-channel retailing, retailers employ technology to integrate online and offline retail channels to offer customers a seamless shopping experience, where they can shop for whatever they want, wherever, and whenever they want to. As this strategy has become more widely adopted, retailers seek to differentiate themselves from competitors by offering ever-increasing ranges of goods at ever decreasing fulfilment times, with same day/ next day deliver firmly established as an industry standard. Whilst the adoption of an omni-channel strategy has proven successful for retailers from a marketing perspective, it has resulted in significant challenges from an operations perspective. The emerging narrative from an operations management perspective indicates that omni-channel fulfilment is associated with a proliferation of inventory, increased complexity, capacity challenges, and a marked increase in operating costs (compared to other configurations of retail fulfilment). In recognizing this problematic situation, the aim of this thesis is to address the question, *how can retailers effectively align operations to meet the demands of omni-channel retail?*

In line with the authors' philosophical perspective of pragmatism, Dewey's process of inquiry is employed as a template for research. The early stages of the process of inquiry are addressed through individual studies presented as unpublished research papers, the reasoning stage is addressed in the discussion chapter. To bring clarity to the *indeterminate situation* that exists at the operations-marketing interface in the omni-channel context, a systematic literature review is conducted to provide a state-of-the-art understanding of the field. Further clarity is provided using secondary practitioner sources to validate the propositions emerging from the literature review. The *institution of a problem* stage is addressed by adopting a structural contingency theory lens and using a proprietary data set from a leading UK omni-channel grocery retailer to explore the back-end fulfilment performance implications of adopting an omni-channel retailing strategy. Panel data analysis is used to quantify the magnitude of the deleterious back-end fulfilment performance resulting from omni-channel adoption and to explore how performance varies by fulfilment network mode. The *determination of a problem solution* stage is addressed by adopting a complex adaptive systems theory lens and conducting a qualitative study on the case organisation to understand the constituent elements of the

problem. The *reasoning* stage is addressed in the discussion and conclusions chapter where two suggested solutions arising from the previous studies are explored.

The inquiry conducted in this thesis has yielded some important findings. First, omni-channel fulfilment will vary according by perishable, non-perishable, and online retailer types (named mode 1,2 and 3, respectively). Second, by focusing on mode 1 fulfilment (the mode typically adopted by UK grocery omni-channel retailers whereby existing bricks and mortar retailers have transitioned into omni-channel retail by adding online channels to the existing offline channels), the findings support the proposition that increased omni-channel retail activity results in decreased fulfilment performance. Additionally, fulfilment performance will vary by ambient and chilled distribution network modes. Finally, current configurations of omni-channel fulfilment are not sustainable from an economic or environmental perspective.

The primary limitation of this thesis is that it does not result in what Dewey refers to as a *unified solution*. This thesis progresses the problems observed at the operations-marketing interface in the omni-channel context from the *indeterminate situation* stage through to the *reasoning* stage of inquiry. To progress beyond this stage, the two suggestions presented in the discussion and conclusion chapter would need to be developed into *experiments* stage of inquiry, where mode 1 omni-channel retailers would be required to adopt the suggestions and observations made regarding the impact the suggestions had on both the operations and marketing functions of omni-channel retail. It is likely that the findings of these experiments do not immediately lead to a *unified solution* and further iterations of the process of inquiry are required. These latter stages are beyond the scope of this thesis.

This study reveals several important implications for practice. First, for mode 1 retailers' online fulfilment is more expensive than offline fulfilment. As online sales continue to grow, this is likely to have an ongoing negative impact upon overall profitability for the retailers. Second, it will be far easier for mode 3 retailers to efficiently transition to omni-channel, rather than mode 1 retailers incorporating online fulfilment. Third, due to the inherent conflicts that exist between online and offline channels of fulfilment, it is unlikely that omni-channel fulfilment can ever be as efficient as single-channel fulfilment. Fourth, due to the increased fulfilment costs associated with omni-channel, mode 1 retailers are at a competitive disadvantage compared to bricks and mortar discount retailers as they are unlikely to ever be able to compete on price. Fifth, cutting-edge logistics technologies are effective at increasing inventory transparency and improving fulfilment planning. It is unlikely that these solutions

will address the fulfilment channel conflicts that currently exists within mode 1 fulfilment configurations. This leads to the final implication, that as omni-channel activity continues to grow, new configurations of omni-channel fulfilment will be required for those bricks and mortar retailers who have transitioned to omni-channel retailers.

This study makes several important contributions to the scholarly literature concerned with omni-channel fulfilment. First, this study identifies and categorizes the different modes of fulfilment configurations that exist for omni-channel retailers. Second, building on the previous case studies that have been presented in the literature, this is the first study to demonstrate to a level of statistical significance that the adoption of an omni-channel marketing strategy has a negative impact upon fulfilment performance. Relatedly, it is the first study to quantify the magnitude of the impact that adopting an omni-channel strategy has upon fulfilment operations. Fourth, by identifying the constituent elements of the problem situation that exists within the operations-marketing interface in the omni-channel fulfilment context, two alternative configurations of mode 1 fulfilment have been suggested. Finally, the findings of this study have raised interesting questions around the application of structural contingency theory and complex adaptive systems theory in the omni-channel fulfilment context that warrants further inquiries.

Chapter 1

1. Introduction

Over the past twenty years, the ability of the operations function to meet expectations presented by the externally-focused marketing function has diminished to the extent that a new approach is now required (Bijmolt et al., 2021, Goh and Eldridge, 2019, Tang, 2010). Organisations are using marketing strategies such as digitally enabled, personalised e-commerce (Forbes, 2022) and same-day, next-day delivery (Chen et al., 2022) to distinguish themselves from their competitors and grow their market share. From an operations perspective, these marketing actions are driving unsustainable shipping costs (Blackhill, 2021), a lack of warehouse space (Hammond, 2021), and a shortage of skilled workers in the fulfilment sector (Logistics UK, 2022). Additionally, there is also a significant environmental impact to consider with such operations contributing to annual global freight carbon emissions of 2.4 Gt (iea, 2021) and to the 4.2 million deaths annually resulting from poor air quality (WHO, 2022).

Despite being a topic of interest for some time, the study of the marketing-operations interface is still at an immature stage (Bijmolt et al., 2021). Fundamentally, this interface is concerned with how an organisation manages its internal resources to provide the necessary capabilities to achieve the market-facing proposition that it offers to its customers (Marques et al., 2014, Tang, 2010). In his seminal work Shapiro (1977) compared the marketing-operations interface to walking a tight-rope in recognition of the conflicts that are likely to arise in managing these two disparate functional areas. A useful contemporary context to explore the marketing-operations interface is grocery omni-channel retail (Gallino and Moreno, 2019, Mak, 2018, Gao and Yang, 2016).

Almost half of all retail customers now demand a personalised shopping experience across all channels (Mobbs, 2019). Characterized by a customer-centric marketing strategy, omni-channel retail provides customers with a seamless shopping experience across both marketing and fulfilment channels (Brynjolfsson et al., 2013), offering customers the products that they want, when, and where they want them (Lemon and Verhoef, 2016, Rigby, 2011). As an evolution of multi-channel retailing, where the channels of marketing and fulfilment were managed independently (Davis-Sramek et al., 2020a), omni-channel is a retail strategy that relies on the integration of the multiple channels of marketing and fulfilment to serve customers (Raza and Govindaluri, 2021).

The attraction of an omni-channel marketing strategy to retailers is clear; it allows them to reach more customers and grow their market share (Abdulkader et al., 2018, Armstrong, 2016), it meets customer demands by providing speed, convenience, and flexibility (Akter et al., 2021), it also provides the retailer with multiple touchpoints across channels in the customer purchase journey, increasing sales and customer loyalty (Timoumi et al., 2022, Barann et al., 2022, Larke et al., 2018). The advantages of adopting omni-channel fulfilment (OCF) are much less certain (Buldeo et al., 2019). Whilst there is a suggestion that the integration of multiple channels of fulfilment should drive synergies for the retailer (Kaczorowska-Spychalska, 2017, Saghiri et al., 2017), there is an emerging discourse highlighting the operational challenges associated with OFC. Recent studies highlight OFC's are more sensitive to inventory inaccuracies (Barratt et al., 2018), require increased internal stock movements (Kembro et al., 2018), is more costly (Ishfaq et al., 2016), increases stock-holding (Kembro et al., 2018), and much more difficult to forecast demand accurately (Pereira and Frazzon, 2021, Wollenburg et al., 2018). The omni-channel retail context has gained significant attention over the past ten years. Most studies explore omni-channel either from a marketing perspective or from an operational perspective. This study adds to the relatively few studies in existence that explore omni-channel at the operations-marketing interface.

8.6 Defining the field of study

Omni-channel is an approach that seeks to deliver a seamless customer experience across channels (Hoogveld and Koster, 2016, Murfield et al., 2017). From this perspective, the definition of channels offered by Neslin et al. (2006:96) is adopted "*A customer contact point, or a medium through which the firm and customer interact".* Omni-channel retail supports a strategy of an "everywhere commerce" experience that connects the brand to the customer (Angeleanu, 2015). It is a strategy that explicitly focusses on the customer experience, allowing them to get the products they desire, when, where, and however they wish, and to have an equally satisfying experience regardless of the channel used (Jeanpert and Paché, 2016). A further defining characteristic of omni-channel marketing is the adoption of technology, especially mobile and social media technologies to a seamless shopping experience (Gonzalez-Lafaysse and Lapassouse-Madrid, 2016).

To support the marketing proposition promised by the omni-channel strategy, integration is also required in the channels of supply (Pereira and Frazzon, 2021, Ailawadi and Farris, 2017). From a fulfilment perspective, previous studies have identified Buy Online Pick-up in store (BOPS) (MacCarthy et al., 2019), ship-to-store (Akturk et al., 2018), Grocery Home Shopping

(GHS)/ Ship-from-store (Lim and Singh, 2018), Reserve Online, Pick-up in store (Jin et al., 2018), locker boxes (Agnihotri, 2015), and delivery to customer cars (Gibbs, 2018) as channels of fulfilment. Omni-channel fulfilment is operationally required to supply a single customer as effectively as a retail store (Burkitt-Gray, 2016), as such, previous studies emphasise the agile nature of omni-channel fulfilment (Ishfaq et al., 2016, Murfield et al., 2017). The extant literature relating to omni-channel supply chains identifies suppliers (Saghiri et al., 2017), internal distribution networks (Kembro and Norrman, 2021), retail stores (Hübner et al., 2016b), last-mile logistics (Lim and Singh, 2018), and customer returns (Frei et al., 2020) as components of omni-channel supply. As this thesis is concerned with the management challenges found at the marketing-operations interface, a narrower unit of analysis is adopted, exploring the relationship between back-end fulfilment and customer purchases. This unit of analysis can be seen in context in *figure 1* which details a typical omni-channel retail fulfilment network.

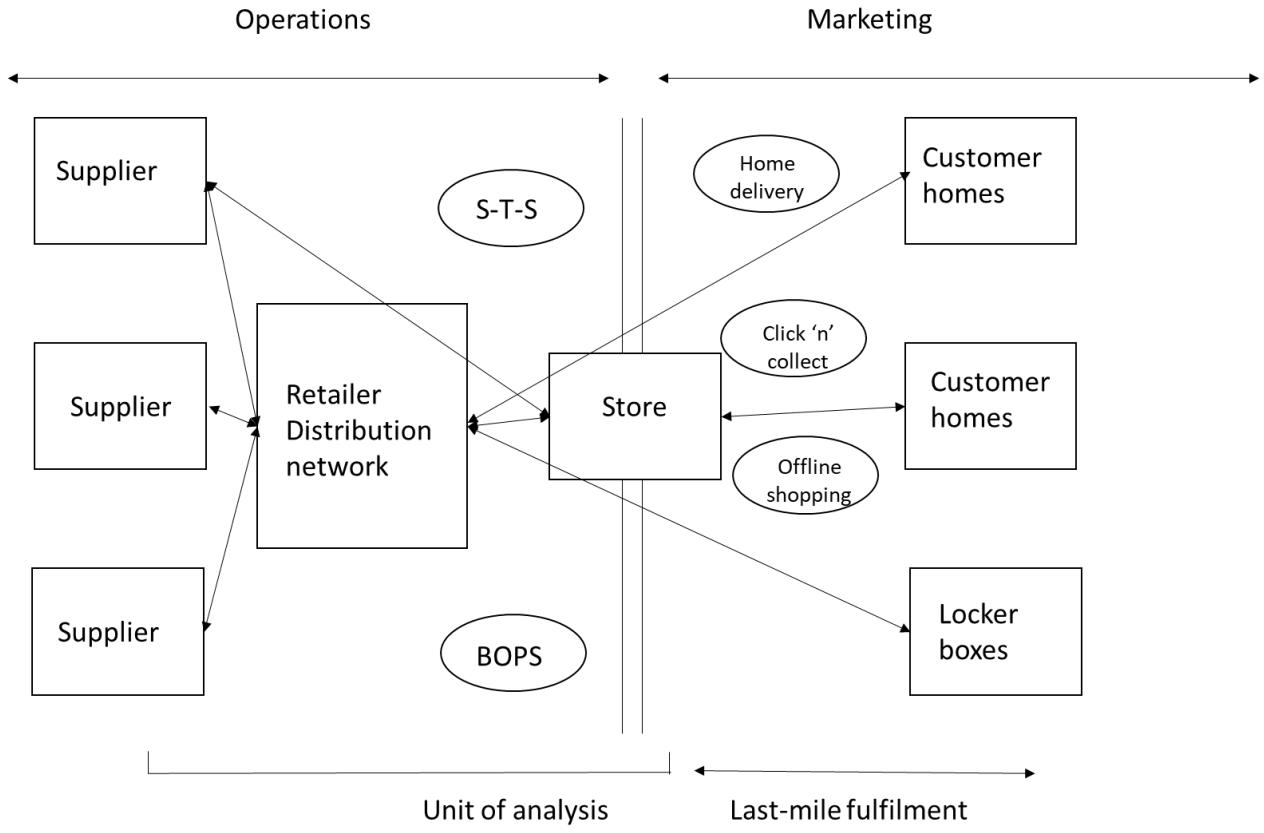


Figure 1: Unit of analysis of study

Specifically, this thesis explores the operations-marketing interface in the omni-channel context by studying the movement of both products and information between at the point where products are shipped from fulfilment operations into retail operations. The multiple supply

chain configurations that exist within omni-channel retail means that this interface will vary between categories of retailer (Saghiri et al., 2017). Irrespective of retail category, the retailer distribution network represents integrated fulfilment channels that are employed to concurrently pick and ship orders for both store replenishment and individual online orders (Kembro et al., 2018, Hübner et al., 2016c, Ishfaq et al., 2016). In the grocery retail sector, it is common for retailers to select several distribution centres to manage slow moving products and use the rest of the distribution estate to manage the fulfilment of fast-moving products (Kembro and Norrman, 2021, Wollenburg et al., 2018). Here, omni-channel fulfilment has caused the role of the store to change; in addition to merchandising products for offline customers, in omni-channel fulfilment, stores are also used as fulfilment centres for online orders (Gao et al., 2022, Larke et al., 2018, MacCarthy et al., 2019). Many of the omni-channel fulfilment processes, such as buy-online, pick-up in store (BOPS) and ship-to-store (S-T-S), are designed to encourage additional customers into physical stores, increasing sales In both the online and offline channels (Abdulkader et al., 2018, Akturk et al., 2018). Pure-play omni-channel retailers such as Amazon and Alibaba typically deliver directly to customers homes or locker box locations directly from their internal fulfilment network or arrange for suppliers to ship orders directly to customers homes (Han et al., 2018).

An understanding of the operational challenges associated with omni-channel fulfilment are emerging from the existing conceptual and limited qualitative empirical studies in this area. Previous studies have identified that the short lead-time and low delivery density associated with the fulfilment of online orders drives inefficient fulfilment operations (Buldeo et al., 2019; Lim and Sing., 2018). A common goal concerning fulfilment efficiency is to reduce the number of freight trips completed (Sathaye et al., 2010). Vehicle fill is a standard indicator of fulfilment efficiency. Vehicle fill measures how much available capacity is utilised on each freight journey (Chopra & Meindl, 2007). Increased vehicle utilisation is strongly associated with fulfilment efficiency (Santen, 2017; Novas et al., 2020). The variable nature of customer shipments means that it is typical for the shipment size not to align precisely with the capacity available in a single freight trip, generating less than full loads (Ni & Wang, 2021). In such cases, improved utilisation can only be achieved by driving vehicles out of their way to make extra stops (Hall, 1987), resulting in longer travel routes and travel times (Wokenius, 2012). As a result, combining multiple deliveries onto one vehicle to complete a pre-defined route is established to increase fulfilment efficiency (Arvidsson, 2013). Fulfilment efficiency can be influenced by overall volume requirements (Rizet & Cruz, 2012), transportation

distance (Abate et al., 2014; Zou et al., 2015), required delivery times (McKinnon et al., 1997), delivery vehicle types (McKinnon & Edwards, 2010), route optimisation, and delivery schedules (Rogerson et al., 2017).

Fulfilment efficiency is a particular challenge for omni-channel retailers as demand is highly volatile and dynamic, making it difficult for them to optimally configure their infrastructure (Zhang et al., 2019). There is also a strong suggestion that the adoption of omni-channel fulfilment by bricks and mortar retailers requires significant investment (Wollenburg et al. 2018; Hubner et al., 2016c; Ishfaq et al., 2016). In summarising the state-of-the-art of omni-channel research, Asmark et al, (2022) noted that it is a novel and emerging area that now requires theory-driven research to advance knowledge. This thesis adds to this existing field of inquiry by conducting an exploration of the ways in which retailers manage their fulfilment operations when transitioning to an omni-channel strategy. To this end, four studies are presented. The first study is a systematic literature review, the contribution of which is a categorization of the varying approaches retailers have adopted to organize their fulfilment operations. The second study uses secondary data to confirm the three approaches identified in the first study. The third and fourth papers focus on the approach typically adopted by UK Grocery retailers who have transitioned from bricks and mortar retailers to omni-channel retailers. The third paper investigates impact of adopting omni-channel fulfilment upon fulfilment operational performance and the fourth paper explores the management decisions which have led to current configurations of omni-channel fulfilment for this retail type.

8.6 Previous studies exploring omni-channel fulfilment

Studies exploring the operational aspects of omni-channel retail have emerged over the past five to eight years. Early studies were predominantly descriptive in nature and tended to focus on the structure and nature of omni-channel fulfilment. These studies indicated that supplier distribution networks, retailer distribution networks, and retail stores form the omni-channel fulfilment system (Hubner et al., 2016a; Ishfaq and Defee, 2016; Saghiri et al., 2017). Of consequence, in omni-channel fulfilment systems, stores are not only responsible for the merchandising of offline goods for sale, but also for the fulfilment of online orders (Ishfaq and Defee, 2016). One of the operational benefits of omni-channel fulfilment systems is the ability for networks to integrate inventory across channels, supporting flexible and demand-driven inventory allocation (Hubner et al., 2016b). Conceptualisation of omni-channel fulfilment presented omni-channel as a singular concept comprising of a variety of omni-channel supply chains (Hubner et al., 2016c; Saghiri et al., 2017).

Recent studies have focussed on approaches to optimise fulfilment operations to minimise the deleterious impact of adopting omni-channel fulfilment. This literature can be further categorised by studies which explore the optimisation of channel integration, infrastructure configuration, and warehouse configuration. With respect to channel integration, Jones et al. (2022) provided consensus for the earlier work of Huber et al. (2016b) in finding that fulfilment channel integration supported superior retail performance. Both Arslan et al. (2021) and Hence and Hubner (2021) have proposed analytical solutions to determine the optimum level of channel integration for various omni-channel supply chains. There is, however, some debate within the literature regarding the operational impact of channel integration. Melacini and Tappia (2018) found that if channel integration is successful, it should yield synergies in both warehouse and transport activities, leading to economic and environmental sustainability. In contrast, Wollenburg et al. (2018) found that channel integration only typically provides operational benefits in non-food retail. In grocery retail, the benefits are dependent upon product, market, and retailer specifics.

There have been several analytical studies seeking to determine the optimal fulfilment infrastructure for omni-channel operations. Hu et al (2022) developed an algorithm to determine the optimal location for retail stores in a city to minimise logistics costs and maximise offline sales. Gao et al (2022) proposed that omni-channel retailers should have fewer physical stores that are larger in size if they experience high return rates for online purchases, and they should have more stores that are smaller in size if they have strong online sales. Ishfaq and Bajwa (2019) explored different fulfilment configurations using distribution centre, direct-to-customer fulfilment centres, retail stores, and vendor facilities to reduce fulfilment costs of online orders for store-based retailers. Similarly, Prabhuram et al (2020) identified four different distribution network configurations of omni-channel and found that integrated transport and warehouse configurations presented better operational performance than non-integrated configurations.

The topic of warehouse configuration has received less attention that the other two omni-channel configuration topics. Kembro and Norrman (2020) highlighted the importance of aligning warehouse configuration with the operational requirements of both upstream and downstream channel partners. They then contributed further by identifying sixteen contextual factors that influenced warehouse configuration, of which assortment range, online fulfilment time, goods size, and volume of sales are the most influential (Kembro and Norrman, 2021).

The section that follows shall detail the philosophical perspective adopted to move this research area forward and address the research question.

8.6 Philosophical perspective

At the core of all research is the question of *why* the research is undertaken in the first place. Once this is understood, the *how* to do research becomes more apparent. The exploration of *why* research is undertaken is typically the concern of one's philosophical perspective (Easterby-Smith et al., 2012). Most discussions concerning philosophical perspective within the social sciences focus on the agreed set of beliefs and practices which guide the field of research, these are typically referred to as paradigms (Kuhn, 1962, Morgan, 2007). The widely accepted framework for categorizing paradigms is that of Burrell and Morgan (1979) who proposed that there are two dimensions for the study of the social sciences, the nature of science and the nature of society. Each of these dimensions can be understood from two opposing perspectives, science can be understood objectively or subjectively, and society can be understood as being regulated or going through radical change. Each of these perspectives by nature are mutually exclusive, resulting in the four mutually incommensurate paradigms (Kuhn, 2012) of radical humanist, interpretive, functionalist and radical structuralist. This paradigm "lock" is problematic in that it demands that research must be either quantitative or qualitative, inductive or deductive, this simply is not reflective of how research is conducted (Johnson and Onwuegbuzie, 2004). In response to these restrictions, social science researchers are adopting an alternative perspective in the form of pragmatism (Gregor, 2006, van Zyl, 2015). Pragmatism can be viewed as a paradigm in its own right, it is a flexible perspective which supports paradigm-crossing, where findings from one paradigm are used to inform research to be undertaken in another paradigm (Cronje, 2016). Pragmatism is a complex philosophical perspective with roots dating back to the works of Charles Peirce and John Dewey in the late 19th and early 20th Century (Neubert, 2009, Wicks and Freeman, 1998). Over time, pragmatism has developed considerably, the remainder of this section shall be devoted to exploring the pragmatic perspective and demonstrating it application in this research.

Pragmatism has a socially flexible ontology (Pratt, 2016), where research is an iterative process between the researcher and the environment. This means that as researchers we understand the world through the active process of exploration (Alexander, 2012). There is no concept of dualism in pragmatism (e.g. psychological- physical, theory -action) as is associated with the classic metaphysical paradigms (Biesta, 2010). Pragmatism views theories as tools or instruments to help us cope with situations as they arise and to construct meaning by applying

concepts in an experimental way (Brandi and Elkjaer, 2011). From a research perspective, pragmatists explore areas where they feel they can make a difference through their research, they do this because they feel that they have a responsibility to take action (Putnam, 1995). This ontological perspective is much broader than the ontological assumptions of other paradigms (Morgan, 2007). Pragmatism recognises that individuals are shaped by anthropic impulses (Dewey, 1983), which establishes human behaviour as an organisation of perceptions and actions (Alexander, 2012). A key concept of the ontology of pragmatism is that of habit (Dewey, 1983), where perceptions are the result of human reactions to phenomena, and these reactions are based on past experiences. According to the pragmatic ontology, social actors will seek to do what they think will work (Hildebrand, 2008). Scientific truth, for the pragmatist, is therefore the emerging consensus from an experienced, empirical reality is simply the best explanation of what is probably going on (Suddaby, 2006). To extend this concept, pragmatism contends that reality can be both objective and subjective in that there may be a single reality but it is possible, and even desirable, for individual actors to have different subjective perspectives of what reality is (Webb, 2007). Pragmatism presents a useful ontology as it does not concern itself with debates around truth(s) or reality/ realities, instead it philosophically reconciles that there may be a singular or multiple realities, however the primary concern is addressing the practical problems in the real world (Creswell and Clark, 2017, Rorty, 2009, Feilzer, 2010).

The epistemology (the relationship between the researcher and sources 8nowledge (Hallebone and Priest, 2008)) of pragmatism is acknowledged as fallibilism, instrumentalism and warranted guidance (Martela, 2015). The pragmatic researcher understands that their research will not allow them to generate results which will allow them to know with certainty what is going on, rather the best that can be achieved is knowledge which they hope might improve the indeterminate situation (Dewey, 1938, Powell, 2002). Pragmatism therefore embraces fallibilism (Dewey, 1938) in that it is impossible to know anything absolutely (Peirce et al., 1994). Pragmatism is then judged on its ability not to find absolute truth, rather to progress matters so that they improve (Joas, 1993). To this end, a key aspect of the pragmatic epistemology is following up on researched areas to see if the suggested solutions were useful (Baert, 2003, James and Thayer, 1975). Strictly speaking, this epistemological tenet falls out of the scope of this thesis as the warranted assertion of a better model of omni-channel fulfilment would be required to be employed for a number of years post implementation to

demonstrate an improvement on the indeterminate situation. This thesis is therefore more appropriately understood as a partial pragmatic inquiry.

To address the instrumentalism characteristic, the pragmatist is best viewed as somewhat of a middle-ground in the science/ society continuum of Burrell and Morgan (1979). Pragmatism separates the "brute facts" of science and the consensus of "social facts" and synthesizes them as the implications of social facts upon science (Pratt, 2016, Webb, 2007). The focus is on utility not on politics or perspectives.

The epistemological characteristic of warranted guidance is best understood through an exploration of the term abduction (Peirce, 1878). The abductive stance permeates from the understanding that the majority of the significant discoveries in science neither followed the pattern or pure deduction nor pure induction (Kirkeby, 1994, Taylor et al., 2002). Abduction is best understood as a surprising fact which once observed, the researcher searches for a hypothesis which would best explain this surprising fact (Martela, 2015), it can be viewed as systemized-creativity to develop "new" knowledge (Kovács and Spens, 2005). Abduction is similar to induction and deduction in that it is used to make logical inferences or to construct theories (Mitchell, 2018). In the pragmatic approach, abduction is the iterative process of moving back and forth between induction and deduction by first creating theories and then assessing these theories through action (Morgan, 2007, Yu, 1994). The abduction principle is very closely related to the principle of fallibility as the testing of new concepts acknowledges the fallibility of human knowledge (Powell, 2002).

The ontology and epistemology of a paradigm are prescriptive in the methods a researcher will employ to collect and analyse data (Crotty, 1998). As pragmatism adopts an abductive epistemology, pragmatism supports the use of mixed methods when conducting research (Mitchell, 2018). The advent of mixed methodologies has been recognised as a response to the "paradigm wars" (Feilzer, 2010), where quantitative (more positivist) and qualitative (more constructivist) academics claim superiority of their approach over the other (Creswell and Clark, 2017, Erlandson et al., 1993). The use of mixed methods supports the "whatever works" ethos of pragmatism by synthesizing the insights provided by qualitative and quantitative research to a valuable solution (Johnson and Onwuegbuzie, 2004).

Pragmatism therefore, is a philosophical perspective that highlights the importance of discovery through experience and inquiry, as well as discovery through the development of societal consensus (Brandi and Elkjaer, 2011, Popa et al., 2015). Discovery from a pragmatic

perspective in four discrete stage: observation of a phenomena, the abductive prediction of what might happen, a new action to test the prediction and then interpretation to validate if the correct action was taken (Whitford, 2002). *Table 1* below summarizes the pragmatic perspective and details how it is applied to this research:

Element	Description	Application
Ontology	Experientialism	Engaging with participants who are active in the practice of omni-channel
Epistemology	Abductive, Fallibilistic, instrumentalism	Validating that omni-channel is a complex adaptive system requires an abductive approach. This is new theory, and the researcher recognises that the findings now may not hold true as the strategy of omni-channel evolves
Method	Mixed method	The author is adopting a systematic literature review to generate a conceptual framework of the operations-marketing interface in the omni-channel context. Based on this observation quantitative and qualitative research will be conducted to validate this model. Research beyond this thesis will explore the impact of the findings of this research (Whitford, 2002).

Table 1: The application of pragmatism to this research

In line with the perspective of pragmatism, this thesis is structured in accordance with the with the pattern of inquiry as presented by Dewey. Dewey (1999-105) defined inquiry as "*the*

controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole.". Whereby an indeterminate situation is situation where elements do not fit together resulting in an unknown outcome (Stremba, 2009). A synthesis of the extant literature leads to the followIng indeterminate situation with respect to omni-channel fulfilment.

8.6 Thesis statement: Indeterminate situation

Whilst omni-channel retail is associated with increased sales and stronger market share, the adoption of an omni-channel fulfilment model is associated with both increased fulfilment costs and a negative environmental impact.

8.6 Pattern of inquiry

Dewey proposed a structured process could be applied to an indeterminate situation which would result in a judgement, which, with the application of judgement could be transformed into determinately unified situation (Dewey, 1999). A diagrammatic representation of this process can be found in *figure 2.*

Conducting

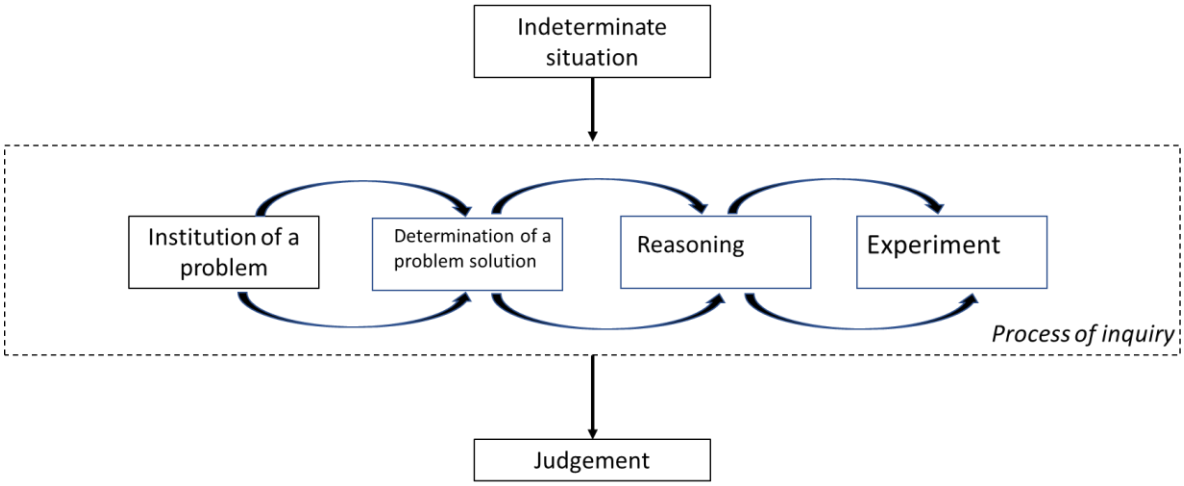


Figure 2: Diagrammatic representation of Dewey's process of inquiry

The process of inquiry is an iterative process comprising of four stages, the output of which is a solution or solutions which requires judgement to determine if they will transform the indeterminate situation to a determinate solution. The *institution of a problem* is the first step of the process where the inquirer takes the steps necessary to judge the situation as problematic. This step should provide clarity as to what the problem and problems are within a problematic

situation. The *determination of a problem solution* is the recognition that the determination of a genuine problem is a progressive inquiry. This step should result in the formation of a genuine problem that is so controlled that further inquiries will move toward a solution. This step is concerned with identifying the constituents of a given situation. Once these are identified, suggestions can then be made to transform the situation. These suggestions propose what might be possible and make predictions about potential outcomes. The *reasoning* step is concerned with developing the suggestions to a state where they can be tested. This involves firmly grounding the suggestions in the situation and demonstrating their value above other routes of inquiry. The final step is *experiment.* This step involves conducting a controlled experiment that allows the hypotheses developed in the reasoning stage to be tested. Based on the outcome of the experiment, a *judgement* is required to determine whether the hypothesized solutions will lead to the transformation of the indeterminate situation into a determined unified state. In accordance with Dewey's process of inquiry, the remainder of the thesis is structured as follows.

Chapters two through four are individual studies which progress this inquiry from the *indeterminate situation* through to the *reasoning* step of the process of inquiry. Chapter two is a systematic literature review. This paper builds on this introduction chapter by providing further clarity to the *indeterminate situation* and progressing the inquiry to the *institution of a problem stage*. The paper finds that omni-channel strategies are becoming of increased importance within the retail sector. Research relating to omni-channel is limited, with the two dominant lenses of marketing and operations management progressing research in a predominantly siloed manner. The paper advances the understanding of omni-channel by going beyond the established boundaries, synthesising the two lenses to generate a holistic framework explicitly identifying the symbiotic relationship between the two functions and providing an agenda for future research. Not only does the paper highlight definitional problems in the omni-channel situation, but it also indicates multiple modes of solution, further complicating the indeterminate situation.

Chapter three moves the inquiry from the *institution of a problem* phase to the *determination of a problem* solution phase. To create greater focus, the study presented in this chapter uses data from a mode 1 omni-channel grocery retailer. The study allows through empirical observation, the quantification of the problem. The study identified contingent variables associated with omni-channel fulfilment, the constituent elements of the problem situation. The study indicated that the retailer observed had already attempted to implement

some suggestions to address the challenges associated with omni-channel fulfilment. The findings indicate that thus far, these suggestions were insufficient to transform the indeterminate situation.

Chapter four is a single case study on the mode 1 omni-channel retailer that provided the empirical data for the study presented in chapter four. This study addresses the *institution of the problem~ determination of a problem situation~ reasoning* interfaces as it explores why the constituent elements identified in chapter four were insufficient to transform the indeterminate situation. The study suggests that the current approach adopted by grocery retailers of attempting to create efficiencies by leveraging their existing fulfilment infrastructures is unlikely to succeed due to the inherent conflicts that exist across several dimensions of omni-channel fulfilment.

Chapter five explores the reasoning stage of the process of inquiry further by exploring alternative configurations of mode 1 fulfilment. The alternative configuration is presented as a warranted assertion, an empirically backed alternative solution to the indeterminate situation (Dewey, 1941). The chapter concludes by indicating the necessary steps to complete the process of inquiry and make a judgement whether the solution may lead to a transformed state of determinate unity. The thesis concludes with chapter six where the contribution made by the thesis is discussed and conclusions presented.

Chapter 2

An exploration of omni-channel through the lenses of marketing and operations management: a systematic literature review and research agenda

Abstract

Omni-channel strategies are becoming of increased importance within the retail sector. Research relating to omni-channel is limited, with the two dominant lenses of marketing and operations management progressing research in a predominantly siloed manner. The purpose of this paper is to address this need for a more integrated approach by conducting a systematic literature review exploring the theoretical and practical advancement of the field through both the marketing and OM lenses. This paper advances the understanding of omni-channel by going beyond the established boundaries, synthesising the two lenses to generate a holistic framework explicitly identifying the symbiotic relationship between the two functions and providing an agenda for future research.

8. Introduction

The dominance of omni-channel as a strategy is of increasing importance within the retail sector (MMR, 2018b, Galipoglu et al., 2018, Schmaus et al., 2017). Omni-channel retailing is characterised as a customer-centric retailing strategy, providing customers with a seamless shopping experience across channels, giving them the product they want, where, and when they want it (Akter et al, 2021, Brynjolfsson et al., 2013,Baird and Kilcourse, 2011). The attraction for retailers is clear: by combining the advantages of traditional offline retailing with online retailing (Rigby, 2011), research suggests omni-channel shoppers are more loyal, spending more money per transaction, and provide retailers with an overall higher lifetime value (Armstrong, 2016, Cummins et al., 2016, Domanski and Adamczak, 2016). However, from an operational perspective the advantages are not clear due to the high level of complexity associated with adopting an omni-channel strategy (Jacobsen, 2019, Chase, 2017, Saghiri et al., 2017).

There is, however, considerable confusion in the literature around the term omni-channel, with related terms such as multi-channel, cross-channel and everywhere-commerce used interchangeably with omni-channel (Ailawadi and Farris, 2017, Hübner et al., 2016c, Beck and Rygl, 2015, Alexander, 2014, Prest, 2014, Napolitan, 2013). There are three main reasons for this lack of clarity. First, there is a rather siloed approach within both practitioner

and academic literature regarding omni-channel. Second, both marketing and operations management (OM) scholars are independently progressing their knowledge of the subject, with little cross-reference. Third, "omni-channel" as an academic subject lacks theoretical maturity, with most studies being empirical in nature (Asmare and Zewdie, 2022), and very few conceptual studies published at the time of writing. Whilst there is a much larger body of practitioner material in publication, without the academic body of literature to underpin it, there is a general lack of focus. As a result of this fragmentation and confusion there is a clear lack of theoretical frameworks available (for both academics and practitioners) upon which they can develop and refine their understanding of omni-channel strategies, and to realise the promised benefits of this strategy (Timoumi, et al 2022., Saghiri and Wilding, 2017., Hübner et al., 2016c).

A comprehensive systematic literature review of omni-channel retailing does not exist in the literature to date. One encompassing both the theoretical and practical advancement of the field and one through both the marketing and OM lenses would be valuable at this moment in the evolution of this complex and fragmented field. This paper therefore aims to address this gap by providing a systematic review of both the marketing and OM literature, from both an academic and practitioner perspective. The review is extensive, in that it also encompasses other related terms such as multi-channel, cross-channel and categorization to ensure a holistic view of the field. The review is underpinned with the aim of creating conceptual clarity between these related terms, identify the current state of knowledge in relation to omni-channel retailing and provide a research agenda for ongoing research in this space. In so doing the paper provides a first classification of how omni-channel differs from previous approaches and synthesizes the extant research relating to the emergence of omni-channel retailing.

The paper is organised as follows. First, we outline the multi-stage approach used to investigate the extant literature in this space. This is followed by a quantitative exploration of the field's development, then a more qualitative classification of the different terms used within the field, leading to clear definitions of these related terms. This leads into an exploration of the specific field of omni-channel retailing, outlining the drivers for and enablers of omni-channel retailing. This leads to the development of a conceptual framework relating to two different approaches to omni-channel emergent in the literature. Finally, we identify the theoretical gaps in the field and suggest a future research agenda.

8. Review Method

To organise and analyse the relevant literature the multi-step approach to completing a systematic literature review as suggested by Denyer and Tranfield (2009) was adopted. This approach consists of several stages that are designed to provide a systematic and transparent framework to guide the literature review process (Denyer and Tranfield, 2009, Pittaway et al., 2004, Tranfield et al., 2003). The starting point of this approach is the formulation of an appropriate research question, as this will ultimately determine whether a paper should be selected for inclusion in the data review (Greenhalgh and Peacock, 2005). The research question was formulated as the result of a steering group conducted by the research team where the problematization of the subject of omni-channel was explored. There is a distinct lack of established theoretical frameworks regarding omni-channel (Saghiri and Wilding, 2017, Alvesson and Sandberg, 2011) and a notable inconsistency in the definition of omni-channel, both in-field and intra-field. This is particularly apparent between the dominant research disciplines of OM and marketing. As a result, the question, "*How do theories of omni-channel differ through the lenses of marketing and operations management?"* was adopted. To address this research question, the following three sub-questions were also generated:

1. How should omni-channel be defined?
2. What are the implications of adopting an omni-channel strategy?
3. What are the characteristics that construct an omni-channel theoretical framework?

The second stage of the process is to generate a key-word search based on the research question. To ensure a thorough search of all relevant literature, including both academic and practitioner perspectives, the bibliographic databases ABI/Inform Global, Business Source Complete, Emerald and Scopus were used as they are generally regarded as the optimum resources for bibliometric studies (Greenwood, 2013). The search terms "Retail" AND: "categorization"; "cross channel"; multi-channel; "omni-channel" were utilized in full text searches within these databases. To ensure optimum inclusivity within the search both possible presentations of *omnichannel* and omni-channel, *multichannel* and *multi-channel* were used. To avoid arbitrarily excluding material there was no search limitation relating to year of publication. The key-word search yielded 28,068 articles, categorized as follows:

Search Terms	Number of articles
Retail AND Categorization	11,482
Retail AND Cross-channel	3,438
Retail AND Multi-channel	8,124
Retail AND Omni-channel	5,024

Table 1: Articles generated by key-word search

These articles are from both practitioner and academic publications representing a large variety of organisational and management perspectives and disciplines. Given the broad search parameters employed such a large number of matches from the initial search is to be expected. However, not all the articles from the initial keyword search were relevant in relation to the research question. To identify those of relevance the next stage in the review process was to screen the titles and abstracts of the articles for those which had a dominant focus on retail strategy. This process resulted in 24,686 articles being discarded from the data set, leaving 3,382 articles for review.

To generate a focussed set of papers the next stage of the process is to apply explicit selection criteria to this smaller review data set. To decide selection criteria a small-scale pilot analysis was conducted on the data. The first explicit criterion applied was that only articles published in English should be included in the review data, this resulted 39 articles being excluded. The subject of the research was the next explicit criterion to be applied, where only articles from a management discipline were included as the research question is concerned with matters relating to management. This resulted in a further 1,143 being excluded as they were written from typically either a food safety perspective or a legal perspective. The context of the research as an explicit criterion was explored next; only articles related to retail channels were included to focus on retail channel strategies. This resulted in a further 1,652 being excluded from the study, leaving 548 articles that satisfied the inclusion criteria and were relevant to the research question.

The final sorting stage is the evaluation stage, where the quality of the research is then considered. As the review data incorporated practitioner articles as well as academic articles, the traditional measures of quality associated with academic articles such as journal rankings or number of citations were not appropriate to the entire data population. To be included in the review data, the articles must demonstrate a contribution to theory and/or practice. Those

articles which were purely opinion pieces or advertisement articles were therefore excluded. Additionally, practitioner articles published after 2019 were not included in the review set as the focus was dominated the impact of COVID-19. This resulted in a further 260 articles being excluded, resulting in 285 papers that met all the inclusion criteria and none of the exclusion criteria. Exploration of the references of these articles increased the final review set by 32 to 317.

Once the review set had been established the next stage was the extraction and synthesis of data. To facilitate the identification and analysis of the key themes in extant research the review articles were thematically coded using NVIVO (version 12) software. The extraction process generated 24 topic-related categories. These categories were created by an iterative process of reading and categorizing the content of an article. The articles were then re-read to validate the initial categorization and to allow the opportunity for all articles to be coded against all available categories. The coding also involved identifying whether the article was contained in an academic or practitioner perspective and whether it was written from an OM or marketing perspective. This coding and categorization then formed the basis for the identification of core themes and subsequent synthesis.

8. Analysis of review data

A fundamental element of the sixth stage; extraction and synthesis, is to complete a descriptive analysis of the review data (Denyer and Tranfield, 2009). The body of the literature identified comprised of 322 publications. The frequency of all publications by year is shown in *Figure 1*.

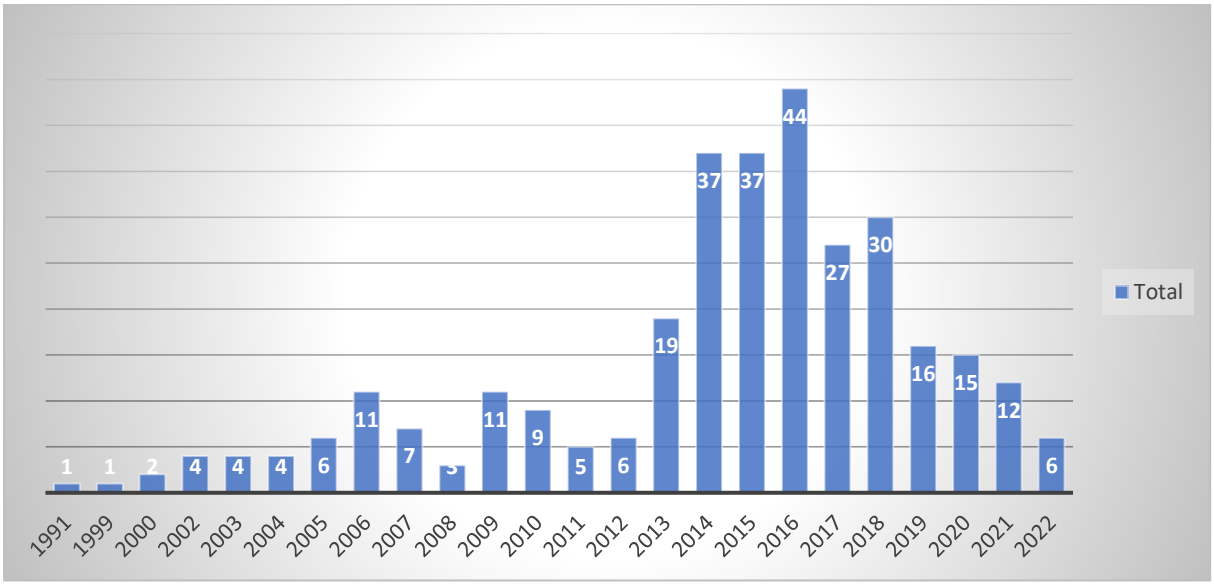


Figure 1: Publications by year

The earliest publications appeared in 1991, with very little publication activity in the research area until 2005. There was a significant increase in publications between the years 2013 and 2016, with publication activity reducing through 2017 to date. No practitioner publications were gathered after 2019 due to the dominance of COVID 19 in the subject material.

Focusing on the core area of interest for this review *Figures 2 and 3* show only the omni-channel academic and practitioner publications by year respectively. The academic papers follow broadly the same profile as seen in *Figure 1* though the activity in 2014 and 2015 is notably less regarding the academic publications, indicating that most of the focus during this period originated from a practitioner perspective.

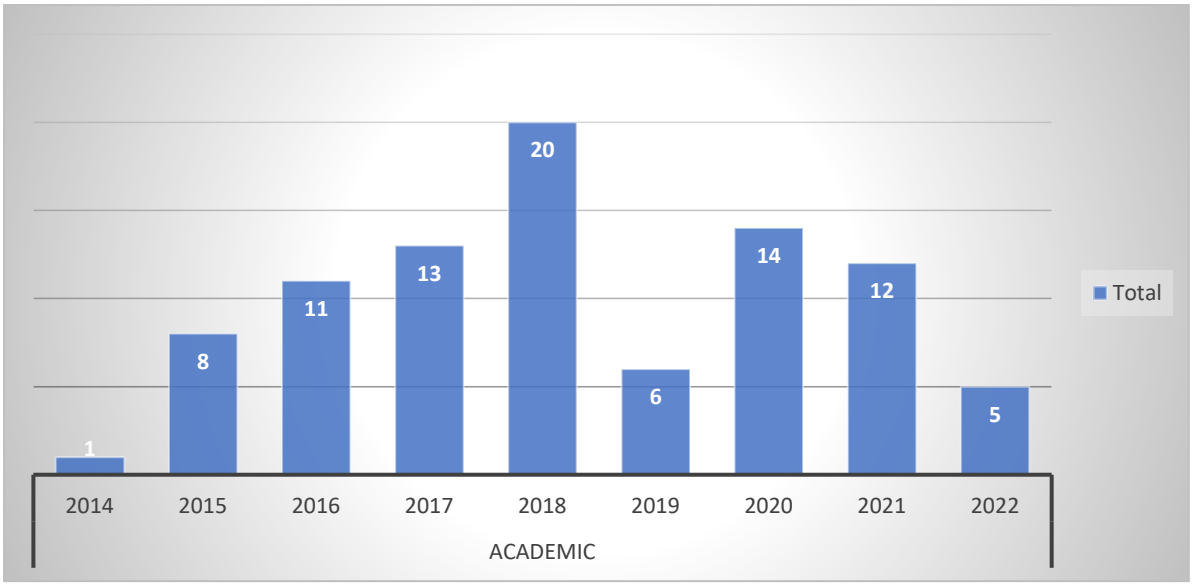


Figure 2: Academic omni-channel publications

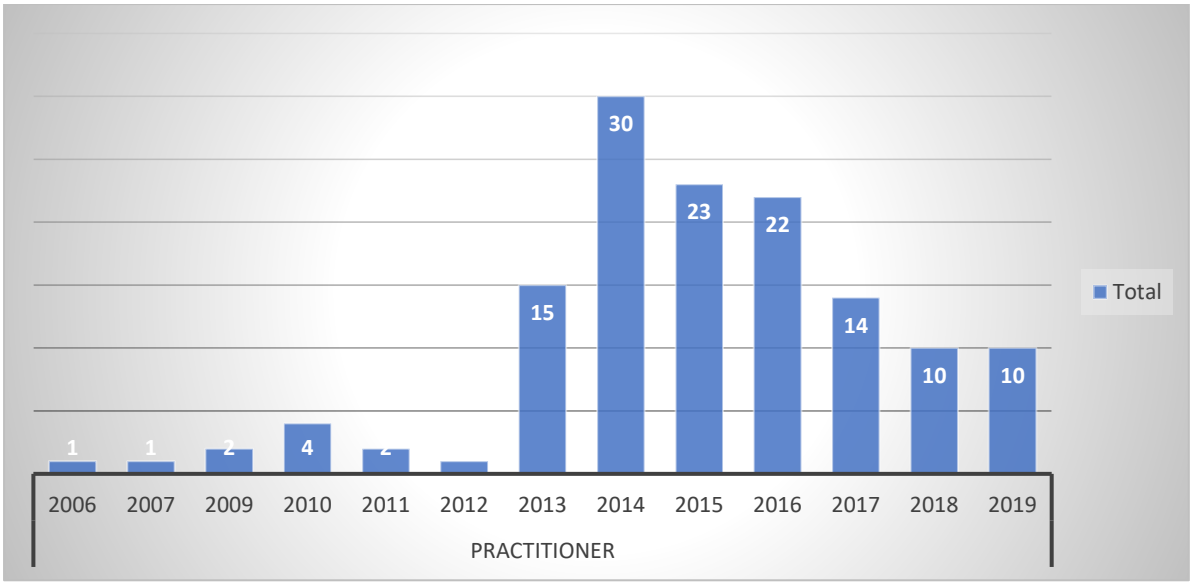


Figure 3: Practitioner omni-channel publications

Of note, there is significantly more practitioner publications regarding omni-channel than there is academic, with practitioner interest in this subject peaking in 2014, compared to 2016 from the academic perspective. The subject of omni-channel as a distinct form of retail strategy was first explored in 2011 from both the academic and practitioner perspective.

Appendix 1 shows the number of articles by publication. There is a broadly even contribution from the academic sources (182 articles, 57.4%) and practitioner sources (135 articles, 42.6%), giving a balanced perspective to the literature review. The contribution from the different subject lenses is also balanced with 46.9% (151) of the articles written through a marketing lens, 51.6% (166) through an OM lens and 5 articles (1.5%) adopting both. To break the categories down further, 75 articles (23.3%) are academic papers written though an OM lens, 107 articles (33.2%) are academic papers written through a marketing lens, 91 articles (28.3%) are practitioner papers written through an OM lens, 44 articles (13.7%) are practitioner papers written through a marketing lens, and 5 articles (1.5%) are academic papers adopting both lenses.

8. A Definition of Omni-Channel

There is considerable confusion around the term omni-channel. The terms “multi-channel”, “cross-channel”, “omni-channel”, “everywhere commerce” and “no-line commerce” are often used interchangeably and without clear differentiation (Ailawadi and Farris, 2017, Hübner et al., 2016c, Beck and Rygl, 2015, Alexander, 2014, Prest, 2014, Napolitan, 2013). Part of the confusion arises from the two distinct lenses from which the subject has been viewed:

marketing and OM. It is impossible to fully appreciate the nuances of the concept of omni-channel without exploring the literature from both perspectives. To gain clarity around the definition of omni-channel we systematically review the definitional traits of each approach.

4.1 Channel definition

The term "channel" has a variety of meanings dependent upon both the context and perspective adopted. For clarity, therefore, it is important to distinguish between marketing channels and OM channels. Marketing channels are means by which a retailer can engage in a two-way interaction with customers (Ailawadi and Farris, 2017, Beck and Rygl, 2015, Neslin et al., 2006, Stone et al., 2002). Such channels can be offline, such as in-store and retailer catalogue (Hardgrave, 2012), and digital (Wilding, 2014), such as via the internet or social media (Armstrong, 2016, Apparel, 2014). Channels from an OM perspective are the means by which the retailer distributes their goods to the customers (Ailawadi and Farris, 2017, Agatz et al., 2006, Aithal and Vaswani, 2005, Stone et al., 2002). Examples of such channels are delivery to a store for customers to select goods from the shelves, collection of pre-ordered goods from a store, delivery to a home location or delivery to a designated collection point such as locker boxes (Saghiri et al., 2017, Hübner et al., 2016c, Ishfaq et al., 2016,). There is a clear relationship between these channel types, where the marketing channels allow the customer to indicate to the retailer which products they would like to buy and the OM channels to satisfy that demand (Ailawadi and Farris, 2017).

4.2 Multi-channel

Retail strategies have evolved over time from a single channel relationship; where the retailer interacts with the customer either in traditional bricks-and-mortar stores or by online markets (Kotler, 2012, Hsieh et al., 2012, Neslin et al., 2006,), through to omni-channel relationships incorporating as many channels as possible (Li et al., 2015b), for example internet, mobile technologies, social media. However, marketing and OM literatures diverge somewhat in their definitions of multi-channel.

From a marketing perspective, retailers have adopted multi-channel strategies as a reaction to the success of internet sales; and in particular that of pure-play online retailers such as Amazon (Stojković et al., 2016, Wang et al., 2016, Steeds, 2014, Kwon and Lennon, 2009, Bahn and Fischer, 2003). A simple definition of multi-channel is "selling through multiple, distinct channels" (Metters and Marucheck, 2007). Deeper definitions of multi-channel are concerned with the utilisation / addition of the internet to existing offline channels (Huang et al., 2015, Melis et al., 2015, Piercy, 2013, Nicholls and Watson, 2005, Cravens et al., 1991),

or vice versa, where online retailers add an offline channel (Dholakia et al., 2005, Burt and Sparks, 2003). The addition of digital channels is an important marketing strategy, allowing enhanced branding, more efficient transactions, and improved customer relationship management (Hu et al., 2014, Hackney et al., 2006). Whilst it is not a new phenomenon for retailers to employ multiple channels such as mail-order catalogues and store-collections, in addition to store-based outlets (Schröder and Zaharia, 2008), the qualification for retailers to be demarcated as multi-channel is somewhat more prescriptive. Multi-channel retail is commonly defined as the sale of goods from both brick-and-mortar as well as virtual locations in much of the literature (Zhuang et al., 2016, Sousa et al., 2015, Agnihotri, 2015, Bell et al., 2014, Mahar et al., 2014, Sousa and Voss, 2012, Ofek et al., 2011, Schröder and Zaharia, 2008, Simons et al., 2002). A key characteristic is often that each channel will offer channel-specific goods (Giles, 2017, Bezes, 2016, Huang et al., 2015, Schröder and Zaharia, 2008).

The separation of channels is also a recurring theme from an OM perspective within the literature. Multi-channel is defined as a strategy where retailers operate multiple channels, but with segregated units, creating stand-alone systems for operations and logistics (Kondo and Okubo., 2022, Hübner et al., 2016c, Hobkirk, 2016). In essence, multi-channel OM literature highlights the use of separate fulfilment operations for each channel (Maras, 2016, Graves and Swartz, 2014, Kull et al., 2013, Liu et al., 2010, Allen, 2010, Christopher, 2010, Agatz et al., 2006, Chitty, 2006, Alptekinoglu and Tang, 2005, Simons et al., 2002).

As multi-channel operations have evolved, a more customer-focused emphasis became apparent in OM definitions. Multi-channel retail is often viewed as the various ways in which a retailer interacts with its customers through independently managed channels, that have been developed to respond to the fast-changing world of e-commerce (Wilding, 2013). A similar theme emerges from the marketing lens, as multi-channel strategies matured the focus turned towards multichannel integration (Oh et al., 2012, Allen, 2010, Kumar and Venkatesan, 2005) and coordination (Ailawadi and Farris, 2017, Cummins et al., 2016, Yan et al., 2011). Customers became unsatisfied with multi-channel and demanded a more seamless solution (van Bruggen et al., 2010). The market responded with cross-channel retailing.

4.3 Cross-channel

Cross-channel retailing is an entirely marketing focused strategy (Hübner et al., 2016c, Beck and Rygl, 2015), further evidenced by a zero return of cross-channel research from an OM perspective in the systematic review. Cross-channel retailing is an evolution from multi-channel, driven by customers who demand to have the same retail experience regardless of

channel (Commerce, 2007), where the customer is recognised and rewarded regardless of the shopping channel they choose to engage with (Dholakia et al., 2005). An emerging definition from the literature is that cross-channel is where the channels operate in a complementary manner (Lewis et al., 2014, Piercy, 2013, Oh et al., 2012, Lee and Kim, 2010), providing a consistent experience (Arnstein, 2010, Kwon and Lennon, 2009,). From a consumer perspective cross-channel shopping is the interaction with a company or a brand across their different channels to market (Piercy and Archer-Brown, 2014).

The absence of OM literature relating to cross-channel retailing is notable. As retailers were operating separate fulfilment operations to support their cross-channel operations, what could be defined as cross-channel from a marketing perspective was still referred to as multi-channel from an OM perspective (Cao and Li, 2015). The result of this new channel coordination is a customer-centric strategy providing a seamlessly integrated unified shopping experience (Michel, 2019, Commerce, 2007). For this reason, Domanski and Adamczak (2016) cite cross-channel retailing as the bridge between multi-channel and omni-channel retailing.

4.4 Omni-channel

Definitions of omni-channel are not clear and will vary according to the retailer. The broad purpose, however, is to efficiently and effectively service the customer using whatever means works best for the market (Bentz, 2016, Berthiaume, 2015). This initial definition would appear very close to some of the definitions for cross-channel, highlighting the evolutionary rather than revolutionary nature of retailing strategies. This results in the inevitable crossovers in the literature when researchers are describing these strategies (Angeleanu, 2015, Beck and Rygl, 2015). It would also appear that in addition to the disparate OM and marketing lenses, there is also a clear demarcation in some respects regarding academic and practitioner views on the nature of omni-channel from an OM perspective.

To first explore the marketing lens, there is some consensus between academic research and practitioner perspectives regarding the importance of customer experience: in that omni-channel is an approach to ensure a seamless customer experience across channels (Hofbauer, 2017, Murfield et al., 2017, Byrne, 2016, Hoogveld and Koster, 2016, Bernon et al., 2016, Everett, 2015, Peltola et al., 2015, Blanchard, 2014, Streatfield, 2014, Brynjolfsson et al., 2013, Driscoll, 2013b). This is also referred to as an “everywhere commerce” experience, connecting the brand to the customer (Angeleanu, 2015, Hardgrave, 2012). Further to this, Hofbauer (2017) and Jeanpert and Paché (2016) state that omni-channel retail is explicitly about the customer experience, allowing them to get the products they need, when where and however

they want, and to have a satisfying experience regardless of the channel used. Cummins et al. (2016) and Domanski and Adamczak (2016) similarly define omni-channel as the synergistic integration of sales and communication opportunities, for the purpose of creating a unified brand experience regardless of channel.

Another key defining characteristic of omni-channel marketing is the adoption of technology, characterised by integrating various technologies, particularly mobile and social technologies, to give a seamless experience (Gonzalez-Lafaysse and Lapassouse-Madrid, 2016, O'Brien, 2014). Other perspectives state that omni-channel is less dependent on mobile and social technologies *per se* and is a result of the integration of offline and online channels (Hobkirk, 2016, Picot-Coupey et al., 2016b, Peltola et al., 2015, Fulgoni, 2014, Rigby, 2011), engaging with the customer through multiple touch points (Barann et al., 2022, Fabiszak, 2018, Bell et al., 2015), where the boundaries between offline and online shopping have disappeared (Jifeng et al., 2016, Verhoef et al., 2015). A useful practitioner perspective which captures the nuances and idiosyncrasies of the above was offered by Armstrong (2016) who defined omni-channel as a description of customer shopping in both physical and digital spaces, and as an umbrella term that describes the consumer using store, web, phones, and tablet channels to shop interchangeably. Larke et al. (2018) highlight that the practice of delivering such an integrated experience is difficult to achieve and requires significant resource to be successful in the market.

There are also some recent indications in the literature that the nature of omni-channel retail is changing. Li et al. (2015a) view omni-channel as a marketing model where organisations sell goods or services to customers though as many channels as possible, whereas Mirsch et al. (2016) suggest that an omni-channel strategy enables consumers to use channels seamlessly, interchangeably, and uniquely. This "*uniquely"* quality supports the notion from the practitioner perspective that beyond omni-channel is customer-centric shopping (Manser Payne et al., 2017, Retailers, 2016), where customers no longer think about channels (Tompkins, 2015a, Tompkins, 2015b, Rosenblum and Kilcourse, 2013, Driscoll, 2013a), rather retailing is just about the brand and the customer (Kaczorowskaspychalska, 2017, Trunick, 2014, Liyakasa and Aquino, 2013).

From a marketing perspective, omni-channel may therefore be viewed as an integrated, evolutionary approach to multi-channel (Huré et al., 2017, Hansen and Siew Kien, 2015, Piotrowicz and Cuthbertson, 2014). Berman and Thelen (2018) support this evolutionary

perspective, identifying four stages of evolution from "pure" multi-channel through to "pure" omni-channel, where access to, and knowledge about the offline channel is completely integrated into an online channel (Herhausen et al., 2015). Omni-channel is broader than multi-channel as it is concerned with how shoppers are influenced and how they move through channels in their search and buying process (Verhoef et al., 2015). The result is seamless retailing in real-time (Johnsen, 2013).

An integrated shopping experience, however, demands integrated channels of fulfilment to support it (Arslan et al., 2021, Hoogveld and Koster, 2016, Wilding, 2013). From this perspective, omni-channel is different to multi-channel. Multi-channel refers to the multiple ways a consumer can make a purchase, in omni-channel the consumer can experience the brand across multiple channels within a single transaction (Lim et al., 2016, Hobkirk, 2013, Blanchard, 2013c). To support this enhanced customer experience, omni-channel incorporates multiple channels to meet customer needs. These channels are fully integrated from both fulfilment and a marketing perspective (Pereira and Frazzon, 2021, Ailawadi and Farris, 2017, Forrest, 2017, Liu et al., 2010). The result is customer driven fulfilment (Covey, 2017, Evans and Mason, 2016, Lapoule and Colla, 2016, Spain, 2015, Nuce, 2015, Burnson, 2014), indicating that fulfilment channels that are capable of supplying a single customer as efficiently as a store (Burkitt-Gray, 2016, Mannix, 2014). The nature of an omni-channel fulfilment (OCF) is that it needs to be agile, to seamlessly serve the customer no matter when, where and how they shop (Murfield et al., 2017, Saghiri and Wilding, 2016, Ishfaq et al., 2016, Berthiaume, 2015, Kumar and Hu, 2015, Pantoja-Navajas, 2015, Andel, 2014b).

There is some debate however around the nature of OCF. Some researchers state that OCF is characterized by multiple sources (manufacturer distribution centres (DC's), retailer DC's, and stores) serving multiple destinations (stores and customer homes) (Saghiri et al., 2017, Hübner et al., 2016a, Alptekinoğlu and Tang, 2005). This supports the sentiment that Amazon is seen as a leader in omni-channel (Blanchard, 2013c). This shares consensus with academic and practitioner definitions that view OCF as providing seamless fulfilment from stores, web sites, warehouses, intermediaries, and manufacturers (McCrea, 2015a, Trunick, 2015, Kelley, 2014), with DC's set up to handle stocked and stockless stock keeping units (SKU's) (Specter, 2016, Andel, 2014a, Blanchard, 2013a). The term OCF therefore refers to the multiple channels the retailer uses to engage customers, and the integration of their own, internal distribution channels (Ailawadi and Farris, 2017, Saroukhanoff and Aryapadi, 2016). The emphasis on "*internal"* distribution channels would interestingly preclude Amazon from

being defined as an omni-channel retailer from an OM perspective due to their reliance upon disparate manufacturer fulfilment channels (Bell et al., 2014). This difference in OCF infrastructure appears to be aligned with product type, with food retailers managing distribution in-house and non-food retailers typically engaging with 3rd parties to manage distribution (Rai et al., 2019, Wollenburg et al., 2018a).

There are also some contrasting views relating to the origins of OCF. Some researchers uphold that omni-channel is a development of multi-channel (Davis, 2015, Graves and Swartz, 2014, Streatfield, 2014). It is seen as an integration of the offline and online channels into one fulfilment channel (Saenz and Revilla, 2016, Hobkirk, 2016, Maras, 2016, Napolitan, 2013). The once separated store replenishment and direct-to-customer shipments are now unified in one logistics system (Hübner et al., 2016c). Customers gain more opportunities to buy what, where, when, and how they want (Hübner et al., 2016b). Other perspectives, however, indicate that omni-channel is an extension of cross-channel marketing practices up the fulfilment channels (MHL, 2017a, Cao and Li, 2015, Baird and Kilcourse, 2011). These could also be a result of the varying nature by which the retailers themselves became omni-channel adopters, with some evolving from a single-channel bricks and mortar retailer, adopting an internet-enabled cross-channel strategy that developed into an omni-channel strategy (Stojković et al., 2016, Wang et al., 2016, Kwon and Lennon, 2009), compared to those retailers who were pure-play internet retailers and are now omni-channel adopters (McCrea, 2015b, Levans, 2014).

From an OM perspective therefore, it seems that, irrespective of the origin, OCF is about dealing with varying demands of products that are part of very large ranges across fragmented channels being demanded at varying speeds (Forrest, 2017). Therefore, OCF is agile and resilient (Zhang et al., 2019, Whitehouse and Osburn, 2016), sourcing inventory from multiple locations to serve the customer (Saroukhanoff and Aryapadi, 2016, Kimball and Muthusrinivasan, 2015, Cassidy, 2015, Kline, 2014, Andel, 2014b). Similar to the marketing perspective, the OM literature also indicates practice beyond omni-channel (Kaczorowskaspychalska, 2017). Some definitions lean towards more customer-focused fulfilment (Nuce, 2015), where neither the retailer nor the customer distinguish between channels (Hübner et al., 2016c). Omni-channel is mass personalisation (Mannix, 2014), where post-omni-channel fulfilment approaches will harness the use of big-data to build models for predicting and influencing consumer buying behaviour, and seamlessly collaborate with key trading partners to fulfil this need (Punia et al., 2020, , Balakrishnan et al., 2018, Perry, 2015).

A synthesis of the extant literature has therefore allowed the following definitions to be offered:

Single channel: Where retailers employ a single marketing channel supported by a single channel of fulfilment.

Multi-channel: Where retailers employ multiple and separated marketing channels supported by multiple and separated channels of fulfilment.

Cross-channel: Where retailers seamlessly employ integrated multiple marketing channels, both physical and digital, supported by multiple, separated channels of fulfilment.

Omni-channel: Where retailers seamlessly employ integrated multiple marketing channels, both physical and digital, supported by an agile, integrated channel of fulfilment. The evolution of retail can be seen in Figure 4 below.

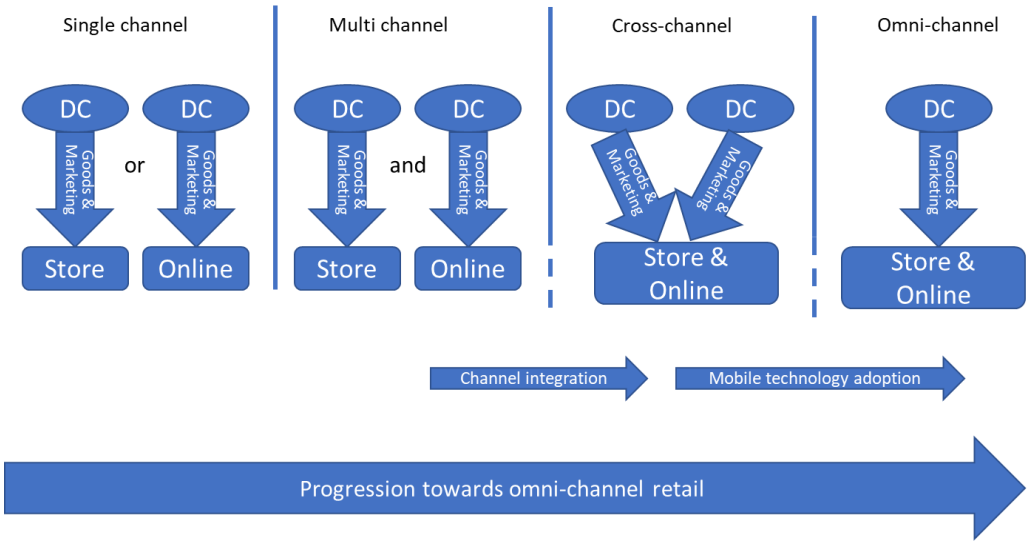


Figure 4: The evolution of retail

There are still significant gaps however in the understanding of omni-channel strategies, from both an academic and practitioner perspective (Bijmolt et al., 2021). The perspective of the marketing practitioner seems to have a somewhat firmer notion of an omni-channel strategy should look like, currently, there is a gap regarding how OM fulfilment can be organised to efficiently and effectively support this (Melacini et al., 2018).

4.5 The development of Omni-channel

As seen in the above definitions the movement towards omni-channel has been evolutionary in nature. In exploring what is known to date about omni-channel retailing we therefore turn to three key areas of interest in the literature: the drivers of omni-channel, the enablers of omni-channel and a conceptual framework for the characteristics of omni-channel retailing.

4.6 Drivers of omni-channel

The literature relating to multi-channel retail has identified several drivers that prompted retailers to move from a single channel retail strategy and adopt a multi-channel retail strategy (Davis-Sramek et al., 2020). The initial transition resulted from a combination of a reaction to the disruptive influence that pure-play online retailers were having on the market (Lewis et al., 2014, Ofek et al., 2011, Liu et al., 2010, Nikolaeva, 2006), supported by improvements in technology allowing the development of online retailing platforms (Lapoule and Colla, 2016, Stojković et al., 2016, Lewis et al., 2014, van Bruggen et al., 2010, Kwon and Lennon, 2009, Alptekinoğlu and Tang, 2005). The newly emerging online market offered customers a much wider range of products to select from, more retailers to choose from, and improved convenience (Agnihotri, 2015). Retailers then realized that if they were to remain competitive in the marketplace, a multi-channel strategy was required (Wang et al., 2016, Doherty and Ellis-Chadwick, 2006, Kumar and Venkatesan, 2005). The adoption of a multi-channel retail strategy then gained prominence in the market as adopters reported an improved customer experience (Saroukhanoff and Aryapadi, 2016, Agnihotri, 2015, Zhang, 2009), resulting in increased sales, customer loyalty and profits (Claro et al., 2021, Armstrong, 2016, Neslin et al., 2006, Verhoef et al., 2007). From an OM perspective, the principal driver for adopting a multi-channel strategy is the associated inventory efficiencies that result from the increased economies of scale (Hu et al., 2022, Zhang et al., 2021, Agnihotri, 2015, Madlberger, 2009, Simons et al., 2002).

As retailers adopted omni-channel strategies a new standard was set and increased customer expectations became a driver for further omni-channel adoption (Covey, 2017, Bentz, 2016, Evans and Mason, 2016, Hoogveld and Koster, 2016, Lim et al., 2016, Saenz and Revilla, 2016, Kimball and Muthusrinivasan, 2015, Hansen and Siew Kien, 2015, Graves and Swartz, 2014, Blanchard, 2013a, Driscoll, 2013a, Rosenblum and Kilcourse, 2013). As was discovered in multi-channel, omni-channel customers are more active, more loyal, and spend more money (Murfield et al., 2017,Gu and Tayi, 2017, FRPT, 2016, Hu et al., 2014, Hobkirk, 2013, Johnsen, 2013), the omni-channel strategy, therefore, is not only beneficial to the customer but also to the retailer. Benefits are also realised in the OM space, with the adoption of an omni-channel strategy with retailers reporting increased efficiency because of integrating their channels of distribution (Bressolles & Lang, 2020, Gao and Su, 2016, Jifeng et al., 2016, Kozlenkova et al., 2015, Mahar et al., 2014).

8. Enablers of omni-channel

The enablers identified in the literature can be aggregated into three broad categories, technology, integration, and inventory. Technology has certainly been viewed as a driver for change in the literature, forcing retailers to engage with, and serve their customers in new ways, from pure-play online retailers, to multi-channel retailers, to cross-channel retailers, and ultimately, omni-channel retailers (Lee, 2020, Rodriguez-Torrico et al., 2020). From a different perspective, technology is also a key enabler, allowing omni-channel retailers to reach new markets (Raza et al, 2021, Bell et al., 2014, Yan et al., 2011).

Integration features predominantly in the literature as a key enabler of omni-channel operations from both a marketing and OM perspective. Integration between the internal distribution partners and the external supply base (Saroukhanoff and Aryapadi, 2016, Hübner et al., 2016a, Jifeng et al., 2016, Agnihotri, 2015, Rabinovich et al., 2007) is recognised as key from an OM perspective, with the integration of data enabling omni-channel operations from both an OM and a marketing perspective (Gu and Tayi, 2017, MHL, 2017a, Hoogveld and Koster, 2016, Maras, 2016, Byrne, 2016, Cummins et al., 2016, Mh and Staff, 2015, Blanchard, 2013d). Whilst inventory management has always been regarded as an essential aspect of retail operations, an omni-channel retailer must have highly sophisticated inventory management capabilities throughout fulfilment channels to enable them to seamlessly serve their customers with whatever they want wherever, and whenever they want it (Hense and Hubner, 2021, Chase, 2017, Byrne, 2016, Hoogveld and Koster, 2016). A summary of the literature highlighting the role of these enablers of omni-channel can be seen in *table 2* below.

Technology	
The development of social media technology has enabled digital showrooms and mobile applications with personalised special promotions	Adivar et al. (2019)
The use of technology to enhance the experiential attributes of physical stores.	Bonfanti & Yfantidu (2021)
Technology has enabled the development of integrated marketing communications	Cummins et al. (2016)
Customers use in-store technology to gain more information about their purchases.	Hosseini et al. (2018)

Digital technology, such as virtual showcasing, enables additional customer touchpoints.	Park et al. (2021)
Improved technology related quality increases customer utilisation of e-commerce	Wagner et al. (2020)
Technology enables consumers to make more informed decisions and obtain faster service.	Grewel et al. (2017)
Integration	
Channel integration can lead to a competitive advantage over pure-play online retail	Herhansen et al. (2015)
Channel integration has a positive effect on consumer perceived trust, leading to customer loyalty, higher market share, sales growth, and cost efficiency	Zhang et al. (2018)
Integration between channels promotes sales growth	Cao & Li (2015)
Channel integration leads to reduced uncertainty in customers	Li et al. (2018)
Channel integration quality has a positive impact on customer participation	Asmare (2022)
Integration of distribution channels is a source of competitive advantage	Freichel et al (2020)
Active integration of channels improves service delivery and levels of customer satisfaction	Jeanpert & Pache (2016)
High levels of integration lead to better sales growth and competitive position	Jones et al. (2022)
Inventory	
Channel integrated inventory allows intensive distribution, leading to a competitive advantage	Hubner et al. (2016c)
Centralised inventory enables short-term allocation decisions and fulfilment synergies	Hubner et al. (2016b)
The ability to utilize inventory in both store and warehouses is an enabler of omni-channel fulfilment	Ishfaq et al. (2016)
The ability to effectively and efficiently manage inventory leads to enhanced customer experience.	Bell et al. (2020)
Inventory transparency and availability is an enabler of omni-channel fulfilment	Berthiaume (2015)

Inventory transparency in terms of assortment and level by channel is an enabler of omni-channel fulfilment	Hubner et al. (2022)
The sharing of inventory information across channels is an enabler of omni-channel fulfilment	Oh et al. (2012)

Table 2: Enablers of omni-channel

An emergent theme from the literature is that the role of the retail store has changed significantly since the introduction of omni-channel (Gao et al, 2022, Kress, 2018). In addition to the merchandising of goods for sale in the offline channel, stores are now responsible for the fulfilment of online orders (Jones et al, 2022, Larke et al., 2018, Zaczkiewicz, 2018). The use of stores as fulfilment centres is beneficial for two reasons. First, it reduces the proximity between the retailer and the customer (Kembro et al., 2018, Melacini and Tappia, 2018). Second, it allows the development of Buy Online, Pick-up in Store (BOPS) (Gao and Su, 2016, MMR, 2018a), which encourages customers to purchase offline goods when collecting their online shopping in store (Jin et al., 2018, MacCarthy et al., 2019).

There are, however, some challenges associated with the use of stores as an online fulfilment centre. First, stores are designed for merchandising goods for resale, not for picking and packing online orders; the result is inefficiencies in both channels (Freichel et al, 2020, Ishfaq and Bajwa, 2019, Ishfaq et al., 2016). Second, store picking for online sales risks stock-outs for offline sales (Hübner et al., 2016, Larke et al., 2018). Third, stores are not equipped to manage the high volume of returns associated with the online channel (Frei et al, 2020, Jorge et al, 2020, Nageswaran et al, 2020). Finally, the growth of the online channel is cannibalising the offline channel (Karabus, 2018), resulting in retail stores that are no longer optimally configured and now too large to support their reduced offline sales footprint (Berman, 2019).

6. Towards a conceptual framework for omni-channel retailing

As retailers move away from a multi-channel strategy to adopt an omni-channel strategy (Davis-Sramek et al., 2020, Verhoef et al., 2015) a body of practitioner research has emerged highlighting that omni-channel retailing is fundamentally different from multi-channel retailing (Apparel, 2014, Streatfield, 2014, Blanchard, 2013c, Napolitan, 2013). Omni-channel is hailed as a profitable retailing model (Cao and Li, 2015), deriving efficiencies from synergistic marketing and OM integration (Chopra, 2016, Lee and Kim, 2010). These claims, however, are not always realised, as retailers must implement strong channel management

strategies to realise these synergies and avoid channel cannibalization (Larke et al., 2018, Jeanpert and Paché, 2016). As such research has highlighted the costs associated with adopting an omni-channel strategy, questioning its resource efficiency (Prabhuram et al, 2020, Wollenburg et al., 2018b, Berthiaume, 2015).

It is also apparent that omni-channel fulfilment cannot be viewed as a homogenic configuration. There is significant evidence within the literature that the nature of the operations-marketing interface varies by retailing context (Villanova et al., 2020; Roggeveen et al., 2020; Wagner et al., 2020), resulting in different internal demand signals for fulfilment operations to respond to. A categorization of the marketing literature pertaining to the generation of such demand signals leads to the identification of three distinct modes of omni-channel fulfilment. Mode 1 represents the configuration typically adopted by grocery retailers. The demand signals for offline products are generated in-store and the demand signals for online products are generated through in-store, online, and mobile technology channels (Villanova et al., 2020; Larke et al., 2018; Baxendale et al., 2015). Mode 1 omni-channel retailers have typically transitioned from traditional bricks and mortar retailers to omni-channel retailers by adding online channel fulfilment capability to their existing fulfilment infrastructure (Hubner et al., 2015; Verhoef et al., 2015). To respond to these demand signals as efficiently as possible, Mode 1 fulfilment is characterized by retailer's using their own bricks and mortar stores and distribution centres to manage most (if not all) product fulfilment (Freichel et al, 2020, Wollenburg et al., 2018).

Mode 2 represents the configuration typically adopted by speciality retailers such as jewellers or fashion retailers (Akturk and Ketzenberg, 2022; Bell et al., 2020; Barratt et al., 2018). Similar to Mode 1 retailers, the demand signals for offline products are generated in-store and the demand signals for online products are generated through in-store, online, and mobile technology channels (Bonfanti and Yfantidou, 2021; Johnson and Ramirez, 2020; Roggeveen et al., 2020). These retailers have typically evolved from multi-channel retailers using in-store and catalogue marketing channels to omni-channel retailers (Boardman and McCormick, 2018). As a result, their legacy internal fulfilment infrastructure was already configured to integrate multiple channels of distribution (Abushaikha, 2018). The key difference between Mode 2 and Mode 1 is the role of the store, in Mode 2 the store is only used to sell goods in the offline channel and as a showroom for the online channel (Gao et al., 2022; MacCarthy et al., 2019; Gao and Su, 2016) and they are not used as fulfilment centres as they are in mode 1. Mode 3 represents the configuration typically adopted by pure-play online

retailers such as Amazon retailers (Kembro and Norman, 2021). In this mode, demand signals originate from the online and mobile technology channels only (Wagner et al., 2020; Grewel et al., 2017; Lemon & Verhoef, 2015).

Mode 3 retailers have designed their fulfilment operations to respond to the volatile nature of the online channel. Mode 3 fulfilment networks are characterized by a light touch internal supply, logistics and distribution system, and third-party manufacturers, who provide more direct fulfilment, either direct to customer's homes or locker box locations (Kembro and Norman, 2020, Rai et al., 2019, Abdulkader et al., 2018).

A key characteristic of all modes is that they are highly complex systems (Armstrong, 2016, Bentz, 2016, Hübner et al., 2016c, Picot-Coupey et al., 2016a, Rusko, 2016, Cao and Li, 2015, Fulgoni, 2014, Alexander, 2014). Retailers face fierce competition where not only price dominates the market putting pressure on profit margins (Allen, 2010), but they are also now operating a model which is highly customer-centric (Gao and Su, 2016, Chopra, 2016, Bell et al., 2014, Berman, 2014, Blanchard, 2013c, Mannix, 2014, Christopher, 2010, van Bruggen et al., 2010). In this environment, competitive advantage is achieved by increasing customer experience and reducing customer delivery times (Pereira and Frazzon, 2021, Zuberi and Rajaratnam, 2020, Cramer, 2019). Furthermore, complexity is added as omni-channel customers can be very demanding (Armstrong, 2016), expecting same day delivery (Rai et al., 2019, Meyer, 2014), at a location that suits them (Ishfaq et al., 2016), at no additional cost (Rai et al., 2019). Omni-channel customers therefore expect a personalised shopping experience (Raza and Govindaluri, 2021, Mirsch et al., 2016) that gives them a relationship with the brand and not necessarily the retailer (Huang et al., 2015). A diagrammatic representation of the modes can be seen in figures 5 through 7.

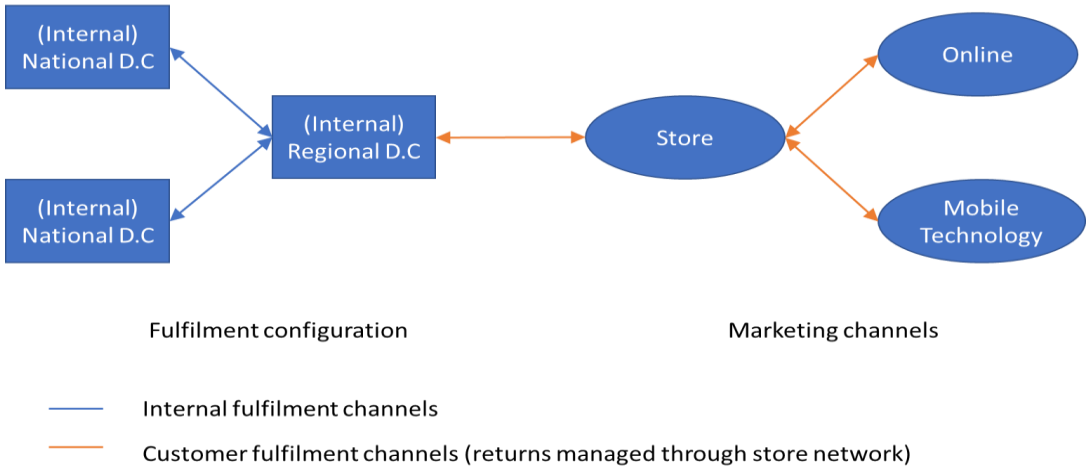


Figure 5: Mode 1 omni-channel fulfilment

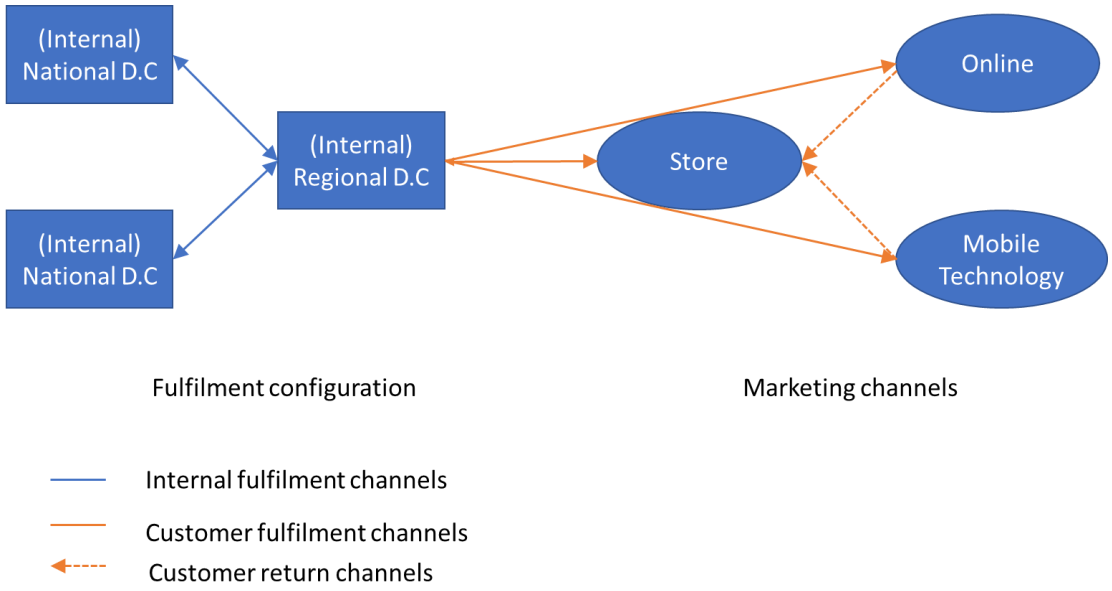


Figure 6: Mode 2 omni-channel fulfilment

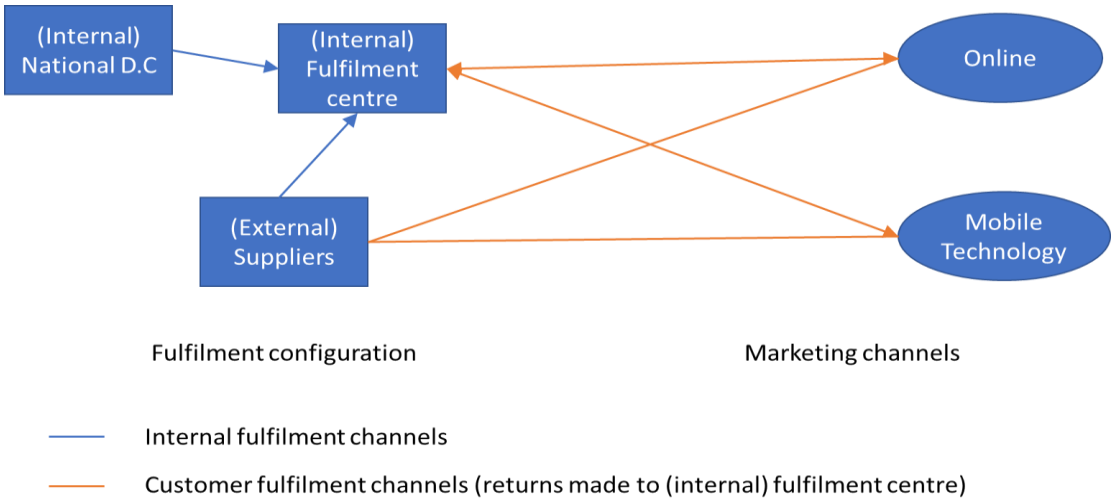


Figure 7: Mode 3 omni-channel fulfilment

Irrespective of mode, the seamless, personalised omni-channel experience is supported by innovative fulfilment solutions (Saenz and Revilla, 2016), which have core competences around all aspects of inventory management and data management in all modes of fulfilment (Byrne, 2016, Gao and Su, 2016, Ishfaq et al., 2016, Andel, 2014b, Bell et al., 2014, Graves and Swartz, 2014, Meyer, 2014, Blanchard, 2013d). As a result, omni-channel retailers need to be excellent at logistics (Ishfaq and Bajwa, 2019, Angel and Tan, 2018, Murfield et al., 2017), ensuring that the right stock is at the right place, at the right time. Fulfilment operations need to be able to respond to the agile demands that the marketing function creates, without generating multiple competing customer experiences (Arnstein, 2010, Pantoja-Navajas, 2015, Perry, 2015, Nuce, 2014,).

Where the modes differ is around the configuration of fulfilment operations, and as such, the core competencies of the retailers in managing this complex system. Mode 1 and 2 retailers tend to use their own internal network to serve their customers (Rai et al., 2019, Wollenburg et al., 2018, Blanchard, 2013b). They manage the additional demands of an omni-channel strategy by building larger warehouses (Logistics and Management, 2019, Kembro et al., 2018, Carr, 2014), and managing fulfilment for online orders from both their distribution network and store network simultaneously (Bentz, 2016, Hübner et al., 2016a, Hübner et al., 2016b). For the customer, Mode 1 omni-channel provides all the benefits of cross-channel: convenience, a somewhat wider-choice of products and a seamless shopping experience (Ishfaq et al., 2016, Brynjolfsson et al., 2013), but is limited by the retailer's fulfilment network capacity. For the retailer, this improved service offering to the customer; enabled by mobile

technology, results in increased sales and increased market share (Zaczkiewicz, 2019), as their customer experience is holistically better managed, and their "in-stock" range becomes network wide, not locally derived (Armstrong, 2016, Domanski and Adamczak, 2016). The fulfilment channels respond by incorporating technology solutions to improve inventory visibility (Huang et al., 2020, Covey, 2017, Armstrong, 2016), supporting a more agile approach that allows products to be distributed to customers from their distribution and store network (Bentz, 2016, Hübner et al., 2016a). However, the negatives of Mode 1 approaches are that the fragmented demand signals and significant operational changes required to pick and ship smaller quantities adds diseconomies and cost pressures to the retailer (Burkitt-Gray, 2016, Graves and Swartz, 2016, Garrett et al., 2014). The retailer is also limited by their capacity to stock and fulfil from within their own, managed supply network (Wollenburg et al., 2018a).

There are several similarities between Mode 1 and Mode 2 omni-channel retailers. Both rely on in-house integrated fulfilment networks (Kembro and Norrman, 2020; Abushaikha, 2018; Saghiri, et al., 2017) and as such, Mode 2 retailers face the same challenges regarding fulfilment capacity and cost challenges. As Mode 2 retailers only fulfil orders from distribution centres, they tend to use their bricks and mortar stores as showrooms (Gao et al., 2022; Zhang et al., 2018), fulfilling online orders by either shipping them to store to be collected by the customer (Jones et al., 2022; Kembro and Norrman 2020; MacCarthy et al., 2019) or shipped from the distribution centre direct to the customer's home (Abushaikha 2018). Mode 2 omni-channel retailers compete by balancing experience with a value proposition (Claro et al., 2021; Bell et al., 2020), achieved through collaboration with 3rd party brands (Zhang et al., 2021) and leveraging technology to enhance supply chain decision making (Yu et al., 2017).

Mode 3 omni-channel retailers, by comparison, will tend to only stock core, fast-moving inventory in their own distribution centres (Ishfaq et al., 2016, Blanchard, 2015). Then seek collaborative arrangements with suppliers to distribute their wider inventory offering directly to customers (Cernivec, 2019, Hobkirk, 2016, Ishfaq et al., 2016). In part, this mode is a more customer-centric strategy than Modes 1 and 2 as it is not bound by the retailers limited fulfilment infrastructure (Rai et al., 2019, Hübner et al., 2016b).

The Mode 3 fulfilment configuration offers the most developed omni-channel experience by providing a truly personalised shopping experience, with almost limitless potential for product offerings and product combinations (Giles, 2017, Mirsch et al., 2016).

From the customers' perspective Mode 3 retailers are simply another distribution channel that the brand incorporates into the service of the customer (Hobkirk, 2016, Ishfaq et al., 2016, Kumar and Hu, 2015).

From a marketing perspective across all modes, issues around inventory volumes and pricing can be highly complex, as they are dependent on a regular flow of information from a disparate number of manufacturers (Akturk et al., 2018). From an OM perspective, the additional demands of increased reverse logistics, proliferation of SKU's, slower stock turns, and volatile forecasting add cost pressures in Mode 1 and 2 fulfilment configurations (Kembro and Norrman, 2020,Akturk et al., 2018, Melacini et al., 2018).

The Mode 3 fulfilment configuration demands that the retailer has a much stronger collaboration with the supply base, as these supply partners are the main channel of distribution to the customer (Blanchard, 2015, Kline, 2014). The adoption of an omni-channel strategy in this market drives sales and market share benefits for both retailers and suppliers, with the retailer providing the holistic customer experience, but manufacturers managing fulfilment. This does leave both parties open to relational difficulties however, and results in a loss of control, from the retailers' perspective in the management of customers fulfilment and post purchase experience. The additional complexity in the fulfilment channels to support this enhanced relationship with the customer is also likely to be costly, with even greater cumulative fulfilment costs due to the dispersion of low volume, high frequency transactions (Burkitt-Gray, 2016, Graves and Swartz, 2016).

7. Research Agenda

To answer the question, "How do theories of omni-channel differ through the lenses of marketing and operations management?" the findings of this review indicate that each lens is at a differing state of development. Adapting the classification offered by Edmonson and McManus (2007), omni-channel theory developed through the operations management lens is nascent to intermediate. In contrast, theory developed through the marketing lens is in a mature state of development.

As characterised by this classification, early operations management studies are suggestive and describe the transition from multi-channel to omni-channel fulfilment (for example, Huber et al., 2015; McCrea, 2015; Armstrong, 2016). Subsequent studies focus on identifying the operational synergies and challenges associated with omni-channel fulfilment (for example, Huber et al., 2016a; Ishfaq et al., 2016; Akturk et al., 2018). The most recent

studies indicate a movement to the intermediate state by offering a provisional theory that is concerned with exploring alternative configurations of omni-channel fulfilment to address the operational challenges identified by the previous studies (for example, Hu et al., 2022; Jones et al., 2022; Millstein et al., 2022).

Omni-channel studies written from the marketing perspective are mature as they build on existing theories of retailing. Early marketing studies explored how omni-channel retailing added to retailer performance (for example, Cao and Li, 2015; Melis et al., 2015; Verhoef et al., 2015). Subsequent studies prescribed marketing approaches to exploit omni-channel retail opportunities (for example, Kokho et al., 2018; Berman & Thelan, 2018; Zhang et al., 2018). The most recent studies explore the use of technology to add new boundaries to existing theories of the customer journey in omni-channel retailing (for example, Villanova et al., 2021; Kondo & Okubu, 2022; Neslin, 2022).

As research thus far into OCF is emerging and theoretically limited (Asmare and Zewdie, 2022, Melacini et al., 2018, Hübner et al., 2016c), most of the gaps identified are the result of reviewing practitioner publications. With emerging practices largely being a result of trial and error (Domanski and Adamczak, 2016), there has been a call for new fulfilment models (Cai and Lo, 2020, Hübner et al., 2015) to further understanding of concepts such as, the integration of home and store deliveries (Hübner et al., 2016b), how to efficiently share logistical resource between channels (Bijmolt et al, 2021, Zhang et al., 2019, Jeanpert and Paché, 2016) and how to promote collaboration between retailers, manufacturers and their partners (Kimball and Muthusrinivasan, 2015). A summary of the emergent research agenda can be seen in *Table 3* below:

Domain	**Subject**	**Research Focus**	**Directions for further research**
Operations Management	Distribution operations	Technology	Integrating picking, packing, and shipping technologies
			The role of RFID omni-channel supply chains
		Inventory	Optimization of omni-channel order fulfilment models
			Developing forecasting techniques that meet the demands of omni-channel
			Developing models that support inventory location decision making
			Approaches to improve real-time inventory visibility
	CSR	Triple bottom line	Identifying the cost drivers of omni-channel supply chain through cost-benefit analysis
			Understanding the environmental and societal impacts of omni-channel
	Procurement	Collaboration	Developing effective frameworks for channel integration
			The role of cloud computing technology in collaborations

			The role of Big Data in brand and retailer collaboration
		Resilience	Developing a robust and resilient omni-channel supply chain
Marketing	Operations management	Customer experience	Identifying new approaches to meet ever growing customer expectations
			Developing a post-sale service to support offline and online sales growth
		Strategy	Understanding the long-term impact of adopting an omni-channel strategy upon a business
			Identifying the key variables that result in successful omni-channel retailing

Table 3: Directions for further research

There is an appreciation that the fulfilment demands within OCF are markedly different to those of the traditional single- and multi-channel fulfilment configurations (Huré et al., 2017, Levans, 2014). As such there are emergent gaps relating to such operational matters as how to effectively balance picking, packing, and shipping technologies (Freichel et al, 2020 Alexander, 2014, Bond, 2014) to meet the ever-growing customer expectations (Hofbauer, 2017, Hoogveld and Koster, 2016). The wider range of orders associated with an omni-channel strategy (Napolitan, 2013) also generates knowledge gaps how to satisfy this increased fulfilment demand (Bell et al., 2014) requiring new strategies that supports order fulfilment (Hübner et al., 2016a), as well as delivery and post-sale service (Ishfaq et al., 2016) that will be capable of managing offline and online sales growth (Hobkirk, 2016).

A further fundamental aspect of the fulfilment challenge that it is not well understood how to achieve the accurate models of inventory management that are required to deliver OCF. The research gaps relating to inventory management models are rather comprehensive. There is a lack of understanding of how to increase the accuracy of current forecasting techniques (Punia et al, 2020, MHL, 2017a, Armstrong, 2016, Lapide, 2016). Additionally, due to the increased fragmentation of supply associated with omni-channel retailing (Allen, 2010) and inventory proliferation (Specter, 2016), resulting in reduced inventory visibility (Covey, 2017, Nuce, 2015) models supporting improved inventory accuracy are now required (Cassidy, 2015, Trunick, 2015, Apparel, 2014, Arnstein, 2010). Such models are required also to support in optimal inventory location calculations (Byrne, 2016) and account for increased returns inherent within omni-channel retailing (Bernon et al., 2016).

Adopting a lens of economic sustainability, an emergent theme from the literature is that current strategies of OCF are not acceptable (Frei et al, 2020, Melacini and Tappia, 2018, Graves and Swartz, 2014). The financial implications of OCF adoption are rather well-documented (see for example Giles, 2017, MHL, 2017b, Meyer, 2014, Andel, 2014a) with a

recognition that a measured approach is required by retailers to both balance the cost to serve (Bressolles and Lang, 2020, Blanchard, 2013b) and understand the cost-benefit analysis associated with increased sales (Driscoll, 2013a). This has resulted in calls for approaches to allow retailers to optimise their operational omni-channel strategies (Maras, 2016) resulting in a profitable omni-channel model (Murfield et al., 2017, Whitehouse and Osburn, 2016). However, the sustainability implications of omni-channel retailing are under-explored. If there is known inefficiencies in terms of stock-handling, returns (Abdulla et al., 2019), and last-mile delivery (Abdulkader et al., 2018, Lim and Singh, 2018, Shenle et al., 2017), there will be a knock-on impact on the retailers environmental and societal footprint, something many retailers are starting to draw greater attention to (Gleim, et al., 2013, Ngobo, 2011, Fetterman, 2006). Further research is needed to explore the relative impacts of, and responses to the environmental and societal implication of omni-channel retailing.

From a marketing perspective, the long-term impact of adopting an omni-channel strategy upon business is not known (Davis-Sramek et al, 2020, Saghiri and Wilding, 2016). There is a general lack of understanding of the key variables that are critical to strategic success in the long-term (Arslan et al., 2021, Hansen and Siew Kien, 2015, Herhausen et al., 2015). This lack of theoretical framework has implications for both suppliers (Wilding, 2014) of omni-channel retailers and their customers (Brynjolfsson et al., 2013). Specifically, frameworks regarding channel integration need to be further developed (Verhoef et al., 2015, Piotrowicz and Cuthbertson, 2014) to better understand how to merge the physical and digital selling worlds (Rosenblum and Kilcourse, 2013).

The final research gap evident from the current literature is concerned with the incorporation of technological developments to support omni-channel strategies (Huang et al., 2020, Jifeng et al., 2016, Lewis et al., 2014). In harmony with contemporary technological advances, the research opportunities in this field are rather broad, with identified needs relating to the role of RFID technology in omni-channel retail (Convenience Store News, 2018, Hardgrave, 2012), the role of cloud storage as a data management solution (Pantoja-Navajas, 2015), and the role of big data to promote collaboration between brands and retailers to shape demand in line with consumer expectations (Nuce, 2015, Liu et al., 2010).

Further research gaps can be identified by exploring established marketing and OM theories and using this to highlight potential area of theoretical enquiry in the omni-channel space. Clearly some “traditional theories” can be applied very easily without further research

to omni-channel theories, however the markedly different characteristics of omni-channel retailing compared to single-, multi- or cross-channel retailing would indicate that there is a need for further research in areas relating to digital marketing and the impact of omni-channel marketing on the customer experience. As omni-channel strategies become more prevalent and represents a greater proportion of overall retail sales further research is required to inform retail operations, retail strategy, as well as models to explore the resilience of the OCF as well as the environmental and social impact of increased omni-channel activity.

8. Conclusion

The purpose of this systematic literature review is to explore how theories of omni-channel differ through the lenses of marketing and OM. In doing so this review contributes to both theory and practice and provides important direction for future research. The principal contribution to academic theory of this paper is the advancement of a first systematic literature review integrating the two distinct lenses of marketing and OM to omni-channel retailing using both academic and practitioner sources. By going beyond the established boundaries this review synthesises the two lenses to generate a holistic framework explicitly identifying the symbiotic relationship between the two functions. Whilst there are numerous definitions of omni-channel in the literature, see for example, (Gao and Su, 2016, Hübner et al., 2016c, Verhoef et al., 2015, Kozlenkova et al., 2015, Brynjolfsson et al., 2013) this review extends and contributes to the existing literature in several ways. This review offers clear distinction between the commonly confused strategies of multi-channel, cross-channel, and omni-channel, whilst such demarcation has been offered previously (Beck and Rygl, 2015), this review is the first to do so by integrating the lenses of OM and marketing from both an academic and practitioner perspective.

This review aims not only at offering a useful holistic definition of retail omni-channel but also explicitly identifies two disparate theoretical frameworks as determined by the retail sectors. Whilst both these frameworks offer a broadly similar customer experience (Herhausen et al., 2015, Kozlenkova et al., 2015, Verhoef et al., 2015) the upstream fulfilment considerations are markedly different for both. The proposed theoretical frameworks identify and propose important OM and marketing relationships that provides the foundation for future research.

This review also suggests implications for management practice. A deeper operational understanding of the parameters that contribute to an omni-channel strategy will aid

practitioners in overcoming the current cost and service issues currently associated with adoption. Omni-channel is very much an emerging strategy (Saghiri and Wilding, 2016) as such retailers are attempting to operate OCF by adjusting their previously channel-specific fulfilment structures (Hübner et al., 2016c). The theoretical frameworks generated by this review give clarity regarding the operational relationships inherent in omni-channel retailing.

Finally, this investigation of omni-channel retailing highlights new research directions from both a marketing and OM perspective. Most of the research undertaken so far has focussed primarily on customer experience and impacts of omni-channel adoption. This review supports a move beyond this initial understanding of the strategy with an opportunity to understand the impacts of omni-channel as adoption becomes more prevalent in the retail market.

Appendix 1

Publication	**Frequency**
International Journal of Retail & Distribution Management	23
International Journal of Physical Distribution & Logistics Management	19
Material Handling & Logistics	17
Modern Materials Handling	10
Journal of Retailing	9
European Journal of Operational Research	8
Journal of Retailing and Consumer Services	7
Supply Chain Management Review	7
SupplyChainBrain	7
Management Science	6
Apparel	6
The Journal of Business Forecasting	5
International Journal of Electronic Commerce	4
Journal of Operations Management	4
Industry Week	4
Journal of interactive marketing	4
International Journal of Production Economics	3
Logistics and Transport Focus	3
Food Logistics	3
Journal of Business Research	3
Chain Store Age	3
WWD: Women's Wear Daily	3
Journal of Marketing Channels	3
Journal of Service Research	3
Journal of Research in Interactive Marketing	3
Logistics & Transport Focus	3
Value Retail News	3
Journal of marketing	3
MIT Sloan Management Review	2
European Journal of Marketing	2
Progressive Grocer	2
International Journal of Production Research	2

Convenience store news	2
Journal of Retailing & Consumer Services	2
CRM Magazine	2
International Journal of Research in Marketing	2
International Journal of Information Management	2
Beverage Industry	2
Marketing Science	2
Journal of Strategic Marketing	2
MIS Quarterly Executive	2
Journal of Business Logistics	2
MMR	2
FRPT- Retail Snapshot	2
Operations Management Research	2
Logistics Management	2
Retail Merchandiser	2
Logistics Management (2002)	2
International Journal of Operations & Production Management	2
World Trade 100	2
Business Horizons	2
Manufacturing Business Technology	2
World Trade, WT 100	2
Omni-Channel conference	1
Managing Service Quality: An International Journal	1
International Journal of Economic Practices & Theories	1
Comparison-Shopping Services and Agent Designs	1
Mathematical Problems in Engineering	1
Computer Weekly	1
Int. Rev. of Retail, Distribution and Consumer Research	1
Computers & Industrial Engineering	1
Advances in Management and Applied Economics	1
Computers & Operations Research	1
Marketing Intelligence & Planning	1
Computers in Industry	1
Industry Week/IW	1
Computers in Libraries	1
Production & Operations Management	1
International Journal of Retail and Distribution Management	1
Supply & Demand Chain Executive	1
Internet Research	1
The Service Industries Journal	1
Journal of Advertising Research	1
Harvard Business Review	1
Journal of Business & Industrial Marketing	1
Industrial Distribution (Online)	1
Journal of Business Forecasting	1
Marketing.com	1
Benchmark Report, March	1
Industrial Marketing Management	1
Benchmark Report, RSR Research, Miami	1
National Real Estate Investor	1
Journal of Business Strategy	1
Pacific Asia Conference on Information Systems, PACIS 2016 – Proceedings	1

Journal of Commerce	1
Information Today Inc.	1
Journal of Commerce (1542-3867)	1
Service Business	1
Customer Relationship Management	1
Supply Chain Forum: International Journal	1
Dealerscope	1
Technology Analysis & Strategic Management	1
Decision	1
Transport Reviews	1
Journal of Interactive Marketing	1
Logistics Research	1
Decision Sciences	1
Managing Service Quality	1
Drug Store News	1
Manufacturing & Service Operations Management	1
Journal of Marketing Management	1
Market Leader	1
Econviews	1
Industrial Engineer	1
Ekonomski Anali / Economic Annals	1
Industrial Management & Data Systems	1
Benchmarking	1
MIS Quarterly	1
American Journal of Management	1
Business Strategy & the Environment (John Wiley & Sons, Inc)	1
Annals of Operations Research	1
Information Systems & e-Business Management	1
Food Manufacture	1
Omnichannel commerce z punktu widzenia konsumenta.	1
Journal of Service Research	1
Information Technology and Management	1
Journal of Services Marketing	1
Proceedings of the 10th European Conference on Information Systems	1
Foundations and Trends in Technology, Information and Operations Management	1
Production and Inventory Management Journal	1
Journal of the academy of marketing Science	1
Quality Innovation Prosperity / Kvalita Inovácia Prosperita	1
Journal of the Association for Information Systems	1
RFID Journal	1
Journal of Theoretical and Applied Electronic Commerce Research	1
Strategic Direction	1
Lecture Notes in Computer Science	1
Supply Chain Europe Magazine	1
LogForum	1
International Journal of Business and Information	1
Business Research	1
Sustainability	1
Logistics and Management	1
California Management Review	1
FT.com	1
Total Quality Management & Business Excellence	1

Global Telecoms Business	1
Transportation Research: Part E	1
Handbook of Business Strategy	1
International Journal of Logistics Management	1
Logistics Manager	1
Journal of Electronic Commerce Research	1
Academy of Marketing Science. Journal	1
Journal of Global Business Issues	1
Grand Total	**317**

Summary of publication frequency

The indeterminate situation of omni-channel fulfilment

The systematic literature review presented in chapter 2 served to highlight the characteristics of the indeterminate situation that this thesis seeks to explore. In this context, indeterminacy indicates a need to specify a specific situation of uncertainty regarding something (Strubing, 2007). Dewey (1999) characterises an indeterminate situation as one which contains confusion, conflict, and doubtfulness. In such situations, problems cannot be resolved by applying existing theory or techniques (Schön, 1992) instead, the problem must be thoroughly explored for the purpose of revealing likely solutions (Morgan, 2013).

The study in chapter 2 develops the problematization of the situation observed at the operations-marketing interface in the omni-channel context, namely, the apparent misalignment that exists between the marketing requirements of an omni-channel strategy and the operational capability of retailers to satisfy these demands effectively and efficiently. In line with definitions of the indeterminate situation, the operations-marketing interface in the omni-channel context represents a whole system, the problem, however, is that the constituent parts of the system do not hang together (Mackay, 1942). In exploring the state-of-the-art of omni-channel retail, the systematic review yielded some further insights as to the indeterminacy of the omni-channel situation.

Omni-channel as an indeterminate situation

By exploring omni-channel from both an operational and marketing perspective, the systematic review found that the marketing perspective of omni-channel is at a much greater stage of research maturity than the operations perspective. Within the omni-channel context, the operations-marketing interface has received very little attention, with only 5 papers adopting this perspective. The indeterminate situation can be observed from the opposing narratives adopted by each perspective. The emerging narrative from the marketing perspective is that omni-channel is a favourable strategy that leads to improved retail performance (Cao and Li, 2015, Grewal et al., 2017, Neslin, 2022). By contrast, the emerging narrative from the operations perspective is that omni-channel adoption leads to greater operational complexity and reduced efficiency (Hübner et al., 2016a, Ishfaq and Bajwa, 2019, Wollenburg et al., 2018). Despite the significant research interest that the omni-channel context has generated, the subject area is still in an early stage of maturity. As such, there is no defined theoretical ground to address the observed misalignment at the operations-marketing interface. To add further complexity to the indeterminate situation, there are multiple definitions of omni-channel, leading to further confusion and ambiguity, particularly amongst practitioners who are seeking

solutions to growing fulfilment challenges. Furthermore, analysis of the literature leads to the broad identification of three modes of omni-channel fulfilment configuration. The existence of multiple configurations of omni-channel fulfilment makes the indeterminate situation even more doubtful and is likely require different solutions for each configuration, leading to the *institution of a problem* stage of inquiry.

The institution of the problem is the first step in transforming the problematic situation into a determinate situation (Dewey, 1999). At this stage in the process of inquiry, the indeterminate situation is not yet problematic (Strubing, 2007) because it is still unclear as to what the problem and problems are within a problematic situation (Dewey, 1999). Dewey termed this process of working through the nature of the problem as *reflection* as the inquirer is required to use their current ideas to think deeply about the problem situation (Morgan, 2013).

To bring clarity to what the problem or problems might be in the problematic situation, it was necessary to narrow the scope of the inquiry to focus on only one mode of fulfilment. A UK omni-channel grocery retailer who adopted mode 1 type fulfilment agreed to participate in research. A diagrammatic representation of their fulfilment network can be seen in figure 1.

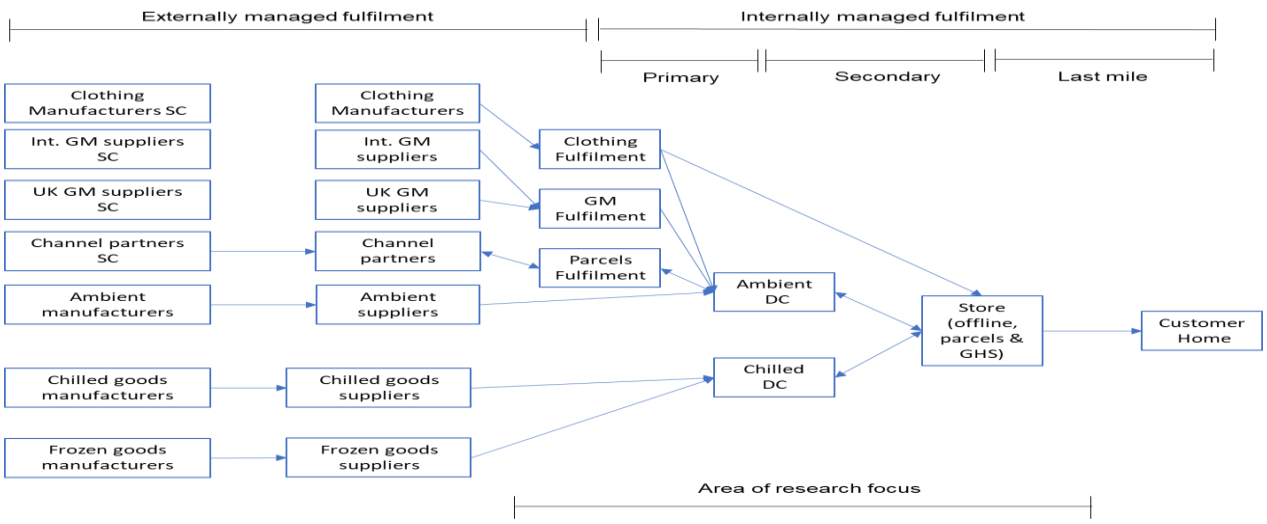


Figure 1: Diagrammatic representation of mode 1 omni-channel fulfilment system

At the left-hand side of the diagram are the upstream suppliers who provide the goods for resale to the retailer. The right-hand side of the diagram details a typical configuration of a grocery retailers internal fulfilment network, indicating how goods are moved internally through the distribution network to retails store and customers' homes. Whilst the movement of goods is

typically downstream and therefore moves from left to right in the diagram, note that some of the arrows have two heads, indicating upstream movements also. The study presented in the following chapter progresses the inquiry to the *institution of a problem* stage by quantifying the magnitude of the impact that adopting omni-channel fulfilment has upon operational performance.

Chapter 3

Omni-channel fulfilment performance: a structural contingency theory perspective
Short title: Omni-channel fulfilment performance

Stuart Milligan, Iain Davies, Baris Yalabik, Melih Celik

Abstract

This study contributes to a theoretical and empirical understanding of the marketing and supply chain interface in the context of omni-channel fulfilment. Adopting structural contingency theory, we posit that customer demand interacts with channel integration to affect fulfilment efficiency. Building on the literature on omni-channel fulfilment, we hypothesise that as omni-channel activity increases, fulfilment efficiency decreases, and second, these inefficiencies will vary by distribution mode. To test our hypotheses, we draw upon a dataset of omni-channel fulfilment activity from a leading global omni-channel retailer. We find significant evidence to support each of our hypotheses. In doing so, the findings of this study allow us to quantify the magnitude of the efficiency implications of adopting omni-channel on back-end fulfilment. Based on these findings, we provide insights into both theory and practice.

1 Introduction

Organisations are increasingly becoming more customer-centric, providing customers with more choices and immediate gratification (Angus & Westbrook, 2019). Yet, organisations need help to develop a customer proposition that can be efficiently supported in the supply and operations functions (Larke et al., 2018). This phenomenon is representative of the operations-marketing interface (Shapiro, 1977), an area of study that explores how an organisation manages its internal resources to meet the demands of the external market (Marques et al., 2014, Tang, 2010). An excellent contemporary example of the operations-marketing interface can be found in the retail omni-channel context (Adivar et al., 2019; Min et al., 2019).

Over the past decade, omni-channel has changed the retail landscape beyond recognition. In addition to completing their purchases in-store, retail grocery customers can also have their online shopping available to collect at a local store (Cao et al., 2016; MacCarthy et al., 2019), delivered to their homes (Hübner et al., 2016), delivered to locker boxes (Agnihotri, 2015), or even to the boot of their car (Gibbs, 2018). This retail proposition is so different from traditional bricks and mortar retailing that fulfilment operations must be realigned to meet the demands of the omni-channel environment (Jones et al., 2022; Bijmolt et al., 2021; Ishfaq et al., 2016).

Emergent themes from the omni-channel literature indicate that supply chain structures can struggle to adapt to an omni-channel strategy (Jeanpert & Paché, 2016). Whilst conceptually it is recognised that the integration of channels of distribution should yield synergies (Saghiri et al., 2017), exploratory empirics indicate that omni-channel supply chains are more sensitive to inventory inaccuracies (Barratt et al., 2018), require complex IT and automation solutions (Oh et al., 2012) and significant investment to re-configure infrastructure. However, insight into the magnitude of operational implications of adopting a customer-centric proposition like omni-channel, is missing from the literature (Melacini et al., 2018; Saghiri et al., 2017).

To address this gap, this study adopts a Structural Contingency Theory (SCT) perspective to explore the implications of adopting a customer-centric proposition on fulfilment operations. SCT allows an exploration of how the adoption of omni-channel fulfilment processes influence fulfilment performance (Drazin & Van de Ven, 1985). Such exploration is required by both academics and practitioners as it will make it possible to hypothesize contingencies and therefore scientifically define the rules of omni-channel survival (Donaldson, 2001). To contribute to this growing field of operations management this paper explores how the customer-centric response to the contingency variables of customer demand and customer behaviour influence organisational performance.

We use primary and secondary data from a global omni-channel grocery retailer. The dataset details omni-channel sales and back-end fulfilment performance measures between the years 2012 and 2019. During this time, the case organisation transitioned from being a primarily bricks and mortar retailer to an established omnichannel retailer. We used random effects panel data analysis with robust standard errors to explore the relationship between the growth of omni-channel sales upon back-end fulfilment performance over time.

This study makes several important contributions. First, it explores the interface between marketing and fulfilment operations, instead of the siloed approach which is prominent in the omni-channel literature. Second, this paper highlights the role of environmental conflicts and resource trade-offs inherent in the customer-centric response to macro-environmental factors in shaping omni-channel operations. Third, this paper is the first to quantify the magnitude of inefficiency that results from the adoption of omni-channel fulfilment.

2 Literature review

This section gives an overview of the emergent themes of omni-channel research, then explores structural contingency theory as a lens theory for understanding the operational implications of omni-channel adoption.

2.1 Omni-channel retailing

An omni-channel retail strategy focuses on providing customers with a seamless integration of sales and distribution channels across both online and physical retail touchpoints (Abdulkader et al., 2018; Verhoef et al., 2015). Customer-centrism is regarded as a key driver in the emergence of omni-channel (Adivar et al., 2019), as the primary aim of an omni-channel strategy is to provide a customer-centric experience (Min et al., 2019). Previous studies attribute the popularity of the omni-channel strategy to increased profits (Rosenblum & Kilcourse, 2013), increased convenience for customers (Ailawadi & Farris, 2017) and increased customer loyalty (Armstrong, 2016). To achieve this proposition, retailers demand an omni-channel fulfilment solution that is both cost-effective and responsive to customer needs, regardless of channel choice or customer journey (Chopra, 2018). The extant literature proposes several fulfilment challenges associated with the migration to omni-channel fulfilment including the requirement for traditional bricks-and-mortar retailers to redesign their distribution processes to make them more flexible (Hübner et al.,2015, 2016; Kuhn & Sternbeck, 2013), and increased expectations placed upon staff who work at the marketing and logistics interface (Galipoglu et al., 2018; Jeanpert & Paché, 2016).

Whilst omni-channel supply chains are defined as an integrated supply chain (Ailawadi & Farris, 2017), in practice, they are often independent channels with conflated front- and back-end logistics (Kembro et al.,2018; Wollenburg et al., 2018). This conflation is an attempt to reduce costs; as in practice, retailers attempt to ship all product through their existing distribution system rather than re-design their distribution infrastructure (Abdulkader et al., 2018). To deliver on the customer proposition; product selection for all channels is integrated at the distribution centre level (Hübner et al., 2016b). This practice is not without complexities, as distribution systems will vary enormously according to the channel used and type of product purchased (Jeanpert & Paché, 2016). Additionally, online sales are very difficult to forecast; owing to high dynamics and strong growth associated with the online channel (Hübner et al., 2015). It is important that this additional complexity is effectively managed, as the online channel cannot be at the detriment of the offline, where customers still demand fresh products and a great shopping experience (Kuhn & Sternbeck, 2013).

Previous studies have offered conceptual frameworks for omni-channel fulfilment. Hübner et al., (2016a) propose that omni-channel fulfilment can be understood in terms of two distinct stages; the "back-end fulfilment" stage, which is concerned with the picking and packing of orders and the "last-mile distribution" stage, which is concerned with delivering products to the end customer. There is extant work exploring the profitability and sustainability of the "last-mile distribution" stage (for recent reviews see Lim, Jin, and Srai., (2018) and Olsson, Hellström, and Pålsson., (2019). However, "back-end fulfilment" studies are under-represented in the literature (Galipoglu et al., 2018; Kembro et al., 2018).

"Back-end fulfilment" can be conceptualised as comprising of three dimensions: distribution network design, inventory and capacity management, and delivery planning and execution (Hübner et al., 2015; Melacini et al., 2018). Of these dimensions, distribution network design has received the most attention, where challenges relating to lower productivity; at both the distribution centre and store level, have been proposed as offline and online orders are integrated, as well as expectations of increased inefficiency in the distribution centre to store shipments as retailers attempt to offset the lower vehicle utilisation associated with channel integration by increasing the number of drops per shipment (Buldeo et al., 2019; Melacini & Tappia, 2018; Wollenburg et al., 2018). Regarding inventory and capacity management, Chopra (2018) contends that back-end fulfilment is only efficient when the offline demand is configured so that it services frequent and predictable demand, and the online is configured to service the infrequent and unpredictable demand. Challenges relating to delivery planning and execution result from the requirement to increase services to customers whilst simultaneously attempting to reduce cost (Hübner et al., 2016c). Currently, solutions to these challenges do not exist, although standardisation of data between channels and channel partners, and the incorporation of new strategies and new technologies may yield improvements (Jeanpert & Paché, 2016). Of note, the research relating to back-end fulfilment is either conceptual (Chopra, 2018; Jeanpert & Paché, 2016; Yadav et al., 2018) or qualitative (Buldeo et al., 2019; Hübner et al., 2016a; Melacini & Tappia, 2018; Wollenburg et al., 2018) in nature. Whilst these studies have provided valuable exploratory insight into the economic and environmental implications of "back-end fulfilment", a holistic understanding of the magnitude of these implications is missing from the literature.

Structural contingency theory (Lawrence & Lorsch, 1967; Thompson, 2003) offers a valuable framework for explicating these implications by viewing fulfilment performance as a

function of how well the customer-centric strategy is aligned with current models of omni-channel fulfilment (Flynn et al., 2010; Galbraith & Nathanson, 1978).

2.2 Structural contingency theory

Structural contingency theory (SCT) is an explanatory framework concerned with the relationship between the organisation, structure, and environment (Yucel, 2016). It maintains that, to optimise their performance, organisations need to align their structures and processes to their environment (Donaldson, 2001; Lawrence & Lorsch, 1967). Whilst there have been several SCT studies in the field of operations management (Kull et al., 2014; Netland, 2016; Romero-Silva et al., 2018), to date there is little exploration of the omni-channel context from a SCT perspective. Research adopting an SCT perspective can make theoretical and empirical contributions by identifying salient contingency variables that serve to distinguish between concepts and grouping different contexts based on these variables (Sousa & Voss, 2008).

2.3 Fulfilment performance and SCT

A review of the core components of an SCT model follows, leading to the development of hypotheses which explore the moderating effects of customer-centrism upon fulfilment efficiency in the omni-channel context. The following sections outline: omni-channel structural fit within the environment and the contingent response of omni-channel, including the omni-channel response to customer demand, and the characteristics of channel integration.

2.3.1 Omni-channel structural fit with the environment

Applying structural contingency theory to omni-channel fulfilment indicates that the dimensions of omni-channel operations must be aligned with the customer-centric proposition of omni-channel retailing to be efficient. Fulfilment capability is the key differentiator in the omni-channel proposition (Yu et al., 2017). Fulfilment capability in this context manifests as shorter lead times (Rabinovich, 2005) and the ability to react to customer demand for high product variety and availability (Mahar & Wright, 2009).

The logistical challenges associated with the reduced lead-time of omni-channel fulfilment has attracted the most research attention. Online orders are often placed for next-day or even same-day delivery, making sales forecasting difficult (Ishfaq et al., 2016; Wollenburg et al., 2018). As distribution centres tend to be located in logistical hubs, away from residential areas, retailers use stores as fulfilment centres to increase their ability to effectively react to the unpredictable demand of online channels (Hübner et al., 2016c). This practice has several implications. First, at the distribution centre, the small transaction size of online orders is labour-intensive in comparison to the larger transaction size of offline orders and therefore

increases picking and packing costs (Ishfaq et al., 2016). Second, to make the shipping to stores as efficient as possible, products for online channels are shipped alongside the products for offline channels (Ishfaq et al., 2016; Marchet, et al., 2018). This leads to increased shipping movements between distribution centres and retail stores (Eriksson et al., 2019; Kembro et al., 2018; Kuhn & Sternbeck, 2013) as well as an increase in less-than-full-load (LTL) movements (Marchet et al., 2018). Third, at the retail store, dedicated picking teams are required to manage online orders (Hübner et al., 2016b), resulting in a model which is more complex and expensive compared to offline fulfilment (Eriksson et al., 2019; Wollenburg et al., 2018).

Regarding the omni-channel proposition of choice and availability, retailers need to balance the predictable offline demand with the unpredictable online demand (Hübner et al., 2016a). This is achieved through additional labour resource and capacity at the distribution centre stage of replenishment (Ishfaq et al., 2016). Here, the wide variety of online products offered often results in a bottleneck (Eriksson et al., 2019) which drives in costs and results in more complex distribution systems (Weber & Badenhorst-Weiss, 2018). Whilst there is a focus on making omni-channel fulfilment as efficient as possible, the constraints of lead time and product availability mean that the emergent networks are not cost-effective (Kembro et al., 2018). The resultant task uncertainty of these varied customer demands interacts with the structural complexity of the omni-channel retailer to affect performance (Drazin & Van de Ven, 1985).

2.3.2 The contingent-response proposition of omni-channel

Previous studies exploring omni-channel fulfilment have addressed warehouse (Kembro et al., 2018), online fulfilment centre (Eriksson et al., 2019) and last-mile fulfilment performance (Lim & Singh, 2018). However, a quantification of the efficiency effects of omni-channel fulfilment is missing from the literature. In SCT, a contingent proposition is where a conditional association between two or more independent variables with a dependent variable is hypothesized and directly subjected to an empirical test (Drazin & Van de Ven, 1985). This study adopts the contingent proposition that omni-channel back-end fulfilment performance is the result of the association between customer demand and channel integration.

Digital technology allows customers to order whatever they want, wherever they want (Kembro et al., 2018) and cheaply (Agnihotri, 2015; Shetty & Kalghatgi, 2018). Furthermore, customers expect a consistent and unequalled service (Picot-Coupey et al., 2016) irrespective of the channel they choose (Hoogveld & Koster, 2016). The result is that the customer behaviours are more complex (Wang et al., 2016) as they will adopt cross-channel shopping behaviour, resulting in multiple interactions between and across channels (Jeanpert & Paché,

2016). Omni-channel, therefore, increases value to the customer by raising service levels and lowering both transaction costs and perceived transaction risk (Akturk et al., 2018).

An omni-channel strategy is the retailers' response to these customer expectations (Adivar et al., 2019; Min et al., 2019; Mishra et al., 2017). The resultant variety of options presents some challenges, as the retailer cannot control which channel the customer will use (Wollenburg et al., 2018), increasing the complexity of fulfilment operations (Larke et al., 2018). To maintain organisational fit, retailers must re-engineer their fulfilment processes (Hübner et al, 2016a; Hübner et al., 2016b) as omni-channel requires a fulfilment proposition that is both cost effective and responsive to customer needs (Chopra, 2018). Retailers need to move inventory to where it is most likely to sell, irrespective of location or channel preference (Saroukhanoff & Aryapadi, 2016) as one of the biggest cost drivers in omni-channel fulfilment is not having inventory in the correct place (Armstrong, 2016).

Characterised by frequent inventory movements (Hübner et al., 2016c) and the requirement to be responsive and cost efficient (Chopra, 2018) omni-channel retailers have had to re-engineer their existing fulfilment structures to achieve these requirements (Hübner et al., 2016a; Hübner et al., 2016c). As omni-channel supply chains are in practice independent channels with conflated front- and back-end logistics (Kembro et al., 2018; Wollenburg et al., 2018), the complexity of the omni-channel proposition results in a series of trade-offs between efficiency (Kuhn & Sternbeck, 2013; Wollenburg et al., 2018), product variety (Jeanpert & Paché, 2016) and delivery responsiveness (Lim et al., 2016). The integration of channels that is required to support omni-channel retail (Lim & Singh, 2018) means that offline deliveries must be made to stores within constraints that will achieve the proposition promised in online channels (Ishfaq et al., 2016; Ma, 2017). This approach presents several challenges. First, the customers' expectation of short lead times for online purchases has significantly reduced the available time for order processing (MacCarthy et al., 2019). Second, as retail stores are designed for product display and not replenishment (Larke et al., 2018) in-store picking is less efficient (Hübner et al., 2016c), resulting in additional cost to store operations (Ishfaq & Bajwa, 2019; Marchet et al., 2018) and is inconvenient for offline customers (MacCarthy et al., 2019). Third, the volatile nature of online sales presents availability challenges (Mahar et al., 2014), which also increases the likelihood of poor availability for offline customers (Gao & Su, 2016). These factors serve to increase the cost pressures for omni-channel retailers (Ishfaq et al., 2016; MacCarthy et al., 2019; Marchet et al., 2018). Leading to the following hypothesis:

Hypothesis 1: As the contingent variable of omni-channel activity increases, the performance variable of back-end fulfilment efficiency decreases.

2.3.3 The implications of distribution mode

There is recognition that different product types will result in differences in channel performance (Manral & Harrigan, 2018; Saghiri et al., 2017), however, there is disagreement around how channel performance varies by product type in grocery retailing. Hübner et al. (2016a) state that the biggest challenge in omni-channel retail is the high cost and complexity of food bought online. In contrast, (Verhoef et al., 2015) suggest that food retailing is less impacted than non-food by the adoption of omni-channel retailing.

The fulfilment of grocery retail can be further understood in terms of ambient (including non-food items) and chilled distribution networks. Chilled products require a higher number of store deliveries and shorter lead times, than slow-moving ambient products (Kuhn & Sternbeck, 2013). Owing to the perishable nature of chilled food (Mishra et al., 2017; Wollenburg et al., 2018), there are perpetual trade-offs between availability, inventory costs and transportation costs (Gružauskas et al., 2019). Additionally, because of the relatively high number of items per transaction, chilled distribution networks are more complex than ambient distribution networks (Kembro et al., 2018). Inefficiencies in ambient distribution are related to the comparatively high fulfilment costs of single units of inventory as is more typical of the non-food purchases, which tend to flow through this network (Cao et al., 2016). Performance differences between chilled and ambient modes of back-end omni-channel fulfilment has never been tested, so remains unclear, leading to the following hypothesis:

Hypothesis 2: The contingent impact of omni-channel activity upon back-end fulfilment performance will vary between chilled and ambient fulfilment networks.

3 Research method

We test our hypotheses by using management performance data collected from the UK operations of a major global retailer between 2012 and 2019, thus removing the major short-term effects of changing grocery shopping patterns associated with Covid-19 regulations. It is important to note that the UK grocery retail market is an oligopoly, with four major retailers representing 69.1% of market share (Statista, 2020). In this sector, retailers are faced with the same challenges of evolving technology, changing patterns of consumption and profitability (Grewal et al., 2017). In this context, this global retailer is typical of the retail sector. The period from 2012 saw this retailer move from a predominantly bricks-and-mortar retailer through to an established omni-channel retailer by 2019. The change in omni-channel activity between

these two points in time is considerable; in 2012, this retailer sold only 77 grocery items online per store per day on average. This increased to 7,154 online items per store per day by 2019. Similarly, in 2012, this retailer did not sell any non-food items such as clothing or electrical products online. By 2019, an average of 52 such items were sold per store per day.

3.1 Data preparation

The dataset comprised of fulfilment performance data from the distribution and retail store operations. Data relating to fulfilment demand by channel and associated activity was captured. Weekly performance data was collected from the distribution network from 2012 through to 2019. Weekly channel sales activity was only available from 2012 through to 2015 due to a change in the way the organisation recorded this performance data. To overcome this limitation, secondary data obtained from IGD.com was used to provide annual sales performance by channel from 2012 to 2019. Weekly sales performance data was forecasted using the actual data captured from 2012-2015 and the annual data provided by IGD.com. Based on the novelty of the study and importance of understanding the contingency response propositions of the company in interpreting the data; interviews were also conducted with six key members of the omni-grocery retailers' senior management team to support the explanation of the results. Each interview lasted an average of 31 minutes. Figure 1details the steps undertaken to prepare this data set.

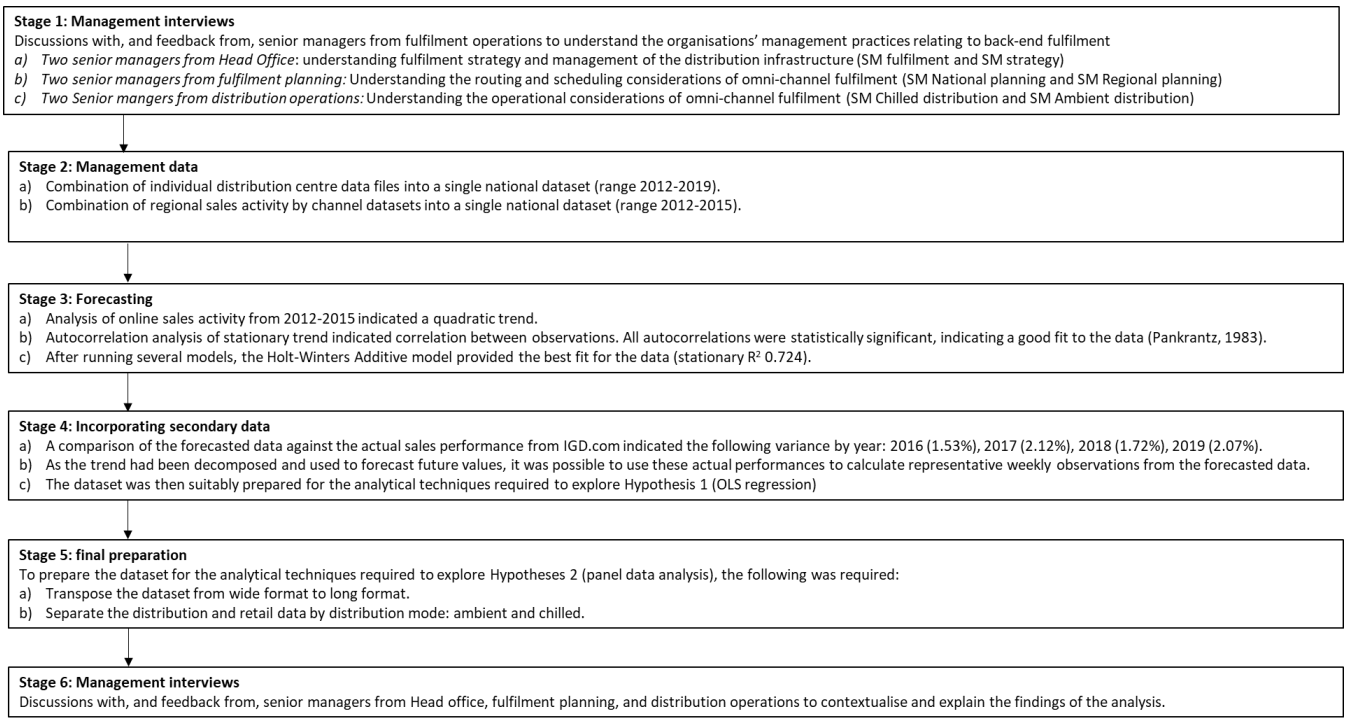


Figure 1: Data preparation process

3.1 Performance variables

Operations management literature highlights management practices for changing capacities, capacity management, adjusting capacity utilisation, and calculating capacity (Blackstone, 1989; Jonsson & Mattsson, 2003; Slack et al., 2010). The implementation of these practices presents managers with a choice; to vary the capacity (by changing capacity and capacity management), or to reallocate capacity (by adjusting capacity utilisation and calculating capacity). With respect to the context of freight distribution management, such practices are monitored by understanding the load factor. The load factor metric is a measure of the ratio of the actual load carried to the maximum load that could be carried (McKinnon & Ge, 2004). In line with the practices highlighted in the operations management literature, load factor can be manipulated to manage capacity by varying the volume on each load, or reallocating capacity across loads to achieve fulfilment in restricted time periods (Rogerson & Santén, 2015, 2017). Whilst the term load factor appears in several studies (Santén & Rogerson, 2018), there is an acceptance that it is a term which can be associated with measures of vehicle fill (Kale et al., 2007; Pålsson et al., 2013; Potter & Lalwani, 2008).

Logistic performance can be measured for strategic, tactical, or operational purposes (Gunasekaran et al., 2001). Capuce and Sheffi (1994) suggest that logistics performance can be understood in terms of three dimensions: utilisation, productivity, and effectiveness. Related studies indicate that the combination of performance measures is important when assessing performance at a strategic level (Andersson et al., 2013; Björklund et al., 2012; Holmberg, 2000). As such, Léonardi and Baumgartner (2004) propose a typology of road freight efficiency measures, comprising of logistic efficiency, vehicle efficiency, driver efficiency, and route efficiency. Of these measures, vehicle efficiency and driver efficiency are concerned with vehicle design and driver behaviour respectively and are therefore out of scope of this study. Logistic efficiency is a measure of vehicle fill and is concerned with increasing the load factor. This is represented by the dependent variable of *cases per journey* (CPJ). Route efficiency is concerned with the optimisation of the route taken and is represented by the dependent variable *Miles per Store Journey* (MPSJ).

To pre-test the salience of these measures an initial exploratory analysis was conducted by means of t-tests. In all measures, a statistically significant difference ($p<0.05$) was found between the performance variables in 2012 and 2019. The average mileage travelled between distribution centre and retail store for each fulfilment journey indicates that in the chilled fulfilment mode, this has increased by 7.02% and by 2.43% in the ambient fulfilment mode.

Regarding trailer fill capacity, chilled fulfilment mode shipments from distribution centre to retail store have experienced a decrease of 1.56% cases per journey and ambient fulfilment mode shipments have decreased by 2.24% cases per journey.

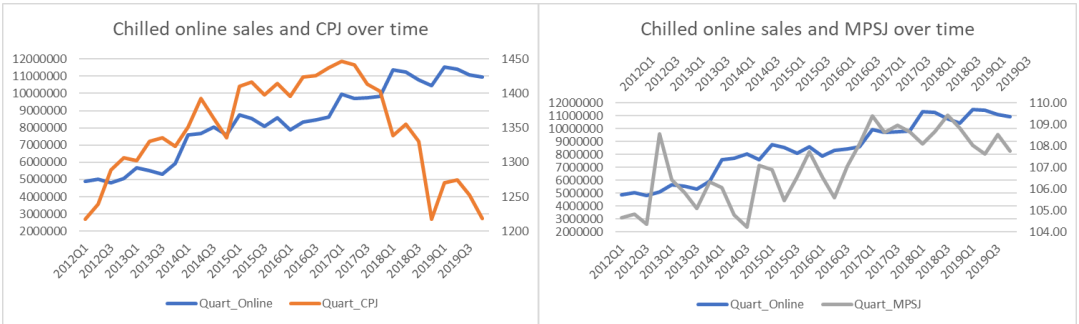
3.2 Response variables

The omni-channel context is characterised by multiple customer touchpoints (Larke et al., 2018; Verhoef et al., 2015; Wagner et al., 2020). Typical of the other major global grocery retailers, the case organisation originated as a bricks and mortar retailer. In response to the demands of the market, they developed three bricks and mortar channels, *convenience* (small format, offering limited food and non-food SKU's), *superstore* (medium format, offering a wide range of food and non-food SKU's), and *hypermarket* (large format, offering the organisations full range of food and non-food SKU's). In response to the omni-channel context, a fourth, *online* channel was added, whereby orders for food home shopping are shipped through the chilled network and online non-food "parcel" orders are shipped through the ambient fulfilment network. Online "parcel" orders were only shipped to *superstore* and *hypermarket* formats, as the low-fulfilment demand of *convenience* stores did not make fully integrated online fulfilment an economically viable proposition, instead they offered a click and collect option for food home shopping orders only. Each of these channels are fulfilled from an integrated distribution system and represent the four response variables.

4 Analysis

4.1 Descriptive analysis

As the case organisation is a traditional bricks and mortar retailer who have transitioned to omni-channel retail by adding an online channel, the online sales variable is a useful indicator of omni-channel activity (Hübner et al., 2016b). The data set represents omni-channel sales and back-end fulfilment performance over an eight-year period. Figure 2 demonstrates the relationship observed between online sales in the ambient and chilled distribution networks in relation to the CPJ and MPSJ fulfilment performance measures over time.



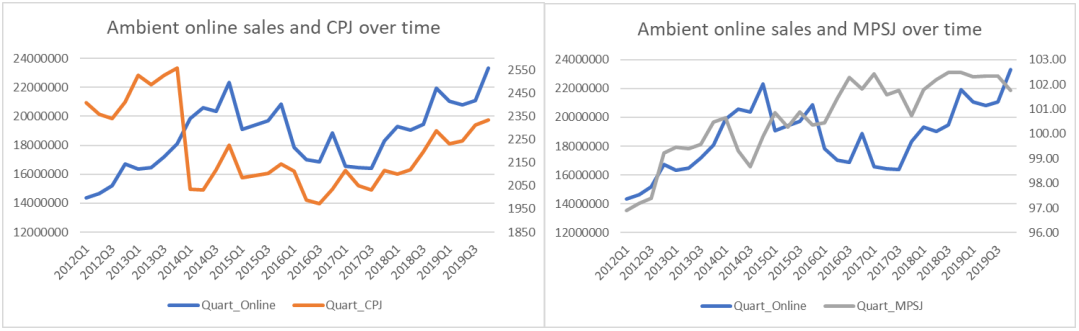


Figure 2: Fulfilment performance over time

When considering the data over time, a relationship between online sales and back-end fulfilment performance is evident in both the chilled and ambient distribution networks. In the chilled network, an increase in online sales results in an increase in CPJ to a point, beyond which, an increase in online sales causes a reduction in CPJ. Additionally, an increase in online sales appears to be associated with an increase in MPSJ. In the ambient network, lower levels of online sales were associated with an increase in CPJ, however operational practices required to manage higher volumes of online sales have caused a reduction in CPJ. In line with the observation made with respect to chilled fulfilment, an increase in ambient online sales is also associated with an increase in MPSJ. Each of these panels therefore highlights a very different response of back-end fulfilment efficiency to the increased online sales. This descriptive understanding of the dataset indicates that further inferential statistical analysis is warranted to explore the nature of the relationship between the variables and to test the hypotheses.

4.2 Addressing potential endogeneity

Following the theoretical development of our model, we adopted the guidance offered by Lu et al., (2018) to empirically test for endogeneity. First, simultaneity is not a strong concern as the volume profile is different each day for each channel. Additionally, there is a natural lag between sales and replenishment: for non-food products, the organisation replenishes on a D-4 basis (sales trigger a fulfilment demand which is replenished 4 days later), and food on a D-3 basis. The only exception, as previously outlined, is online sales which are ordered with a 1-day lead time. Second, omitted variables are not a concern as all channels/ touchpoints have been accounted for, as verified by IGD.com data. Third, reverse causality is extremely unlikely, as it is improbable that changes in either *CPJ* or *MPSJ* would result in changes to either the total volume demanded by the market, or the sales mix by channel.

As a final test for endogeneity, we analysed our models in STATA using 2SLS regression. Adapting the notation offered by Conley, Hansen, and Rossi (2012) we developed

the following instrumental variable regression models for each of the measures of back-end fulfilment efficiency:

$$CPJ = \beta_1(distribution\ volume)+\gamma_1(online\ sales)+\gamma_2(convenience\ sales)+\gamma_3(superstore\ sales)+\gamma_4(hyperstore\ sales)+\alpha+\mu_{it}+\varepsilon_{it} \quad (1)$$

$$MPSJ = \beta_1(distribution\ volume)+\gamma_1(online\ sales)+\gamma_2(convenience\ sales)+\gamma_3(superstore\ sales)+\gamma_4(hyperstore\ sales)+\alpha+\mu_{it}+\varepsilon_{it} \quad (2)$$

Where β is the explanatory endogenous variable, γ is the set of predictor variables, α is the unknown intercept for each variable, μ_{it} is the between-entity error, and ε_{it} is the within-entity error/ disturbance term. Robustness tests indicate that *distribution volume* is an exogenous variable with respect to *CPJ* (Durbin Chi_2: *p=0.0968*, Wu-Hausman: p=0.0981), but is an endogenous variable with respect to *MPSJ* (Durbin Chi_2: *p=0.0001*, Wu-Hausman: p=0.0001). To address any potential endogeneity concerns with our hypotheses, we ensured that they were practically relevant through interviews conducted with senior managers of the distribution planning and operational teams (Lu et al., 2018) who explained the practice of splitting full-loads and multi-dropping (delivering to multiple stores on a single vehicle) as a necessary practice to meet the time demands associated with omni-channel fulfilment. From a theoretical perspective, this is in line with the practices associated with the practice of route optimisation (Léonardi & Baumgartner, 2004; Santén, 2017). Based on both the field data and previous studies, there is sufficient evidence to support that in the case of *MPSJ*, the empirical estimate is correct in terms of the direction, however the magnitude of this effect may deviate from the estimate provided by the model due to endogeneity (Lu et al., 2018).

4.3 Hypothesis testing

After computing the response and explanatory variables, we verified that the predicted residual scores met the assumptions of normality, consistent variance, and independence (Wooldridge, 2010) for each of the models. The Jarque-Bera test (Jarque & Bera, 1980) for residual normality indicated that the standard errors were normally distributed in the models (p>0.5). The Breusch-Pagan (Breusch & Pagan, 1979) and White (White, 1980) tests suggested that heteroscedasticity was not a concern in both models (p>0.5 for both tests), and the VIF test (Baum, 2001) indicated collinearity on the hypermarket sales variable. The hypermarket sales variable was therefore removed from analysis. To address the concerns relating to heteroskedasticity, OLS regression with robust standard errors was used to test Hypothesis 1

and panel data analysis with random effects was selected to test Hypothesis 2 (Koenker & Hallock, 2001).

Response variable	***Predictor variable***	***Coefficient***	***Robust Std. Error***	***P***	***R_2***
CPJ (1)	*Online sales*	*-8.95 e^{-06}*	*7.26 e^{-07}*	*0.000*	*0.7270*
	Convenience sales	*0.0000176*	*3.95 e-06*	*0.000*	
	Superstore sales	*1.75 e^{-06}*	*8.01 e^{-08}*	*0.000*	
	Intercept	*1456.827*	*27.2124*	*1.000*	

Response variable	***Predictor variable***	***Coefficient***	***Robust Std. Error***	***P***	***R_2***
MPSJ(2)	*Online sales*	*3.52 e^{-08}*	*2.14e^{-08}*	*0.100*	*0.1150*
	Convenience sales	*-6.8 e^{-07}*	*1.42 e^{-07}*	*0.000*	
	Superstore sales	*-3.58 e^{-09}*	*3.09 e^{-09}*	*0.248*	
	Intercept	*96.36509*	*1.040243*	*0.000*	

Table 1: OLS regression analysis

Table 1 presents the results of our OLS regression analysis random effects panel data analysis. The results provide strong support for hypotheses 1: *as omni-channel activity increases, back-end efficiency decreases.* Model 1 indicates that an increase in online sales is associated with a decrease in cases per journey (CPJ) (β = -8.95 e^{-06}, ρ = 0.000). Conversely, and in line with previous studies (Santen 2017; Liimatainen et al., 2014; McKinnon 2009), an increase in offline sales across all store formats is associated with an increase in cases per

journey. Model 2 indicates that an increase in online sales was not statistically significant on miles per store journey (MPSJ) (β=3.52 e^{-08}, p=0.100). The only variable to present a statistically significant relationship with MPSJ is convenience sales, where an increase in convenience sales is associated with a decrease in MPSJ (β=-6.8 $e^{-07,}$ p=0.000).

Over the period examined, the case organisation made several operational adjustments to manage their omni-channel fulfilment processes in response to the consumer demand contingent variable. Table 2 presents a summary of these adjustments with respect to Hypothesis 1. The interviews with senior managers provided insight into the drivers behind the variance in back-end fulfilment performance experienced and some of the actions taken to mitigate against this impact.

Acton taken	**Management explanation**
Online orders combined with store orders	*"We have to wait for the online stock to come, we then have to scan them in and then scan them onto the load they are going out on to then dispatch the to the stores*" (SM Ambient distribution).
Offered next-day delivery on online orders	*"So, 5 years ago, 7 to 10 days on a delivery would have probably been okay if you had spent £50 on something. Now if it's not there the next day customers have a problem with it"* (SM Fulfilment).
Revised inbound delivery profile to depot	*"Supply and the central teams did a lot of work with suppliers to make sure our inbound profile moved early to allow us to do deliver to store earlier"* (SM Chilled distribution).
Increased multi-dropping of store orders to increase vehicle fill	*"To hit the proposition offered by online shopping, we must send loads earlier than we would like for store deliveries, causing a reduction in vehicle fill. To overcome this, we multi-drop to stores a lot more now"* (SM Fulfilment).
Collaborate with other retailers to increase efficiency of online fulfilment.	*"We offer the opportunity for retailers to come and work with us and allow their customers to either collect or return an order in our store network. It's a service that we launched the back end of 2015 and has grown significantly"* (SM Strategy).
Increase use of high-capacity, double deck trailers to increase load factor efficiency	*"The more the customer demands, the less efficient our schedule becomes. We have invested in additional double decks to deliver fewer, cheaper miles"* (SM National planning)

Table 2: Management insights relating to hypothesis 1.

The OLS regression analysis provided a cross-sectional understanding of the data set and provided valuable insights with respect to Hypothesis 1.

To explore Hypotheses 2: *The omni-channel impact upon back-end fulfilment performance will vary between chilled and ambient fulfilment networks*, panel data analysis was conducted, the results of which are summarised in tables 3 and 4.

Variable	***Label***	***Estimate***	***t Value***	***Pr > (t)***
CS1	*Cross-sectional Effect*	*-863.8141*	*-75.2336*	*<0.000*
Response variable	***Predictor variable***	***Coefficient***	***Std. Error***	***P > (z)***
CPJ (3)	*Online sales*	*$-6.80e^{-06}$*	*$2.21e^{-06}$*	*0.002*
	Convenience sales	*0.000764*	*0.0000104*	*0.000*
	Superstore sales	*$4.32e^{-06}$*	*$1.05e^{-07}$*	*0.000*
	Intercept	*1278.522*	*14.28511*	*0.000*

R^2 within (0.3391), between (1.000), overall (0.9340), Wald Chi^2 (11721.91), prob>Chi^2 (0.000)

Table 3: Cases per journey (CPJ) as performance variable

Variable	***Label***	***Estimate***	***t Value***	***Pr > (t)***
CS1	*Cross-sectional Effect*	*6.374*	*95.6283*	*<0.000*
Response variable	***Predictor variable***	***Coefficient***	***Std. Error***	***P > (z)***

MPSJ (4)	*Online sales*	*$2.63e^{-07}$*	*$3.07e^{-08}$*	*0.000*
	Convenience sales	*$1.35e^{-08}$*	*$1.45e^{-07}$*	*0.926*
	Superstore sales	*$4.24e^{-08}$*	*$1.46e^{-09}$*	*0.000*
	Intercept	*105.4708*	*0.1984447*	*0.000*

R^2 within (0.3347), between (1.000), overall (0.8124), Wald Chi^2 (3585.60), prob>Chi^2 (0.000)

Table 4: Miles per store journey (MPSJ) as performance variable

An examination of the t-scores of the cross-section variables (model 1, t = -75.2336, ρ= <0.000, model 2, t = 6.374, ρ=<0.000) highlights a statistically significant difference between the ambient and chilled panels. This difference can be explained through the different warehouse configurations adopted by each distribution mode. Typical of omni-channel food distribution networks, interviewees suggest the case organisation uses retail stores as fulfilment centres for chilled online sales (MacCarthy et al, 2019). However, in line with industry norms, the ambient fulfilment network manages the non-food online sales (Kembro et al, 2018).

Model 3 explains the relationship between channel sales performance and cases per journey over time. Across chilled and ambient distribution panels, an increase in online sales is associated with a decrease in cases per journey ($\beta=-6.80e^{-06}$, ρ=0.002). Whereas an increase of both convenience and superstore sales is associated with an increase in cases per journey ($\beta=1.35e^{-08}$, ρ=0.000 and $\beta=4.32e^{-06}$, ρ=0.000 respectively). The Wald Chi^2 test indicates that the variables are a good fit for the model and the overall R^2 score indicates that the model explains a significant amount of the variance observed in cases per journey.

Model 4 explains the relationship between channel sales performance and miles per store journey over time. Across chilled and ambient panels, an increase in online sales is associated with an increase in miles per store journey ($\beta=2.63e^{-07}$, ρ=0.000). The only other statistically significant relationship is between supermarket sales and miles per store journey, where an increase in sales in this channel is associated with a decrease in miles per store journey ($-4.24e^{-08}$, ρ=0.000). The Wald Chi^2 test indicates that the variables are a good fit for the model and the overall R^2 score indicates that the model explains a significant amount of the variance observed in miles per store journey. Table 5 provides insight from the case organisation relating

to the operational considerations for each panel relating to managing the response to the contingent variable of consumer demand.

Acton taken	**Management explanation**
Home shopping picked at stores	*"There is pressure to meet the store delivery times on certain products because the stores are waiting on that product to fill their home shopping. The Chill operation is more crucial because the ambient products are picked from carry-over store inventory. As chilled products are perishable, there is no carry-over store inventory" (SM Fulfilment).*
Chilled fulfilment completed by 3am to allow stores to be fully merchandised for online order fulfilment.	*"Grocery home shopping does put us under more pressure from a fulfilment perspective, it does add cost. If we weren't trying to get to stores by 3am, which is what the business tasks us with instead of 8am as it used to be, then we would be dispatching those loads at 0:30 in the morning rather than 1030 pm, that means that you put both the warehouse and transport functions under a lot of pressure to finish that much earlier*" (SM Chilled distribution).
Ambient fulfilment completed by 2pm to meet next day delivery proposition to customer	*"Most stores get their ambient product delivered in 2 hits, one at the start of the schedule, and one at the end, but guess what's in the middle - that click and collect delivery with a 2pm deadline. The first delivery is too early because the trunk hasn't arrived at depot and the second one is too late. Now I've got to get this other channel product to the shop, I've got to add it to a delivery for a nearby store and deviate"* (SM Ambient distribution).
Estimate online order volume on ambient shipping schedule.	*"Because we have completed the ambient store load plan before order capture for online orders is complete, we just leave 2 cage spaces, that seems to be average of what a shop gets"* (SM Regional planning).

Table 5: Management insights relating to hypothesis 2.

5 Discussion

By confirming that an increase in omni-channel sales results in a reduction in back-end fulfilment performance, this study supports the proposition that omni-channel sales can be understood as a response to the contingent variable of consumer behaviour that retail organisations must respond to (Flynn et al., 2010, Sousa and Voss, 2008). The data gathered

from the case organisation indicates that they have successfully arranged the required contextual factors (Donaldson, 2001) to attain organisational fit against the contingent variable (Lawrence and Lorsch, 1967, Woodward, 1980) of omni-channel, as the online sales variable has continued to grow over the time period observed. Hamilton and Shergill (1992) explain that organisation fit is evidenced when the organisation enjoys higher performance which generates surplus resources and then supports further expansion (as is evidenced in online sales growth). The different contextual factors adopted by chilled and ambient distribution operations to respond to the omni-channel contingent variable is in accordance with the fundamental assumption of structural contingency theory that there is no one best approach to respond to contingent variables, and even within a single organisation, different approaches may be required to respond to different aspects of the contingent variable (Drazin and Van de Ven, 1985, Sousa and Voss, 2008).

In line with previous studies exploring SCT, this study supports the view that an organisations response to a contingent variable is not static (Donaldson, 1987, Pennings, 1987, Grinyer et al., 1986). Chandler Jr (1969) highlight the cycle of fit/misfit/fit that organisations' will experience as they must constantly realign their organisational structures to fit contingent variables. The phenomenon can be observed in both the chilled and ambient distribution networks in the case organisation. In the chilled network, interviews with management participants revealed that early in the adoption of omni-channel retailing, when online orders were low, retail stores could pick, pack, and ship online orders within a replenishment schedule that was optimised around offline sales. As online sales volume grew, it became impossible to meet the service proposition within the existing fulfilment schedule, so the organisation optimised the chilled fulfilment schedule for online sales, meaning that all fulfilment to stores had to be completed by 3am instead of 8am. This meant that it was no longer possible to optimise the fulfilment schedule in terms of CPJ, so stores that were geographically close were grouped together to increase load efficiency as the expense of distance efficiency. A similar approach was adopted in the ambient fulfilment network, whereby the fulfilment schedule that was optimised for offline sales became unsuitable when online sales volume grew, so the ambient fulfilment schedule was then optimised for online sales, meaning that all fulfilment to stores had to be completed 8 hours earlier, at 2pm instead of 10pm. A further complexity was also experienced in the ambient fulfilment network; due to short lead-time associated with online sales, it was not possible to accurately plan to space requirements of offline orders on the loads for stores, so space requirements were estimated, often resulting in poorer CPJ. Both

the panel data analysis and interview data indicate that this structural re-alignment of the back-end fulfilment to achieve organisational fit resulted in poorer back-end fulfilment performance, both in terms of cases per journey and miles per store journey.

5.1 Implications for structural contingency theory

By utilizing structural contingency theory to explore the nature of organisational behaviour at the operations-marketing interface, this study extends the current understanding of SCT. Previous studies that have adopted SCT to explore organisational behaviour from an operations management perspective (Flynn et al., 2010, Sousa and Voss, 2008, Wong et al., 2011) offer support to the theoretical proposition that in successfully organising contextual factors to align with contingency variables (Donaldson, 2001), an organisation will achieve strategic fit and performance will increase as a result (Drazin and Van de Ven, 1985, Lawrence and Lorsch, 1967, Woodward, 1980). This study highlights that this view does not adequately explain the performance dynamics of the operations-marketing interface. In the omni-channel grocery retail sector, it would appear that successful organisation of the contextual factors relating to back-end omni-channel fulfilment do indeed increase performance in the omni-channel contingency variable in terms of sales volume, customer convenience, and customer satisfaction (Kembro and Norrman, 2021). What SCT in its current form fails to recognise, is the deleterious performance in the operations side that results because of improved marketing performance. SCT posits than organisations can re-align to achieve fit on an almost perpetual basis and continue to indefinitely improve performance (Donaldson, 2001, Van de Ven et al., 2013). The findings of this study suggest that there is an optimum level of omni-channel contingency activity in the marketing side, growth beyond which becomes operationally unsustainable.

5.2 Contribution to the study of omni-channel

Our study addressed an important question: How does the customer-centric response to the contingency variables of customer demand and customer behaviour influence organisational performance? By focussing on back-end fulfilment operations, this study highlights that the customer-centric response to the contingency variables of customer demand and customer behaviour results in a less-efficient operational performance. In addressing this empirical question through a descriptive study using a unique dataset from a global grocery retailer, we extend the current understanding of the operational implications of adopting omni-channel fulfilment. This study makes three important empirical contributions to the literature on omni-channel fulfilment.

First, it adds to the existing conceptual and qualitative omni-channel fulfilment literature (Hübner, Kuhn, et al., 2016; MacCarthy et al., 2019; Wollenburg et al., 2018) by providing empirical evidence that retailers perform less efficiently by adopting an omni-channel strategy, even without considering the inefficiencies of home delivery, which we did not explore in this paper. Omni-channel distribution results in reduced cases per journey, increased mileage, and therefore increased time to complete deliveries, echoing the problems that are often associated with last-mile deliveries (Deutsch & Golany, 2018; Hübner, Kuhn, et al., 2016; Lim et al., 2016).

There are several response variables under the broad umbrella of "customer-centrism" which are adopted by omni-channel retailers which account for this reduced performance. There are two drivers for this in the ambient distribution mode. First, the short lead time offered by retailers of e-commerce lines (Hübner et al., 2015) means that it is difficult for fulfilment planners to account for the correct amount of space required on vehicles when building store delivery plans, so an estimate of the potential volumes is made with some contingency, driving in inefficiencies. Second, the very short lead times often mean that goods are shipped nationally; as soon as these goods are received at depot and cross-docked, they are then dispatched to store. This time horizon is often optimal for achieving the e-commerce proposition, but sub-optimal for achieving maximum load fill. In the chilled distribution mode, the reduction in cases per journey is again driven by the need to ship e-commerce orders early. As stores are used as fulfilment centres (Wollenburg et al., 2018), then the food must be shipped earlier than is optimal for offline merchandising so that it can be merchandised and picked for online orders (Hübner et al., 2016a). The efficient utilisation of load capacity has a significant impact upon the efficiency of fulfilment operations (Edwards et al., 2010). As such, retailers are keen to limit the impact of the above operational imperatives as much as possible. This is achieved by grouping deliveries for several stores onto a single vehicle (Abdulkader et al., 2018), as the costs associated with the additional miles and time taken is offset by the improvements offered by increasing load capacity.

Third, it highlights that omni-channel fulfilment cannot be understood as a singular practice; rather as a strategy which has multiple modes, each of which will perform differently in delivering the retail proposition. This research provides consensus for the proposition that the addition of retail channels results in operational challenges (Wollenburg et al., 2018) and that performance will vary by channel type (Jeanpert & Paché, 2016; Saghiri et al., 2017). As grocery home shopping items are picked and packed at the retail store level (Hübner, et al.,

2016c) the demand volume from this channel simply adds to the offline store volume, creating an overall increase in the demand volume, promoting greater fulfilment efficiency in the chilled mode which serves to offset some of the deleterious load factor implications associated with the reduced lead-time. The online volume that flows through the ambient distribution mode, by contrast, is not integrated with the offline ambient demand volume in the same way. The ambient mode online volume is picked at a separate distribution centre (Ishfaq & Bajwa, 2019; Marchet et al., 2018), and therefore does not add to the offline demand at store level, resulting in a greater negative impact upon load factor.

Hübner et al. (2016a) identify that a response behaviour of omni-channel adoption is to move inventory more frequently through the network. This is evidenced in the results of this study by the observation of reduced cases per journey being associated with omni-channel activity, as retailers prioritise the fulfilment of the delivery proposition to the customer over operational efficiency. Both fulfilment models highlight the attempts of retailers to mediate the impact of this inefficiency by a combining several store deliveries into a single load, hence the increase in miles per store journey, as the load factor impact is more profound in the ambient mode, it follows that the increase in miles per store journey will also be more marked in the ambient mode. An explanation for this response is offered by Hübner et al. (2015), who posit that these operational responses result from difficulties associated with accurately forecasting online sales, hence operators must react at short notice to customer requirements rather than create an optimal fulfilment schedule as is the practice in single channel fulfilment.

The results of this study also bring clarity to previous omni-channel research conducted from an operations management perspective. Ishfaq and Bajwa (2019) posit that there are inherent trade-offs in trying to manage the contingent variables of customer behaviour and expectations. Similarly, Wollenburg et al. (2018) posits that operating multiple channels is less efficient. The findings of this study suggest that fulfilment efficiency will vary by mode; however, the conflicting retail propositions of the online and offline channel results in a reduction in fulfilment efficiency across both modes.

Additionally, through the identification of customer demand as a contingency variable, measures of channel integration as response variables; and cases per journey and fulfilment mileage as performance variables, back-end omni-channel fulfilment now has a context specific framework through which operational performance can be understood and modelled. Additionally, this framework provides the means to optimally design omni-channel operations,

such a framework was previously missing from the literature, resulting in retailers augmenting their existing networks through trial and error to see what works (Abdulkader et al., 2018).

The results of this study also challenge some of the findings from previous research. Kozlenkova et al., (2015) posit that omni-channel retailing should reduce operational costs. The results of this study would suggest that the opposite is true, as both chilled and ambient fulfilment models of omni-channel display a reduction in fulfilment efficiency. These results also serve as a cautionary note to researchers who explore omni-channel from only the marketing perspective and highlight the benefits of omni-channel adoption to the retailer in terms of increased sales and market share (Berman & Thelen, 2018; Cao & Li, 2015; Yrjölä et al., 2018), whilst this is true, there are also fulfilment inefficiencies to consider.

5.3 Managerial implications

The results of this study are also of interest to omni-channel retail managers. The identification of how the response variables affects economic and environment performance for each mode allows retailers to make informed decisions regarding operational configuration. Whilst previous studies have recognised the efficiency challenges associated with omni-channel fulfilment (Akturk et al., 2018; Ishfaq et al., 2016; Wollenburg et al., 2018), this is the first study that demonstrates this inefficiency relates to dimensions of load factor and offers a quantification of the magnitude of this inefficiency. By considering both the retail benefits of an omni-channel strategy (Armstrong, 2016; Berman & Thelen, 2018; Verhoef et al., 2015) and the operational costs highlighted in this study, omni-channel retail managers will be better equipped to understand the cost-dynamics of their fulfilment operations and develop their retailing strategies accordingly.

Building upon the literature that addresses freight sustainability (Edwards et al., 2010; Mangiaracina et al.2015; Martí et al., 2015), reduced cases per journey and increased fulfilment mileage is associated with an increased carbon footprint and poorer air quality. The quantification of the impact of adopting omni-channel fulfilment allows retailers to identify the carbon input by distribution mode that is associated with omni-channel fulfilment. Retailers can use the results of this research to configure their operations to minimise these impacts.

5.4 Limitations and future developments

Whilst this study makes a significant contribution to the omni-channel literature and has important implications for practice, there are some limitations and opportunities for future studies. First, this study is purely empirical in nature. Whilst the case data is from a global

retailer, representative of the omni-channel retail context as is evidenced by the strong relationship between the practices observed in this retailer and those accounted for in the omni-channel literature, there are undoubtedly other configurations adopted by other retailers. It would therefore be beneficial for future research to approach this problem from an analytical perspective and then conduct a controlled experiment to test the relationships between the contingency, response, and performance variables. Second, this study is concerned with the quantification of the contingency, response, and performance variables. Whilst this is important and the results contribute to both omni-channel literature and management practice, what this study fails to address are the reasons why retailers configure their fulfilment operations as they do. To this end, it would be fruitful to conduct a qualitative inquiry which explores the marketing-operations interface.

6.0 Conclusion

The aim of this study was to expose the implications of retail omni-channel integration on operational efficiency in relation to fulfilment operations. The findings provide evidence that customer-centric activity as observed in the omni-channel context can be associated with a decrease in structural efficiency. By adopting a structural contingency theory lens, this research validated the contingent, response and performance variables associated with the omni-channel context. It contributes to the growing understanding regarding the nature and performance of omni-channel supply chains. We hope that our empirical study will encourage and support novel studies in this important area.

Determination of a problem solution

The study presented in chapter 4 brought clarity to the problem situation in several important ways. First, it highlighted the magnitude of the impact of adopting omni-channel upon operational performance. Second, the study identified further complexity within mode 1fulfilment by identifying fulfilment performance will also vary by ambient and chilled network types. Finally, the study incorporated structural contingency theory to determine the genuine problem that mode 1 omni-channel fulfilment is not sustainable beyond a threshold level of online sales participation. The findings of the study in chapter 4 have progressed the inquiry by bringing clarity as to what the problem situation is, what is still not clear at this stage of inquiry are what the constituent elements of the problem are, namely *why* the problems occur. This issue is addressed by the next stage of Deweys' process of inquiry, the *determination of a problem solution*.

The determination of a problem solution addresses the issue that the statement of a problematic situation is not in itself a solution, it is merely a reference to a possible solution (Dewey, 1999). This stage of inquiry requires empirical observation to discover the aspects of the problem that need to be considered to reach a relevant solution (Strubing, 2007). The outcome of this stage of inquiry is a problem so controlled that subsequent inquiries would lead towards a solution (Morgan, 2014).

The determining of a problem solution stage is addressed by the study presented in chapter 4. This study adopts a complex adaptive systems theory lens to identify the agents of omni-channel fulfilment and explore how these agents arrange fulfilment practices in response to energy imported from the omni-channel retail environment. CAS is a useful and appropriate lens through which to explore the omni-channel context as the omni-channel grocery retail sector is currently facing is a tension between an increase in retail sales (Statista, 2020), and associated increased fulfilment costs resulting in poorer profit performance (Davey, 2020; FT.com, 2020). Research focused on grocery omni-channel fulfilment highlights an environment characterised by short delivery terms, flexible delivery options (Daugherty et al., 2018), and low volume density (Buldeo et al., 2019). The result is a complex environment associated with poorer operational performance (Gilgor et al., 2015).

Complex adaptive systems (CAS) theory has been highlighted as a useful lens through which to explore such tensions of flexibility and efficiency (Nilsson and Gammelgaard, 2012, Saghiri et al., 2017). CAS theory indicates that these tensions will exist until a preferred state

of equilibrium between fulfilment operations and the omni-channel environment is reached (Smith and Lewis, 2011). Thus far, operations management studies adopting a CAS perspective have focussed on topics relating to the behaviour of the system (Nair and Reed-Tscochas, 2019), with very little attention devoted to the nature of the environment. Building on the research of Saghiri et al. (2017) which recognizes omni-channel as a CAS comprising of three dimensions, channel stage, channel type, and channel agent, the study in chapter 4 adopts a single in-depth case study approach with a leading global omni-channel grocery retailer to explore the tensions arising from the environmental agility offered to the omni-channel customers and the operational requirements of maintaining an efficient fulfilment solution. This study contributes to the study of CAS by proposing a new understanding of the CAS environment in the omni-channel context.

Chapter 4

When supply meets demand: an exploration of the operations/ marketing interface in the omni-channel context.

Despite the prevalence of omni-channel, grocery retailers need help to organise their fulfilment operations efficiently. Adopting Complex Adaptive Systems theory, this study considers the case of a leading omni-channel grocery retailer to explore the current fulfilment challenges in the omni-channel fulfilment context. Analysis of the case data identifies two agents of omni-channel fulfilment, online and offline, whereby each agent imports different energy from the environment. These findings imply that the current approach adopted by grocery retailers of attempting to create efficiencies by leveraging their existing fulfilment infrastructures is likely to fail due to the inherent conflicts that exist across several dimensions of omni-channel fulfilment.

1 Introduction

In some sectors, the environment has evolved so much that new operational strategies are required (Nair and Reed-Tsochas 2019). One such sector is grocery omni-channel retail, which has adopted a strategy which has shifted its operating environment from one which serves only bricks-and-mortar customers to one which simultaneously manages the demands of bricks-and-mortar and online customers (Beck and Rygell, 2015), interacting through a greater number of touchpoints (Verhoef et al., 2015). The challenge the omni-channel grocery retail sector now faces is tension between increased retail sales (Statista, 2020) and associated increased fulfilment costs resulting in poorer profit performance (Davey, 2020; FT.com, 2020).

Recent research has started to focus on the impact of adopting an omni-channel strategy upon fulfilment operations. Studies focused on last-mile fulfilment highlight how short delivery terms and low-density drive inefficiency to fulfilment operations (Aktas et al., 2021, Buldeo et al., 2019a, Lim and Singh, 2018). Customers demand fast service with flexible delivery options customised and tailored to their needs (Daugherty et al., 2019). Retailers need to reconfigure their fulfilment operations to meet these customer demands (Lim and Winkenbach, 2019, Jiu, 2022, Millstein et al., 2022). The challenge is that customer demand is highly variable and dynamic. Thus, retailers are unable to adapt their infrastructures in such a way to efficiently meet customer demand (Zhang et al., 2019).

The pace and scale of changes within the omni-channel context has resulted in a theoretical lag relating to efficient fulfilment operations (Huang et al., 2020). In practice, there is an apparent misalignment between the operational practices adopted by omni-channel retailers and their environment, resulting in fulfilment inefficiencies (Bijmolt et al., 2021). Research thus far fails to explain this phenomenon. To explicate this gap in understanding, we adopt a complex adaptive systems (CAS) theoretical perspective to conduct an exploratory study (Stebbins, 2001). CAS theory provides a useful lens to explain omni-channel fulfilment performance (Saghiri et al., 2017) as there are many parts to an omni-channel system (Chopra, 2018, Larke et al., 2018), with many interactions (Lapide, 2016, Verhoef et al., 2017). In this paper, a single, in-depth case study approach with a leading global omni-channel grocery retailer is used to understand the challenges and opportunities associated with omni-channel fulfilment as a complex adaptive system.

2 Conceptual background and research question

Omni-channel retailing represents a paradigm shift in retailing (Simone and Sabbadin, 2017) and is set to become the dominant retailing strategy in the near future (Saghiri and Wilding, 2015). The majority of studies exploring omni-channel fulfilment thus far have adopted an atheoretical stance, however, this study builds on a recent paper by Saghiri et al. (2017) that conceptualised omni-channel as a CAS. To develop a conceptual ground for this study, this section presents an overview of omni-channel fulfilment, complex adaptive systems, and finally omni-channel as a CAS literature streams before presenting our research question.

2.1 Omni-channel fulfilment

Omni-channel fulfilment is a concept based on complementarity, whereby the use of multiple channels of fulfilment drives synergies for the retailer (Kaczorowska-Spychalska, 2017). The common channels of fulfilment offered by retailers are buy-online and pick-up in store (BOPS) (MacCarthy et al., 2019, Hu et al., 2022), ship-to-store (STS) (Akturk et al., 2018), grocery home shop (GHS)/ship-from-store (SFS) (Lim and Singh, 2018; Jiu, 2022) and reserve-online and pick-up-in-store (Jin et al., 2018). This proposition is much more complex than traditional bricks and mortar retailing (Jones et al., 2022, Jorge et al., 2020, Larke et al., 2018), in which retailers need to reconfigure their fulfilment infrastructure to deliver the omni-channel proposition (Hübner et al., 2016a, Hübner et al., 2016b).

The literature has identified many operational areas of the omnichannel fulfilment process; distribution centres (DCs) (Hübner et al., 2016c, Kembro et al., 2018, Wollenburg et

al., 2018), store operations (Larke et al., 2018, MacCarthy et al., 2019, Ye et al., 2018), and returns (Akturk et al., 2018, Bernon et al., 2016, Ofek et al., 2011).

2.1.1 Distribution centres

In DCs, fulfilment systems are required to concurrently fill orders for both store replenishment and e-commerce (Kembro et al., 2018). This integration of channels means that distribution centres must simultaneously manage bulk deliveries to a relatively small number of stores whilst managing the picking and shipping of individual items for online customer orders (Hübner et al., 2016a, Ishfaq et al., 2016). The fulfilment configurations that omni-channel retailers adopt will vary according to the different types of products offered and the market being served (Kembro and Norrman, 2021). In the grocery sector, it is common for retailers to use several central DCs specifically for slow moving products and use regional DCs for fast moving consumer goods (Wollenburg et al., 2018b). One of the main challenges highlighted in the literature is the effective and efficient management of inventory, as typically online and offline inventory systems are not integrated, meaning that online orders will be shipped to store from the DC even if there is availability of that product in store (Akturk et al., 2018). What is clear is that irrespective of the retail sector, significant investment is required to allow DCs to process the high variability of order profiles associated with omni-channel fulfilment (Hübner et al., 2016c, Ishfaq et al., 2016, Wollenburg et al., 2018a).

2.1.2 Store

The role of the store has changed with omni-channel retailing, in that stores are now responsible for the fulfilment of online products as well as offline retail (Larke et al., 2018, Hübner et al., 2022). Omni-channel retailers use stores as fulfilment centres due to their proximity to the customer (Kembro et al., 2018, Melacini and Tappia, 2018). Many of the omni-channel fulfilment processes are designed to draw additional customers into physical stores, increasing sales in both channels (Abdulkader et al., 2018, Akturk et al., 2018, Akturk and Ketzenberg, 2022). However, stores are designed for merchandising and not picking operations, so this is not always an efficient solution (Ishfaq et al., 2016, Ishfaq and Bajwa, 2019). Adapting a store so that it is capable of omni-channel fulfilment requires significant financial investment (Akturk et al., 2018).

Studies relating to omni-channel fulfilment have to date explored the challenges associated with the role of the store. Ye et al. (2018) found that the addition of the online channel to bricks and mortar stores is very disruptive. Further, if inadequately planned and managed, store picking for online sales also has the potential to increase out of stock issues and

interfere with customers shopping in the offline channel (Hübner et al., 2016b, Larke et al., 2018). From a replenishment perspective, Wollenburg et al. (2018b) found that omni-channel fulfilment deliveries to store are more costly than single channel deliveries to store. Buy online, pick-up-in-store (BOPS) is a popular channel to add to a retail store as it not only draws additional customers into the store, but it also negates the expensive last-mile element of the fulfilment journey. However, BOPS is not always a good strategy as some goods return a lower profit through this channel than they would through a regular store purchase (Gao and Su, 2016). Additionally, despite its popularity as a fulfilment channel, most retailers find it very difficult to effectively execute a BOPS proposition due to inaccurate store inventories (MacCarthy et al., 2019). A useful perspective is that the optimum fulfilment model is to only allow selective stores to offer an omni-channel proposition, rather than adopting this proposition for every store in the retail estate (Mahar et al., 2014).

2.1.3 Returns

The studies relating to returns are largely descriptive in nature. Hübner et al. (2016b) identified that returns can originate from the customers home or the retail store and will be processed either at store, in a DC, or a dedicated returns centre. As return rates from online sales can be more than double those from store purchases (Bernon et al., 2016), product returns to stores can lead to significant inventory imbalances which need to be manually corrected (Du et al., 2018). Additionally, the cost of returns is typically borne by the retailer (Abdulla et al., 2019, Kembro et al., 2018, Larke et al., 2018).

In summary, all the omni-channel fulfilment activities represent a trade-off between increased demand and increased complexity (Larke et al., 2018). Retailers are faced with managing the trade-off that emerges from operating multiple distribution configurations to provide a seamless service experience to consumers and the increased cost and inefficiencies that this brings (Lim et al., 2016). Within the CAS context, these trade-offs are typical of a system that is not presently aligned with its environment and the energy from the environment is creating tension between the agents (Anderson, 1999). These trade-offs should ultimately be resolved as the agents co-evolve and develop new schemata, adapting the system to its environment (Miller and Page, 2009).

2.2 Complex adaptive systems (CAS)

A CAS comprises four key elements (Anderson, 1999). An *agent with schemata* can be an individual, a group, or a function, but their agency is determined by their schemata, which are a common cognition shared by the members which determines what action the agents will take

(Holland, 1992). Complexity, from an environmental perspective, is equated with the number of items or elements that must be dealt with by the organisation simultaneously (Scott, 2002). This stimulus from the environment forces the agents to react, organising activity to deal with these elements. Hence, the concept that CAS *import energy* from the environment. *Co-evolution* emphasises the adaptive nature of CAS. To react more efficiently to the elements of the environment, and to other agents, the agents will modify their schemata (Holland and Miller, 1991). As a result of this strive for efficiency, the agents are in a state of constant co-evolution (Choi et al., 2001). After periods of unsettled activity, resulting from the agents trying to adapt to each other and their environment, and learning from previous experience, new agents ultimately emerge (Pathak et al., 2007), resulting in *system evolution based on recombination*. Based on these conceptualisations, the CAS journey of an organisation adapting to its environment can be presented as a cycle, as detailed in *figure 1*.

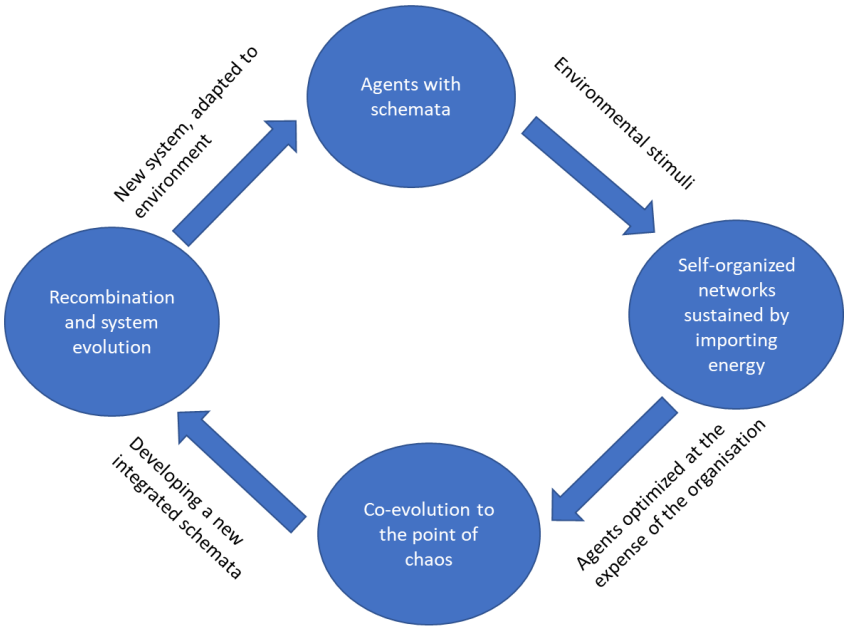


Figure 1: The four CAS stages of adapting to the environment.

Complexity theory posits that organisations act in unpredictable and surprising ways because they are nonlinear (Casti, 1994). This means that small operational changes can result in significant changes in performance (Holland, 1992, Rousseau and House, 1994). Similarly, large operational changes can result in little or no change in performance. This is attributed to the fact that organisations, by nature, are incredibly complex (Daft and Lewin, 1990). By focusing on the components of an organisation, the rules they follow, and how they interact with the external environment, CAS models demonstrate how complex outcomes flow from

these simple interactions (Anderson, 1999, McCarthy et al., 2006, Miller and Page, 2009). Traditionally, research relating to supply chain management has been based upon assumptions of linearity and control (Touboulic et al., 2018). Specifically, omni-channel research has focused on dyadic relationships (Kozlenkova et al., 2015) between supplier and retailer (Armstrong, 2016, Berman and Thelen, 2018, Ishfaq et al., 2016) or the retailer and the customer (Bernon et al., 2016, Grewal et al., 2016, Verhoef et al., 2017). This sub stratal approach, although providing conceptual clarity, fails to address the rich complexity inherent in an omni-channel system, necessitating a CAS perspective of omni-channel (Saghiri et al., 2017).

2.3 Omni-channel as a CAS

A key feature of a CAS is that it contains many parts that have many interactions (Simon, 1996). An omni-channel system is similarly characterised by multiple customer touchpoints (Baxendale et al., 2015, Verhoef et al., 2015), supported by many integrated supply chain stakeholders (Hübner et al., 2016a, Kozlenkova et al., 2015, Larke et al., 2018). Additionally, in a CAS, the typical response to increased environmental complexity, is increased internal complexity (Galunic and Eisenhardt, 1994, Schneider et al., 2017). This is observed within omni-channel systems by the rapid adoption of technology infrastructures to meet the service demands of customers (Grewal et al., 2017, Verhoef et al., 2017; Hübner et al., 2021) as well as the transformation of distribution and supply networks to enhance the customer value-adding journey (Huré et al., 2017, Wollenburg et al., 2018a). Further perspectives of CAS suggest that complexity can be understood by the volume activity across the vertical, horizontal, and spatial planes within an organisation (Daft, 2015). Accordingly, omni-channel retailers are complex, with many levels of organisational hierarchy both internally and externally, controlling many departments and functions over many geographical locations (Pereira et al., 2018, Piotrowicz and Cuthbertson, 2015). Due to these factors, it is both appropriate and useful to adopt a CAS lens through which to view and understand omni-channel and predict a future state of omni-channel fulfilment.

Anderson's (1999) theorization of the four elements of a CAS support this characterisation. A review of the extant literature would suggest agents in the omni-channel system would include retail stores (Brynjolfsson et al., 2013, Gao and Su, 2017), logistics providers (Lim et al., 2018, Pan et al., 2017), distribution centres (Galipoglu et al., 2018, Hübner et al., 2016c), store merchandisers (Armstrong, 2016, Chase, 2017) and centralised logistics teams (Ishfaq et al., 2016). Agents in a CAS are partially connected to each other to

the extent that the actions of a particular agent are dependent upon the actions of the other agents in the system (Stacey, 2002). As such they create s*elf-organising networks which import energy from the environment* (Anderson, 1999). Agents are connected to one another through feedback loops, meaning that each agent observes and acts upon local information only, obtained from those other agents to whom they are connected (Anderson, 1999). To cope with the new operating environment inherent with the adoption of an omni-channel strategy, retailers have increased the importance placed upon customer value (Berthiaume, 2015, Bell et al., 2020). The result is that omni-channel customers and agents act based upon their own priorities, interests, and capabilities (Saghiri et al., 2017).

Holland and Miller (1991) suggest that each agent will try to adapt to its environment over time. This constant shifting of agent behaviour creates a *co-evolution of both the system and the environment* (Oughton et al., 2018). Regarding the omni-channel CAS, the system is the omni-channel retailer, and the environment is the consumer market (Choi et al., 2001). This co-evolution produces a system that is then forced to create new opportunities for itself to survive (Nilsson and Darley, 2006). At a fundamental level, the evolution from multi-channel retailing to omni-channel retailing is the result of this co-evolution (Pereira et al., 2018, Piotrowicz and Cuthbertson, 2015). This co-evolution has forced the omni-channel system to adopt more customer touchpoints (Baxendale et al., 2015, Verhoef et al., 2015) and modify the supply chain significantly to support this augmented proposition (Ailawadi and Farris, 2017, Galipoglu et al., 2018). This concept is closely related to the fourth distinctive property of a CAS, in that a *complex adaptive system will evolve over time* as the agents transform; some agents will leave the system, whilst other new ones will emerge (Anderson, 1999, Choi et al., 2001, McCarthy et al., 2006). It is possible, based on this premise, for a CAS to contain other "sub" complex adaptive systems (Gell-Mann, 1995). Again, this is observed in the omni-channel system in sub-systems such as last-mile delivery networks (Lim et al., 2018, Lim et al., 2016, Pan et al., 2017) and reverse logistics networks (Ang and Tan, 2018), which could justifiably be viewed as complex adaptive systems in their own right.

2.4 Research question

Previous studies have highlighted that there are inefficiencies associated with the adoption of omni-channel fulfilment. CAS is a useful theory to understand how the omni-channel fulfilment system reacts to the complexity found in the grocery retail market. The study by Saghari et al (2017) identified three agents of omni-channel fulfilment – retailers, manufacturers, and delivery companies. Omni-channel fulfilment research and practice was at

a lesser stage of maturity at the time the paper was written, as such it fails to account for the recent fulfilment challenges observed. In addressing this gap, this paper seeks to understand how the omni-channel system should be organised so that it moves beyond the current state of flux and becomes aligned with its environment. This study adopts a case study approach to explore the research question: *How can fulfilment agents be organised to efficiently respond to the varying needs of the omni-channel environment? Figure 2* details the research framework, whereby we explore the elements of omni-channel fulfilment and use insights from our case organisation to understand how the fulfilment system may adapt to provide efficient, effective customer service.

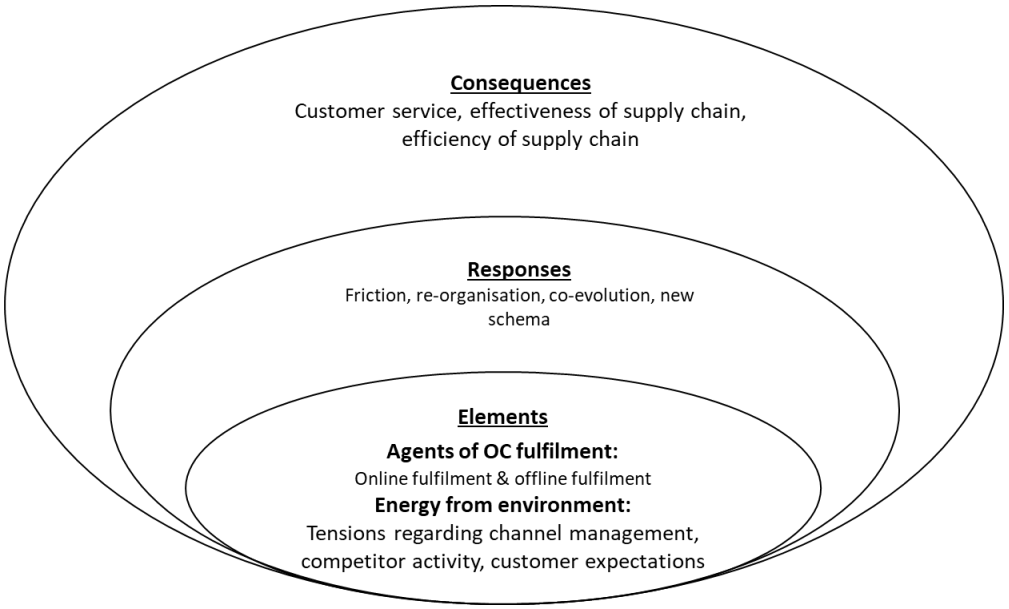


Figure 2: The omni-channel CAS (adapted from (Wycisk et al., 2008).

3. Method

The case study is a powerful approach as it allows empirical descriptions of instances of a phenomenon using rich qualitative evidence (Yin, 2017). Further, case studies are effective tools in the early phases of theory development, such is the case of this study, where key variables and their relationships are being explored (Gibbert et al., 2008).

The organisation we studied is a global grocery retailer who is recognised as a world leader in omni-channel retail, which we call "Omnigrocer". We are focussing on the UK operations of Omnigrocer as the dynamics of the UK grocery retail market present an ideal context to explore the fulfilment operations of omni-channel retail (Ameen et al., 2021, Omar et al., 2021). The UK grocery retail sector is shaped by complex market forces that have caused retailers to adopt common strategies in their approach to omni-channel retailing (Saghiri et al., 2017). Dominated

by the "Big 4", two-thirds of the market is controlled by Tesco (27.1%), Sainsbury's (15.2%), Asda (14.0%) and Morrisons (10.1%) (IGD, 2021). These retailers are well-established bricks-and-mortar retailers who have adopted an omni-channel strategy in the past 15 years (Simone and Sabbadin, 2017). Not only are the retailers in this market facing the challenge of adapting their fulfilment infrastructure to meet the demands of an omni-channel proposition (Hübner et al., 2016c, Picot-Coupey et al., 2016), but they are also doing so in a highly competitive market. Online grocery grew by 209.88% between 2015 and 2021 and forecasts predict that in the short-term online grocery will maintain growth of 15.8% between 2022 and 2025 (Statista, 2022). By means of comparison, *figure 3* details the online and total sales growth experienced by Omnigrocer between 2012 and 2019. This period has been selected to avoid the distortions associated with the Covid-19 global pandemic. In this period online sales grew by 72.06% and total sales decreased by 25.24%.

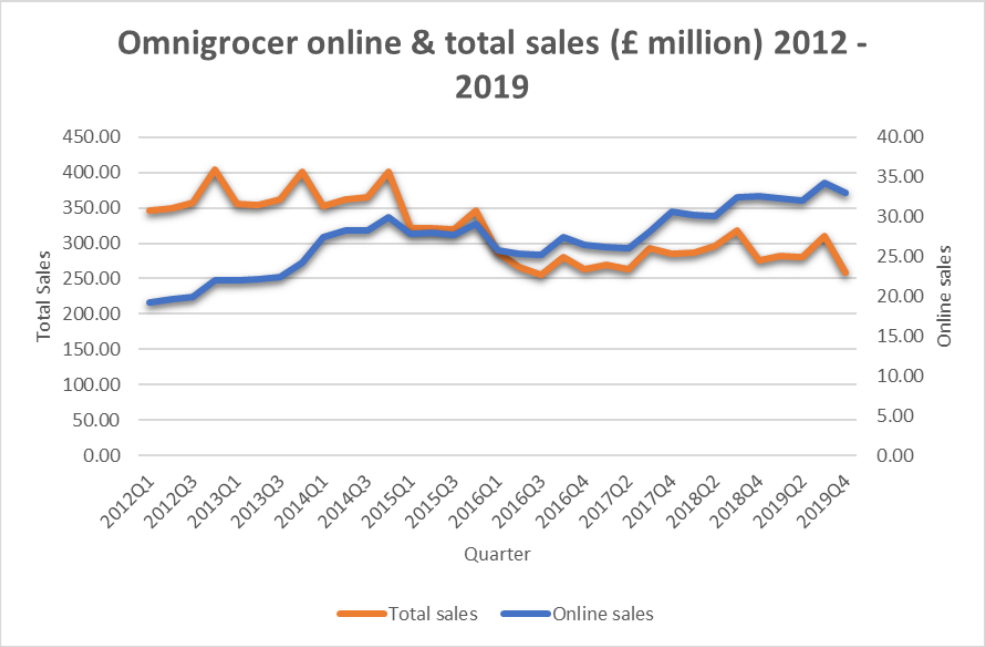


Figure 3: Online sales performance 2012 - 2019

The omni-channel grocery retailers are also facing competition from other retail modes. In the offline channel, they are facing aggressive price pressures from the grocery discounters (Grocer, 2020). In the online channel, pureplay retailers such as Amazon are shaping consumer expectations in terms of price, range and delivery lead times (Guardian, 2021). The result is that, despite their significant market share, net profits for these retailers range between 0.52%

and 1.25% (Screener, 2021; FT.com, 2021), leaving very little room for error, or indeed, to invest in infrastructure.

Omnigrocer operates over 600 stores and 20 distribution centres throughout the UK, employing over 140,000 staff and generating more that £20bn in revenue each year. Omnigrocer are a traditional bricks and mortar grocery retailer who have adopted an omni-channel strategy over the last 15 years. The adoption of omni-channel has been gradual, starting off with click-and-collect grocery home shopping in a few stores, which then developed into an advanced grocery home shopping provision including home delivery, click-and-collect and drive through collections. On the non-food side of the business, Omnigrocer started their omnichannel proposition by offering click-and-collect on their clothing and general merchandise range. Recently, Omnigrocer has expanded this provision further by partnering with other retailers to enable them to distribute their goods through the Omnigrocer fulfilment network. In line with previous studies (Saghiri et al., 2017, Wollenburg et al., 2018), this case study shall focus on the internal fulfilment operations of the grocery retailers, exploring fulfilment operations in the national distribution centres (clothing, general merchandise (GM) and parcels), regional distribution centres (ambient and chilled), and retail stores.

3.1 Sample

We selected the participants by following Lincoln and Guba (1985) guidelines for purposeful sampling. We initially selected participants who were most likely, based on their role within Omnigrocer, to inform us on our research question relating to the organisation of omni-channel fulfilment. We then used a snowball technique, asking each participant to recommend other participants who can offer insights into our research area. We adopted an iterative process of collecting and analysing data and then seeking out additional participants to explore emerging lines of inquiry until no new insights were provided, indicating that theoretical saturation had been achieved (Glaser and Strauss, 2017). In total, we interviewed 15 participants who held senior to executive positions within Omnigrocer and had significant responsibility for the management of omni-channel fulfilment. Confidentially and anonymity were assured using pseudonyms. The summary of the participants can be seen in Table 1.

Position of participant	Number of participants
Director, Supply chain strategy	1
Senior Manager, Grocery home shop	1
Senior Manager, Supply chain	2
Senior Manager, Inventory management	1
Senior Manager, Supply chain finance	1
Senior Manager, Fulfilment planning	2
Senior Manager, Supply chain strategy	1
Senior Manager, Online shopping	1
Senior Manager, Retail	2
Senior Manager, Depot operations	2
Senior Manager, Primary transport	1

Table 1: Details of the Interview Data

3.2 Data collection and analysis

For this study we conducted semi-structured interviews as this is widely regarded as a highly effective data collection technique for qualitative research (DiCicco-Bloom and Crabtree, 2006, Seuring, 2008), as it allows the participants to reflect upon and explore their needs, experiences and understanding of phenomena (Nunkoosing, 2005, Anyan, 2013). To maintain consistency, all the interviews were conducted by the lead author. Additionally, the interview protocol was standardised across all participants and focussed on the challenges, successes and lessons learnt from managing omni-channel fulfilment. As the data collection process developed, different sub-questions were introduced to explore the rich granular detail of the insights provided. Interviews lasted between 50 and 90 minutes, were digitally recorded and transcribed verbatim.

The transcripts were then uploaded into QSR Nvivo 11 for analysis. Major themes were developed and coded using an open coding process (Yin, 2017). This process allowed the data to be broken down, examined, and categorised into initial codes (Miles et al., 2018). Once the initial codes were recorded, we started the iterative process of organising these codes into themes, alternating between open and axial coding (Hashimov, 2015) to identify the emergent patterns in the data. Once the patterns in the data were understood, they were then processed further through the iterative technique of selective coding (Strauss and Corbin, 1994), whereby

the axial codes were organised, rearranged, and abstracted to reveal the final patterns (Yin, 2017) that explained omni-channel fulfilment. The final data structure is displayed in *figure 4*.

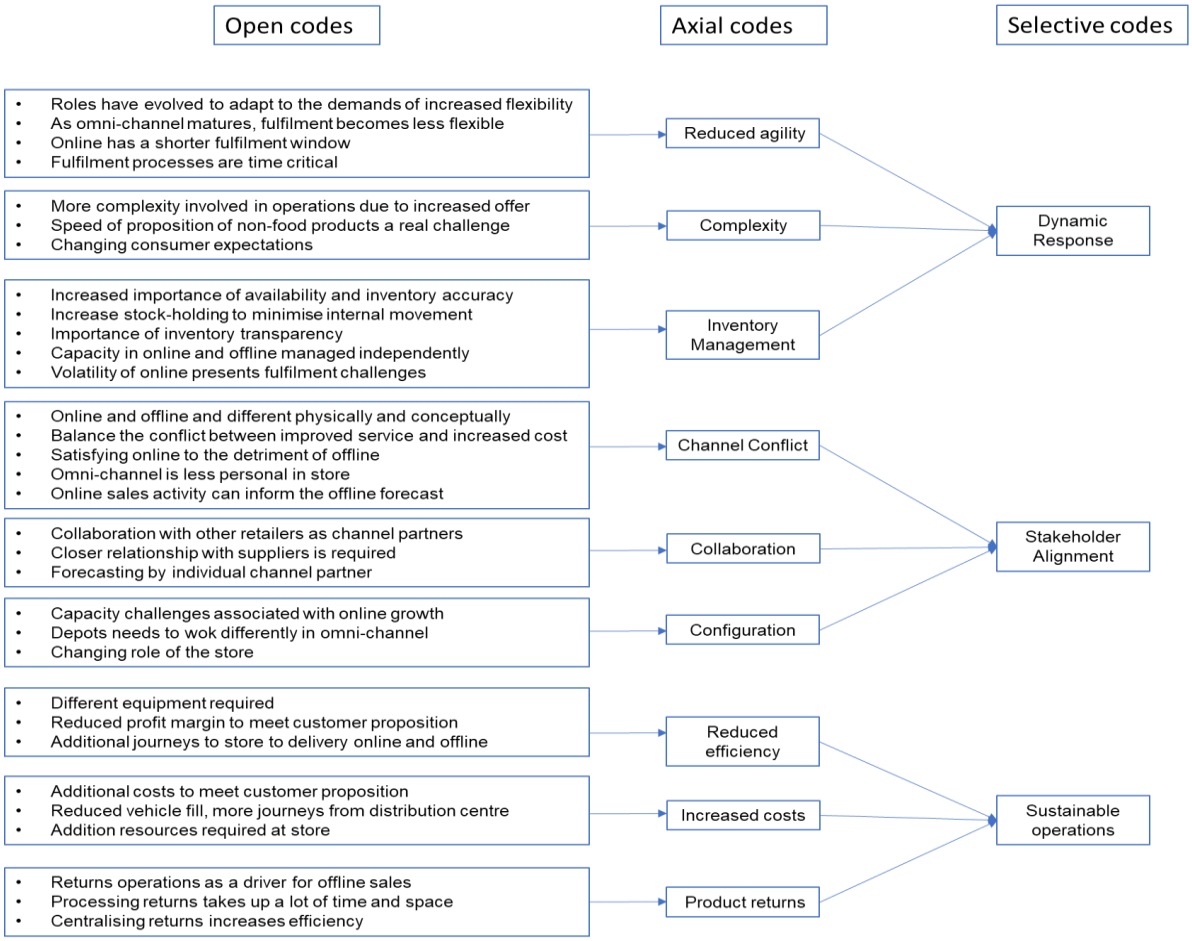


Figure 4: Omnigrocer data structure diagram

To ensure rigour and trustworthiness of the data we followed the guidelines provided by Lincoln and Guba (1985). First, we carefully managed all the interview documentation including, informed consent forms, interview protocol and interview transcripts as they were completed. Second, we employed member checking, whereby engaged with the participants to sense check the integrity, accurateness, and appropriateness of the emergent themes. Finally, we used peer-debriefing, whereby we engaged with other researchers not involved in the study to critically explore the emerging patterns in the data. Three specific themes relating to the management of omni-channel fulfilment emerged from the participants experiences, *dynamic response*, *stakeholder alignment* and *sustainable operations*.

4 Omnigrocers' shift to Omni-channel

As is the case with the other major retailers in the UK grocery retail sector, fulfilment practices in Omnigrocer had been developed and optimised around replenishing a retail store. The replenishment schedule was built around the needs of the offline customer, where the goal was to have the store fully merchandised by 9am each day, ready for the day's trade ahead. From a fulfilment schedule perspective, this resulted in ambient goods being delivered to store by 10pm to allow the store teams to merchandise the delivery overnight, and the temperature-controlled perishable goods to be delivered by 8am, allowing them to be merchandised by 9am whilst providing the maximum shelf-life possible.

To integrate the online fulfilment channel with the offline, Omnigrocer have made significant changes to their fulfilment schedule Non-perishable online orders such as clothing and electrical items are shipped through the ambient fulfilment network. The ambient fulfilment network is best suited to shipping these online orders as the operating temperature within this network will not damage the products. Online non-perishable orders are shipped to stores on a "buy today, collect tomorrow" basis. To achieve this fulfilment proposition, these orders must arrive in store from the distribution centre by 2pm, effectively shortening the offline ambient fulfilment schedule by eight hours. Omnigrocer also offers grocery home shopping in all its retail stores. Here, customers can place online orders for grocery shopping, and have it picked in their local store to either collect that shopping from store (all store formats), or have it delivered to their homes (medium and large store formats only) on a next-day basis. Whilst the store will likely have sufficient inventory to fulfil the longer-life items in the online grocery orders, this will not be the case for short-life perishable products. To meet the needs of the grocery home shopping proposition, the chilled distribution schedule has been shortened to complete all fulfilment by 3am. The reduction of five hours in place to allow all merchandising of short-life products to be completed by 5am, so that grocery home shopping pickers can complete their first orders by 7am, in time for the first scheduled deliveries to customer homes. Due to these changes, distribution centres are predominantly impacted by the adoption of the online non-perishable goods sales channel and retail stores by the grocery home shopping sales channel. Analysis of the data provided by Omnigrocer suggests that their response to the environmental demands of omni-channel can be understood in terms of dynamic response, stakeholder alignment, and sustainable operations.

4.1 Dynamic response

A key theme that emerged was Omnigrocers' focus on being able to quickly adapt, to dynamically respond to the varying needs of their customers. From a fulfilment perspective, online customers define value in terms of short lead times, range of available products, the ability to shop conveniently, and the ability to return unwanted products easily. By comparison, offline customers define fulfilment value in terms of range of products available in store and strong on-shelf availability throughout the shopping day.

The management of fulfilment practices to enable the dynamic responses required to meet the needs of both channel customers can be categorized by three sub-themes. First, as Omnigrocer increases their ability to dynamically respond to the retail needs of their customers, their fulfilment operations become less agile. Second, the practice of integrating online and offline fulfilment drives increased complexity. Third, the only viable way that Omnigrocer was able to dynamically respond to the online and offline channels effectively was to manage inventory separately for each channel.

4.1.1 Reduced agility

The integration of the offline and online fulfilment channels has made operations less agile in both stores and distribution centres. In stores, it has necessitated the addition of stock-keeping processes which are strictly time-bound. These processes are vital to allow fulfilment volumes to be accurately calculated to accommodate the additional sales that result from online shopping.

> *"Everything is quite time bound within the stores now so that is no flex within the hours, you have got people to do a certain job at a certain time, if they're not there that is going to impact on someone else or something else"* (Senior Manager, Retail 1).

In distribution centres, the shortened delivery schedule in both chilled and ambient distribution networks reduces the flexibility of the delivery schedule. Historically, store managers were able to request ad-hoc deliveries of ambient goods if they found themselves unexpectedly running low of certain lines, however the restrictions placed upon the fulfilment schedule means that it is no longer possible to respond to such requests.

> *"There is no flexibility left in the plan. Any extra deliveries resulting from store requests we have to defer to head office, so they put it in the poll for*

> *the next day, on the next available planned delivery, rather than add it to the current delivery schedule"* (Senior Manager, Fulfilment planning).

Additionally, the sales demand of some of the small format stores meant that they did not require an ambient delivery every day; a replenishment schedule of three or four deliveries per week would be sufficient to meet the sales demand. However, because online sales were demanded every day, this required ambient deliveries to be made to these stores, whether offline replenishment was required or not.

> *"We would like to apply frequencies to smaller formats. We would like to deliver to supermarkets on a reduced frequency, however they are part of the Click and Collect solution, so we have to deliver parcels there 7 days a week. It drives a fair bit of inefficiency into a supply chain"* (Senior Manager, Supply chain strategy).

The impact that adopting omni-channel fulfilment has upon distribution agility has not been widely explored in the literature. Adivar et al, (2019) propose that omni-channel fulfilment is characterized by responsiveness and being effective and efficient. Bijmolt et al, (2021) associate reduced fulfilment agility with increased product range. The findings of this study suggest that it is the conflict that exists between the fulfilment requirements of the online and offline sales channels that results in reduced fulfilment agility.

4.1.2 Complexity

In line with the expected behaviour of a complex adaptive system, this increased agility in response to the external environment results in increased operational complexity in Omnigrocer. This is evidenced by the additional activities that have been introduced both at the distribution centre and store levels of fulfilment. At the distribution centre level, every stage of the fulfilment journey has experienced some level of additional complexity. Before new online products can be received into the ambient network, the volume requirements of each stock keeping unit (SKU) need to be understood so that storage space requirements can be calculated.

> *"Item file in this industry in general is poorly maintained. So, what items do we have going into DC, what size are they, are the dimensions right? If they are not then we need to go back to suppliers and find out exactly what they are, and then match that up"* (Senior Manager, Fulfilment planning 1).

The dynamic nature of online non-perishable products means that this is a perpetual endeavour. Upon receipt of online products in an ambient distribution centre, each parcel must be scanned to provide delivery tracking capability to the customer.

> *"We have to wait for the parcels to come, we then have to scan them in and then scan them onto the load they are going out on to then dispatch the to the stores"* (Senior Manager, Depot operations).

When the parcels are then shipped to store, the fulfilment schedules have become so complex in some distribution centres that additional vehicles have been procured to manage the distribution of some online orders to stores.

> *"We have found that some of the depots are actually using little vans to run the stuff in, so the synergies that we think we are getting from putting all the stuff together on big vehicles to get to stores is probably not true"* (Senior Manager, Fulfilment planning 2).

Within retail stores, every stage of the grocery home shopping fulfilment journey demands additional processes, resulting in increased complexity. Pickers are required to check the shelf-life of each perishable product they select to ensure it meets the promised shelf-life in the customer's house.

> *"Our customers are saying we are not doing a great job, we are choosing dates that they wouldn't expect and quality which they wouldn't expect"* (Senior Manager, Grocery Home Shop).

If a customer has requested an item that is not available, then it must be substituted with an appropriate alternative product.

> *We might substitute a product because the customer wants a 10 pack of Omnigrocer ready salted crisps for example, and we haven't got any, so we then have a decision tree on the system that says ok we're not going to pick that because it's not there, we want you now to pick the Walkers crisps instead. If we substitute anything we have backup processes that say that was a dearer product we have now picked so that hits our waste ledger, so we are not losing money to shrink"* (Senior Manager, Retail 2).

Grocery home shopping fulfilment requires a lot of specialist knowledge and additional resource. As such, each store has a dedicated grocery home shopping team that manage the online grocery operation. It is not unusual for Omnigrocer to experience significant variances against forecast online grocery sales volumes. When this happens, the store leadership team must focus their efforts in supporting the grocery home shopping operation, often at the detriment of the offline customer.

> *"Managing GHS is quite high maintenance. On a good day on home shopping everything runs smoothly, but when something goes wrong on home shopping it is difficult because it is a speciality area. So, if a driver doesn't turn up or a picker doesn't turn up, I have to train other colleagues from the shop floor to be able to step in and get the GHS orders done"* (Senior Manager, Retail 1).

The emergent narrative from Omnigrocer at both distribution centre and store levels of fulfilment is that online sales drives additional activities which makes fulfilment more complex. These findings are in line with previous studies which indicate that omni-channel fulfilment is associated with increased complexity (Jones et al., 2022; Pereira et al., 2018; Ishfaq and Defee, 2016).

4.1.3 Inventory management

Contrary to the ethos of omni-channel fulfilment, Omnigrocer have elected not to integrate the inventory records for the online and offline channels. Instead, online products are integrated with offline products from a shipping perspective only.

> *"We are very much siloed between online and retail inventory being managed differently"* (Senior Manager, Fulfilment planning 2).

This separation of inventory management by channel relates to the non-perishable online sales items shipped through the ambient distribution channel. One of the drivers behind Omnigrocer electing to manage the inventory files of both channels separately is the fact that the channels have different sources of demand. Offline demand is generated by store sales, whereby a system count of inventory is captured at 10pm daily at the close of trade which is then used to determine the volume of products to be replenished to the store on a three-day lead time basis. Online demand is generated through the customer orders placed on the online shopping website and is replenished on a next-day delivery basis. To manage these very different demand characteristics, Omnigrocer has implemented separate teams to manage each channel.

One of the challenges that the online inventory management team reported was the difficulty in managing the space demanded by online sales. As the range offered through the online channel is significantly greater than that of the offline channel, a lot more warehouse space is required to store the inventory ready for fulfilment. Additionally, the sales demand of some lines is so low that the minimum order quantity for suppliers results in several years of inventory being held. The lack of space means that online inventory teams spend a lot of time and resource moving stock around the network, locating it wherever there is capacity, irrespective of its proximity to the customer.

> *"We are tending to process online inventory wherever we have got space to process them rather than being able to see that this is a definite space we were going to do this process"* (Senior Manager, Fulfilment planning 1).

The addition of grocery home shopping also presents some challenges to the management of store inventory. In situations where there is high demand for grocery products and there is insufficient in store, then the practice of substituting items creates a false demand pattern for the substituted items, leading to excess inventory and waste.

> *"From a supply chain point of view it blows my forecast out completely because nobody wanted to buy R Whites lemonade (for example) but that's what we sent them because we didn't have any Omnigrocer lemonade so it's twice the price, I've lost all the money but they have a look at my forecast going, why do I have this sudden spike in R. Whites lemonade, so causes all sorts of confusion in there"* (Director, Supply Chain Strategy)

Additionally, to ensure availability of goods for grocery home shopping retailing, the online inventory team have increased the replenishment of temperature controlled perishable products, again increasing the likelihood of food waste.

> *"We were having to give customers a high degree of substitution. We tried a number of different ways to tackle this, so we tried taking long life fresh food for example and increasing the amount of product that was sent into stores so that on an evening at 10 o'clock you closed with a much fuller shop floor on the long-life fresh food areas"* (Senior Manager, Fulfilment 1).

The integration of online and offline distribution channels is recognised as resulting in a retail supply chain that is more efficient in terms of inventory management (Hu et al., 2022, Hubner

et al, 2016c, Liu et al., 2010). The findings of this study provide further explanation to the general position adopted by studies exploring back-end fulfilment in the omni-channel context that inventory management issues arise from conflict between the online and offline channel (Hubner et al., 2022, Arslan et al., 2021, Hubner et al., 2015).

4.2 Stakeholder alignment

The adoption of omni-channel fulfilment has caused the agents within the Omnigrocer fulfilment system to organise themselves differently. Building on the discussion around the management practices that have emerged in Omnigrocer as they attempt to dynamically respond to the varying needs of each channels' customers, there is some incompatibility between the fulfilment requirements of online and offline customers resulting in demand conflict. In response to this conflict, fulfilment agents have adapted their schemata, both in terms of collaboration with channel partners and how fulfilment operations should be configured.

4.2.1 Channel conflict

Within distribution centres, channel conflict has caused Omnigrocer to reconsider their schema relating to the increased cost to serve. Prior to the adoption of omni-channel, Omnigrocer designed and optimised their fulfilment practices around serving retail stores as efficiently as possible. They developed a fulfilment schedule which allowed them to get as much product on a vehicle as was physically possible, using the least amount of resource to replenish stores. The enhanced service proposition of the online channel means that the focus has shifted away from efficiently serving retail stores, to providing a personalised service to online customers.

One of the key initiatives adopted by Omnigrocer was the extensive use of high-capacity, double-deck trailers in the ambient distribution network. The use of double-deck trailers meant that more product volume could be shipped to stores in a single journey, reducing both resource requirements and the carbon impact of fulfilment operations. Whilst the extensive use of double-deck trailers was ideal for replenishing the offline channel, their use was incommensurate with the requirements of the online channel.

> *The more the customer demands, the tighter our schedule becomes. The more double decks you put on the road to deliver fewer, cheaper miles, you restrict yourself even more. Your decker goes out in the morning, comes back, goes out in the evening. Most stores get most of their product delivered on those 2 hits but guess what's not in the middle - that click and collect delivery. The first one is too early and the second one is too late, I've saved*

miles, but now I've got to get this other channel product to the shop, I've got to deviate" (Senior Manager, Fulfilment planning 1).

Within retail stores, there is a strong feeling that the management of online channels is executed at the detriment of the offline channel. As an example, the increase in sales in the non-perishable online channel has come at the expense of the non-perishable offline channel in store. Omnigrocer reported that since the adoption of the online channel, they have found that they have too much non-perishable merchandising space in stores to support sales volume.

"*I think large stores will be phased out. If we even look at it now, we are struggling in the GM space. A lot of traders don't want that extra space"* (Senior Manager, Supply chain 1).

This notion of channel conflict is not novel, however the emergent narrative in the literature highlights the overall benefit to retailers resulting from channel integration (Neslin, 2022, Barann et al., 2022, Hense & Hubner, 2021). Studies exploring channel conflict tend to focus on how retailers should organise their infrastructure to avoid channel conflict (Jones et al., 2022; Gao et al., 2022, Chopra, 2018). This study extends this narrative by highlighting the characteristics of channel conflict at the distribution and store levels of fulfilment.

4.2.2 Collaboration

To offset the increased costs associated with the enhanced service demanded by the online channel, Omnigrocer have collaborated with other retailers. The collaboration takes the form of Omnigrocer allowing other retailers who offer online non-perishable products to use their distribution infrastructure to ship their goods to customers. This collaboration has several benefits. First, it reduces the net road freight traffic in the online retail sector. Second, it provides additional revenue for Omnigrocer through shipping charges. Third, it provides additional revenue to the offline channel because of additional sales made when the retail partners customers come in to Omnigrocer to collect their shopping.

There are some challenges associated with the collaboration. When volume shipped through the network surges, often because of partner promotional activity, additional strain is placed on the Omnigrocer fulfilment network.

"When you see the exponential growth on the back of having some of the bigger suppliers on board and the impact of their promotions. Up to 4 or 5 cages per store and they are now taking up space on ambient vehicles that would traditionally be used to ship grocery goods and we are having to find

different transport solutions to move this now" (Senior Manager, Online shopping).

The adoption of omni-channel fulfilment has also prompted Omnigrocer to have a closer relationship with their suppliers. This relationship allowed Omnigrocer to bring goods in earlier in the chilled distribution network to support the shorter delivery window to stores.

> *"We did a lot of work with suppliers to move our inbound profile earlier to allow us to get into store earlier"* (Senior Manager, Primary transport).

Similarly, stores now work closely with distribution centres as fulfilment partners. The interdependence between retail store and distribution centre is much greater for the online channel, resulting in a much stronger working relationship.

> *"The relationship with stores has got less emotional than it used to be. We probably get the same issues and feedback, but it's received a lot better and understood a lot better rather than just the old blame culture. That's gone away, they come to me to understand what the issue is. We work a lot better together then we would have 5 years ago"* (Senior Manager, Depot operations 2).

The findings of this study align with the dominant narrative in the literature that a key enabler of omni-channel fulfilment is collaboration between the fulfilment stakeholders (Bijmolt et al., 2021, Melacini et al., 2018, Wollenburg et al., 2018). The findings of this study also support the classification of the agents of omni-channel presented by Saghiri et al, (2017).

4.3.3 Configuration

The role of the store has changed significantly for Omnigrocer because of adopting omni-channel fulfilment. To support the grocery home shopping proposition, the store has been completely reconfigured. Prior to offering grocery home shopping, the back-of-house area in retail stores was used solely to store goods for resale, supporting on-shelf availability of products for store customers. The introduction of grocery home shopping meant that a significant proportion of space has now been dedicated to grocery home shopping delivery vehicles and warehousing space to store online grocery orders waiting to be shipped.

> *"As the online part of the business grows and you put in larger home shopping pods and more home shopping vans all operating out of that space at the back of store. That is the same space that we deliver into from depot,*

and you can end up with some challenges regarding space" (Senior Manager, Deport operations 1).

The demands of grocery home shopping upon retail stores are so great that Omnigrocer is concerned that there simply not the available space within retail stores to support grocery home shopping sales much beyond current levels without significant re-configuration.

> *"We are starting to have some boundaries come in to play, so the physicality of stores, the space that we can fit within those four walls is becoming a real challenge"* (Senior Manager, Grocery home shop).

The findings of this study add a new dimension to the existing research relating to omni-channel fulfilment configuration. Most studies in this area adopt an analytical approach to optimise fulfilment configurations (Millstein et al., 2022; Jiu, 2022; Hu et al., 2022). This study highlights the capacity challenges that have emerged at both the distribution centre and stores levels of fulfilment because of adopting omni-channel.

4.4 Sustainable operations

The conflict arising from the adoption of omni-channel fulfilment has prompted Omnigrocer to question the sustainability of the proposition. The addition of online fulfilment to the existing offline distribution network has resulted in reduced efficiency, increased costs, and an increased level of product returns.

4.4.1 Reduced efficiency

Within retail stores, Omnigrocer reported that the grocery home shopping operation demands a lot of additional resource. The demand for additional resource is so great that the cost of delivering in this channel far exceeds the income generated by the delivery fees.

> *"The break-even point was for people who didn't drive, those who went by bus or by taxi was £5 per delivery, so that is where the market settled. More recently, competition has driven that down. In reality, it costs 3 or 4 times that amount"* (Director, Supply chain strategy).

To mitigate some of the additional costs, Omnigrocer has elected to invest less resources in the shop-keeping standards for the offline customers. Before the adoption of omni-channel, an industry standard was for stores to open the trading day with full shelves and products presented neatly, ready for customers. This standard has been relaxed by Omnigrocer to reduce cost.

> *"We used to say there should be no gaps and it should be packet perfect, but we are now saying is it will not be faced up to perfection but there should be no gaps"* (Senior Manager, Supply chain strategy)

In the distribution centres, the reduced fulfilment window means that there is less time to pick goods for each journey to store.

> *"Because stores need deliveries earlier, it puts a massive peak and pressure on the depot picking out, and then you have a massive peak of deliveries, driver requirements and vehicle requirements needed, all driving in more resource"* (Senior Manager, Fulfilment planning 1).

Additionally, because of the short lead-time of the online perishable goods proposition, the fulfilment plan is completed for the offline ambient channel before the orders are received for the online channel. To overcome this, the space required on each load for the online sales is estimated.

> *"We just leave 2 cage spaces, that seems to be average of what a shop gets"* (Senior Manager, Fulfilment planning 2).

The result of both these factors is that vehicles are going to store with less product on them than the capacity of the vehicle would allow. Additional journeys are therefore required to replenish the store compared to an optimised offline only fulfilment plan. To reduce this impact, Omnigrocer try to maximise vehicle fill by adding multiple store deliveries to one vehicle. Omnigrocer reported that this does result in improved load efficiency, however it also increases the miles that a vehicle must travel, and the time taken to complete delivery journeys.

> *"If you are looking at online shopping, the extra miles that it generates, there is clear evidence that we are dropping cages of online shopping onto vehicles that are not going to that store, because we haven't got a schedule that fits the online model into that particular store, so we have to divert off route. That adds driver hours in, adds miles, and uses more fuel"* (Senior Manager, Supply chain finance).

Independent of studies relating to omni-channel fulfilment, there is an established literature stream that explores factors impacting road freight efficiency (Pathak et al 2019, Kumar et al., 2019, Zhu & Hu, 2018). The findings of this study highlight how the integration of online deliveries with an existing offline fulfilment infrastructure negatively impacts load factor

(vehicle fill) and increases fulfilment journey distance, resulting in a reduction in fulfilment efficiency.

4.4.2 Increased costs

The original idea of adding the online fulfilment to the existing offline fulfilment channel was that the space requirements for the online products were so inconsequential that they would in effect get a "free ride" through the offline distribution network to store, ready to be collected by the customer. As sales in the online channel have grown and sales in the offline channel have declined for Omnigrocer, this has not been the case. The results in that a disproportionate amount of cost is required to fulfil the online channel.

> *"It used to be, you know I am going to Cardiff anyway, or I am going to Torquay anyway Now when you have got 1, 2 or 3 cages, it's not a free ride any more you have got to plan the space in. Which is when it starts to cost really* (Senior Manager, Depot operation 2).

There is consensus in the literature that omni-channel fulfilment results in increased costs Arslan et al., 2021, Chopra, 2018, Melacini & Tappia, 2018). This study highlights some of the operational practices that drive the additional costs.

4.4.3 Product returns

The addition of online non-perishable sales has forced the store to take on the role of processing the high volume of sales returns associated with online shopping. This level of returns presents several challenges for stores. First, it demands additional labour resource which must be funded by profits made from offline sales, further eroding Omnigrocers profit margin.

> *"We are getting these online returns all the time. It is more labour intensive for a store, debagging it, hanging it, making sure there is a ticket on it, putting it back into PI, putting it on sale, and then potentially, reducing it to sell it through. It might not necessarily be a line that you stock so it may not scan you may have to edit the file, it does have a real impact on store costs"* (Senior Manager, Retail 2).

Second, it presents a problem of what to do with the returned goods. In some cases, if the returned goods are suitable for resale, then they can be manually added to the stores inventory and sold locally. Where this is not the case, or it is not desirable to add the product to local inventory, then they must be returned through the distribution network, again incurring additional resource demand.

> *"It might be stuff that's been on clearance previously that doesn't have a place in the store, etc so you have got to make room in stores, it goes in an odds bin or whatever it might be. I think there is quite a bit there around what do we truly want our returns to be in the next 3 to 5 years and that will start to come in our strategy document"* (Director, Supply Chain Strategy)

These findings provide consensus for the emergent narrative that exists within the literature that existing omni-channel fulfilment infrastructures are not equipped to effectively and efficiently manage the high volume of product returns that are associated with online retail (Jorge et al., 2020, Bernon et al., 2016, Ofek et al., 2011). The dominant perspective from Omnigrocer when considering the fulfilment challenges associated with the omni-channel proposition is that it is not a strategy that would be adopted if market forces allowed otherwise.

> *"The margin in it is so small, the complexity is so great you would never go down this route"* (Senior Manager, supply chain)

The conclusion reached by Omnigrocer is that adding the online channel to the existing offline fulfilment network has resulted in a reduced profit margin and is not sustainable in its current form.

5 Discussion

Analysis of the data gathered in Omnigrocer indicates that the omni-channel fulfilment system must respond to two separate energies from the environment, online energy, and offline energy. Our findings suggest that the current practice adopted by UK grocery retailers of trying to adapt a fulfilment infrastructure that was initially designed for offline fulfilment only, is resulting in increased costs and a poorer shopping experience for offline customers. This study provides consensus for previous studies that explain the nature of omni-channel fulfilment in different contexts (Saghiri et al., 2017, Arslan et al., 2021, Shao, 2021). The findings from Omnigrocer support the proposition that omni-channel fulfilment is more complex than traditional bricks and mortar fulfilment (Larke, 2018), and in adopting omni-channel fulfilment, retailers must reconfigure their fulfilment infrastructure to meet the proposition of the online channel (Hubner et al., 2016a, Millstein et al., 2022). The practices of Omnigrocer are also in line with those found by Akturk et al. (2018) who found that omnichannel retailers tend to manage online and offline inventory management systems independently, and Hubner et al. (2016b) who found that inventory issues in the online channel often manifest to issues that are of detriment to the offline customer. Furthermore, this study provides consensus for the proposition that not only

is the addition of an online distribution channel to an existing bricks and mortar fulfilment network disruptive (Ye et al., 2018), it is also more expensive (Wollenburg et al., 2018).

The findings of this study also highlight an important conflict that arises in the agents of fulfilment by attempting to respond to two separate environmental energies. Ironically, the online energies drive to increase flexibility for the customer appears to have a deleterious effect on agility in fulfilment operations for offline fulfilment. This leads to several critical operational barriers, such as an inability to efficiently react to the volatile demands associated with the online channel, even if the inventory required is in stock (Lee, 2004). The proliferation of products (SKU's) offered through the online channel is also associated with deleterious operational performance; as an increase in goods being offered is associated with increased costs and reduced service performance (Um et al., 2017, Salvedor et al., 2002, Salvedor et al., 2001). A further obstacle to consider is that retailers can damage the collaborative relationship they enjoy with suppliers by demanding reduced lead times (Thomas, 2010). The product of these pressures is that organisations typically have trouble balancing being agile with being efficient and environmentally responsible (Marti, et al., 2015).

The findings of this study offer some insights as to why the adoption of omni-channel fulfilment is apparently so disruptive for grocery retailers. The study highlighted that the omni-channel fulfilment system consists of two environmental energies, online and offline. The tensions that have been highlighted in this and the previous case studies discussed support the proposition that the online and offline energies are connected to each other, reacting to information produced by each other (Anderson, 1999). In a CAS, agents import energy from the environment and adapt to the environment over time (Holland and Miller, 1991). What has emerged from this study is the understanding that the energy imported from the environment is very different for the online channels and the offline channels.

The energy for the offline channel is characterized by predictable demand (Chopra, 2018), a (relatively) small range of products (Melacini et al., 2018), and low levels of product returns (Bernon et al., 2016) in a channel that is declining in sales volume (Grewal et al., 2017). By comparison, the energy for the online channel is characterized by volatile demand (Hancerliogari, 2016), a large range of products (Jeanpert and Pache, 2016), high levels of customer returns (Nageswaran et al., 2020), and the ability to shop from any location at any time (Aktea et al., 2021). The online channel is also characterized by rapid sales growth (Galipoglu et al., 2018). The tensions that exist between the agents and the resulting

inefficiency observed in fulfilment operations is a result of the incompatibility of the two energies being imported by the omni-channel fulfilment system. CAS theory does not account for a system importing multiple energies from the environment. The implications of this for omni-channel fulfilment for grocery retailers is that they will always be in a state of flux, resulting in conflict between the energies (Van de ven et al., 1995) and poorer performance. To resolve the conflict, each agent may develop their own sub-system (Gell-Mann, 1995), effectively reverting to multi-channel fulfilment. Indeed, elements of this behaviour are emerging within Omnigrocer already, as evidenced by individual inventory management systems for each agent and the adoption of additional vehicles in the distribution centres to manage online orders only.

This study makes several important contributions to knowledge. It extends the work of Saghiri et al (2017) by understanding omni-channel fulfilment as a complex adaptive system and exploring the nature of adaption that the fulfilment system undergoes in response to the omni-channel environment. We identify two separate environmental energies being imported to the omni-channel fulfilment system and highlight the unique challenges fulfilment agents face as they simultaneously adapt to both the external environment and internal conflicts that arise. In doing so, this study highlights the need for a new conceptual understanding of omni-channel fulfilment configuration to address the finding that a fulfilment system that has been optimized for bulk deliveries to a small, finite number of location (as is the case for bricks and mortar grocery retailers) cannot perform adequately in the agile, integrated, responsive environment of omni-channel retail.

The findings of this study should also be of interest to practitioners as it highlights the tensions, operational challenges, responses, and some of the benefits gained through the adoption of omni-channel fulfilment. Practitioners can use these findings to inform the management practices required for their fulfilment needs and use them to support their wider omni-channel proposition.

This study also contributes to complex adaptive systems theory. CAS assumes a single channel of marketing; a singular source of energy being imported from the environment. Whilst several items or elements must be dealt with by the system simultaneously (and therefore creating a complex system), the energy described in the CAS literature is uniform and leads to agent co-evolution in response to this singular energy. Where the energy imported into the system is not uniform, in instances where the agents are reacting to different and unique

elements as observed in the omni-channel fulfilment context, then they cannot evolve. Instead, the internal schemata will adapt to a threshold point, each agent making trade-offs to align with the external environment. Beyond this threshold point, the cost of operations will exceed the value obtained from the market. To survive, two independent sub-systems will emerge, each independently aligned with their own environmental energy.

6 Conclusion and future research directions

The rich insights gleaned from Omnigrocer suggest that the paradigm of supply chain optimisation that has been characteristic of bricks and mortar retailers is incommensurate with omni-channel fulfilment. Exploring omni-channel fulfilment through a complex adaptive systems theory lens leads to the identification of two agents within the system, each importing different energy from the environment. Based on the findings of this study, the current fulfilment configuration adopted by grocery retailers is unsustainable.

This study offers an important first step in empirically identifying challenges associated with omni-channel fulfilment and uses CAS theory to explain why this apparent misalignment with the environment exists. To develop this work, future research directions should include analytical simulation and empirical testing of alternative omni-channel fulfilment configurations as well as case studies of other complex systems that import more than one type of energy from the environment.

Chapter 5

Developing a warranted assertion

1 Introduction

The study presented in Chapter five progressed the inquiry by moving it on from the *determination of a problem-solution* stage through to the *reasoning* stage of Dewey's process on inquiry (Dewey, 1999). The study presented in Chapter four used empirical observation to quantify the magnitude of the back-end fulfilment performance issues associated with the adoption of omni-channel retailing. This study determined the reduction in vehicle fill and the increase in store delivery mileage associated with a unit increase in online sales activity for both ambient and chilled grocery distribution networks. The study in Chapter five progressed the inquiry to the *reasoning* stage by determining the relationship between the constituent elements of the situation in the wider context of the system of which it is a member (Dewey, 1999). The study in Chapter five sought to understand *why* the observed behaviour occurred (Strubing, 2007). The rich insights gleaned from the participants from the case organisation, Omnigrocer, indicated that the addition of online fulfilment to an existing offline fulfilment distribution system resulted in poorer operational performance because the environmental energy for the offline and online channels is different. This understanding supports the fuller exploration of the *reasoning* stage; the proposal of possible solutions in the form of warranted assertions (Dewey, 1999, Morgan, 2007, Strubing, 2007).

A warranted assertion is concerned with the rational, progressive stabilization of ideas through the testing of their practical consequences (Strubing, 2007). This aspect of *reasoning* is concerned with whether the suggested course of action will not only solve the problem, but also lead to a new situation that is not problematic (Morgan, 2013). Dewey (1999) emphasises that this stage of inquiry should be viewed as a series of thought experiments as nothing in existence is manipulated at this stage of inquiry. The product of a warranted assertion is an idea which can be developed into action (Morgan, 2013). Two warranted assertions will be presented in this chapter. Building on the findings of the studies presented in Chapters four and five, two alternative configurations of grocery back-end omni-channel fulfilment are suggested. The first suggestion explores the suggestion of fully integrating the internal ambient and chilled delivery volume to drive synergies within the fulfilment network, the second suggestion is to negate the deleterious impact experience by the grocery retailer of integrating the online fulfilment channel with the offline by integrating the channels at the point of supply, rather than the point of replenishment.

2 Suggestion 1: full internal integration

The utilisation of excess fulfilment capacity at one location to support another location which has exceeded its fulfilment capacity is an inventory management practice routinely performed in the retailing, manufacturing (Dong & Rudi, 2004), and humanitarian distribution networks (Toyasaki et al., 2017). As an evolution from multi-channel fulfilment, mode 1 omni-channel retailers use their legacy distribution network to adopt this practice by independently shipping inventory from distribution centres to retail stores (Seifert et al., 2006; He et al., 2014). Emerging research suggests that such siloed transhipments are uneconomical (Silbermayr, 2020; Wang et al., 2020; Xu et al., 2020), and a horizontally coordinated approach to inventory management is likely to more efficient (Arkan & Silbermayr, 2017). Inventory integration at the distribution centre level may present a horizontal coordination approach to inventory management.

Inventory integration, also referred to as inventory pooling (Alfaki and Swinney, 2021), is associated with improved fulfilment performance, as measured by reduced lead times, and improved replenishment accuracy (Bell et al., 2018; Bendoly et al., 2007; Eppen 1979). In the context of omni-channel retail fulfilment, the high volatility associated with in-store demand means that integrating inventory at the distribution centre level is operationally more favourable that integrating inventory at the store level (Liu at al., 2010). Further, integration at the distribution centre level is most economical when stores with high demand variation are fulfilled before low-demand variation stores (Bouma et al., 2014) and the fulfilment infrastructure supports a low level of stock transhipment (Bouma et al., 2016).

Hübner et al. (2015) suggested that inventory integration should be a fruitful strategy for omni-channel fulfilment but recognised that (mode 1) omni-channel retailers may resist adoption due to challenges arising from channel conflict. In contrast, and in line with the findings from chapter three, Melacini et al. (2018) suggested that (mode 1) retailers must reconfigure their fulfilment networks as their legacy networks were not suitable for efficient omni-channel fulfilment. Based on the findings from chapter three, an alternative configuration for back-end fulfilment is proposed. Figure 1 represents what this configuration may look like. The front-end internal fulfilment network remains unchanged, receiving general merchandise goods from external suppliers to be distributed to the distribution centre network and suppliers of chilled and ambient goods delivering directly to regional distribution centres. The difference in this configuration is that instead of having separate distribution centres for chilled and

ambient goods, these goods would be integrated in a single distribution centre that served stores within a geographic location, not only integrating chilled and ambient deliveries, but also online and offline orders.

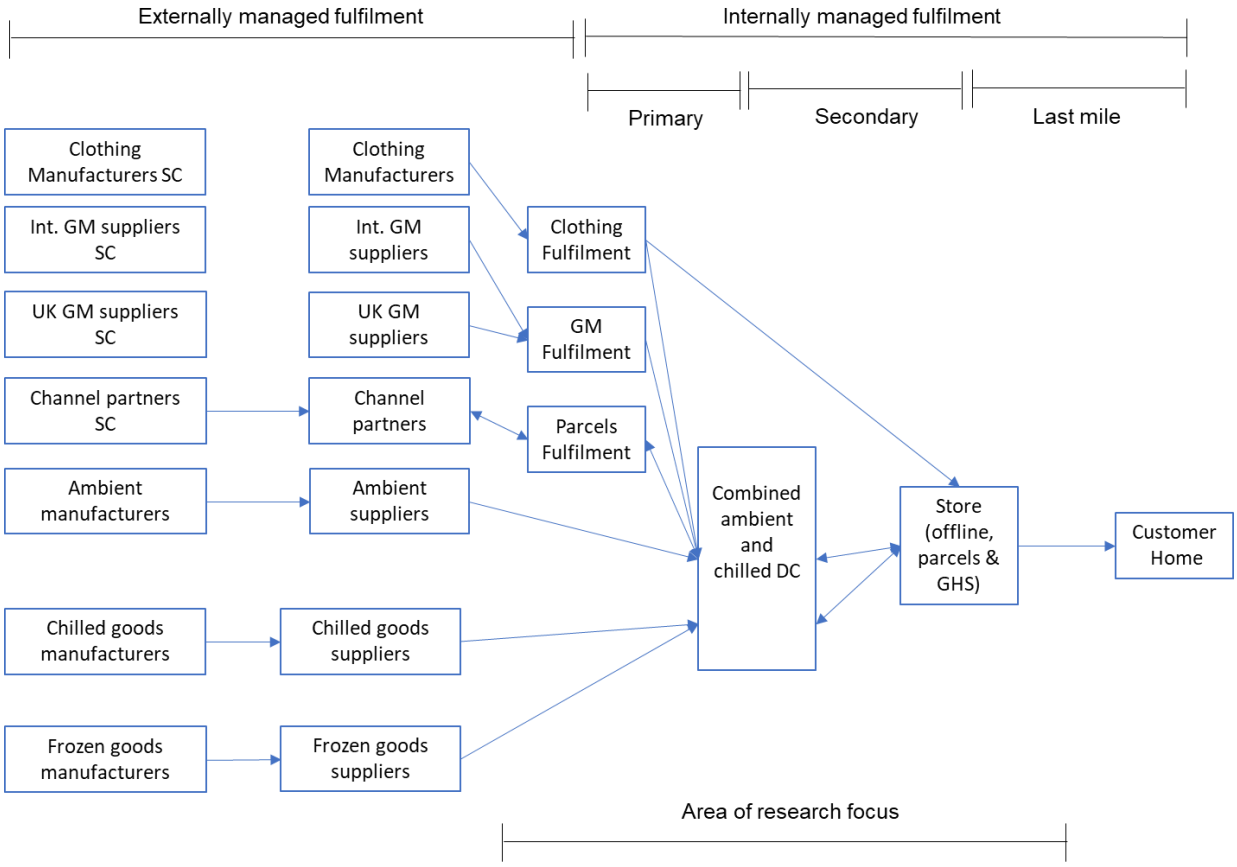


Figure 1: Fully integrated internal fulfilment suggestion

2.1 Implications of suggestion 1

The fully integrated internal configuration should allow mode 1 retailers to realise the increased load factor benefits achieved by mode 3 retailers (Sun et al., 2020; Xu et al., 2020). The current fulfilment configuration results in the recognised barriers of lower delivery volume (Rizet & Cruz, 2012) and increased transportation distance (Abate et al., 2014) being adopted to achieve the delivery proposition promised by the online channel. The combination of ambient and chilled delivery volume in an integrated distribution centre would alleviate the challenges associated with reduced load factor due to the increased volume shipped to stores on each freight journey.

This suggestion is based on the premise that an integrated fulfilment solution would not only require significantly less resource but also reduce the average miles required to replenish stores each day (Kumar et al., 2019), resulting in a significant reduction in carbon footprint and

vehicle emissions compared to the current fulfilment model adopted by the retail sector (Hübner et al., 2016b, Wollenburg et al., 2018).

This suggestion also builds on the findings of previous studies with respect to the operational efficiencies gained from delivering multiple shipments on the same vehicle (Abdulkader et al., 2018, Al Chami et al., 2016). In line with previous studies of last-mile fulfilment (Boyer et al., 2009, Campbell and Savelsbergh, 2005), the suggestion warrants that the pursuit of increased cases per journey as an isolated indicator of efficiency may not yield the desired operational results. This suggestion brings benefits to the retailer as the stores would receive their shipments over a shorter time horizon, allowing them to replenish the stores earlier; whereas the anticipated increased CPJ brings benefits to operations as it requires less resources (vehicles and operators) to complete.

Whilst it is suggested that this alternative configuration should improve fulfilment efficiency, there are some limitations to this suggestion. First, a significant amount of investment will be required to reconfigure the distribution network to integrate chilled and ambient warehousing in single distribution centres and to allow delivery of goods stores at multiple temperatures on a single vehicle. Second, this suggestion only addresses the volume dimension of fulfilment efficiency. Whilst this should also result in reduced transportation as the need to consolidate multiple shipments on a single vehicle is reduced, it does not address the barriers to fulfilment efficiency driven by the restrictive delivery times associated with the online channel. The fully integrated internal configuration should allow mode 1 retailers to realise the increased load factor benefits achieved by mode 3 retailers (Sun et al., 2020; Xu et al., 2020). The current fulfilment configuration results in the recognised barriers of lower delivery volume (Rizet & Cruz, 2012) and increased transportation distance (Abate et al., 2014) being adopted to achieve the delivery proposition promised by the online channel. The combination of ambient and chilled delivery volume in an integrated distribution centre would alleviate the challenges associated with reduced load factor due to the increased volume shipped to stores on each freight journey.

3 Suggestion 2: full internal separation

The study conducted in Chapter five highlighted several critical operational problems experienced by Omnigrocer that provided consensus for previous case studies exploring the challenges of omni-channel fulfilment, such as an inability to efficiently react to the volatile demands associated with the online channel, even if the inventory required is in stock (Lee, 2004). The proliferation of products (SKU's) offered through the online channel is also

associated with deleterious operational performance; as an increase in goods being offered is associated with increased costs and reduced service performance (Um et al., 2017, Salvedor et al., 2002, Salvedor et al., 2001). A further obstacle to consider is that retailers can damage the collaborative relationship they enjoy with suppliers by demanding reduced lead times (Thomas, 2010). The product of these pressures is that organisations typically have trouble balancing being agile with being efficient and environmentally responsible (Marti, et al., 2015). In recognising these challenges, omni-channel fulfilment should not be measured in terms of service and cost efficiency alone. Incorporating the findings of related studies, omni-channel fulfilment systems must also be measured in terms of agility (Yu, et al., 2018), responsiveness (Danese, et al., 2013), as well as a reduction in non-value adding inventory and minimal product returns (Lee, 2004), in addition to the traditional metrics of cost and service.

Agile supply chains are those that can quickly respond to internal and external uncertainties (Fayezi et al., 2017; Kispeska-Moron and De Haan, 2011; Argawel et al., 2006). As these characteristics strongly align with the demands associated with the omni-channel retail market (Davis-Sramek et al., 2021; Armstrong, 2016; Bell et al., 2014), it fits that omni-channel retailers should adopt an omni-channel fulfilment strategy. The reduction of non-value adding inventory is typically associated with the lean paradigm of supply chain management (Cil et al., 2021; de Haan and Overboom, 2006; Jones et al., 1997). It follows, therefore, that a hybrid approach that incorporates the benefits of both strategies should be advantageous for omni-channel fulfilment. Such a strategy is commonly referred to as a leagile approach (Argawel et al., 2006). In their seminal paper, Naylor et al, (1999) described a leagile supply chain as one that adopts an agile approach to respond to volatile demand and incorporates a strategic de-coupling point along the supply chain to facilitate the adoption of a lean strategy to efficiently manage upstream supply. In line with the characteristics of mode 1 omni-channel retail, leagile models of fulfilment are appropriate for the replenishment of fast-moving consumer goods as fresh food commodities (Nakada and Lau, 2018). Further, leagile models of fulfilment are associated with improved customer service (Rahiminezhad and Helmi, 2016), reduced operating costs (Banjereet and Mukhopanhyay, 2016), effective response to volatile demand (Bharma et al., 2021), and reduced inventory carrying costs (Goldsby et al., 2006).

Based on these observations, a further alternative omni-channel fulfilment configuration is suggested for bricks and mortar grocery retailers in figure 2.

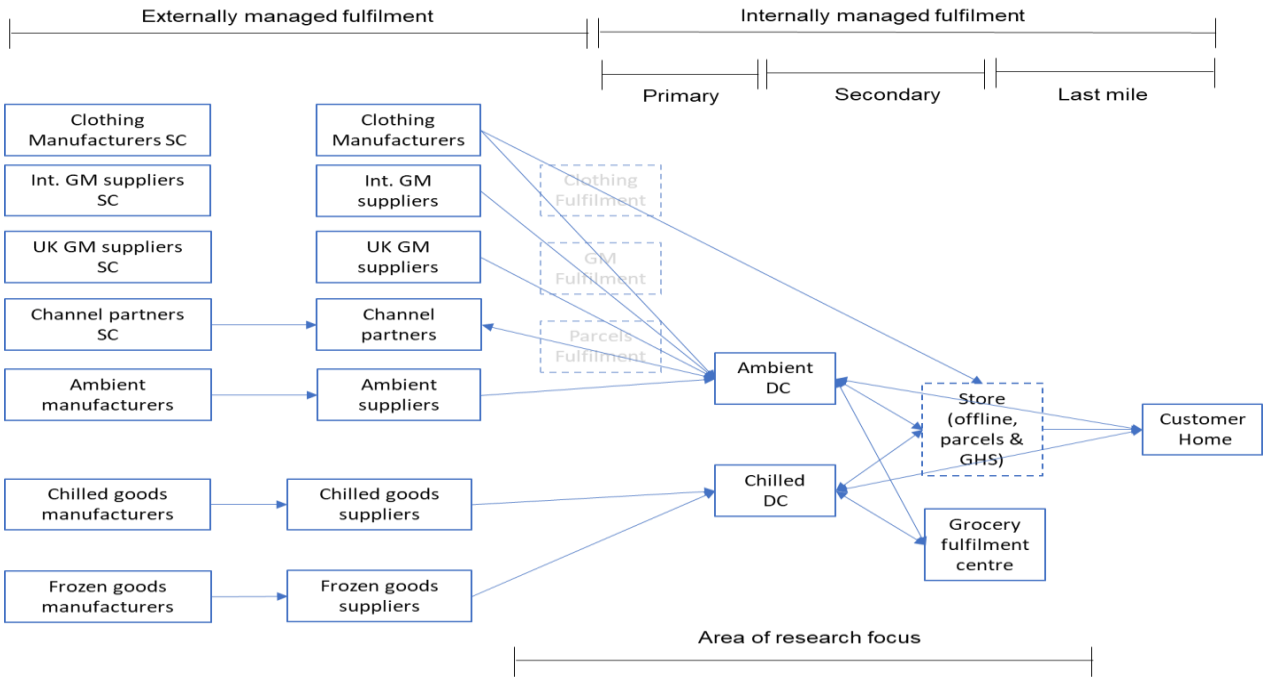


Figure 2: Fully separated internal fulfilment suggestion

The above fulfilment configuration proposes a different fulfilment model that leverages the externally integrated relationship with supply partners to organise products by order at the point of supply. The diagram details the removal of the internal national fulfilment centres that supply the regional distribution centres with general merchandise goods, allowing all online general merchandise orders to be picked and shipped at the supplier level (as is the practice of pure-play online retailers such as Amazon). Additionally, the diagram details the inclusion of a grocery fulfilment centre which would be employed in high-density demand areas to manage all grocery home shop orders for the region. These changes would address two issues. First, they would reduce the time pressure on the supply partners as it negates the need to collate and sort orders internally, reducing non-value adding time. Second, the internal segregation of inventory allows greater control over the inventory by channel. The second proposal is to integrate the distribution channels only where it provides synergies, and not as an all-encompassing strategy. By introducing online fulfilment centres where density of demand supports them, and by using both depot and stores as fulfilment centres for the online channel, an agile fulfilment system is possible that can be optimised to cope with the external environmental challenges associated with omni-channel fulfilment. The above model represents a potential co-evolution of the offline and online agents based on the current responses they have implemented because of adopting omni-channel fulfilment. The new system emphasises a closer relationship between the external supply agents and the internal

fulfilment agents which is vital for the successful management of the volatility incumbent with the online channel. By separating the channels earlier in the fulfilment journey, each channel can benefit from fulfilment operations that are optimised to its characteristics as well as supporting greater responsiveness to market requirements. The new system will demand a new schema with respect to performance, incorporating the measures of agility, responsiveness, a reduction in non-value adding stock, and a reduction in product returns in addition to the existing schema of performance which is focused on efficiency and service. This alternative configuration should deliver greater value and ultimately a greater competitive advantage to the whole omni-channel system.

This suggestion is based on the premise that configuring a multi-drop fulfilment network where the offline and online channels are integrated at the supplier level (the suggested strategic de-coupling point) will perform better that the current configuration of omni-channel fulfilment adopted by UK grocery retailers (Mason-Jones et al., 2000; Naylor et al., 1999). This suggestion overcomes some of the established challenges of omni-channel fulfilment. First, by internally categorizing the volume as either ambient or chilled only, this configuration overcomes the issues associated with online inventory and capacity management (Melacini et al., 2018). Second, as the volatility of omni-channel demand is typically associated with the online channel, this configuration helps alleviate the operational issues associated with demand uncertainty (Hançerlioğulları et al., 2016). Third, by categorizing product internally by ambient and chilled modes, retailers can optimize each distribution centre in terms of picking and shipping without the distraction of managing channel conflict (Kembro et al., 2018).

The suggestions presented are fundamentally different from each other. *Suggestion 1* allows the retailer to retain more control over their back-end fulfilment operations as it does not require the close collaborative relationship associated with the leagile approach of *suggestion 2* (Haq & Boddu, 2017). Considering the drivers of fulfilment efficiency, *suggestion 1* should benefit from an increase in transport volume and an associated decrease in transportation distance. The independent management of the offline and online channels at the back-end fulfilment stage in *suggestion 2* means that this configuration will not benefit from increased transportation volume. However, this configuration will allow retailers to optimise distribution by channel as practised in single and multi-channel distribution. The independence of channels in *suggestion 2* may allow retailers to deliver a curated fulfilment service for each channel. However, the use of additional smaller delivery vehicles will likely be required to meet the demands of the online channel as is practised by pure-play retailers.

Considering the above, it is possible that *suggestion 1* may offer the more favourable solution of the two suggestions. An aspect of these suggestions that needs to be explored in further iterations of the process of inquiry through simulation are the implications associated with continued growth of the online channel. *Suggestion 1* is likely to be subject to the same capacity constraints experienced in the current state. These capacity constraints can only be overcome by the retailer increasing their capacity to manage more online orders, namely through increasing the available warehouse space. *Suggestion 2* is less likely to be so readily impacted by online order capacity constraints as these demands will be addressed at the supplier level, and not internally.

Chapter 6

1 Discussion and conclusions

The aim of this thesis was to discuss the question, *how can retailers effectively align operations to meet the demands of omni-channel retail?* The underlying assumption presented in the recent omni-channel fulfilment literature is that the current indeterminate situation resulting in poor operational performance can be resolved (Milstein et al., 2022; Siawsolit and Gaukler, 2021; Park et al., 2021). It is simply a matter of finding the correct solution in the form of optimum configuration for back-end fulfilment operations. This thesis contributes to this perspective by not only providing further evidence from a leading grocery retailer that the current approach implemented by grocery retailers to back-end omni-channel fulfilment is problematic and offered an explanation as to the cause of these problems, but it also identified the magnitude of this problem. The identification of the constituent elements of the omni-channel fulfilment problem supported the presentation of two tentative suggestions. The first suggestion, to fully integrate the internal fulfilment systems, is in line with other current suggestions (Jiu, 2022; Hübner et al., 2022; Hu et al., 2022), and seeks to create efficiencies by pooling inventory. This suggestion differs from previous suggestions as it uses empirical findings to construct the suggestion as opposed to adopting a strict analytical approach with no empirical grounding. This solution suggests an effective approach for grocery retailers to align operations to meet the current demands of omni-channel retail. The second suggestion borrows evidence from studies exploring leagile supply chains in different contexts to fully separate the internal fulfilment systems essentially adopts a multi-channel fulfilment model internally to deliver an omni-channel proposition. This configuration allows grocery retailers to manage fulfilment operations largely as they did prior to omni-channel fulfilment adoption.

2 Contribution to the study of omni-channel fulfilment

This thesis makes several contributions to the study of omni-channel fulfilment. Previous studies have recognized the existence of different omni-channel supply chains (Shao, 2021; Arslan et al., 2021; Saghiri et al., 2017). By means of systematic literature review, this thesis is the first the categorize the literature exploring omni-channel fulfilment to identify three modes of omni-channel fulfilment. By identifying that mode 1 fulfilment (Wollenburg et al., 2018; Ishfaq and Defee 2016; Huber et al., 2016b) is typically adopted by perishable/ grocery omni-channel retailers, mode 2 fulfilment (Akturk 2022; Bell et al., 2020; Abushaikh 2018) by non-perishable (furniture, clothing, electrical goods) omni-channel retailers, and mode 3

(Mandal et al., 2021; Zhang et al., 2019) by online retailers, this study offers a conceptual foundation for future study.

This thesis also fills an important gap in the literature. Previous qualitative empirical studies have identified that omni-channel fulfilment is challenging (Bijmolt et al., 2021; MacCarthy et al., 2019; Melacini et al., 2018). Recent studies have built on this narrative and developed analytical solutions that attempt to address these challenges by optimizing omni-channel fulfilment configurations (Millstein et al., 2022; Arslan et al., 2021; Kembro et al., 2021). This thesis is the first to test the hypothesis emerging from the qualitative empirical studies that the adoption of omni-channel fulfilment results in adverse omni-channel fulfilment performance to a level of statistical significance. In doing so, this is the first study to quantify the magnitude of the deleterious impact upon fulfilment operations that result from adopting an omni-channel strategy for a mode 1 omni-channel retailer. Further, this is the first study to propose alternative configurations of omni-channel fulfilment that are grounded in the outcome of such empirical analysis. As a final contribution to the study of omni-channel fulfilment, this thesis adds to the very limited and emerging narrative that explores omni-channel at the operations-marketing interface (Bijmolt et al., 2021).

3 Contribution to theory

Through the process of inquiry conducted for this thesis, omni-channel fulfilment was viewed through a structural contingency theory (SCT) lens and then a complex adaptive systems theory (CAS) lens at different stages of the inquiry. On both occasions, the findings from the studies provided results which were surprising in the context of each of these theoretical lenses.

With respect to structural contingency theory, organisations align contextual factors with contingency variables resulting in strategic fit with the environment and improved organizational performance (Drazin and Van de Van, 1985; Woodward, 1980; Lawrence and Lorsch, 1967). The findings of this and previous inquiries support this hypothesis in part by associating increased omni-channel activity with improved retail performance and a competitive advantage (Neslin, 2022; Kembro and Norrman, 2021; Verhoef et al., 2015). In contrast, however, the findings of this thesis indicate with statistical significance in mode 1 omni-channel fulfilment contexts, an increase in omni-channel performance results in an associated decrease in operational performance. It follows that the SCT prediction of an indefinite improvement in performance (Van de Van et al., 2013; Donaldson 2001) is not sustainable as market forces are unlikely to support the increase in retail prices required to fund omni-channel fulfilment operations (Hardisan and Fernando, 2018). In contexts such as mode

1 omni-channel fulfilment where the functional performance variables are in direct conflict with the operational performance variables, there is an optimum level of marketing activity which can be sustained by operations, activity beyond which becomes unsustainable.

An explanation for the inability of SCT to account for the behaviour found in the mode 1 omni-channel fulfilment context can be found by exploring some of the assumptions of SCT. Structural contingency theory maintains an organisation is constrained by their environment and forced to adopt certain structural designs (Pennings, 1987) and therefore assumes that the organisation always operates in that environment. Retailers who adopt mode 1 omni-channel fulfilment used to be bricks-and-mortar retailers before they transitioned to omni-channel retailers by adding the online channel of fulfilment to the existing offline channel fulfilment infrastructure. When mode 1 omni-channel retailers developed their structural design, it was for an environment whose sole purpose was to efficiently replenish bricks and mortar stores for offline sales. Mode 1 retailers aligned their structures to this environment very effectively through strategies such as the introduction of regional distribution centres, cross-docking, and factory gate pricing (Fernie and Sparks, 2018). SCT fails to account for contexts such as those evidenced by mode 1 retailers where the market has evolved to such an extent that the organisation is effectively now responding to a new environment; one which their structure was never designed for.

The findings of this thesis conflict with previous discussions relating to the nature of the relationship between the environment and the adaptive system in complex adaptive systems theory. The findings conflict with previous discussions in two ways. First, previous research adopting CAS to explore the operations and supply chain management field only recognize a singular energy from the environment (Zhao et al., 2019; Zegarra and Alarcon, 2017; Nair et al., 2016). Mode 1 omni-channel fulfilment is an example of a system that imports two energies (online and offline), resulting in the self-organising agents adopting practices that separate online and offline fulfilment activities to avoid the poor performance that is associated with integration. In such cases, the energies are so incompatible that the system is not likely to ever achieve alignment with the environment.

Second, there is disagreement in the literature as to the location of the environment. Some studies conceptualise the environment as separate from the system (Van de Van et al., 2013; Choi et al., 2001; Anderson, 1999). Others have conceptualised that the environment forms part of the CAS and does not exist outside of it (Nair et al., 2019; Alderson, 1965;

Shapiro, 1964). The findings of this thesis indicate that the location of the environment is not as straightforward as either belonging to the system or not. When considering the omni-channel retail environment, there are some elements of the environment such as collaborative relationship with suppliers, relative position within the market, and consumer trends where the retailer clearly has an influence and could reasonably be perceived to be part of the environment. There are in contrast, elements of the environment controlled by macro-economic factors such as regulation, inflation, disposable income, that are clearly not controlled by the organisation and could reasonably be perceived to be separate from the system. Perhaps a conceptualisation that extends the position of Choi et al, (2001) whereby the environment itself consists of agents. Rather than being separate from the organisation as Choi et al, (2001) suggest, perhaps a conceptualisation that recognises that some of the agents will be internal to the system and others will be external, but all are interconnected in the environment is pertinent. In summary, the findings of this thesis indicate that current conceptualisations of the nature of the relationship between the environment and the system do not adequately explain the behaviour exhibited in mode 1 omni-channel fulfilment systems and calls for new conceptualisations to explain this behaviour.

4 Contribution to practice

The findings of this thesis have several implications for current practice. First, due to inherent infrastructure limitations associated with the mode 1 bricks and mortar retailers, the transition to omni-channel fulfilment will be far easier for pure-play online retailers than bricks and mortar retailers. As the online channel is more complex and restrictive from a fulfilment perspective, pure-play retailers wishing to add a physical offline presence can locate their stores in optimal locations to reinforce their existing online fulfilment infrastructure. This finding is in direct contrast to earlier suggestions from the marketing perspective which indicated that bricks and mortar retailers have a strategic advantage due to their existing physical infrastructure (Agnihotri, 2015, Avery et al., 2012, Pauwels and Neslin, 2015), affording them greater opportunity to engage with their customers and strategically locate inventory.

Second, irrespective of fulfilment mode employed, it is unlikely that omni-channel fulfilment can ever be as efficient as single channel fulfilment. Whilst there are synergies to be gained through the integration of channels (Kaczorowska-Spychalska, 2017, Melacini and Tappia, 2018, Saghiri et al., 2017), offering operational efficiencies compared to multi-channel fulfilment systems, the markedly different environmental energies that shape fulfilment

demands inevitably leads to operational compromise when integrating online with offline fulfilment.

Third, the clarification of the indeterminate situation with respect to the operations-marketing interface in the omni-channel back-end fulfilment context, and the subsequent defining of the constituent elements of the problem have yielded some important strategic insights for the UK grocery retail sector. Fundamentally, it is economically unsustainable for retailers to absorb the additional operational costs associated with omni-channel fulfilment. The initial strategy of offsetting these costs by making operational savings elsewhere (Bulmer et al., 2018) is not viable in the long term, especially as the migration of sales from the offline channel to the online continue to grow. The only viable option left to retailers is to execute a strategy which includes a combination of raising prices and diluting the online service proposition to profitably adopt omni-channel fulfilment. Discount retailers, such as Lidl and Aldi, can gain a competitive advantage over omni-channel grocery retailers by avoiding entering the omni-channel market. As global markets enter a period of recession, the ability of discount retailers to further invest in price through the savings made by avoiding an omni-channel strategy is likely to support increased market share at the expense of omni-channel grocery retailers. This perspective is again at odds with the dominant narrative in the marketing literature which maintains that omni-channel is a fruitful strategy (Mimoun et al., 2022, Neslin, 2022, Verhoef et al., 2015).

One final implication to consider is that the new logistics technologies that are being explored in the operations literature, such as the use of RFID and big data analysis to improve inventory visibility and forecasting accuracy (Caro and Sadr, 2019, Hauser et al., 2021, Ovezmyradov and Kurata, 2022) are unlikely to be effective suggestions to solve the current problems associated with omni-channel fulfilment as they fail to address the constituent problem of competing environmental demands experienced by the offline and online channels.

5 Future research directions

Future research should be concerned with the final stage of Dewey's process of inquiry, *experiment (Dewey, 1999)*. In this stage, the suggestions proposed in the reasoning stage are tested to determine their suitability in transforming the indeterminate situation into a unified solution (Dewey, 1999). In the context of the cycle of inquiry discussed in this thesis, suitable experiments would require at least two grocery omni-channel retailers to adopt the suggested fulfilment configurations. Future research should incorporate empirical observation and analysis of the operational performance impact of altering the fulfilment configuration as

suggested. An important variable in these studies will be online sales, understood as a participation of total retail sales. If current forecasts are realised, then the expected increase in online sales activity is likely to shape the problem-situation significantly.

As this thesis represents the first cycle of a process of inquiry, it is unlikely that the outcome of the experiment stage described above will generate a solution to the indeterminate situation (Morgan, 2013). As Dewey (1999:118) noted "*only execution of existential operations deciding by an idea in which the process of ratiocination terminates can bring about the re-ordering of environing conditions required to produce a settled and unified situation".* Meaning, that as these suggestions only represent probabilistic conclusions, and not fully known facts, they may not be wholly correct and further cycles of the process of inquiry will be required to approximate the problem situation (Strubing, 2007). Dewey (1999) also highlighted the temporal nature of solutions, further highlights the need for ongoing investigations.

6 Limitations of the scope of the thesis

Whilst this thesis makes several unique and original contributions to knowledge around the marketing-operations interface, there are some noteworthy limitations to be acknowledged. First, the primary data collected for this thesis originates from a single case organisation. The case organisation is representative of the omni-channel grocery retail sector as it is a global organisation and is one of the "Big 4" grocery retailers in the UK. The data was collected over an eight-year period from 2012 through 2019 and does not include data from the time where the retail sector was impacted by the Covid-19 pandemic. Whilst this longitudinal data comprises a proprietary data set from a global grocery omni-channel retailer, it is solely from a single-case. The single-case design is limited as data can only be understood in the context of a single situation, rather than across situations (Yin, 2009). Second, whilst this thesis uses a proprietary data set to quantify the magnitude of the impact that adopting an omni-channel strategy has upon back-end fulfilment performance, and is the first study to do so, it does not offer granular solutions based on these findings. To address this limitation, future studies in this area should combine empirical data with analytical methods to determine optimised configurations to manage the operations-marketing interface effectively and efficiently in the omni-channel context.

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