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A Conceptual Model for identifying Out-of-stock Logistics Risks in Store-based Omni-channel Retailing

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Mauricio Rodrigues de Magalhães

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RESUMO

Os avanços tecnológicos têm transformado a maneira como o consumidor final acessa e utiliza os canais de compra e os varejistas se vêm pressionados a atender a estas novas demandas. Por um lado, como diferencial no serviço ao cliente, por outro, pela eficiência operacional de seus concorrentes. A integração de canais tem sido utilizada como solução a todos estes movimentos, e tem sido apontada pela literatura não como uma tendência, mas com uma condição de sobrevivência para os varejistas. O ápice desta integração de canais tem sido chamado de varejo omnichannel e significa uma experiência de compra única por parte do cliente, que tem para isso múltiplos canais disponíveis. No entanto, com os benefícios de diferencial de serviço ao cliente e possível eficiência operacional, vem a complexidade das operações logísticas, requerendo um estudo cuidadoso dos riscos que podem impactar os resultados da empresa em função destas mudanças. Para investigar o que tem sido estudado na literatura sobre os riscos logísticos no omnichannel, o pesquisador fez uma revisão sistemática da literatura, através da qual ele comprovou que apesar de muitos trabalhos discutirem o assunto, estes falham em explorar estratégias de mitigação ou tratamentos destes riscos. O instrumento de intervenção utilizado para esse fim foi o ProKnow-C. Através de uma análise dos desafios logísticos emergentes da estratégia omnichannel encontrados no portfólio bibliográfico resultante da revisão sistemática da literatura, o pesquisador revelou uma gama de lacunas de pesquisa a serem tratadas. Dentre essas possibilidades, um contexto apresentou maior carência, o omnichannel baseado em lojas, onde tanto os pedidos online quanto os clientes do autosserviço são atendidos pelo estoque da prateleira da loja. Por outro lado, um risco logístico também se destacou: a ruptura de estoques. Ela é resultante da complexidade de múltiplos locais de armazenagem, atendimento de pedidos online e devoluções de mercadorias. Através de uma revisão exploratória, o pesquisador percebeu que a ruptura de estoques no varejo tem sido tratada como um problema relevante há quase seis décadas. Embora a literatura sobre falta de estoque no varejo online seja esparsa e muito mais recente, os estudos mostram o mesmo. Por outro lado, no varejo omnicanal, foram encontrados apenas estudos que abordavam as respostas dos clientes à falta de estoque. Diante do exposto, o pesquisador desenvolveu um modelo conceitual para a identificação dos riscos logísticos, especialmente para o varejo omnichannel baseado em loja. Para tanto, ele precisou definir o principal processo logístico responsável pela disponibilização dos estoques nas prateleiras da loja, decompô-lo em subprocessos e, em seguida, cruzar as causas de ruptura de estoque do varejo tradicional e os desafios logísticos do omnichannel com estes subprocessos. Usando a dinâmica do sistema, ele construiu diagramas causais para cada subprocesso. Estes foram todos então conectados no contexto do processo central e os principais feedbacks do sistema identificados e analisados. O resultado foi um passo importante na direção de um avanço da literatura na compreensão do tema e uma poderosa ferramenta de suporte ao gestor logístico na visualização sistêmica e compreensão dos processos logísticos neste contexto.

RESUMO EXPANDIDO

Introdução

Impulsionados pela evolução tecnológica e mudanças nos hábitos de consumo, os varejistas vêm buscando formas de se manterem atualizados de forma sustentável (MELACINI e TAPPIA, 2018; SAHA e BHATTACHARYA, 2020; BIJMOLT et al., 2021). Uma das mudanças mais significativas a esse respeito é o aumento da demanda por canais online para interação em processos de compra (ISHFAQ et al., 2016; MELACINI et al., 2018; MARCHET et al., 2018; DIFRANCESCO et al., 2021; HÜBNER et al., 2021; BIJMOLT et al., 2021), que foi ainda mais acelerado pela pandemia COVID-19 (PEREZ, 2020; HÜBNER et al., 2021). Porém, não se trata de uma migração de canais físicos para canais online, mas sim de uma busca pela disponibilização de ambos de acordo com a conveniência do cliente (WEBER e WEISS, 2018; KEMBRO e NORRMAN, 2019). A partir disso, soluções de canal integrado têm movido o segmento de varejo em todo o mundo (MELACINI e TAPPIA, 2018; KEMBRO e NORRMAN, 2019). Nesse contexto, surge a estratégia omnichannel, com o objetivo de proporcionar aos clientes uma experiência de compra homogênea, oferecendo-lhes acesso aos inúmeros canais e pontos de contato disponíveis (VERHOEF et al., 2015). Assim, os clientes "podem fazer seus pedidos em um canal (por exemplo, em um smartphone), retirar ou receber por outro canal (por exemplo, entrega em domicílio) e devolver produtos em um terceiro canal (por exemplo, loja física)" (KEMBRO et al., 2018, p.1). Porém, aliada aos benefícios oferecidos aos clientes, a integração de canais traz maior complexidade às operações logísticas para o varejista (MURFIELD et al., 2017; KEMBRO e NORRMAN, 2019). Vários pontos de atendimento de pedidos online, diferentes estratégias de alocação de estoque, extensão de serviços de entrega (ISHFAQ et al., 2016; WOLLENBURG et al., 2018) e facilidades para devoluções de produtos (BERNON et al., 2016; DE BORBA et al., 2020) são características desses modelos de integração. E junto com a complexidade vêm ameaças aos resultados do varejista, trazendo riscos ao negócio. Assim, surge a primeira pergunta de pesquisa: *Quais são os riscos logísticos emergentes em estratégias omnichannel?* Para responder à pergunta de pesquisa acima e identificar lacunas de pesquisa, foi realizada uma revisão da literatura, cujos objetivos foram: identificar oportunidades de pesquisa sobre riscos logísticos no varejo omnichannel e apoiar a definição da pergunta-chave de pesquisa desta tese. A partir da revisão da literatura, foi formado um portfólio bibliográfico com artigos que representam o fragmento da literatura sobre o tema. Os resultados mostraram uma falta de estudos científicos sobre o assunto. Embora muitos dos artigos encontrados tenham discutido os riscos logísticos no varejo omnichannel, a maioria deles falhou em trazer estratégias de mitigação ou tratamento de risco, deixando espaço para esforços futuros neste tópico (a saber HÜBNER et al., 2016b; ISHFAQ et al., 2016; LIM et al., 2016; MURFIELD et al., 2017; WOLLENBURG et al., 2018; KEMBRO e NORRMAN, 2019 e 2020; JANJEVIC et al., 2020). Com base nos desafios logísticos omnichannel encontrados, cinco dimensões foram usadas para organizá-los e analisá-los. A partir disso, várias questões de pesquisa foram formuladas. Dentre os achados da revisão sistemática da literatura, destacou-se uma importante lacuna de pesquisa sobre os 'riscos logísticos omnichannel'. Por um lado, entre os diferentes tipos de estratégias, o omnichannel baseado em loja se destacou como o contexto mais lógico (MARCHET et al., 2018), principalmente para varejistas iniciantes (HÜBNER et al., 2016b; ISHFAQ et al., 2016; DIFRANCESCO et al., 2021). Por outro lado, a disponibilidade do produto ao consumidor final surgiu como resultado fortemente ameaçado pelos processos de integração de canais (HÜBNER et al., 2016a; HUBNER et al., 2016b; HÜBNER et al., 2016c; WEBER e WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA e BHATTACHARYA, 2020). No entanto, para gerenciar o risco de ruptura de estoque, o varejista precisa conhecer suas causas e, em seguida, mitigá-las. A partir disso, uma pergunta de pesquisa mais específica foi formulada: *Quais são os riscos logísticos de ruptura de estoque no varejo omnichannel baseado em loja?* Nesse sentido, o objetivo desta tese foi dar o passo inicial no caminho da gestão dos riscos logísticos de ruptura de estoque no varejo omnichannel, por meio de um modelo conceitual que permite identificar os principais fatores internos que causam esses riscos. Na perspectiva da 'Dinâmica de Sistemas', o modelo conceitual representa a 'hipótese dinâmica', cuja finalidade é "explicar as causas por trás da dinâmica problemática" (BARLAS, 2007, p.1143), no caso deste estudo, a ruptura de estoque. A Dinâmica de Sistemas se enquadra no objetivo deste estudo, pois foi desenhada para ser uma ferramenta prática para auxiliar os tomadores de decisão na resolução de problemas complexos (STERMAN, 2000).

Objetivos

Segundo Kothari (2004, p.2), o objetivo da pesquisa é buscar as respostas à pergunta de pesquisa "por meio da aplicação de procedimentos científicos, [...] a verdade que se esconde e que ainda não foi descoberta". Neste sentido, o objetivo principal, refere-se à conclusão do trabalho de pesquisa, com um enunciado mais amplo, buscado a partir do título da tese (PRODANOV e FREITAS, 2013). Com isso em mente, o objetivo geral desta tese é: ***Desenvolver um modelo conceptual que permita identificar os principais riscos logísticos de ruptura de estoque no varejo omnichannel baseado em loja***. Por outro lado, os objetivos específicos referem-se a objetivos mais simples, atingíveis em menos tempo e com desempenho observável. Eles permitem que o pesquisador atinja o objetivo principal e devem ser buscados na estrutura do trabalho, ou seja, em seus capítulos (PRODANOV e FREITAS, 2013). Assim, os objetivos específicos desta tese são: (1) Identificar lacunas de pesquisa sobre riscos logísticos no varejo omnichannel e definir a pergunta de pesquisa central da tese com base nelas; (2) Definir o processo de base do modelo e sua arquitetura; (3) Identificar as principais causas de falta de estoque no varejo tradicional e online; e (4) Identificar os principais desafios logísticos no omnichannel.

Metodologia

O enquadramento do método de pesquisa deste estudo foi classificado de acordo com três abordagens: abordagem da pesquisa, objetivo da pesquisa e procedimento técnico. Quanto à abordagem da pesquisa, este estudo caracteriza-se por um enfoque qualitativo, uma vez que os dados coletados não são mensurados e, após sua análise, é possível aprimorar a pergunta de pesquisa a partir de questionamentos de ações que se movem entre os fatos e sua interpretação no processo de análise (HERNÁNDEZ SAMPIERI et al, 2013). Segundo Martins (2012, p.53), na pesquisa qualitativa, "o interesse não é só nos resultados, mas como se chegou até eles". Por outro lado, no que se refere ao objetivo de pesquisa, é classificado como exploratório, pois se propõe a gerar mais informações sobre o tema, proporcionando sua definição e design (PRODANOV e FREITAS, 2013). Por fim, quanto ao procedimento técnico, este estudo classifica-se como pesquisa bibliográfica, por ser elaborado a partir de material já publicado por diversos autores e de fonte comprovada, no caso, artigos científicos publicados em periódicos de alto impacto (PRODANOV e FREITAS, 2013). O referencial teórico é um mapeamento da literatura em torno do tema de pesquisa, situando-o no contexto da literatura disponível sobre o assunto (TURRIONI e MELLO, 2012). Neste trabalho, parte do referencial surge como resultado de uma revisão sistemática da literatura, a qual gerou em um portfólio bibliográfico (BP). A outra parte vem da pesquisa exploratória. A partir da análise da literatura, foi possível identificar lacunas de pesquisa que justificam este estudo, além da identificação de construtos para o propósito estabelecido. Outra preocupação deste estudo foi a delimitação da pesquisa, estruturada também com base neste referencial (TURRIONI e MELLO, 2012). A produção da tese seguiu uma 'trajetória de pesquisa' que se iniciou com um problema e uma pergunta inicial de pesquisa, passou pela definição do problema e uma pergunta central de pesquisa, e terminou com a construção e entrega de um modelo conceitual. A pergunta inicial de pesquisa teve como objetivo descobrir quais riscos logísticos estão surgindo a partir de estratégias omnichannel. Para respondê-la, foi necessário investigar os estudos existentes sobre o assunto, bem como possíveis lacunas de pesquisa. Para tanto, foi realizada uma revisão sistemática de literatura, com foco no tema 'riscos logísticos no omnichannel', resultando em um portfólio bibliográfico. Os resultados evidenciaram diversas lacunas de pesquisa, dentre as quais uma chamou a atenção do pesquisador, sendo escolhida como o 'problema central de pesquisa' desta tese, a partir da qual foi definida a 'pergunta central de pesquisa'. A fim de responder à 'pergunta central de pesquisa', foi definido o objetivo geral. Para não começar do zero, foram investigadas e identificadas as causas da ruptura de estoque no varejo tradicional, que caracterizam um dos objetivos específicos deste estudo (Objetivo específico 3). No entanto, a logística de varejo omnichannel possui características próprias que a diferenciam da logística do varejo tradicional. Com isso em mente, os desafios emergentes da logística omnichannel foram investigados e identificados, apresentando um segundo objetivo específico (Objetivo específico 4). Para conectar as 'causas da ruptura de estoque no varejo tradicional' com os 'desafios logísticos no omnichannel' e produzir um ambiente que permitisse a 'identificação dos riscos de ruptura de estoque no omnichannel', optou-se por uma estrutura baseada em processos. Como não foram encontradas na literatura estruturas prontas que atendessem a esse propósito, uma estrutura específica para o processo logístico omnichannel foi definida no Capítulo 5, caracterizando o quarto e último objetivo específico deste estudo (Objetivo específico 2). Atendidos os objetivos específicos, deu-se início ao objetivo geral, ou seja, o desenvolvimento do modelo (Capítulo 6). Com este propósito, os inputs, o funcionamento interno e outputs de cada subprocesso foram descritos, onde os inputs considerados foram aqueles que poderiam influenciar o funcionamento interno na produção de outputs que representassem fatores de risco para o 'objetivo de risco', ou seja, ruptura de estoque na prateleira. Um padrão de funcionamento interno dos subprocessos foi identificado (denominado Processo Genérico de Gerenciamento de Disponibilidade de Loja - G-SAMP). Em seguida, foram analisadas as causas de ruptura de estoque identificadas no Capítulo 4. Aquelas relacionadas ao processo de base do modelo foram selecionadas e classificadas nos subprocessos de acordo com suas fontes. Uma vez que as 'causas de ruptura de estoque' encontradas na literatura referiam-se ao varejo tradicional, as lacunas encontradas foram então complementadas com os 'desafios logísticos no omnichannel', identificados também no capítulo 4, de acordo com os respectivos subprocessos. A partir dos elementos da estrutura dos subprocessos e abordando as causas da ruptura de estoque e os desafios logísticos para o elemento correspondente, foi possível formular perguntas específicas que permitem auxiliar na identificação dos principais 'fatores de risco' de ruptura de estoque em cada subprocesso. A relação causal desses 'fatores de risco' foi então representada por diagramas causais, primeiro por subprocesso, depois reunindo todos os subprocessos em uma visão geral do processo em foco e suas respectivas conexões, a saber, o 'modelo conceitual'. Esta tese está organizada em sete capítulos. O Capítulo 1 apresenta o contexto, o objetivo geral e objetivos específicos, a justificativa e delimitação da pesquisa, bem como a metodologia da pesquisa. O capítulo 2 apresenta a revisão sistemática da literatura realizada sobre o tema, com seu método de pesquisa, análise dos resultados e conclusões. O capítulo 3, por sua vez, apresenta um referencial teórico robusto sobre os três principais temas envolvidos com o tema, a saber: varejo omnichannel, logística empresarial e gestão de riscos. Já o Capítulo 4, atende aos objetivos específicos 3 e 4 desta tese, explorando as causas da ruptura de estoque no varejo tradicional e os desafios logísticos no omnichannel, que são insumos importantes para o modelo. O capítulo 5, por outro lado, atende ao objetivo específico 2 desta tese, apresentando a arquitetura do processo base do modelo. O Capítulo 6 apresenta o desenvolvimento do Modelo de Identificação de Riscos, sendo considerado o conteúdo principal desta tese, uma vez que atende ao objetivo geral. Por fim, o Capítulo 7 traz as discussões dos resultados e considerações finais da tese.

Resultados e Discussão

Até onde se sabe, alguns poucos estudos sobre ruptura de estoque têm sido realizados utilizando-se ‘loops de feedback’, como o estudo de Chuang et al. (2016), por exemplo. No entanto, o modelo desenvolvido pelos autores, assim como nos demais estudos encontrados, não explicam as relações causais da ruptura de estoque. Assim, essa discussão traz o suporte da literatura sobre os resultados do modelo, embora represente uma análise sobre os principais achados e não sobre o modelo como um todo. O feedback negativo de não considerar as informações de vendas perdidas na previsão de demanda e os consequentes erros desta nos outros subprocessos, por exemplo, foi um achado relevante do modelo. Essas evidências corroboram os achados de Ehrenthal e Stolzle (2013, p.65) em uma investigação das causas da ruptura de estoques (Out-of-stock ou OOS em inglês) de que “rupturas persistentes distorcem a demanda de forma não observável”. Este fenômeno tem sido denominado 'perpetuação OOS' por diversos autores. Para Moussaoui et al. (2016), a maioria dos sistemas de previsão usa dados históricos de vendas, que apenas capturam a demanda atendida. Quando uma OOS é gerada a partir dessa limitação "as previsões futuras subestimarão novamente a demanda real e causarão mais OOS", causando um efeito de autoperpetuação da OOS (MOUSSAOUI et al, 2016, p.519). Portanto, "esse ciclo vicioso ilustra o efeito de autoperpetuação da OOS e é exacerbado pela autocorrelação da demanda" (MOUSSAOUI et al, 2016, p.525). Outra descoberta importante do modelo foi o loop de feedback de imprecisão dos estoques. A discrepância entre os registros do sistema e os níveis reais de estoque, seja para mais ou para menos, acaba afetando o equilíbrio do sistema, causando, ainda que de maneiras diferentes, situações de OOS. Esta descoberta corrobora a afirmativa de Kok e Shang (2007, p.186) de que "o efeito direto da imprecisão do registro de estoque são as perdas resultantes de decisões de pedido de estoque ineficazes". De acordo com Mou et al. (2018), quando os registros do sistema são superiores ao estoque real, podem causar "congelamento de estoque" onde nenhum pedido é acionado, uma vez que se acredita que há estoque suficiente. Por outro lado, de acordo com Kok e Shang (2007), quando os registros do sistema estão abaixo do estoque real, pode implicar em pedidos desnecessários, levando a uma sobrecarga do depósito da loja. Por fim, a sobrecarga do depósito leva à dificuldade de acessar os produtos e, portanto, a uma ruptura de estoque. Finalmente, outra descoberta do modelo foi o loop de feedback de sobrecarga das prateleiras, que é um resultado da inconsistência da capacidade das prateleiras com a demanda do produto. Esta descoberta corrobora a afirmativa de Garcia-Arca et al. (2020), de que o desalinhamento da capacidade de prateleira de um produto com sua demanda pode aumentar o risco de eventos OOS, pois aumenta a frequência, urgência e, consequentemente, a carga de trabalho do processo de reposição. Este loop de feedback ocorre, no entanto, devido ao reflexo da OOS nas informações de demanda e, consequentemente, nas escolhas de sortimento. Esta descoberta é suportada por Ehrenthal et al. (2014), que afirmam que informações incorretas de demanda levam a escolhas ruins de sortimento, uma vez que o varejista considera a demanda igual às vendas reais e, consequentemente, alocando incorretamente o espaço nas prateleiras.

Considerações Finais

É correto afirmar que um risco identificado, se não mitigado, não produz valor para a empresa. Mas também fica claro que se um risco não for identificado, para a empresa ele não existe e, portanto, não pode ser mitigado. Portanto, a simples consciência de sua existência já resulta em certa vigilância por parte dos gestores, ainda que não tenha sido aplicado um processo formal de gestão. É importante também destacar a originalidade e atualidade do estudo. De acordo com os achados da revisão da literatura, não foram produzidos estudos sobre o assunto, apenas discussões envolvendo a logística omnichannel e alguns riscos emergentes, que atestam sua originalidade. Além disso, a atualidade do tema de pesquisa pode ser verificada pelos resultados da revisão sistemática da literatura, que evidenciou que o tema 'logística omnichannel' começou a ser explorado há pouco mais de cinco anos. Os objetivos específicos foram essenciais para o cumprimento do objetivo geral, e foram cumpridos com as entregas do capítulo 2 (objetivo específico 1), capítulo 4 (objetivos específicos 3 e 4) e capítulo 5 (objetivo específico 2) deste estudo. Quanto ao objetivo principal, este foi cumprido com a entrega do modelo de diagrama causal que abrange todo o escopo do contexto proposto, ou seja, o Processo de Disponibilidade de Loja. Foi entregue não apenas o modelo do diagrama causal geral, mas também seu detalhamento em cada subprocesso, bem como a análise dos principais loops causais encontrados. A entrega do modelo de identificação de risco foi a principal contribuição para a comunidade científica, constituindo um importante ponto de partida no caminho para a gestão do risco de faltas de estoque no varejo omnichannel, a caminho da mitigação. Além disso, o método de construção do modelo pode inspirar outros pesquisadores em estudos semelhantes, nos quais envolve contextos inovadores e complexos e com literatura escassa. Por outro lado, os diagramas causais utilizados para a construção do modelo, são de fácil leitura, o que não tira seu valor, mas adiciona ao permitir uma melhor visualização de sistemas complexos. Com isso, os profissionais de logística de varejo podem direcionar não apenas suas decisões estratégicas para realinhar o tamanho e layout das áreas, mas também reavaliar seu planejamento, procedimentos e diretrizes de pessoal para evitar ruptura de estoque. As principais pesquisas futuras aqui sugeridas são justamente aquelas que podem suprir as limitações deste estudo. Portanto, a primeira sugestão é aplicar o modelo em um estudo empírico. Outra consideração importante é uma extensão da cobertura do estoque de uma loja pelo estoque de outras lojas da mesma empresa dentro do modelo, por meio de transbordos. Por fim, outra sugestão é a adaptação desse modelo para atendimento de pedidos online a partir de um centro de distribuição e/ou de fornecedores (estratégia *'drop shipping'*).

Palavras-chave: Logística. Varejo Omnichannel. Identificação de Riscos.

ABSTRACT

Technological advances have transformed the way in which the final consumer accesses and uses the purchase channels and retailers are being pressured to meet these new demands. On the one hand, as a customer service differential, on the other hand, due to the operational efficiency of its competitors. Channel integration has been used as a solution to all these movements, and has been pointed out in the literature not as a trend, but as a condition of survival for retailers. The culmination of this integration of channels has been called omni-channel retail and it means a unique shopping experience for the customer, who has multiple channels available for this. However, with the benefits of differential customer service and possible operational efficiency, comes the complexity of logistics operations, requiring a careful study of the risks that may impact the company's results as a consequence of these changes. To investigate what has been studied in the literature on logistics risks in the omnichannel, the researcher performed a literature review, through which he found that despite many works discussing the subject, they fail to explore mitigation strategies or treatments for these risks. The intervention instrument used for this purpose was the ProKnow-C. Through an analysis of the logistics challenges emerging from the omnichannel strategy found in the bibliographic portfolio resulting from the literature review, the researcher discovered a range of research gaps to be addressed. Among these possibilities, one context showed greater need, the store-based omnichannel, where both online orders and self-service customers are served by the store's inventory. On the other hand, a logistics risk also stood out: out-of-stock, resulting from the complexity of multiple storage locations, online order fulfillment and product returns. Through an exploratory review, the researcher realized that out-of-stock in retail have been treated as a relevant problem for nearly six decades. Although the literature on online retail out-of-stock is sparse and much more recent, studies show the same. On the other hand, on omnichannel retailing, only studies that addressed customer responses to out of stock were found. Given the above, the researcher developed a conceptual model for identifying logistics risks, especially for store-based omnichannel retail. To do so, he needed to define the main logistics process responsible for making inventories available on the store shelves, break it down into subprocesses, and then cross the out-of-stock causes in traditional retail and omnichannel logistics challenges with these sub-processes. Using system dynamics, he built causal diagrams for each sub-process. These were all then connected in the context of the core process and the main system feedbacks identified and analyzed. The result was an important step towards advancing the literature in understanding the topic and a powerful tool to support the logistics manager in the systemic view and understanding of logistics processes in this context.

Keywords: Logistics. Omni-channel retailing. Risk identification.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAS	Assortment Architecture Sub-process
B2C	Business-to-consumer
BM	Brick-and-Mortar
BP	Bibliographic Portfolio
CSCMP	Council Supply Chain Management Professionals
DC	Distribution Center
DFS	Demand Forecast Sub-process
G-SAMP	Store Availability Management Process Generic
ITS	Internal Transport Sub-process
OC	Omni-channel
OCL	Omni-channel Logistics
OOS	Out-of-stock
RFS	Return Forecast Sub-process
S&OP	Sales and Operations Planning
SACP	Store Availability Core Process
SAMP	Store Availability Management Process
SAP	Store Availability Process
SASP	Store Availability Support Process
SBS	Store Backroom Sub-process
SC	Supply Chain
SCM	Supply Chain Management
SCRM	Supply Chain Risk Management
SCS	Stock Control Sub-process
SFS	Store Floor Sub-process
SOS	Store Ordering Sub-process
SRS	Store Returns Sub-process
SSS	Store Shipping Sub-process

SUMMARY

1 INTRODUCTION

Powered by technological evolution and changes in consumer habits, retailers have been looking for ways to keep themselves updated in a sustainable way (MELACINI and TAPPIA, 2018; SAHA and BHATTACHARYA, 2020; BIJMOLT et al., 2021). One of the most significant changes in this regard is the increase in demand for online channels for interaction in purchasing processes (ISHFAQ et al., 2016; MELACINI et al., 2018; MARCHET et al., 2018; DIFRANCESCO et al., 2021; HÜBNER et al., 2021; BIJMOLT et al., 2021), which was further accelerated by the COVID-19 pandemic (PEREZ, 2020; HÜBNER et al., 2021). However, this is not a migration from physical channels to online channels, but rather a seek for the availability of both according to the customer's convenience (WEBER and WEISS, 2018; KEMBRO and NORRMAN, 2019).

Based on this, solutions of integrated channel have been moving the retail segment around the world (MELACINI and TAPPIA, 2018; KEMBRO and NORRMAN, 2019). In this context, the omni-channel strategy emerges, with the purpose of providing customers with a seamless buying experience, offering them access to numerous available channels and touchpoints (VERHOEF et al., 2015). Hence, the customers "can place their orders in one channel (e.g., on a smartphone), pick up or receive through another channel (e.g., home delivery), and return products in a third channel (e.g., physical store)" (KEMBRO et al., 2018, p.1).

However, together with the benefits offered to customers, the integration of channels brings greater complexity to the logistics operations for the retailer (MURFIELD et al., 2017; KEMBRO and NORRMAN, 2019). Multiple online order fulfillment points, different stock allocation strategies, extension of delivery services (ISHFAQ et al., 2016; WOLLENBURG et al., 2018) and facilities for product returns (BERNON et al., 2016; DE BORBA et al., 2020) are characteristics of these integration models. And along with the complexity come threats to the retailer's results, bringing business risks. Hence, the first research question arises:

- *What are the emerging logistics risks in omni-channel strategies?*

To answer the above research question and identify research gaps, a literature review was performed, whose purposes were: to identify research opportunities on logistics risks in omni-channel retailing and to support the definition of the key research question of this dissertation. From the literature review a bibliographic portfolio was formed with papers which represent the literature fragment on topic. The findings showed a lack of scientific studies on it. Although many papers found have discussed the logistics risks in the omni-channel retailing, most of them have failed on bringing risk mitigation or treatment strategies, leaving room for future endeavors on this topic (namely HÜBNER et al., 2016b; ISHFAQ et al., 2016; LIM et al., 2016; MURFIELD et al., 2017; WOLLENBURG et al., 2018; KEMBRO and NORRMAN, 2019 and 2020; JANJEVIC et al., 2020). Based on the omni-channel logistics challenges found, five dimensions were used to organize and analyze them. From this, several research questions were formulated.

According to Fleury (2012, p.40), the first activity of a research project is "to (re)define the research question from an existing theoretical framework". For the author, only then will it be possible "to produce a result that has value, that is a contribution". With this in mind, using the literature review findings, an important research gap on the omni-channel logistics risks stood out, which was used to drive the general study of this dissertation. This refinement pointed not only to a context that was more needy and dependent on guidance on the omni-channel strategy, but also a more specific and common risk phenomenon for newcomers to the strategy.

On the other hand, among the different types of omni-channel strategies, store-based omni-channel stood out as a most common choice (MARCHET et al., 2018), mainly for beginning retailers (HÜBNER et al., 2016b; ISHFAQ et al., 2016; DIFRANCESCO et al., 2021). Product availability to the final consumer emerged as a result that is strongly threatened by the channel integration processes (HÜBNER et al., 2016a; HUBNER et al., 2016b; HÜBNER et al., 2016c; WEBER and WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA and BHATTACHARYA, 2020).

However, to manage the risk of out-of-stock, the retailer needs to know its causes and then mitigate them. While out-of-stock is a long-standing problem for single-channel retailers (e.g., PECKHAM, 1963; EMMELHAINZ, 1991), whether online or offline, integrating channels means that new factors and connections emerge that need to be revealed and then managed (HUBNER et al., 2016b; WOLLENBURG et al., 2018). In doing so, a more specific research question was formulated as follows:

- *What are the out-of-stock logistics risks in store-based omni-channel retailing?*

With this in mind, the objective of this dissertation was precisely to kick-start the path of managing the out-of-stock logistics risks in omnichannel retailers, through a conceptual model that allows identifying the internal factors that cause these risks.

In the system dynamics perspective, the conceptual model represents the dynamic hypothesis, whose purpose is to "explain the causes behind the problematic dynamics"

(BARLAS, 2007, p.19), in the case of this study, the out-of-stock of product. The system dynamics fits with the purpose of this study, as it was designed to be a practical tool to help decision makers to solve complex problems (STERMAN, 2000). All things considered, the main and specific objectives are presented in the next topic.

1.1 OBJECTIVES

According to Prodanov and Freitas (2013, p.94), "the research objective is directly linked to the meaning of the dissertation proposed by the researcher and to the placement of purposes that are directly related to the research problem. For Kothari (2004, p.2), it is seeking the answers to the research question "through the application of scientific procedures. [...] the truth which is hidden and which has not been discovered as yet". In doing so, the main and specific objectives are presented below.

1.1.1 Main Objective

The main objective, refers to the research work conclusion, with a wider statement, sought from the dissertation's title (PRODANOV and FREITAS, 2013). With this in mind, the main objective of this dissertation is:

- *To develop a conceptual model that allows identifying the main logistics risks of out-of-stock in store-based omni-channel retailing.*

1.1.2 Specific Objectives

On the other hand, specific objectives refer to simpler objectives, attainable in less time and with observable performance. They allow the researcher to achieve the main objective and must be sought in the work structure, i.e., in its chapters (PRODANOV and FREITAS, 2013). In doing so, the specific objectives of this dissertation are:

1) *To identify research gaps on logistics risks in omni-channel retailing and to define the key research question of this dissertation based on them;*
2) *To define the model's basis process and its architecture;*
3) *To identify the main causes of "out-of-stock" in traditional and online retailing;*
4) *To identify the main omni-channel logistics challenges.*

Since the main and specific objectives are defined, the next step is the research justification, which is presented in the sequence.

1.2 JUSTIFICATION

According to the literature review findings, no studies were produced on the subject, only discussions involving omni-channel logistics and some emerging risks, which attest to its originality. Furthermore, the topicality of the research theme can be verified by the literature review results, which evinced that the omni-channel logistics theme began to be explored in 2016, and in the last three years (2018 to 2020), it maintained an average of 6.3 articles per year (the subject is further explored in section 2.2)

Why the Omni-channel retail? The share of online sales in total retail sales has been growing consistently. According to the CRR (2021b), the UK online sales in 2019 were £ 76.036bn, representing 19.4% of the retail total sales. As a comparison, in 2012 it represented 10.6% of the retail total sales. In the USA, the online sales share went from 9.7% in 2012 to 16.5% in 2019, and in Germany, the growth was even more expressive, from 5.9% in 2012 to 15.9% in 2019. According to Ali (2021), the US physical stores sales growth had been maintaining an average of 2.6% year-over-year from 2011 to 2019, while online sales had a more aggressive average growth of 15% year-over-year in the same period. Influenced by COVID-19 pandemic, the innovations, including e-commerce, accelerate even more (YEGANEH, 2021). The online sales worldwide average, for instance, increased 27.6% from 2019 to 2020, although it is speculated that there will be an abrupt reduction in online sales with a recovery of part of this growth in the post-pandemic (for more information on online sales and the COVID-19 pandemic, see section 1.2.1).

Why the store-based omni-channel? The store-based omni-channel has been the choice of most retailers (MARCHET et al., 2018), mainly for the omni-channel retailers beginners (HÜBNER et al., 2016b; ISHFAQ et al., 2016; DIFRANCESCO et al., 2021). The low initial investment in the face of uncertainties (HÜBNER et al., 2016b; ISHFAQ et al., 2016; KEMBRO and NORRMAN, 2019; RAI et al., 2019; DIFRANCESCO et al., 2021) and greater proximity to customers (MARCHET et al., 2018) have been used as justifications for this. In addition, some authors identified an evolutionary path from the single to omni-channel retailing

(HÜBNER et al., 2016a; WOLLENBURG et al., 2018), usually based on online sales volume and initiated by store-based online order fulfillment strategy (WOLLENBURG et al., 2018).

Why the out-of-stock risks? Maintaining product availability in the physical store to serve offline and online sales were mentioned as a “logistics risk” by some authors (namely HUBNER et al., 2016b; WOLLENBURG et al., 2018), and as omni-channel logistics challenge by many others (such as HÜBNER et al., 2016a; HÜBNER et al., 2016c; WEBER and WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA and BHATTACHARYA, 2020). Thus, while retailers need to meet customer expectations, such as high-product availability, they need to manage "their own costs and complexity arising from different channels and network options" (WOLLENBURG et al., 2018, p.2).

Why a model for risk identification? According to Neto and Pureza (2012, p. 170), "a model can be defined as a representation of a situation or reality, as seen by a person or a group of people, and constructed in such a way as to assist in the treatment of that situation in a systematic way". Considering that only identified risks can be assessed and forwarded to be mitigated and that multiple sources of uncertainty in the supply chain make risk identification a broad and undefined task (KERN, 2012), it was understood that a model for risk identification could be a relevant contribution for both the scientific and the practical community.

Why a conceptual model? In systems dynamics, a conceptual model is known as a dynamic hypothesis (BALA et al., 2017), and follows rules very similar to those used in this study, i.e., problem definition, system structure mapping, model boundary definition, subsystem architecture, relationship between variables and causal representation (STERMAN, 2000). In addition to being relevant to understanding the causal network of a system, it operates at the limit between hypothesis and practice, allowing the model to be adjusted to the specific context of the company under analysis.

1.2.1 Addendum on the influence of COVID-19 in the study

Pandemics are classified as an external risk in the supply chain, of the environmental type, which also includes the risks of natural disasters and climate change (MANNERS-BELL, 2014). "Consideration of socially disruptive events such as quarantine, isolation, social distancing, and civil unrest at any point in the chain" is a premise applied to a pandemic paradigm, which is used to conduct supply chain risk management activities (LYNCH, 2009, p. 79).

In this sense, the COVID-19 pandemic situation has been occurring around the world since the end of 2019 and has been unstable until the completion date of this study, bringing economic, political, and social disruption. Attempts to control the global virus spread included social distancing, closing non-essential businesses, and indefinitely postponing great public gatherings or sporting events. Thus, to reduce the virus' spread, people stayed at home, further increasing consumer demand for online shopping (NIELSEN-IQ, 2020). As a result, the online sales worldwide average increased 27.6% from 2019 to 2020, with emphasis on the regions of Latin America (36.7%), North America (31.8%), and Central & Eastern Europe (29.1%) (KEENAN, 2021). In Brazil, for example, online sales grew 73.88% from 2019 to 2020 (MCC-ENET, 2021).

However, for Yeganeh (2021, p. 14), the innovations of acceleration as emerging trend associated with the COVID-19 pandemic "are not a rupture with the past; instead, they are considered the continuation of the global transformations in the past three decades". According to IBM's US Retail Index report, "COVID-19 pandemic accelerated the shift to e-commerce by 5 years" (PEREZ, 2020). Therefore, there are great hesitations on the online demand in the COVID-19 post-pandemic. Although about 55% (UNCTAD, 2020) and 65% (SNEADER and SINGHAL, 2021) of customers who adopted online shopping during the COVID-19 pandemic stated that they expect to continue shopping online in post-pandemic, it is still not possible to predict such a scenario (YEGANEH, 2021). There are forecasts, for instance, of an abrupt reduction in online sales (for instance, -9.1% in 2021 in the UK according to the CRR, 2021a) and recovery of part of this growth, slowly, until it stabilizes in a new growth (COHEN, 2021).

Considering the above and the fact that this dissertation is not focused on external risk factors, care was taken so that this event, which is expected to be punctual, does not influence it.

1.3 DELIMITATIONS

The omni-channel's logistics network scope can be extensive and involve several different nodes, as well as different combinations of functions and strategies. In order to reduce this complexity, it was also necessary to reduce the scope of the model.

Regarding omni-channel context focus - due to the multiple alternatives of fulfillment point strategies that exist in omni-channel retail, to the of the literature is on the strategy. The most common for newcomers to omni-channel is store-based retail. Thus, even though the model allows us to glimpse at coincidences of risk sources for other strategies, such as order fulfillment based on DC or dynamic order fulfillment, it was not properly structured for this. On the other hand, even though the model foresees the existence of an intermediary DC between the suppliers and the retailers' stores, it is possible to use it for direct delivery strategies from suppliers to the stores, simply by replacing the supplier with the DC in the model structure.

Regarding omni-channel logistics process covered by the model - According to most literature on out-of-stock in retail, the main source of out-of-stock is in the store, where concentrate from 45% to 98.5% of these, followed by the DC, with 1.3% to 15% of the out-of-stock situations (see GRUEN and CORSTEN, 2007; FERNIE and GRANT, 2008; AASTRUP and KOTZAB, 2009; GARCIA-ARCA et al, 2020). In doing so, the analyzed context, on which the model was built, ranges from the picking of store orders by the DC, to the products replenishment on the shelves. So, the process responsible for making the product available on the DC storage area or any activity before that, is not considered by the model. Likewise, online order picking activities and product withdrawal by walk-in customers from the shelves, as well as all subsequent activities, are also not considered by the model. An exception is the return of products from customers, whether due to purchase regret or order cancellation. This can be explained by the fact that products returned in conditions of resale to physical stores impact the balance of their inventory levels, constituting an input for the main process of this model. Furthermore, these activities are usually also under the management of the store manager. Therefore, returns are considered in the model.

Regarding the risk sources considered - the model considered mainly the internal risk factors, although the downstream, the demand-related risk factors were indirectly considered. However, the upstream risk factors, mainly the supplier-related risk factors, were not. It was supported here by the statement of Christopher (2011), that when a company is aware of its own internal vulnerabilities, it can isolate the most relevant and critical threats. Furthermore, it was noticed that a scope that also encompassed the various external risks of a company would bring even more complexity to the model, making it superficial and with little practical use.

Regarding the risk perspectives - the interest field in this dissertation is to understand the side of the risk causes, so the customer's response to an out-of-stock situation and its consequences are not considered here. Each company is assumed to have its own availability targets and out-of-stock thresholds for each product category, just as each market segment has its own response to out-of-stock situations. So, whether a 10% out-of-stock rate is acceptable or not, is relative to the company, market and/or product category. With this in mind, when it comes to the out-of-stock rate, it means that its value has exceeded the acceptable limit for the company. Thus, if the acceptable out-of-stock rate for a given company in a given category of its products was 5%, for example, any value equal to or less than it, may not be the focus of its attention. And if it is, then this value is actually not acceptable. Anyway, it is up to the company to determine them.

1.4 RESEARCH METHODOLOGY

The research methodology is a condition for the solid contribution of research to the expansion of knowledge and improvements in production processes. A robust scientific methodology is what differentiates a scientific study from a mere exposition of opinion. Its function is to give legitimacy to the research conclusions and provide the path taken by the researcher (MARTINS, 2012). In doing so, the research method framing and the methodological procedures are presented below.

1.4.1 Research Method Framing

The first stage of the research method framing classification is the research approach, which can be qualitative or quantitative. In this regard, this study is characterized by a qualitative research focus, since the collected data are not measured, and after its analysis, it is possible to improve the research question based on questioning actions that move between the facts and their interpretation in the analysis process (HERNÁNDEZ SAMPIERI et al, 2013). According to Martins (2012, p.53), in qualitative research, "the interest is not only in the results but how they were reached". The second stage of the research method framing to be classified is the objective of the research. In this regard, its objective is exploratory, as it proposes to generate more information on the theme, providing its definition and design (PRODANOV and FREITAS, 2013). The third stage of framing is the technical procedure. In this regard, this study is classified as bibliographic research, since it is prepared from material already published by several authors and from a verified source, in this case, scientific articles published in high impact journals (PRODANOV and FREITAS, 2013). See Figure 1.1. The theoretical framework is a mapping of the literature around the research issue, situating the research topic in the context of the available literature on the topic (TURRIONI and MELLO, 2012).

Figure 1.1 – Research Framing

Source: by the author (2021)

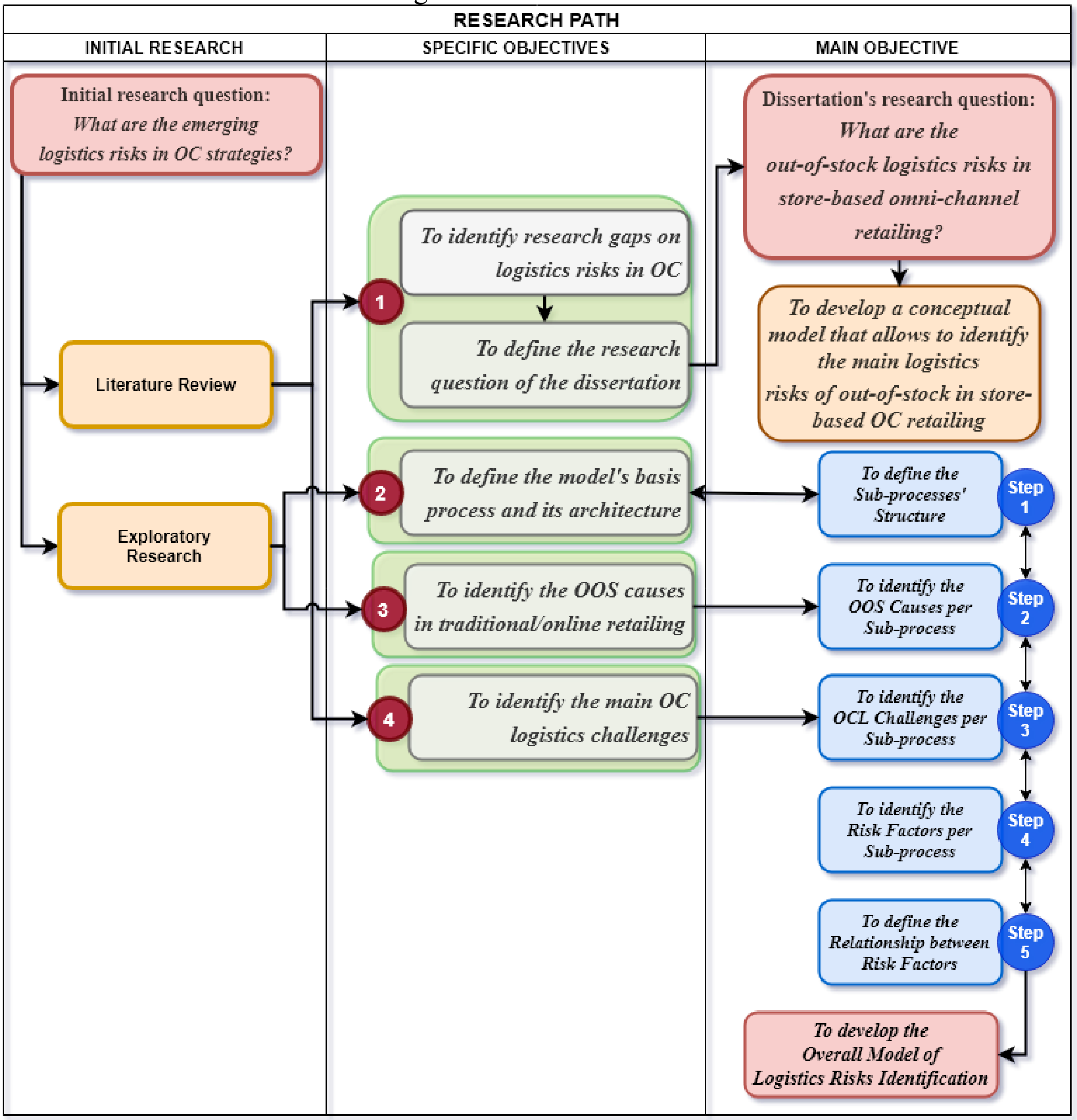
In this work, part of the referential appears as the result of the literature review through the resulting bibliographic portfolio (BP). The other part comes from the exploratory research. From the research and bibliographic organization, it was possible to identify gaps where the research can be justified, in addition to the identification of constructs for the established purpose. Another concern of this study was the research delimitation, structured based on this framework (TURRIONI and MELLO, 2012).

1.4.2 Methodological Procedures

The production of this dissertation followed a research path, which began with an initial problem and research question, went through the definition of a central problem and research question, and ended with the building and delivery of a conceptual model. Figure 1.2 shows the research path from the general problem to the model building. The initial research question aimed to discover what logistics risks are emerging in omni-channel strategies. In order to answer it, it was necessary to investigate existing studies on the subject, as well as possible research gaps. Therefore, a literature review was performed, focused on the theme 'logistics risks in omni-channel', resulting in a bibliographic portfolio. The results showed several research gaps, which caught the researcher's attention, and became the central research problem of this dissertation, thus answering the research.

To answer the central research question of the dissertation, the main objective was defined: to develop a conceptual model that allows identifying the main logistics risks of out-of-stock in store-based omni-channel. In order not to start from scratch, the causes of out-of-stock in traditional retail were investigated and identified, which characterized one of the specific objectives of this study (Specific objective 3). However, omni-channel retail logistics has characteristics that differentiate it from traditional retail logistics. With this in mind, the emerging omni-channel logistics challenges were investigated and identified, featuring a second specific objective (Specific objective 4).

Figure 1.2 – Research Path



Source: by the author (2021)

To connect the causes of out-of-stock in traditional retail with the omni-channel logistics challenges, and to produce an environment that allowed for the identification of out-of-stock risks, a process-based structure was chosen. No structures were found in the literature to serve this purpose, thus, a specific structure for the omni-channel logistic process was designed in Chapter 5, characterizing the fourth and last specific objective of this study (Specific objective 2).

Since the specific objectives were fulfilled, the main objective began, that is, the development of the model (Chapter 6), which took place as follows. Inputs, internal functioning and outputs of each sub-process were described, where the inputs considered were those that could influence the internal functioning in the production of the outputs that represented risk factors to the ‘risk objective’. A pattern of the internal functioning of the sub-processes was identified (named Generic Store Availability Management Process - G-SAMP). The next, the out-of-stock causes identified in the Chapter 4 were analyzed, those related to the model base process were selected and classified into the sub-processes according to their sources. Since these out-of-stock causes referred to the brick-and-mortar retail, the gaps found were complemented with the omni-channel logistics challenges identified also in Chapter 4, according to the respective sub-processes. From the elements of the subprocesses’ structure and by addressing the causes of OOS and logistics challenges to the corresponding element, it was possible to formulate specific questions that allowed identifying the main OOS risk factors in each sub-process. The cause-effect relationship of these risk factors was then represented by causal diagrams, first individually, then joining all the sub-processes into an overview of the process in focus and its respective links, namely, the conceptual model.

1.4.3 Manuscript Organization

This dissertation is organized into seven chapters. Chapter 1 introduces the context, the main and specific objectives, the justification and delimitation of the research, as well as the research methodology. Chapter 2 shows the literature review performed on the topic, with its research method, analysis of the findings and conclusions. Chapter 3, in turn, presents a robust background on the three main topics involved with the theme, namely omni-channel retailing, business logistics and risk management. Since Chapter 4, meets specific objectives 3 and 4 of this dissertation, exploring the OOS causes and OC logistics challenges, which are important inputs to the model. Chapter 5, on the other hand, meets specific objective 2 of this dissertation, presenting the model base process architecture. Chapter 6 presents the development of the Risk Identification Model, being considered the main content of this dissertation, since it meets the main objective. Finally, Chapter 7 brings the final considerations of this dissertation.

2 LITERATURE REVIEW ON OMNI-CHANNEL LOGISTICS RISKS

In order to support the research justification and to evidence the study's uniqueness and originality, and topicality of the theme, a literature review was performed. Its purpose was to answer the following research questions:

- *What has been studied by the scientific community about Logistics Risks in the Omni-channel Retail?*
- *What are the research opportunities related to this subject?*

To answer these questions, it was necessary to capture a fragment of literature on the theme "Logistics risks in the omni-channel retail", representing what had already been produced on the subject. The result was a portfolio of articles, here called Bibliographic Portfolio (BP), recognized by the scientific community. This structured research process is justified based on the assumption that academic knowledge is dispersed in several data sources (TASCA et al, 2010). Therefore, the first purpose of the literature review was to identify research opportunities on logistics risks in omni-channel retailing, based on the aforementioned bibliographic portfolio (BP). However, its second and most important purpose was defining the key research question of this dissertation based on the research opportunities found.

This chapter is organized into four sections. The first section presents in detail the literature review's research method, which is a relevant part of this dissertation, since it seeks to give credibility to the BP found, by demonstrating the data analysis procedures and methods. The second section shows the bibliometric analysis of the BP data, with relevant information, such as authors and scientific journals highlighting, the number of articles per publication year and the citations number of BP articles. The third section, in turn, brings the findings on BP papers about the theme "Logistics risks in the omni-channel" in order to understand the path that the scientific community has taken over time in this direction. The fourth and last section presents the conclusions and final considerations of the literature review, as well as defines the key research question of the dissertation, based on these conclusions.

2.1 RESEARCH METHOD

According to Fink (2019, p.254), "a literature review is a systematic, explicit, comprehensive and reproducible method for identifying, evaluating, and interpreting the existing body of original work produced by researchers and scholars". For Seuring and Müller

(2008), literature reviews have two main objectives: to summarize the existing research, identify patterns, themes and issues, and identify the conceptual content of the field. According to the authors, it can be divided into four steps: material collection, descriptive analysis, category selection and material evaluation. The material collection aims to define and delimit the material to be collected, as well as to form a bibliographic portfolio as a unit of analysis, which is described in this section. On the other hand, the descriptive analysis assesses the formal aspects of the bibliographic portfolio, and it is described as bibliometric analysis in the second section of this manuscript. The category selection chooses structural dimensions and related analytic categories. Finally, the material evaluation analyzes the structural dimensions, allowing the identification of relevant issues and interpretations of results. Both the category selection and the material evaluation are defined and developed in the third section of this study.

2.1.1 Material Collection

The material collection is organized into three stages: research method framing, intervention instrument presentation, and data selection procedure.

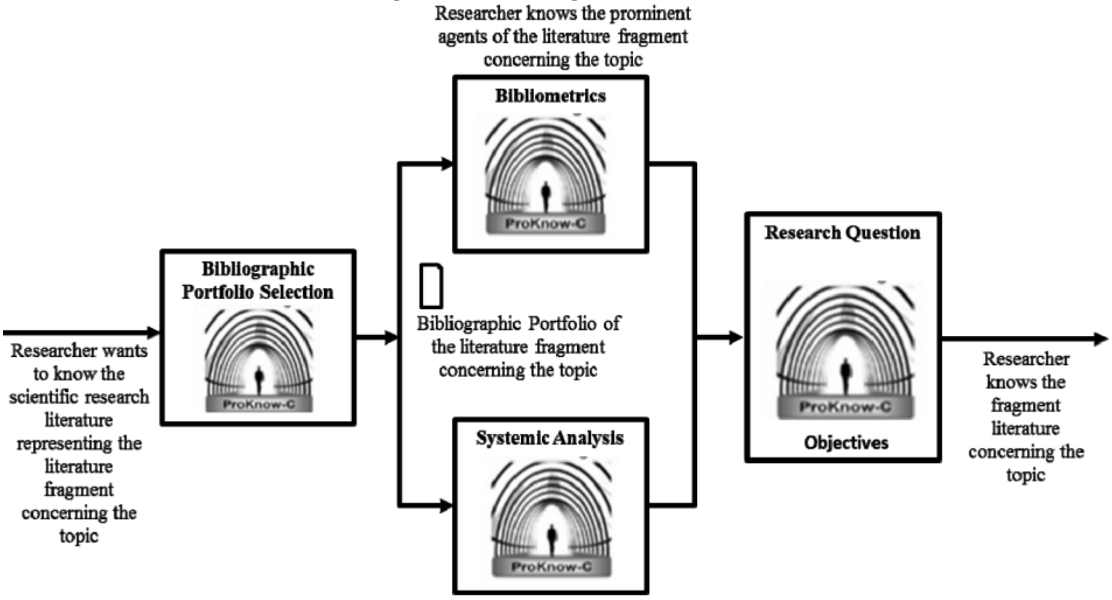
2.1.1.1 Research Method Framing

Regarding the research method framing, this study is classified as: qualitative research (since the data collected are not measured), exploratory objective (since it proposes to generate more information on the theme), and as bibliographic research (since it is prepared from material already published).

2.1.1.2 Intervention Instrument

The intervention instrument applied for the bibliographic portfolio (BP) selection was the Knowledge Development Process - Constructivist (ProKnow-C), which was consolidated in 2011 as an instrument of guidance in the knowledge construction, considering the delimitations, perceptions and motivations of the researcher (VALMORBIDA and ENSSLIN et al, 2017). ProKnow-C consists of four stages: BP selection, a bibliometric analysis of the BP, systemic analysis of the BP and formulation of research questions. In doing so, ProKnow-C meets the four stages of the literature review proposed by Seuring and Müller (2008). Figure 2.1 shows the stages of ProKnow-C.

Figure 2.1 – Stages of the ProKnow-C



Source: Valmorbida and Ensslin (2017, p.486).

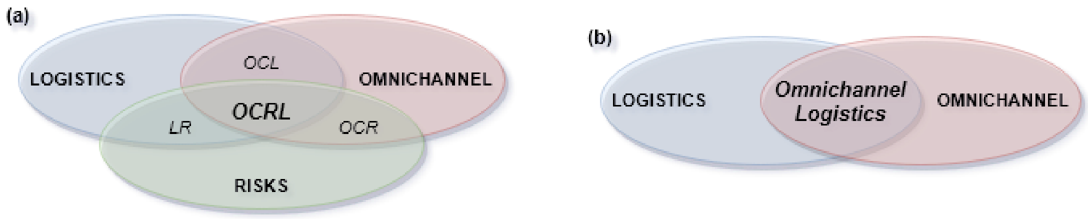
2.1.1.3 Data Selection Procedure

The execution of the BP selection process, fulfilled the role of establishing a set of articles that were aligned with the research theme and available for reading and analysis by the researcher. It started with the selection of raw articles bank, which established the consulted databases, and determined the research axes and keywords used.

The search system used was the "Research Portal Integrated to the University Library Collection of the Federal University of Santa Catarina", from which it is possible to search simultaneously in the catalog of this library, Portal CAPES, SCIELO, and in other important databases of scientific articles (for instance, EBSCOhost, IEEEXplore, ProQuest, Springer, Wiley online Library, Scopus, Science Direct and Emeral Insight). The search command of the first attempt included the three axes in Figure 2.2.a, i.e., logistics, omni-channel and risk. Therefore, the keywords were composed of these three terms and their variations.

The search specifications were restricted to scientific peer-reviewed articles and in English. No limits were set on publication dates, as this is a relatively new topic. However, the search terms should be either present in the title, abstract, or keywords.

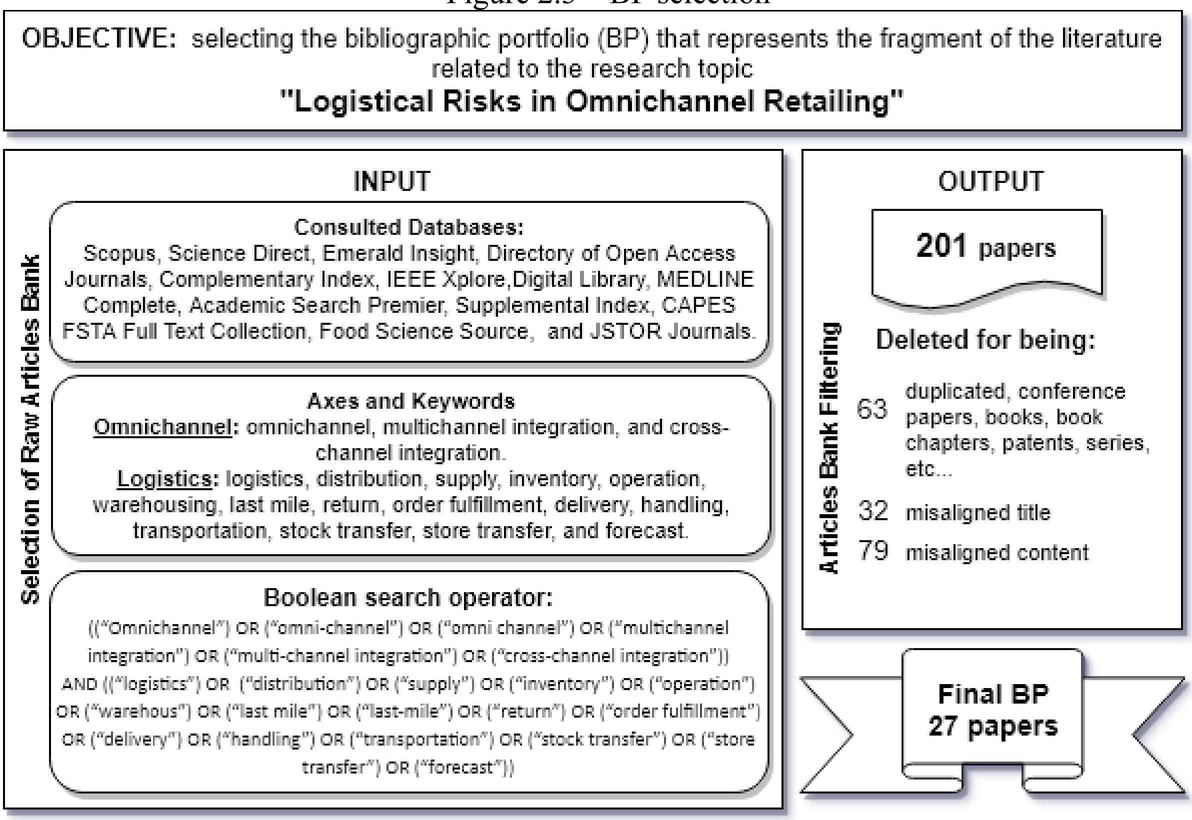
Figure 2.2 – Research Axes



Fonte: by the author (2021).

Notwithstanding, the first set of search commands did not bring up relevant articles. As a result, the term "risk" was excluded from the search command. In this way, the main axes, i.e., logistics and omni-channel (see Figure 2.2.b), could raise questions about the interaction of these subjects that would represent substitute terms for "risk", such as "challenges", for example. In doing so, the axes, keywords and final Boolean search operators used, as well as each stage results, are presented in Figure 2.3.

Figure 2.3 – BP selection



Source: adapted from Valmorbida and Ensslin (2017)

Even if the term "risk" has been deleted from the search command, the objective of this study is still to find research questions about "logistics risks in the omni-channel retailing". When using the Boolean search operator, as shown in Figure 2.3, 201 documents were found, which became part of the raw articles bank.

A total of 174 documents were deleted by raw article bank filtering. Most of them due to misaligned content. A first group, 63 documents, were deleted in the first step, since they were duplicates, conference papers or book chapters. In the second step, the article titles were analyzed, when those that obviously dealt with other subjects were excluded, in this case, 32 articles.

According to Martins (2012, p.54), in a qualitative approach, “the construction of the objective reality occurs through the researcher's perspective, based on the literature review”. Therefore, the third step was the most subjective, therefore more dependent on the researcher's judgment.

Several articles addressed the omni-channel subject, superficially or presenting tools or solutions that could be used in other environments, in addition to the omni-channel environment. In the same way, several articles dealt with logistics subject, but equally superficial, as part of a business context solution, strategy, or analysis. Here, it was necessary to define the scope of the "logistics" phenomenon that the article needed to address, as well as to define which maturity level of channel integration could be accepted as an omni-channel context.

Regarding the "omni-channel" theme, further details were needed, since it could easily be confused with multichannel and/or even pure online contexts. According to Beck and Rygl (2015), even though omni-channel is generally conceptualized as the total integration of channels, both from the customer experience and management side of the retailer, the reality of the market is fragmented channel scenarios, which use the channels integration according to their possibilities and conveniences. Moreover, according to the authors, there is a gap between the total integration proposed by the omni-channel and the total separation of channels proposed by the multichannel. This situation was evident during the classification stage of articles by content alignment for BP since several papers presented fragmented integrations of channels as omni-channel strategies. For this reason, Beck and Rygl' multiple channel categorization was used, which classifies multiple channels retail according to two dimensions: whether channel interaction can be triggered by the customer, or is controlled by the retailer, and how many and what channels are considered. In this context, the Beck and Rygl' categories adopted for the BP articles classification were those that fit with Omni-channel (i.e., hybrid categories III & VIII, VII & IV or VII & VIII. For more details, see the "Taxonomy of multiple channel retailing" developed by BECK and RYGL, 2015, p.171). For this, the retailer needed to have full integration of channels on at least one of two sides, either from the customer's viewpoint, or from the retailer's viewpoint, with partial integration on the other side; or even to have full integration of the channels on both sides. With this in mind, as long as the article's proposal did not deviate from any of these conditions, in addition to focusing on logistics, it would then be classified in the BP. However, in case an article's proposal was generic, being able to fit in different strategies not only the omni-channel, it was then considered as misaligned.

On the other hand, regarding "logistics", it was established that the article needed to treat it as a central element of the study, developing its processes and/or strategies. At this step, 79 articles were deleted, with 27 articles remaining, which compose the articles bank aligned with the research objective.

Three other steps are proposed in the filtering process of the article bank by ProKnow-C: selection of articles by scientific recognition, exclusion of articles not freely available, and inclusion by representativeness (VALMORBIDA and ENSSLIN, 2017). The "scientific recognition" is the step that deals with the search of citations number of the remaining articles and the selection of that part with more citations (about 75% of the articles). Articles with up to two years after their publication are analyzed separately since the availability time in the databases directly influences the possible number of citations. Older articles had more time to be found, read, and considered suitable for citing them. However, due to the topicality of the theme, it was noticed that almost half of the portfolio articles were published from 2019 onwards. In addition, one of the main functions of scientific recognition is to reduce very extensive bibliographic portfolios, which was not the case in this study. For these reasons, it was then decided not to exclude any of the remaining 27 articles due to lack or low scientific recognition. There were also no exclusions due to the document’s unavailability since all 27 articles were accessible through the Capes Portal. Finally, the "representativeness test" deals with the analysis of the references of the articles that compose the articles bank aligned with the research objective, i.e., the 27 articles, to check for possible inclusions. This step is planned to enable the collection of relevant articles published in databases different from those chosen here, but used by the authors of the pre-selected articles. Although several new articles related to the theme have appeared, none of them met the minimum criteria that justified their inclusion. This was probably due to the amplitude and variety of databases used in the search for papers.

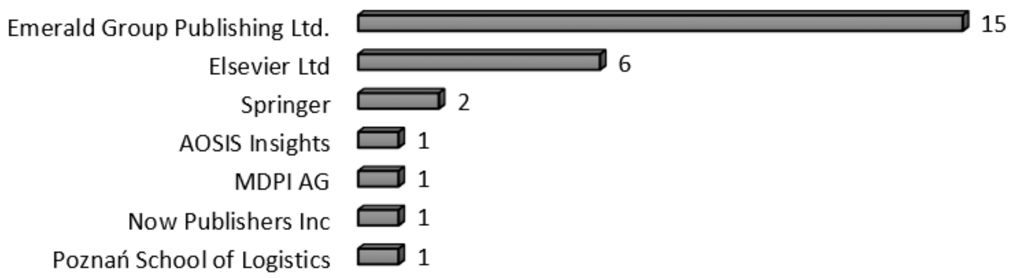
In doing so, the 27 articles aligned with the research objective become the final bibliographic portfolio of this study, which are listed in Appendix A. Since the bibliographic portfolio was formed, the next step is to get to know its prominent agents, which will be explored in the next section.

2.2 BIBLIOMETRIC ANALYSIS

The "bibliometric analysis" was designed to observe the BP characteristics, such as databases, authors and scientific journals highlighted, as well as the number of articles per publication year and the citations number of BP articles.

The first analysis was the analysis of databases, where the Emerald Insight gained emphasis, with more than half of the BP articles, followed by Elsevier, with a fifth of the BP articles. Figure 2.4 shows the databases that brought results to the BP.

Figure 2.4 – Databases that brought results



Source: by the author (2021).

The next analysis was the number of articles per year of publication. This analysis is relevant because it demonstrates the topicality of the theme. Figure 2.5 shows this distribution.

Figure 2.5 – Scientific articles published per year

Source: by the author (2021).

Please note in Figure 2.5 that the theme "omni-channel logistics" started to be explored systematically in 2016, when about 25% of the articles were published. In 2017, only one article was published. This attests to the pioneering spirit of the first six publications on the subject, with half of them from the same cluster of authors. What these authors realized in 2016 was only clear to the rest of the scientific community from 2018 onwards.

Another relevant analysis is standout authors in publications number for having devoted more attention to the subject. In this regard, four authors were the ones that stood out the most, with four articles published with the theme. Another three authors with three articles and five with two articles also appeared in BP. Figure 2.6 shows the most stood out authors in BP.

Figure 2.6 – Standout authors of the BP.

Source: by the author (2021).

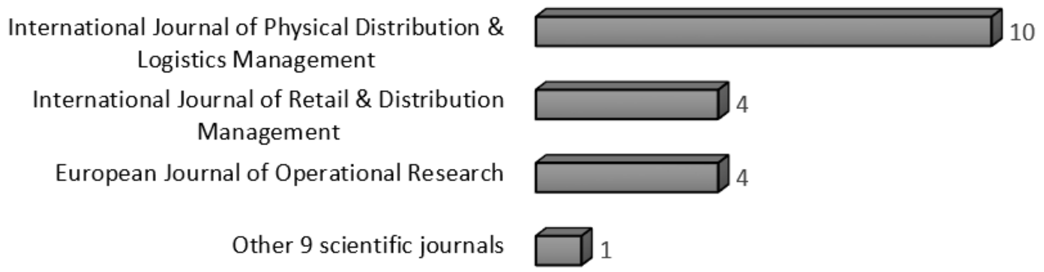
The twelve authors that stood out the most, with at least two publications, represent a fifth of the total number of authors of the BP, however, they published 56% of the articles. Most of them are grouped into four distinct clusters, attached to four different universities and schools.

The cluster that stood out the most is affiliated with the Catholic University Eichstätt-Ingolstadt (Ingolstadt, Germany) with five publications and two of the four most prominent authors (Alexander Hübner and Johanes Wollenburg). The second cluster that stood out the most is affiliated with the Faculty of Engineering of the Lund University (Lund, Sweden) with four publications and the other two most prominent authors of BP (Joakim H. Kembro and Andreas Norrman). The third cluster is affiliated with Politecnico di Milano (Milano, Italy) with three publications and two main authors (Marco Melacini and Elena Tappia). Last but not least, the cluster is affiliated with the Georgia Institute of Technology (Atlanta, United States) with two publications in which one author stood out (Benoit Montreuil).

The pioneer cluster, with the oldest publications (most in 2016), is also the most prominent cluster. So, the most recent publications are from the fourth cluster (2020) and the second cluster (most in 2019).

The next bibliometric analysis is the highlighted scientific journals. See in Figure 2.7.

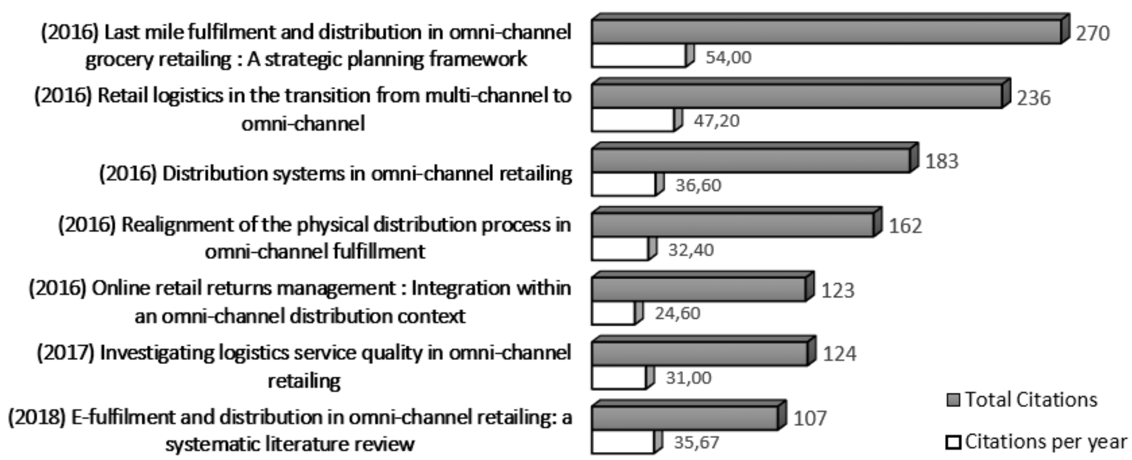
Figure 2.7 – Featured scientific journals



Source: by the author (2021)

In this regard, the International Journal of Physical Distribution & Logistics Management (98% of CiteScore percentile rank in 2019, according to Scopus) was the journal that published the most BP articles, with 10 publications (40% of the BP) between 2016 and 2019. Two journals occupied the second position, the European Journal of Operational Research and the International Journal of Retail & Distribution Management (97% and 84% of CiteScore percentile rank in 2019, according to Scopus, respectively), with three publications each. These three journals together represent two thirds of the articles in the BP, with an average CiteScore percentile of 93%, which attests to its high level of the required quality.

Figure 2.8 – Recognition by scientific community



Source: Consulted from Google Scholar on March 31, 2021.

Last, but not least, is the analysis of the scientific community recognition, determined by the citations number of the articles under analysis. Although all articles are relatively recent, there is a significant difference between the first and the last publication, making comparison difficult by the absolute number of citations.

With this in mind, a calculation of the number of average annual citations was made. Although not perfect, the comparative disparity narrows. Both the absolute number of citations and the relative number of the seven most cited articles of the BP are shown in Figure 2.8.

In doing so, the annual average of citations of the seven most cited articles was 33 citations and of the complete BP was 12 citations. The most prominent among the most cited articles were the *"Last mile fulfilment and distribution in omni-channel grocery retailing: A strategic planning framework"* and *"Retail logistics in the transition from multi-channel to omni-channel"*, with 54 and 47.20 average annual citations respectively. Both have in common the first author, Alexander Hübner, the year of publication (2016) and the affiliation, Catholic University Eichstätt-Ingolstadt (Ingolstadt, Germany).

2.3 SYSTEMATIC ANALYSIS

The systemic analysis purpose is to reference the findings on BP papers about the theme "logistics risks in the omni-channel" in order to understand the path that the scientific community has taken over time in this direction.

2.3.1 Omni-channel Logistics Risks

Since the purpose of this study is to investigate the fragment of the literature on the topic "logistics risks in the omni-channel retailing" and the BP is focused on "omni-channel logistics", a thorough search was performed in the full text to unveil this issue from the papers. To map the main issues related to e-fulfillment and distribution in omni-channel retailing, the findings were classified according to the three omni-channel logistics dimensions used by Melacini et al. (2018): distribution network design, inventory and capacity management, and delivery planning and execution. These findings are presented in Table 2.1.

Table 2.1 – Findings on omni-channel logistics risks in the BP

DIMENSION	***DESCRIPTION***	***AUTHOR(S)***
Distribution network design	By not integrally considering the highly interrelated decisions, such as facility locations and types, as well as transportation modes, could put the success of omni-channel retailing strategy at risk.	Janjevic et al. (2020)
	The choice of fulfillment point strategy of online customers' orders depends on risk management, in addition to the economics of inventory and delivery costs.	Ishfaq et al. (2016)
	Proactive cross-docking can reduce handling costs in distribution center but could cause the risk of build-up of unsold products in stores.	Kembro and Norrman (2020)
	Strong governance and the leverage of last mile networks with partner resources can reduce retailers' risks and uncertainties through greater product availability and distribution capabilities.	Lim et al. (2016)
	The business risks involved with the implementation of a new information system (IS) to support the omni-channel retailing strategy (e.g., related to cost and implementation time) lead to an increase in the use of IS provided by logistics service providers (LSP).	Kembro and Norrman (2019)
Inventory and capacity management	There is the out-of-stock risk when the store fulfills the online orders, "due to the time gap between order placement and picking, as other customers can meanwhile buy the item".	Hübner et al. (2016b, p.235)
	When physical stores fulfill online orders, there is a risk of out-of-stock due to the sharing of on-shelf stock between store and online customers, in addition to the high inventory inaccuracy in stores.	Wollenburg et al.(2018)
Delivery planning and execution	The risk of alienation of the omni-channel customer segment due to failures in the speed and reliability of delivery processes.	Murfield et al. (2017)

Source: by the author (2021)

Although many papers discuss the logistics risks in the omni-channel retailing, most articles fail on bringing risk mitigation or treatment strategies, leaving room for future endeavors in this topic. With this in mind, to increase the coverage of the BP analysis, possible "challenges" of omni-channel logistics were uncovered in order to deepen the logistics risk potential causes.

2.3.2 Omni-channel Logistics Challenges

The Royal Society's risk concept (WARNER, 1992, p.2), one of the most cited in the risk literature, defines risk as "the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge". According to the Oxford Dictionary (Oxford Advanced Learner's Dictionary, n.d.), 'a challenge' means "a new or difficult task that tests somebody's ability and skill". Omni-channel implementation is an innovation (CAO and LI, 2018; PARK and KIM, 2019; SHI et al., 2020) since it involves significant changes in the retailers' operational processes, as well as in the services provided by them to customers (GAULT, 2018). Additionally, some activities which, in a conventional retail setting are the responsibility of the consumer, become the retailer's responsibility in an omni-channel retail context, increasing the complexity of the distribution system for retailers (WEBER and WEISS, 2018). Thus, the innovation and complexity characteristics of the omni-channel retailing strategy reinforce the consistency of its challenging character for retailers, representing a threat to business outcomes.

In this matter, the skills of retailers are tested by facing the threats originated from the implementation of the omni-channel retailing strategy, which represents some risks to the outcomes of their business. Thus, the challenges can be seen as strong candidates for risk sources and are valuable resources for their identification.

2.3.2.1 BP papers addressing Logistics Challenges

In the BP, the first part of the articles only mentioned some challenges of omni-channel logistics or presented generic challenges of the omni-channel strategy. A second part did not even mention them. However, a third and final part of BP focused on these challenges, becoming an important source for this analysis. Table 2.2 presents the findings on omni-channel logistics challenges in the BP.

Table 2.2 – Findings on omni-channel logistics challenges in the BP

AUTHOR(S)	DESCRIPTION
Hübner et al. (2016c)	The authors presented in their study the main advantages and challenges for some of the main omni-channel implementation strategies, such as warehouse processes integration, inventory centralization, use of physical stores for fulfillment and / or pick up online orders, and product return points. Although the authors have mentioned the inventory centralization, this practice is not an exclusive strategy of the omni-channel retailing, often used in single channel network solutions.
Hübner et al. (2016b)	The authors developed a planning framework for last mile order fulfillment in omni-channel grocery retailing, describing the challenges for different design concepts for back-end fulfillment and delivery modes in omni-channel retailing. Regarding the back-end fulfillment, they compare orders picked from the store, from dedicated dot-com-only fulfillment centers, and an integrated central warehouse.
Weber and Weiss (2018)	Focused on omni-channel grocery retailing, the authors analyzed the last mile logistics challenges hindering the efficiency of omni-channel retailers.
Kembro et al. (2018)	The authors studied how warehouse operations and design are affected by the omni-channel strategy implementation.
Kembro and Norrman (2020)	The authors explored the different warehouse configurations in omni-channel retailing, presenting a synthesis of their challenges.
Bernon et al. (2016)	In a study on the impact of online sales return levels, the authors described the challenges for network design and return processes in omni-channel retailing strategies.
Kembro and Norrman (2019)	The authors explored, among other aspects, the challenges of information systems related to omni-channel logistics.
Freichel et al. (2020)	The authors investigated the role of the packaging system in omni-channel fashion distribution and identified three points of the omni-channel distribution channel where the packaging system poses greater challenges.
Lafkihi et al. (2019)	In a literature review of procurement of freight transportation service, the authors identified some challenges regarding transportation organization and procurement mechanism design in the omni-channel e-commerce.

Source: by the author (2021)

The findings of the omni-channel logistics challenges, from these and other authors of the BP, were then organized, so that it was possible to analyze them, which is dealt with in the next section.

2.3.3 Dimensions of Omni-channel logistics challenges

After a thorough analysis of BP papers, five dimensions could be identified: inventory and capacity management, back-end fulfillment, last mile distribution, product returns, and logistics information systems. The "Inventory and Capacity Management" dimension encompasses the inventory sharing, products assortment, and inventory replenishment policies (KEMBRO et al., 2018; MELACINI et al., 2018). The "Back-end Fulfillment" and "Last Mile Distribution" represent the forward omni-channel distribution system and encompass the fulfillment and delivery of customer orders, respectively (HÜBNER et al., 2016b). While the "Product Returns" represent the backward distribution system, encompassing the return modes and their processing locations (Hübner et al., 2016c). Finally, the "Logistics Information Systems" represents the control and sharing of information among the other dimensions, encompassing issues such as order management and inventory accuracy and visibility (KEMBRO et al., 2018; KEMBRO and NORRMAN, 2019; KEMBRO and NORRMAN, 2020). These dimensions are presented in Figure 2.9.

Figure 2.9 – Dimensions of the Omni-channel Logistics Challenges

Source: by the author (2021)

Omni-channel logistics challenges were then classified into these five dimensions, which were subdivided into categories in order to further their analysis (a detailed analysis of these challenges is presented in section 4.2, as well as the full list of them is shown in Appendix B).

2.4 LITERATURE REVIEW CONCLUSIONS

The first purpose of the literature review was to identify research opportunities on logistics risks in omni-channel retailing. In this regard, it was possible to verify, based on the bibliographic portfolio, the lack of scientific studies on the subject, opening up a wide range of possibilities to be explored.

As previously mentioned, although many papers have discussed on logistics risks in omni-channel retailing, most of them fail on bringing risk mitigation or treatment strategies. According to the 'risk' definition described by the Royal Society (WARNER, 1992, p.2), the risk is “the probability that a particular adverse event occurs during a stated period of time or results from a particular challenge”. In this sense, the 'omni-channel logistics challenges' issue was deeply explored by the BP authors and then used as a basis to guide this study.

On the other hand, the main contribution of the literature review was to define the key research question of this dissertation based on its findings. Since the latter showed a wide range of possibilities to be explored on the topic, it was necessary to define a more specific context of the omni-channel to be studied, as well as a more specific risk phenomenon.

Regarding the context, it was possible to notice that there is a very common journey taken by most traditional retailers to become omni-channel (HUBNER et al, 2016a). According to a survey performed by Marchet et al. (2018) in Italy, manage picking in-store is the preferred solution of about 85 percent of companies. Therefore, the exploration of physical stores to leverage inventory positioning and fulfill online orders has been a constant for beginning omni-channel retailers (ISHFAQ et al., 2016; DIFRANCESCO et al., 2021). Indeed, "in-store picking is usually the primary option for a bricks-and-mortar retailer who wants to enter the OC business” (HÜBNER et al., 2016b, p.234). The ability to quickly expand the reach of online sales, without investing in new logistics facilities, given the still uncertain demand from customers, as well as reducing delivery time and cost, has been the main arguments for this (HÜBNER et al., 2016b; ISHFAQ et al., 2016; KEMBRO and NORRMAN, 2019; RAI et al., 2019; DIFRANCESCO et al., 2021). The stores are very close to the customers, so the response time to orders is much shorter than DCs (MARCHET et al., 2018). Thereby, stores are used not only to fulfill online orders but also as a pick-up and returns point (BERNON e al., 2016; ISHFAQ et al., 2016). Another important factor is that a single-channel retailer goes through different stages of interconnection and integration to achieve omni-channel status (HÜBNER et al., 2016a). Typically, it is the volume of online orders that drives this process that, according to Wollenburg et al. (2018), has three phases. In the first phase, physical stores are used to the fulfillment of all channels. Only in the second and third phases, online fulfillment is provided by DCs, first by a dedicated DC, finally by a central DC. Therefore, the context of this dissertation becomes the store-based omni-channel, where the store fulfills all the customers' online orders and has the function of receiving and processing products return, in addition to its basic function of serving walk-in customers.

Regarding the risk phenomenon, among the topics covered by BP, omni-channel “distribution” was the most explored topic, appearing in 70% of the articles. "Returns" and "warehousing" came in second with 40% of papers, and the topic "inventory" appeared in a quarter of BP's papers. Other topics were also explored with less emphasis, such as "transportation" (15% of papers), "logistics information system", "outsourcing", and "packaging" (all with about 4% of papers each). Although maintaining product availability in the physical store to serve offline and online sales have been mentioned as a “logistics risk” by some authors (namely HUBNER et al., 2016b; WOLLENBURG et al., 2018) and as omni-channel logistics challenge by many others (such as HÜBNER et al., 2016a; HÜBNER et al., 2016c; WEBER and WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA and BHATTACHARYA, 2020), it was observed that 'inventory' topic received little attention from the scientific community. This is contradictory, since inventory management has been considered the most critical challenge in omni-channel retailing (ARSLAN et al., 2020; SAHA and BHATTACHARYA, 2020). Furthermore, inventory-related issues such as demand fluctuations (HÜBNER et al., 2016c; KEMBRO et al., 2018), mismatch between replenishment forecasts and inventory holding (WOLLENBURG et al., 2018), balancing between demand and capacity (KEMBRO et al., 2020), inventory record inaccuracy (MELACINI et al., 2018; WOLLENBURG et al., 2018) and reinsertion of canceled order products (BERNON et al., 2016; SAHA and BHATTACHARYA, 2020), are also mentioned as omni-channel logistics challenges. The increasing returns issues, such as lack of data on returned items (WEBER and WEISS, 2018), restocking the returned product (BERNON et al., 2016; DE BORBA et al., 2020), difficulty of forecasting the returned volume (DE BORBA et al., 2020) and misplacement of products (DE BORBA et al., 2020), are also mentioned as inventory-related issues, as they influence the inventory level balance. With this in mind, and considering that inventory availability is a critical issue for the omni-channel retailing, especially store-based omni-channel retailing (HUBNER et al., 2016b), the out-of-stock risk was the risk phenomenon chosen.

In doing so, although four different research questions on inventory and capacity management dimension were formulated (see Appendix C), the risk of out-of-stock in a store-based omni-channel seems to somehow involve all of them. As a result, a more comprehensive research question was formulated to serve the purpose of the dissertation.

What are the out-of-stock logistics risks in store-based omni-channel retailing?

The above research question was then transferred to the introduction of this dissertation, and drove the formulation of the main and specific objectives.

3 BACKGROUND ON OMNI-CHANNEL LOGISTICS RISKS

The market is changing. This change influences the way business relationships happen, mainly the B2C. The proximity of retail to the consumer market affects it even faster and more impactfully. As retail makes the consumer life more comfortable and practical, it takes their responsibilities, increasing its workload and the complexity of its operations. One of the management areas that were most influenced by these changes is logistics management (XING et al., 2011). It is relevant to understand not only the supply chain context in which omni-channel retail is inserted, but also how logistics operates in that context. Another demand is the clarification of the concept and composition of a risk, as well as how it is managed in supply chains.

Hence, the purpose of the background on omni-channel logistics is threefold: first, describing the context of omni-channel retailing, from the macro-environment to the specific environment; second, describing the phenomenon of omni-channel logistics and its main processes; finally, clarifying the concept and composition of risk and how it is managed.

3.1 THE RETAIL CONTEXT

In general, a supply chain is composed of one or more distribution channels, and the designation of "retailing" makes more sense within the distribution channel context than in the supply chain context, although the former is inserted in the latter. The following sections define these relationships.

3.1.1 Supply Chain

There is not exactly a consensus in the literature about the supply chain concept. In its narrowest sense, the supply chain refers to a company's first-tier relationships. However, in its broadest sense, the supply chain becomes a large and complex structure. According to Mentzer et al. (2001, p.4), a Supply Chain (SC) is:

> "… a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer".

Since for Christopher (2005, p.17), the supply chain concept is broader, where:

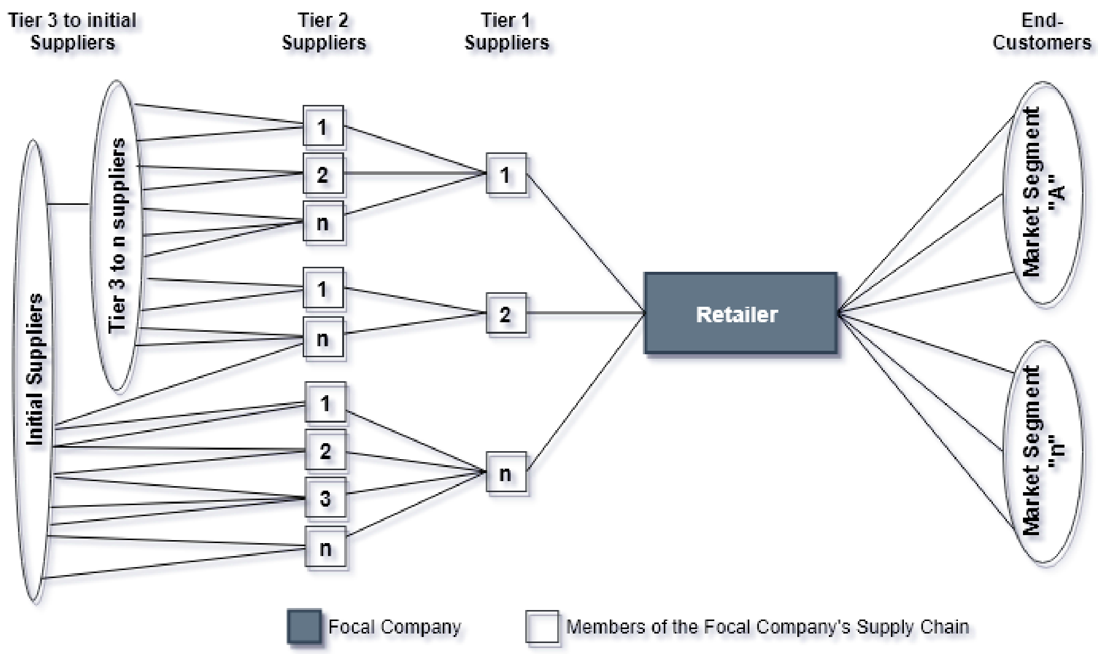
> "… the supply chain is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer".

On the other hand, for Ayers and Odegaard (2017, p.9), supply chains are:

> "Product life-cycle processes comprising physical, information, financial, and knowledge flows whose purpose is to satisfy end-user requirements with physical products and services from multiple and linked suppliers".

With the product life cycle, the authors refer to the sales life cycle and the useful life cycle. The flow of knowledge, on the other hand, considers that, in order to design processes in supply chains, coordination of intellectual input is necessary. For Lambert (2008), “any combination of processes, functions, activities, relationships, and pathways along which products, services, information, and financial transactions move in and between enterprises”, is a supply chain. For the author, a supply chain is observed from the perspective of a specific firm (focal firm) and its supply chain will look different depending on the firm position in it. Figure 3.1 shows the network structure of the retail supply chain.

Figure 3.1 – Retail Supply Chain Network Structure



Source: adapted from Lambert et al. (1998a, p.3)

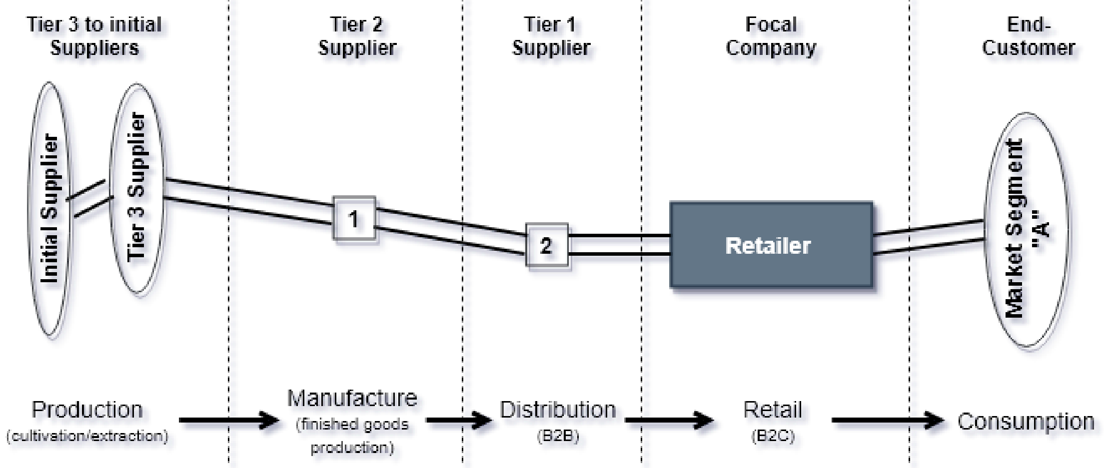
Each tier, also called echelon, represents the level of distance and intermediation from that position to the focal company. Considering a retailer supply chain (Figure 3.1), the tier 1 can be composed of original equipment manufacturers (OEMs), distributors/wholesalers, and supply chain service providers. The latter includes warehouse operators, process and information technology providers, consultants, transportation companies, trading companies, and customs brokers (AYERS and ODEGAARD, 2017). On the opposite side of Figure 3.1 are the end-customers. As this grouping is composed of a large number of individuals with specific and heterogeneous characteristics, they are grouped in blocks, called segments. Each segment shares similar buying habits and product preferences and needs (AYERS and ODEGAARD, 2017).

3.1.2 Distribution Channel

According to the CSCMP - Council of Supply Chain Management Professional - (VITASEK, 2013, p.63), the distribution channel is a set of “one or more companies or individuals who participate in the flow of goods and services from the manufacturer to the final user or consumer”. Note that this concept is similar to the supply chain concept defined by Mentzer et al. (2001). The similarity between the concepts of "distribution channel" and "supply chain" is not a mere coincidence. This is because a "supply chain is built by distribution channels" (NOVAES, 2007, p.124). A distribution channel is a set of companies with different roles, in an effort to produce and deliver a certain product to a certain consumer market. In doing so, for each product or product line of a company, there may be one or more distribution channels in its supply chain. Therefore, it is strategic to define the path through which a product will competitively reach the market, using the best possible combination of distribution channels (NOVAES, 2007). Figure 3.2 shows an example of a specific “distribution channel” clipped from the focal retailer’s supply chain exemplified in Figure 3.1, as well as the roles of its elements.

Often, a company plays more than a distinct role in a distribution channel, characterizing “vertical integration”. Thus, a manufacturer, for example, can assume the distribution of its products in a channel, or even the role of the retailer when selling its product directly to the final consumer. This vertical integration can be “inverse” (or “backward”), when a channel component returns positions in the supply chain flow to perform them, for example, a retailer that has its distribution center to serve its chain store. On the other hand, if a channel component moves towards the consumer in the supply chain, the integration is "advanced" (or "forward"), for instance, a wholesaler or manufacturer that also sells products directly to the end consumer (LEVY and WEITZ, 2012; AYERS and ODEGAARD, 2017).

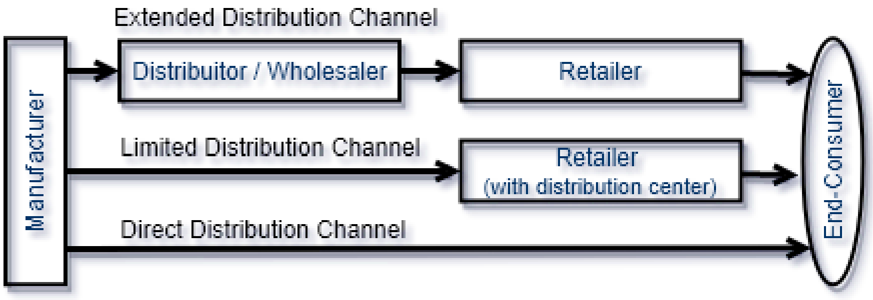
Figure 3.2 – Example of distribution channel clipped from a retailer's SC



Source: based on the Lambert et al. (1998a)

The position in the distribution channel used as a basis for determining whether vertical integration is reverse or advanced depends on the main activity/role with which the focal company identifies. Figure 3.3 shows the main possibilities for configuring a distribution channel.

Figure 3.3 – Different compositions of Distribution Channel



Source: Mattar (2011, p.47)

In the "extended channels" configuration, different companies play each of the different roles in the distribution channel, between industry and the end consumer. On the other hand, in a "limited channel" configuration, both the manufacturer may be playing the role of the distributor (advanced integration) and the retailer may have a distribution center and be structuring its physical distribution (reverse integration). Note in Figure 3.3 that the "direct channel" configuration is an advanced integration, where the manufacturer strives to distribute and sell his/her own product to the final consumer, thus playing both the role of distributor and retailer.

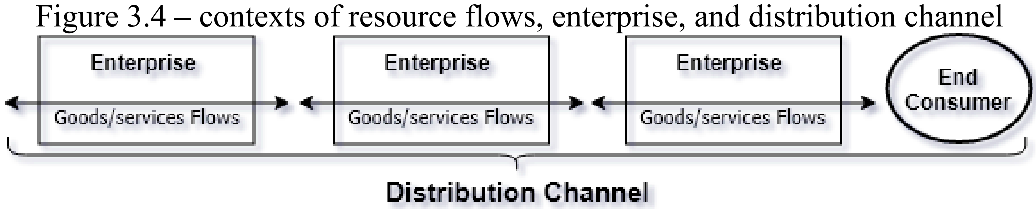
However, independently of the vertical integration level of a distribution channel, its main roles (raw material production, manufacturing, distribution, and retail) need to be performed by one or more of its components. Therefore, vertical integration is about accumulating roles and not eliminating them. In other words, the components of the distribution channel can be eliminated, a strategy called disintermediation (AYERS and ODEGAARD, 2017), but their roles cannot.

The practice of "retail activity" is a role played by a company, which does not necessarily have retail as its main activity. Therefore, a wholesaler can operate serving small retailers, but can also sell directly to the end consumer (a wholesale club), which characterizes an advanced integration. By the same token, a retailer can perform the role of the distributor from the manufacturer to its retail stores, by its distribution centers (LEVY and WEITZ, 2012).

3.1.3 The Enterprise Environment

Although each one of the distribution channels that compose a certain supply chain presupposes a collective concept, each company inserted in this context usually acts as a business entity, an individual enterprise, i.e., with its objectives and methods. Given the purpose of this work, what is the most appropriate definition for "enterprise"? According to Gonçalves (2000a), an enterprise is a large processes collection, which uses the resources of the organization in order to offer objective outcomes to its customers. This concept corroborates the concept of Porter (1998, p.36), where "every firm is a collection of activities that are performed to design, produce, market, deliver, and support its products". Since a supply chain involves flows of products, services, information, and financial resources (MENTZER et al., 2001), which flow throughout its distribution channels, so do its constituent companies.

Figure 3.4 – contexts of resource flows, enterprise, and distribution channel



Source: by the author (2021)

In doing so, resource flows are inherent in the enterprise's operation to generate its outcomes. Thus, it can be said that a "resource flow" range, an "enterprise", a "distribution channel" and a "supply chain", are different extensions of the business context, which aim, in the end, to meet the needs of their customers. See Figure 3.4.

In other words, a set of resource flows (and not just them) constitutes an enterprise, a set of enterprises constitutes a distribution channel and, finally, a set of distribution channels constitutes the supply chain of a certain focal company (the enterprise). Therefore, this focal company participates, in one way or another, in each of the distribution channels of this (its) supply chain.

3.1.4 The Retail Business

Retail is a set of business activities in an effort to sell goods or services to end consumers, for personal or family use or consumption (MATTAR, 2011; BERMAN et al, 2018). According to the Council of Supply Chain Management Professional (VITASEK, 2013, p.166), a retailer is “an individual or organization which purchases products from a manufacturer or distributor and resells them to the ultimate consumer.”

However, a retailer is an organization whose main activity is retail. They can also play other roles in the distribution channel as previously explained, in an inverse vertical integration movement. Retail is not something new. Since bartering, in the early days of humanity, the trade (exchange) of goods and services has been practiced. Since the emergence of general stores in the 18th century in small towns, commerce expanded in the middle of the 19th century to the entire civilized world. It did not take long for intermediaries to supply small retailers, i.e., wholesalers, and then the mass-selling trade, called discount store appeared. In the US, in 1912, the first store where customers could help themselves, the Great Atlantic and Pacific Tea Company grocery stores were opened. This concept, called self-service, became popular after the Great Depression and gave rise to the model that is currently used by most retail stores, such as supermarkets, department stores, among others (MATTAR, 2011).

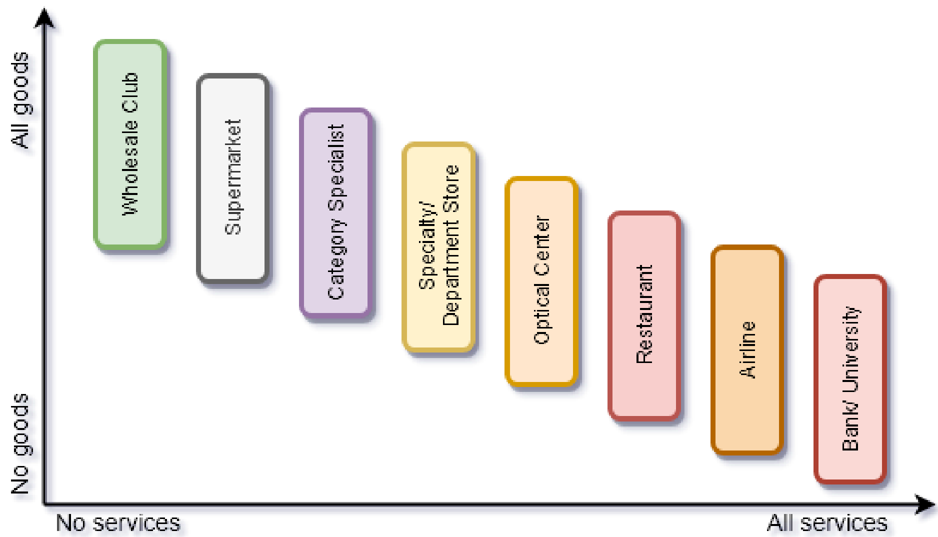
On the one hand, retail activities add value to products and services and comprise the last stage of distribution channels in a supply chain in delivering these to end consumers (BERMAN et al., 2018). This value is based on meeting some consumer needs that extend beyond just the physical product, to cover broader questions such as convenience, delivery, financing, information, guarantees, service, etc. (MATTAR, 2011). As a specialist in the distribution of goods and services to the end consumers, retail makes the life of manufacturers and producers easier through four utilities offered to consumers: assortment, quantity, location, and time. For Mattar (2011, 'Presentation' section), "retail is complex and covers all areas of administration, excluding only Production".

Running a retail business can be just as or more complex than running a manufacturing business. This is because a retailer performs a large number of commercial activities, raises capital for investment, acquires goods and services, uses complex management and accounting information systems, manages warehouses and distribution systems, designs, and develops new products and even performs marketing activities, such as advertising, promotion, sales force management and market research (LEVY, 2012).

For Ayers and Odegaard (2017), successful retailers are experts in three things: identifying their target market segment offerings, designing and developing an effective retail format, and establishing a sustainable competitive advantage. According to Levy and Weitz (2012), every retailer provides some degree of service and goods for their customers, and the combination between them is a characteristic of the retail format

In terms of participation of the service in the business, retail can be classified as full service, limited services or self-service. Self-service retailers include not only these but supermarkets, which depend on their size, mixed products, price level, and the number of checkouts.

Figure 3.5 – Continuum of merchandise and services retailers



Source: Levy e Weitz (2012, p.49)

These can be classified from convenience stores, to superstores, hypermarkets, or supercenters. Figure 3.5 shows some examples of retail formats with different combinations of services and goods. The further left on the scale in Figure 3.5, the greater the share of goods as a sale element to the end consumer. As it moves to the right closest to pure service is the retail format. For instance, wholesaler sales predominantly goods, on the other hand, banks sales predominantly services. This understanding is relevant since services have characteristics that make them more complex to manage, such as intangibility, simultaneous production, and consumption, perishability, and inconsistency (LEVY and WEITZ, 2012).

Regarding the existing sales channels, retail can be classified as physical retail - such as stores, stalls, kiosks, and newsstands - or retail without a physical store – such as direct sale by consultants, vendors, catalogs and virtual media, such as mobile and internet for example (MATTAR, 2011). To thrive today, a retailer needs a good strategic plan and a willingness to adapt (BERMAN et al, 2018). It is assumed that continually moving to meet the latest consumer needs is essential for the retailer, for this reason channel integration alternatives have been used. The next section explores this issue further.

3.1.5 RETAIL CHANNEL STRATEGIES

A channel is the means by which a retailer accesses a customer, whether for sale or delivery (LEVY and WEITZ, 2012). It works as a contact point that provides two-way communication, allowing the firm and customer interaction (VERHOEF et al, 2015). The most common and used retail channel around the world is the traditional retail of physical stores, also known as brick-and-mortar (BM). However, with the internet, a new customer service channel emerges, the online channel (MATTAR, 2011). The use of the internet- enabled "electronic links between dispersed sources of information, the enhanced collection and use of real-time data, the replacement of inventory with information, and the changing of traditional tasks and roles in the distribution channel" (BURT and SPARKS, 2003, p.276).

3.1.5.1 Single Channel Retail

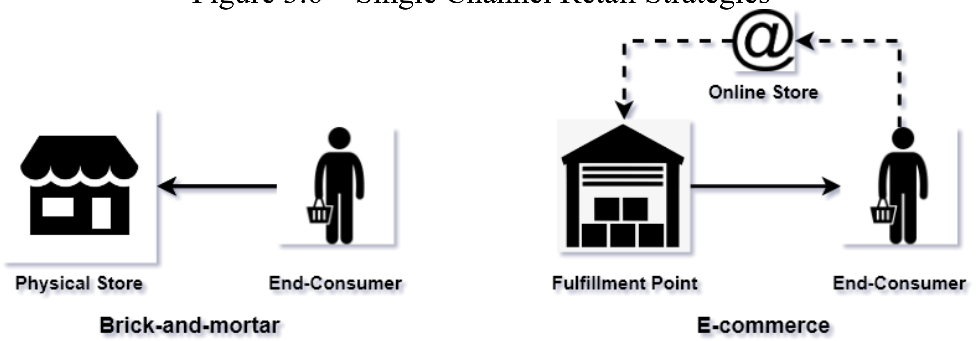
Initially, it was believed that the internet would meet customer needs only with standardized products. However, companies like Zappos shoes solved this issue by sending the product to the customer along with returns documentation to facilitate it, as needed, with the minimal inconvenience (AYERS and ODEGAARD, 2017). This type of solution popularized and established online sales as a type of sales channel that has come to stay. Although the most-used channel is still the physical store, the retail without stores, such as the internet, catalog, direct mail, direct sales, television, and automated retail, has been increasing its participation rapidly.

Nevertheless, buying in a physical store has some advantages for the consumer when compared to buying online, such as (LEVY and WEITZ, 2012):

- *touching and feeling products;*
- *accessing personalized services;*
- *reduction of dissatisfaction risk;*
- *having the immediate satisfaction of obtaining and possessing it;*
- *enjoying social and entertainment experiences;*
- *checking different alternatives for your needs;*
- *being able to pay in cash.*

When a retailer operates with a single channel, it is either an exclusive BM player, using only physical stores, or it is a pure online player, using online environments to sell and fulfillment points for shipping the orders (HUBNER et al, 2016a). See Figure 3.6.

Figure 3.6 – Single Channel Retail Strategies



Source: by the author

This uniqueness facilitates the management of the business, allowing for greater specialization and focus for managers.

3.1.5.2 Multichannel Retail

According to Levy and Weitz (2012), when realizing that online sales were gaining market share, the exclusive BM retailers saw the implementation of an online channel parallel to their traditional business some benefits such as:

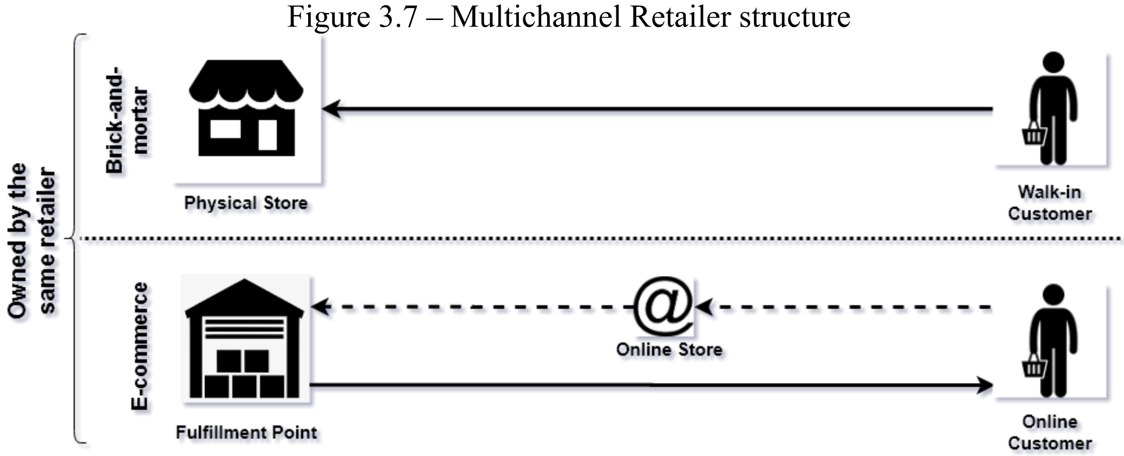
- *opportunity to overcome limitations of the primary channel;*
- *increased customer satisfaction and loyalty;*
- *use of the electronic channels as a valuable source of information on customers' buying behavior;*
- *opportunity to enter economically in a new market and building a base to obtain strategic advantage.*

Like BM retailers, pure online players realized that they could benefit from the advantages perceived by the customer when shopping in physical stores, as previously mentioned, to gain market share. This strategy of using more than one sale channel to the end consumer is called multichannel retailing (LEVY and WEITZ, 2012).

However, multichannel is not a new strategy. For example, Sears launched its online channel in 1998 but began with mail-order sales in 1886, opened a physical store in 1925 and a gift registry kiosk in 1996. When a retailer adopts a multichannel, it needs to decide whether or not to integrate these channels, and to the degree to which this will occur (CAO, 2014).

However, the apprehension of overlapping target segments and the consequent cannibalization between them, made the multi-channel retailers decide to operate them and offer them separately (LEVY and WEITZ, 2012; CAO, 2014), as well as other challenges such as the distribution format, information systems and pricing (LEVY and WEITZ, 2012). An example of a multichannel retailer structure is presented in Figure 3.7.

Figure 3.7 – Multichannel Retailer structure



Source: by the author

Often, multichannel retailers were once single players who decided to implement a multiple channels strategy (HUBNER et al, 2016a).

3.1.5.3 From Multichannel to Omni-channel

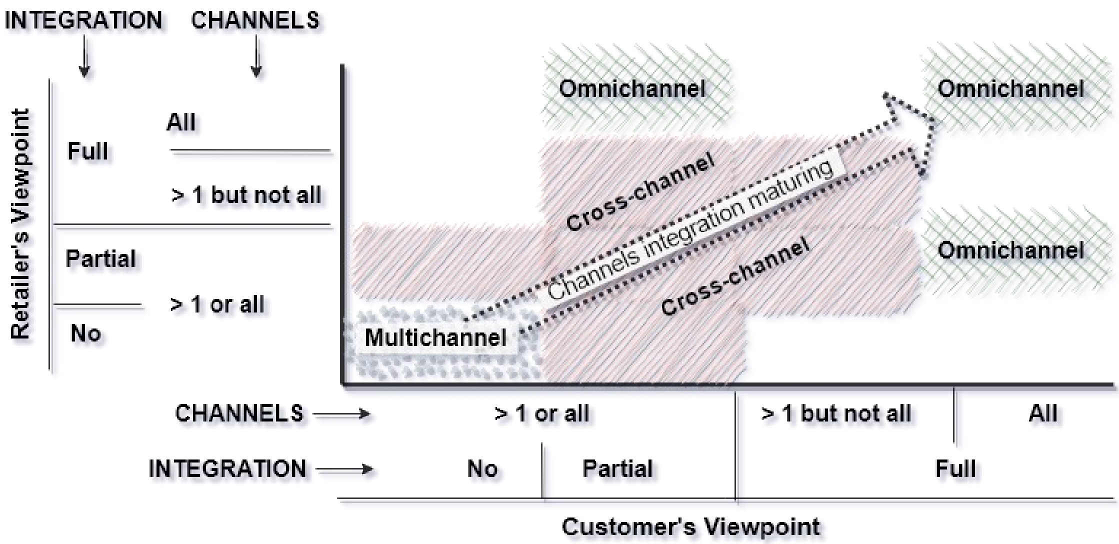
Driven by technological development and digital disruption, the demand for integrated channel solutions emerges, which is further accentuated with the power of mobile connection (SIMONE and SABBADIN, 2017). Seeking to satisfy this demand and taking advantage to increase its competitiveness, many retailers started offering several touch points with the customer, operating simultaneously physical and online stores, a strategy which has been called omni-channel. (BERMAN et al, 2018). The literature usually treats the multiple channel strategies at two extremes. At one extreme is the multichannel strategy, where a retailer has more than one channel but manages and offers them to the market separately (as seen in previous section). At the opposite extreme is the omni-channel strategy, where the retailer fully integrates the management and offer of these channels, in order to obtain efficiency gains and provide a unique customer experience (BECK and RYGL, 2015).

However, the reality of the market are fragmented channel scenarios, which use the channels integration according to their possibilities and conveniences (BECK and RYGL, 2015). In addition, the channels integration "goes through different stages in its level of interconnection and process integration" (HUBNER et al, 2016a). Therefore, there is a gap between the total integration proposed by the omni-channel and the total separation of channels proposed by the multichannel (BECK and RYGL, 2015).

In order to understand the different types of channel integration, Beck and Rygl (2015) proposed a taxonomy of multiple channel retailing, which classifies them according to two dimensions: whether channel interaction can be triggered by the customer, or is controlled by the retailer, and how many and what channels are considered. For the authors, there is an intermediate connection between multichannel and omni-channel, called cross-channel. Considering the two faces of the channel integration, i.e., from customer and retailer viewpoints, a cross-channel has at least one or both partially integrated and, although fully integrated, not all retailer's channels participate in this. From this perspective, in a multichannel, neither face is integrated. On the other hand, in the omni-channel, all retailer's channels have at least one fully integrated face and the other at least partially integrated. Figure 3.8 shows a summary the Beck and Rygl’s multiple channel taxonomy.

An "OC maturity" means that the company has reached "a certain ability to integrate and coordinate operations among channels and, thus, a certain ability to provide customers a seamless shopping experience" (MARCHET et al., 2018, p.440).

Figure 3.8 – Integration maturity of multiple channels

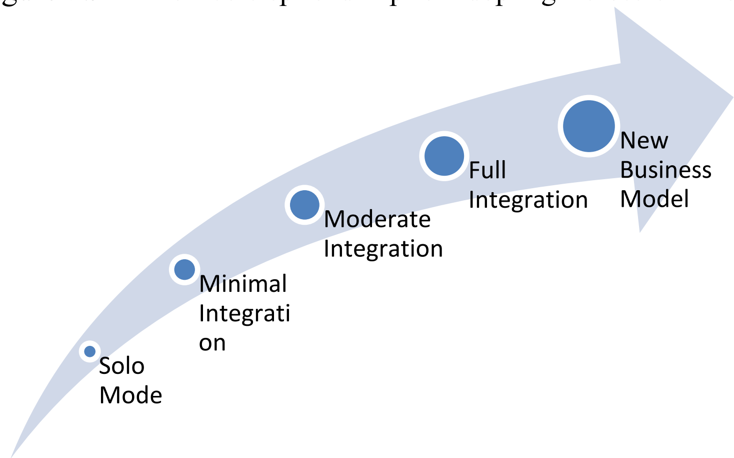


Source: adapted from Beck and Rygl (2015, p.175)

With this in mind, and assuming that a company desires and/or needs to implement an omni-channel strategy, there is a maturity path to follow until it can do so (see Figure 3.8). However, omni-channel strategy is not necessarily a strategy that brings better results for all companies that implement it, since the effort to become omni-channel can be more costly than its benefit. For this reason, it is assumed that it can be strategic to adopt a certain intermediate position of integration, due to the company and market characteristics (BECK and RYGL, 2015). Cao (2014) also addressed the multiple channels integration level, where the author outlined a five-step roadmap for adopting a cross-channel strategy. Figure 3.9 shows his roadmap for this purpose.

The first stage, called "solo mode", corresponds to multichannel strategy, with more than one channel operating, but independently. The second and third stages, named "minimal" and "moderate" integration, respectively, are in the cross-channel scope established by Beck and Rygl (2015), with partial integrations. The fourth stage, named "full integration", corresponds to the omni-channel strategy reached by channel alignment and organizational restructuring. The fifth and last stage, which is considered the culmination of the evolutionary process of integrating channels according to the author, means redefining the role in the whole value chain, changing profit formula, or co-creating value with other stakeholders.

Figure 3.9 – The five-step roadmap for adopting a cross-channel strategy



Source: Cao (2014, p.71)

On the other hand, Hübner et al. (2016a) advocated the idea that there is no single best practice valid for every market situation. Rather, the different omni-channel distribution concepts must be known to apply a context-specific distribution model. In this regard, they divided the omni-channel distribution into forwarding and backward distribution and developed a distribution typology for each of them. The forward distribution typology is classified into two archetypes, according to dispatching locations (DC or store of the retailer, and supplier's DC) and the customer reception (store delivery, store pickup, and home delivery). These two archetypes combined, generate six different types of forwarding distribution. The omni-channel backward distribution typology is classified into two archetypes, according to return mode (carrier, express, and parcel providers (CEP) return, and store return) and return processing locations (distribution center, specialized returns center, and store). Combining these two archetypes, they found five different types of backward distribution. Thus, as the retailer gains more experience, the company is structured according to the most appropriate strategy. Table 3.1 presents the concepts of the three different integration levels of multiple channels, according to some of the main authors. However, adopting an omni-channel strategy also presents some challenges. Some of them, according to Simone and Sabbadin (2017), are:

- *customer centricity;*
- *change in channel management;*
- *investment, development and implementation of technology;*

- *channel integration;*
- *optimization of the physical channel;*
- *payment systems.*

Table 3.1 – The concepts of the different integration levels of multiple channels

STRATEGY	**CONCEPT**	**AUTHOR(S)**
Multichannel	"A siled approach that operates channels as independent entities"	(SHEN et al, 2018, p.62)
	"Multi-Channel Retailing is the set of activities involved in selling merchandise or services through more than one channel or all widespread channels, whereby the customer cannot trigger channel interaction and the retailer does not control channel integration"	(BECK and RYGL, 2015, p. 174)
	"Using two or more marketing channels to reach one or more market segments and managing each channel separately."	(KIM e CHUN, 2018, p.9)
Cross-channel	Cross-channel is "the set of activities involved in selling merchandise or services through more than one channel or all widespread channels, whereby the customer can trigger partial channel interaction and/or the retailer controls partial channel integration"	(BECK and RYGL, 2015, p.175)
Omni-channel	Omni-channel is "the set of activities involved in selling merchandise or services through more than one channel but not all widespread channels, whereby the customer can trigger full channel interaction and/or the retailer controls full channel integration"	(BECK and RYGL, 2015, p.175)
	"An advanced version of multi-channel providing customers with an integrated shopping experience and enabling customers to move freely between the online (PC), mobile devices, brick-and-mortar stores, all within a single transaction process"	(KIM e CHUN, 2018, p.9)
	"A unified approach that manages channels as intermingled touch points to allow consumers to have a seamless experience within an ecosystem"	(SHEN et al, 2018, p.62)

Source: by the author (2021)

Since the context of omni-channel retail was explored, the next step was exploring the phenomenon of omni-channel logistics.

3.2 BUSINESS LOGISTICS

Since logistics manages the flow of materials, services and information, regardless of context, logistics activities get confused with supply chain management activities. The next topic presents the differences between them.

3.2.1 Supply Chain Management

If, on the one hand, "supply chain (SC)" is a set of entities directly involved in meeting the requirements of the end user (MENTZER et al., 2001; AYERS and ODEGAARD, 2017), on the other hand, "supply chain management" (SCM) is its systemic and strategic coordination with the purpose of improving its long-term performance (MENTZER et al., 2001). Therefore, in a sense of collectivity with common objectives.

However, in addition to common objective, a SCM seeks to add up the skills and specialties of each member. According to Council of Supply Chain Management Professional – CSCMP (VITASEK, 2013, p.187), SCM is "an integrating function with primary responsibility for linking major business functions and business processes within and across companies into a cohesive and high-performing business model".

However, SCM does not change the main objective of the SC, on the contrary, it only reinforces it. Thus, meeting the customer's needs remains SCM's main objective as well. In this regard, Christopher (2011, p.3) states that the SCM involves the "management of upstream and downstream relationships with suppliers and customers in order to deliver superior customer value at less cost to the supply chain as a whole". In doing so, the author highlights the most important SCM objective, delivering customer value. A more complete concept is provided by Mentzer et al. (2001, p.18), where SCM is:

> "…defined as the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."

For Stadtler (2005, p.578), SCM "represents a new focus on how to link organizational units to best serve customer needs and to improve the competitiveness", and not a new paradigm. In general terms, the "supply chain" is a set of distribution channels and their constituent companies. So, "supply chain management" is long-term management, channel by channel, to achieve the objectives of its stakeholders.

In the retailing context, Fernie and Sparks (2019) highlight that the retailer went from passive recipient of products to controller, organizer, manager of the supply chain and from production to consumption. And Levy and Weitz (2012, p. 248) complement by stating that "efficient supply chain management is important to retailers because it can provide a strategic advantage that increases product availability and an inventory turnover that produces a higher return on assets".

However, it is the SCM concept described by Ayers and Odegaard (2017, p.12) that best fits the model construction method proposed in this dissertation, where:

> "Supply chain management is the design, maintenance, and operation of supply chain processes, including those for base and extended products, for satisfaction of end-user needs"

As can be seen in section 5.3.1.1 of this dissertation, the design, management and operation of the processes are the foundation of the construction of the model.

3.2.2 Logistics Management

The same relationship described between ‘supply chain’ and ‘supply chain management’ can be said about ‘flows of goods and services’ and ‘logistics’. It means, logistics is not the flow, but its management. Therefore, logistics is a management area, as well as finance, people management, marketing, and production management.

Since, in its most generic concept, logistics is the management of the flow of goods and services, it can be applied in the most diverse contexts, as long as such flows exist, as well as their related information. A more comprehensive concept for logistics is provided by Christopher (2011, p. 12), who defines the supply chain logistics management as:

> “… the means whereby the needs of customers are satisfied through the co-ordination of the materials and information flows that extend from the marketplace, through the firm and its operations and beyond that to suppliers.

Similarly, the CSCMP (VITASEK, 2013, p.117) expands the concept of logistics to cover the entire supply chain, defining the logistics management as:

> "… that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements."

These two concepts assume that the flow of goods and services existing in each of the companies that make up a distribution channel are managed in an integrated manner, moving and positioning inventory along it (BOWERSOX, 2002). According to Bowersox (2002, p.4), "integrated logistics serve to link and synchronize the overall supply chain as a continuous process and is essential for effective supply chain connectivity"

However, a company has its management, called business management. This concept was also defined as a "value chain" by Porter (1998). In this sense, logistics is one of the primary activities, and it is managed in the business context, connected with the other primary activities and supported by a set of support activities. Therefore, business management is more comprehensive than business logistics, since it involves other activities, such as design, produce and, marketing, for example (PORTER, 1998).

Indeed, business logistics is an integral part of business management. In the business context, for example, logistics is responsible for the company's goods flow, from its suppliers and service providers, for its internal flow through the facilities, until reaching its customers (VITASEK, 2013). Thus, according to the CSCMP (VITASEK, 2013, p.25), the business logistics can be described as:

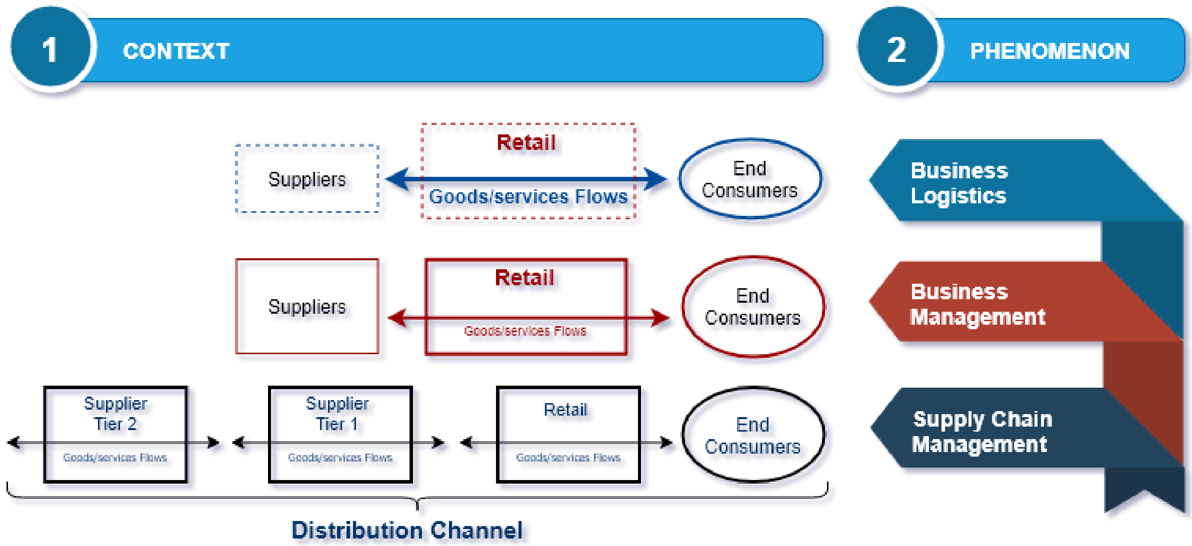
> "… the systematic and coordinated set of activities required to provide the physical movement and storage of goods (raw materials, parts, finished goods) from vendor/supply services through company facilities to the customer (market) and the associated activities-packaging, order processing, etc.-in an efficient manner necessary to enable the organization to contribute to the explicit goals of the company."

Summarizing, a similar relationship that the "goods and services flow", "enterprise", and "supply chain" concepts have, the "business logistics", "business management", and "supply chain management" also have. Figure 3.10 shows these three contexts and their interrelationships.

Observe in Figure 3.10 that supply chain management encompasses the management of a set of different entities (which join to form a distribution channel) and has the end-consumer at its end. Business management, in turn, covers the broad company management and its relationship with its first level suppliers and customers.

In the example in Figure 3.10, the enterprise is a retailer, so its customers are also the end-consumers. Finally, business logistics is responsible for managing the flow of goods and services in the context of business management. By integrating the logistics of each of the companies in the distribution channel, it can be called supply chain logistics management.

Figure 3.10 – The retail context and logistics management



Source: by the author

3.2.3 Retail and e-tail Logistics

It is common in the literature to find the expressions retail and e-tail to refer to traditional and online retail, respectively. Since there is a significant difference in the logistics used by each of them, the following sections explore them further.

3.2.3.1 Retail Logistics

Retail logistics differs from others mainly by the retailing positioning into the distribution channels. This gives it the supply chain connection status with end customers. As a result, as the customer has grown in importance to supply chains, the relevance of retail logistics in this context has also increased (LEVY and WEITZ, 2012). Other issues that differentiate retail logistics from other areas, mentioned by Berman et al. (2018), are: coordinating shipments from various suppliers, placing merchandise on the sales floor efficiently, coordinating customers' returns and, greater reliance on information systems.

Regarding the logistics components relevant for the fulfillment of the retail function, Gustafsson et al. (2006) mentioned five: storage facilities, inventory, transportation, packaging and, communications. The retailer's storage facilities might be warehouses, distribution centers, or simply the store's backroom. They are more and more "stock-less" and act as sortation hubs. Regarding inventory, managing its quantity and location is a key issue for retailers, due to its low-profit margin on the one hand and the risk of being out of stock on the other. Transportation management for retailers involves varying forms of transport, sizes of vehicles, and scheduling availability of drivers and vehicles, in addition to restricted store access times. Concerning packaging, retailers make use of both primary and secondary packaging, as well as transit packaging in their operation. Among them, only the primary is essential, so there is a continuous effort to reduce or replace the others with returnable handling packages. Finally, communication is increasingly strategic for the retailer, as every movement of merchandise is preceded by information, both supply and demand must be reliable.

3.2.3.2 E-tail Logistics

According to Fernie et al. (2010), online shopping brought some challenges to logistics, such as the substantial increase in the volume of goods to be handled, customers from different socioeconomic backgrounds, high logistics expectations of online shoppers, and rapid and reliable delivery demands. The authors also highlighted some differences between the distribution of traditional retail logistics and e-tail logistics, such as:

- *home-delivery, with orders for a small number of items, and use of large parcel carriers or mail order companies;*
- *DC orders are individually packaged, increasing the volume of the packaging, and taking up more space on vehicles;*
- *the increase of returned products flow requires a major reverse logistics operation, and a considerable effort in "refurbishment" of the returned product for re-sale online.*

This is due to last mile logistics responsibility transfer which in the BM made by the client, to the retailer in online retail. As a result, the complexity of logistics operations for online retailing increases (XING et al., 2011).

3.2.3.3 From Single Channel Logistics to Multichannel

Since there are differences between online retail logistics and BM retail logistics, whichever of the two business models that decide to become multichannel will need to adapt its logistics structure. For most BM retailers, home delivery is a new area. By the same token, managing physical stores is a new area for online retailers (XING et al., 2011). Although the management of the channels in multichannel strategies is done separately, the retailer needs to master the logistics management of both.

3.2.4 Omni-channel Logistics

To manage the logistics of different channels, albeit separately, it is already a challenge, integrating its processes and managing them together is an even greater challenge.

Table 3.2 – Differences between multichannel and omni-channel logistics

AREA	MULTICHANNEL	OMNI-CHANNEL
Inventory	Retailers have channel-separated inventories.	Retailers manage integrated inventory in one warehousing solution.
Picking	Retailers pick separately by channel.	More developed phase methods are applied for process improvements in cross-channel picking.
Assortment	Offering a more limited set of SKUs online than physical store.	More extensive assortment online complementing the offline.
Delivery	Retailers exclusively offer postal delivery for distance orders.	The delivery options are expanded through process integration to include pick-up services as well.
Return	Customers can only return online bought goods through the postal service.	The return of goods is not obligated to the channel where it was bought.
Organization	Operations responsibility for the channels is separate.	A single, integrated logistics unit with cross-channel coordination.

IT Systems	Retailer has separate and channel-specific ERP[1] systems.	Advanced solutions are based on a joint, cross-channel ERP system with real-time access.

Source: Hübner (2016a, p. 577)

According to Hübner et al. (2016a), seven logistics areas undergo significant changes in the transition process from multichannel to omni-channel: inventory, picking, assortment, delivery, returns, organization, and IT systems. Each of them is differently influenced but interconnected. Table 3.2 shows the differences between multichannel and omni-channel for each of these logistics areas.

Table 3.3 – Dimensions of multichannel and omni-channel logistics

DIMENSIONS	CATEGORY	*MULTICHANNEL*	*OMNI-CHANNEL*
Distribution network design	Distribution System	Inventory location, picking location.	Inventory aggregation, picking integration.
	Logistics facilities	Design of e-fulfillment center (automation degree, layout), design of return center.	Traditional warehouse restructuring, role of store, store restructuring.
Inventory and capacity management	Assortment planning	Assortment overlapping	Assortment integration
	Replenishment policy	Definition of stock level for online channel, integration of returns.	Aggregation of stock levels, integration of control policies, inventory visibility, channels priorities.

[1] "Enterprise Resource Planning (ERP) System: A class of software for planning and managing "enterprise-wide" the resources needed to take customer orders, ships them, account for them and replenish all needed goods according to customer orders and forecasts" (VITASEK, 2013, p.73).

Delivery planning and execution	Delivery service	Types of home delivery, velocity, time slot, price differentiation.	Alternative delivery modes (Click&Collect[2], Click&Drive[3]).
	Shipment policy	Routing for home delivery.	Joint delivery

Fonte: Melacini et al (2018, p. 408)

For Melacini et al. (2018), there are three dimensions of issues related to e-fulfillment and distribution in multichannel and omni-channel retailing: distribution network design, inventory and capacity management, and delivery planning and execution. Table 3.3 shows more details about them.

Since omni-channel logistics and its specific characteristics were defined, it was necessary to define the relevance of the inventory availability service as a logistics service for customers, which is presented in the next section.

3.2.5 Inventory Availability Logistics Service

Availability is one of four dimensions of customer logistics service in the omni-channel most commonly found in the literature, namely: availability, delivery timeliness, service quality, and returns ease.

According to Chopra and Meindl (2007, p.346), "the level of product availability, also referred to as the customer service level, is one of the primary measures of a supply chain's responsiveness". For Christopher (2011, p.31), it is evident that "there is no value in the product or service until it is in the hands of the customer or consumer". However, without stock availability, even intermediaries, such as carriers and logistics operators, cannot fulfill their commercial responsibilities, making it an essential element to meet customer demand (BOWERSOX and CLOSS, 2009). Therefore, any factor that affect the process of making products and services available to customer, impact the customer service in some way (CHRISTOPHER, 2011).

[2] Click&Collect - use of traditional stores as pick-up points of the online orders for customers. (MELACINI et al, 2018, p.405).
[3] Click&Drive - drive-through delivery mode where customers “can collect goods bought online very quickly and without leaving their cars” (MELACINI et al, 2018, p.405).

In this context, retailing has a key role, since it is the final logistics link to the consumer in the supply chains (FERNIE and SPARKS, 2018). The closer to the end the consumer is in the supply chain, the more deteriorated availability is (ECR Europe, 2003), which makes retail substantially dependent on its upstream partners. In essence, making the product or service ‘available’ is what the distribution function of the business is all about (CHRISTOPHER, 2011), and the "fundamental service offering provided by the retailer" (EHRENTHAL et al., 2014, p.43). As can be seen in the Table 3.4, basically availability depends on two elements: on-hand stock, and demand.

In BM retailing, the indicator of product availability is the "on shelf availability" (OSA), "situation where at least 1unit of undamaged stock is visibly accessible on the shelf by the shopper" (ECR ASIA PACIFIC, 2013, p.6).

Table 3.4 – Availability Concepts

AUTHOR(S)	AVAILABILITY CONCEPT
Bowersox et al. (2002, p.73)	"Availability is the capacity to have inventory when desired by a customer".
Levy and Weitz (2012, p.317)	"Product availability is defined as the percentage of the demand for a particular SKU that is satisfied" […] "… is also referred to as the level of support or service level".
Christopher (2011, p.51)	"Stock availability ... relates to the percentage of demand for a given line item (stock keeping unit, or SKU) that can be met from available inventory".

Fonte: by the author (2021)

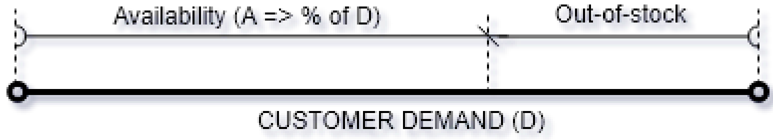
However, in online retailing, availability is information provided to the customer on the website, and its indicator is the "online availability" (OLA), where the product is displayed as (1) in-stock, (2) it can be bought at the retailer's partner, or (3) it can be purchased in the selected physical store of the same retailer. The latter two depend on whether the retailer has these options or not (CORSTEN and GRUEN, 2018).

However, in the online stores, since the customer has no contact with the physical product, the retailer can provide multiple order fulfillment points, as long as it meets the service deadline. Therefore, understanding the product's availability from the retailer's side depends on his/her strategy.

3.2.5.1 The Out-of-stock Concept

If on the one hand, availability is the positive side of meeting demand, on the other hand, out-of-stock (OOS) is its inverse, i.e., the unmet side of demand (ECR ASIA PACIFIC, 2013).

Figure 3.11 – Relationship between availability and out-of-stock



Fonte: by the author (2021)

Some of the main OOS descriptions found in the literature are presented in Table 3.5.

Table 3.5 – Out-of-stock descriptions

AUTHOR(S)	**OUT-OF-STOCK DESCRIPTION**
Bowersox et al. (2002, p.74)	"Being out of stock does not affect service performance until a customer demands a product".
Levy and Weitz (2012, p.250)	"A stockout occurs when an SKU that a customer want is not available".
ECR Europe (2003, p.13)	"An item is considered to be out-of-stock when it is not available from the point of view of the shopper".

Fonte: by the author (2021)

In a more specific description, in physical stores, a product is OOS when it "has shelf space and a price tag and it is not found in saleable condition anywhere in the store; not even 1 unit of undamaged stock, is visibly accessible on the shelf by consumers" (ECR ASIA PACIFIC, 2013, p.5)

On the other hand, a product is "not online available" (NOLA), "if it is (1) Out-of-Stock (OOS), i.e., the product page is accessible, but the retailer indicates that the item is physically unavailable for purchase, or (2) void, i.e., the product is digitally inaccessible because retailers have suppressed the product page for commercial or technical reasons" (CORSTEN and GRUEN, 2018, p.2).

According to Trautrims et al. (2012), the studies about OOS have focused on two main perspectives: customer behavior and supply chain flow. The customer behavior "investigates how consumers or retailers respond to OOS", while the supply chain flow "considers where OOS are caused and how product OSA can be improved from a logistics or inventory perspective". Therefore, the OOS situation is a point of intersection of logistics distribution and brand loyalty behavior. While distribution is concerned with OOS frequency, behavioral loyalty is concerned with the customer's reactions to OOS (KUCUK, 2008).

3.2.5.2 The Availability Attributes

Since product availability is the outcome of interest in this work, its exposure to certain threats can lead to OOS, it is necessary to further characterize it. Up till now, it is quite clear that "availability" means to have inventory when it is desired by the customer (BOWERSOX et al., 2002; LEVY and WEITZ, 2012; CHRISTOPHER, 2011). There is also widespread agreement among the scientific community that the main values added by logistics are the "time" and "place" values of the product availability to customers (for instance, BOWERSOX et al, 2002; BALLOU, 2006; LEVY et al., 2014; and CHRISTOPHER, 2011).

Therefore, in addition to "when" the customer desires (the time value), the product must also be "where" the customer desires, otherwise it will have no value (BALLOU, 2006). At the first moment, it seems obvious. However, as explained in section 4.1.3, in traditional retailing the product is sometimes in the store backroom not on the shelf, where the customer will search for it. Therefore, in BM retailing case, the "where" is a specific point, "on the shelf". On the other hand, if the product was replenished a couple of minutes after the customer searched for it on the shelf, it has also lost value to this customer.

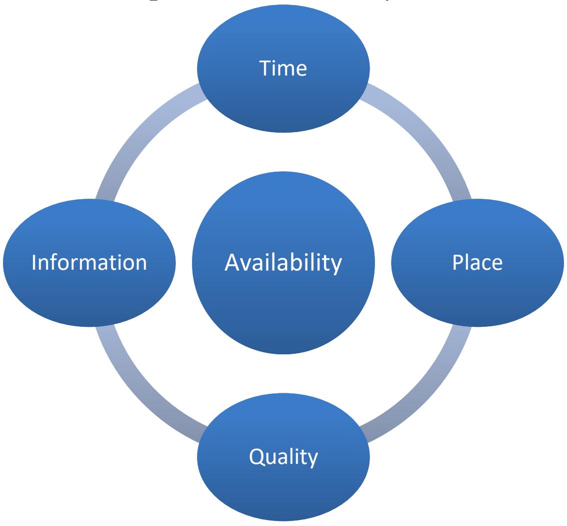
For Novaes (2007), in addition to the time and place values, there are two other logistics values, namely, the "quality" and "information" values. The quality value deals with logistics service quality, not the product quality that is a manufacture responsibility. Thus, the product demanded by the customer, and not a similar one, should be available, under suitable conditions, undamaged, and within the expiration date. Finally, the information value means the traceability of the product's position in the process. Therefore, logistics issues such as inventory visibility and accuracy, which are so important in omni-channel strategies, are capabilities generated by the information value.

As a result, availability can only be considered a valid result if it has at least the following three attributes met (ECR ASIA PACIFIC, 2013):

- ***On place*** *- product placed in the planned location, in an accessible and organized way;*
- ***On-time*** *- according to the planned process deadline;*
- ***In suitability*** *- no damage, no expired, with the suitable packaging.*

If any of the three attributes are not met, the availability as a relevant logistics service is strongly hindered. The fourth attribute, "information", is increasingly differentiating an omni-channel retailer from its competitors, expressed in terms of "product availability information" in the website and "order status information" provided to the customer. Figure 3.12 presents the four product availability attributes in the omni-channel.

Figure 3.12 – The four product availability attributes in the omni-channel



Fonte: by the author (2021)

The distribution centers (DCs) usually have more complete control through warehouse management systems (WMS). However, in the stores, having control through all stages of the logistics processes is something costly, even at the processes end as an outcome control. In face of that, any impediment, sourced inside or outside of a logistics process, that threatens the fulfillment of one or more product availability attributes is equally a potential out-of-stock risk cause.

3.3 RISK MANAGEMENT

There is little consensus in the literature regarding the risk concept. According to Yates and Stone (1992), there are three main reasons for this. First, people confuse the entire risk construct with the elements that compose it. Second, the diversity in the way the risk manifests itself and, finally, its feature of subjectivity.

One of the etymologies of the word "risk" is its origin from the Greek term "rhizikon", describing the need to avoid "difficulties at the sea". Adopted by Italian traders in the 14th century to designate the risk of losing their ships, the term expressed fear of loss or devaluation in business (HECKMANN et al, 2015).

Although there are several different definitions for risks, there are elements in common among them. The Royal Society's risk concept (WARNER, 1992, p.2), one of the most cited in the risk literature, defines risk as “the probability that a particular adverse event occurs during a stated period of time, or results from a particular challenge”.

However, what does an "event" mean? According to Oxford Dictionary (Oxford Advanced Learner's Dictionary, n.d.), an event is "a thing that happens, especially something important". Therefore, risk is not a trivial thing and it should have a certain relevance for the one who is observing it. For Rausand (2011), an event is something that occurs in a specific location and at a given time in the future. The occurrence of the risk event triggers its effects, for this reason, it receives other names, such as disturbance, disruption, disaster, or crisis (HECKMANN, 2016).

3.3.1 The Risk Perspectives

Most organizations, considers a negative connotation for the term "risk" (MITCHELL, 1995; CHRISTOPHER and PECK, 2004; VILKO et al, 2014). The Oxford Dictionary (Oxford Advanced Learner's Dictionary, n.d.), for example, describe risk as “the possibility of something ‘bad’ happening at some time in the future; a situation that could be ‘dangerous’ or have a bad result”. In the risk literature, several descriptions with a negative sense have also been found, such as:

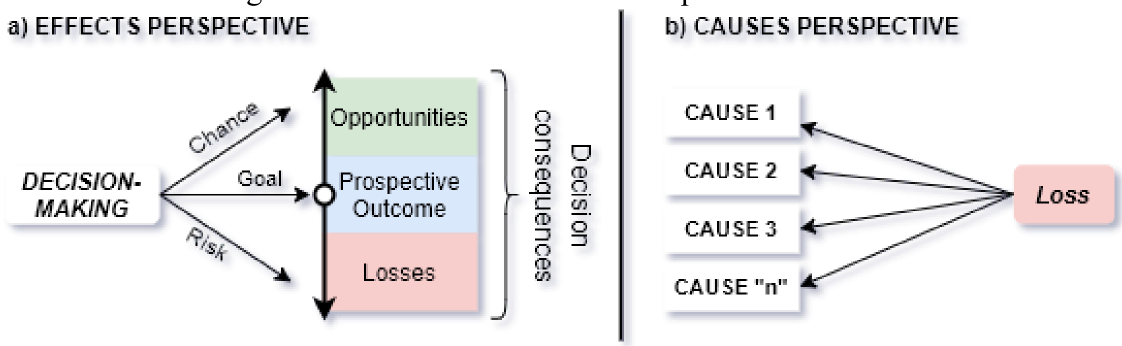
- ✓ *"... likely to be lost or damaged" (CHRITOPHER and PECK, 2004, p.5);*
- ✓ *“... an incident or failure to seize opportunities...” (RITCHIE and BRINDLEY, 2009, p.11)*
- ✓ *“... the chance that an unexpected event can harm an organization.” (WATERS, 2007, p.13)*

✓ *"... restricted to 'negative' consequences" (RAUSAND, 2011, p.45).*

For Hubbard (2020, p.110), for example, risk is "a state of uncertainty where some of the possibilities involve a loss, injury, catastrophe, or other undesirable outcomes, i.e., something bad could happen". However, Curkovic et al (2015, p.47) stated that "some risks if managed proactively may lead to a positive outcome for a firm", although vast majority of these firms focus on the negative outcomes.

According to Pfohl et al. (2011), there are two ways to observe risks: under causes or effects perspectives. When related to **causes**, risks are classified according to their sources, such as internal or external (MILLER, 1992). Therefore, the focus is centered on the negative variation of an outcome (loss) and seeks to understand its causes in order to manage them (PFOHL et al., 2011). On the other hand, when related to **effects**, the focus is centered on the consequences of a decision and the risk is not making the goal. In this perspective, both the positive and the negative variation of the outcome are a miss of the goal (PFOHL et al., 2011). Nonetheless, a positive miss of the goal may be desired and, then, considered an opportunity. Thus, "managers should not try to avoid risk, but to analyze it and work with it" (WATERS, 2007, p.77). That way, "a risky choice is one with a wide range of possible outcomes", which includes gains and losses (MITCHELL, 1995 p.117). For this reason, risk "can impact both adversely and positively" the direction and survival of a company (COOK, 2017, p.5). Figure 3.13 shows the effect and cause perspectives of the risk and their context.

Figure 3.13 – Effect and Cause Perspective of the Risk



Source: adapted from Pfhol et al. (2011)

By contrast, according to Aven (2003), when the risk outcomes can assume either favorable or unfavorable performance measures, the risk is called speculative. Conversely, when the risk outcomes are purely unfavorable, it is called pure risk. A further perspective is from Ritchie and Brindley (2009), where the risk is not assessed in terms of negative or positive, but on scale and probability of its result, and the trade-off between less desirable results and the opportunity to achieve desirable results is an attribution of the risk.

In light of the foregoing, it is possible to speculate that more conservative decision-makers will possibly use the perspective of causes to avoid the risk, while those who are riskier, the perspective of effects to guide their decisions. Thus, the approach used to manage risk, conservative or risky, can define its perspective and, consequently, the way companies set their goals.

3.3.2 The Risk Composition

According to Roberts et al. (2009), a more primitive composition had been defining risk as a function of the frequency and magnitude of the threat, which was later complemented by replacing magnitude with a broader concept, vulnerability. By contrast, in place of frequency, the concept of "hazard" has been used. Then:

$$Risk = f(vulnerability, hazard) \tag{3.1}$$

Hazard, in this sense, means the "probability that a particular threat occurs within a given period of time" (ROBERTS et al., 2009, p.166), therefore it also involves the concept of frequency previously used. Thus, risk is a function of vulnerability and hazard (BIRKMANN and WISNER, 2006; BAAS et al., 2008). However, other concepts such as probability and significance of loss (MITCHELL, 1995), likelihood and impact of a risk event (COLICCHIA and STROZZI, 2012), probability and consequence of a risk event (AQLAN and LAM, 2015) also have been used. Other authors have proposed "exposure" as an element external to "vulnerability" (see VILLAGRÁN DE LEÓN, 2006). However, the argument of the Cardona (2011, p.113) that "one cannot be vulnerable unless one is exposed" is consistent.

According to Waters (2007, p.25), probability "is a measure of likelihood, relative frequency or proportion of times an event occurs", and can be found by observation, where historical data are used as a source of information for an experimental model. So:

$$Probability = \frac{number\ of\ occurrences\ of\ the\ risk\ event}{number\ of\ observations} \tag{3.2}$$

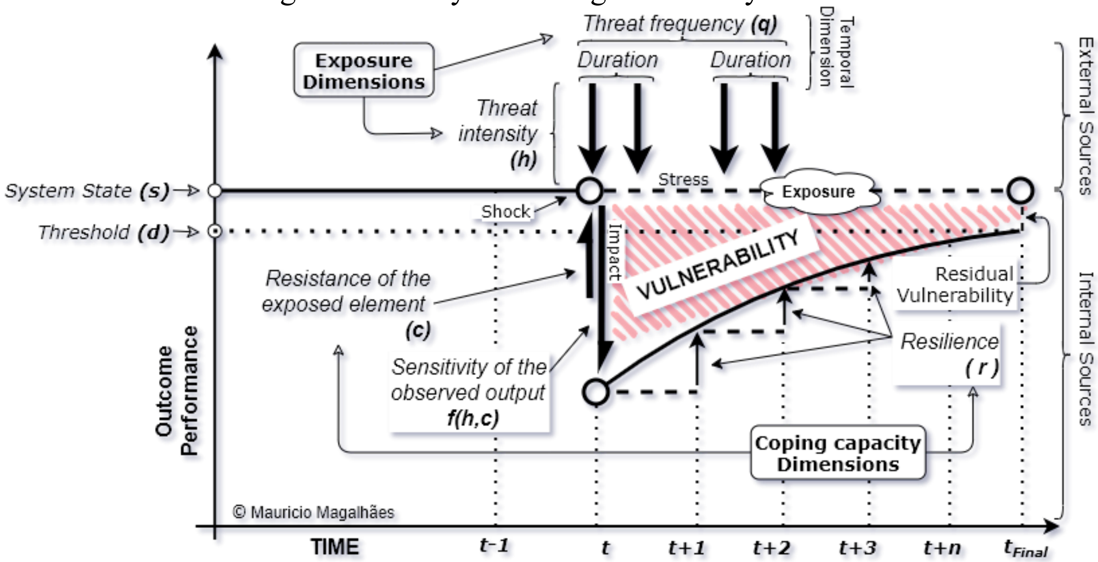
Due to the relevance of the vulnerability in the risk composition, its framework is better explored in the next section.

3.3.3 The Vulnerability Conceptual Framework

For Nguyen et al. (2016), the fundamental elements of vulnerable situation are: the system (subject of the analysis), the valued attributes of concern (the outcome), the hazard (which for the authors means the threat to the outcome), and a temporal reference (time period of interest and punctual or dynamic reference). Please note the Figure 3.14. For a better understanding of the conceptual framework, it was considered a hypothetical situation in which a system is exposed to a certain threat from the time "t". The system had been maintaining until the time t-1 a constant state of its result, was above its threshold.

Considering the estimated intensity of the threat (h) and the resistance of the system (c) at the time "t", that "sensitivity" is a function of these two variables (LUERS et al. 2003), the impact can also be estimated, generating a vulnerability state. From this point on, the system's resilience comes into play, which recovers part of the result at each new period.

Figure 3.14 – System being attacked by a threat

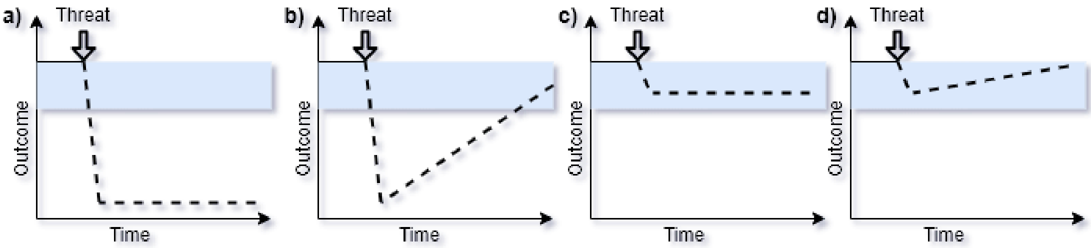


Source: based on Bogardi (2006) apud Villagrán De León (2006, p.51), and Asbjørnslett (2009, p.17)

However, if the threat persists, i.e., if it lasts for more than one unit of time, the system remains exposed to the threat. In doing so, the state of vulnerability at time "t+1" is again a function of the intensity of the threat and the resistance of the system at “t+1”, plus the residual vulnerability from time “t”, which is influenced by the resilience of the system.

The possibility of occurrence of the threat is the essence of the state of vulnerability. In the case of the possibility of a threat at any time, it means that the system is in a constant state of vulnerability. Figure 3.15 shows four different situations involving coping capacity of the system, i.e., different combinations of resistance and resilience of the system.

Figure 3.15 – The resistance and resilience combinations



Source: based on Mumby et al. (2014, p.24)

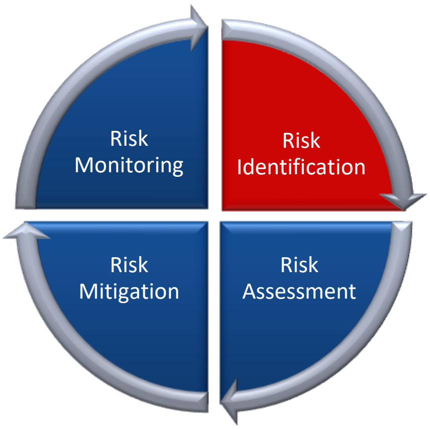
In scenarios "a" and "b", the system offers very low resistance under threat. “If resistance is low then even a small hazard stress can lead to systems failure” (PELLING, 2003, p.48). On the other hand, in scenarios "c" and "d" it offers high resistance. By contrast, the system has no resilience in scenarios "a" and "c", however, it offers high resilience in scenarios "b" and "d". In a perspective in which the vulnerability is an undesired situation, the worst scenario is the "a" scenario, where the system was heavily affected and failed to recover. In contrast, scenario “d” is the best scenario, offering both high resistance and resilience, recovering fully.

Pelling (2003, p.49) reinforces that resilience "is a product of the degree of planned preparation undertaken in the light of potential hazard, and of spontaneous or premeditated adjustments made in response to felt hazard".

3.3.4 Supply Chain Risk Management

Supply Chain Risk Management (SCRM) means managing risks in a supply-chain context and, according to Waters (2011, p.75), "risk management is the process for systematically identifying, analyzing and responding to risks throughout an organization". Indeed, for most researchers on the topic (such as WU and BLACKHURST, 2009; WATERS, 2011; KERN et al., 2012; HO et al., 2015; VISHNU et al., 2019), there are at least four core stages of the SCRM: risks identification, assessment, mitigation, and monitoring. The first three, aim to generate a planned response to each relevant risk, while the fourth generates control feedbacks, characterizing the Supply Chain Risk Management (SCRM) is a cyclical and continuous system. Figure 3.16 shows the SCRM cycle.

Figure 3.16 – The four core stages of the Supply Chain Risk Management



Source: by the author (2021)

The risk identification stage examines the logistics processes, "defining the separate activities and their relationships, and systematically studying these to find areas of risk" (WATERS, 2011, p.89). This involves identifying all potential threats and all relevant vulnerabilities (KERN et al., 2012). The output from this stage is a list of the relevant risks (WATERS, 2011).

The risk assessment stage, in turn, receives the list of relevant risks generated as output of the risk identification stage, with the purpose of ascertaining the vulnerability and the probability of each threat occurrence (WU and BLACKHURST, 2009; WATERS, 2011; KERN et al., 2012; Ho et al., 2015). For this, the characteristics of the threats involved are investigated, such as intensity, duration, and probability of occurrence, as well as the coping capacity of the system exposed to the threat.

On the other hand, the risk mitigation stage receives a list of priority risks from the previous stage, the risk analysis stage, and investigate the effective ways of minimizing supply chain risks (WATERS, 2011; KERN et al., 2012; HO et al., 2015). The purpose is "generating and considering alternative scenarios and solutions, judging their respective merits, selecting solutions and undertaking the implementation" (WU and BLACKHURST, 2009, p.16). The main responses to priority risks are the prevention (WATERS, 2011), the mitigation, and the contingency plan (WATERS, 2011; KERN et al., 2012).

Finally, the risk monitoring stage proposes to control the risk and analyze the effectiveness of the applied mitigation strategy, as well as adjust the measures if necessary (WU and BLACKHURST, 2009; WATERS, 2011; KERN et al., 2012). The purpose is to identify abnormal data and determine whether a warning should be issued (HO et al., 2015).

4 THE OOS CAUSES AND OC LOGISTICS CHALLENGES

The purpose of this chapter is to reach the third and fourth specific objectives of this dissertation, i.e., to identify the main causes of "out-of-stock" in traditional and online retailing and to identify the main omni-channel logistics challenges. Identifying the causes of OOS is justified by the fact that no specific studies were found in the BP. In doing so, the OOS causes of traditional retail and the challenges of omni-channel logistics were used together to reframe OOS in the reality of this new context that is omni-channel retail. The findings in this chapter resulted in the "Out-of-Stock Causes by Source" list, shown in Appendix D, and the "Omni-channel Logistic Challenge Ranking" list, shown in Appendix B, which were used as a basis in Chapter 6.

4.1 OUT-OF-STOCK CAUSES CLASSIFICATION

In this study, it was necessary to investigate the customer behavior, in order to understand the customer responses to OOS and their consequences on the company's outcomes. However, the main focus was on OOS causes, in order to understand their interrelationships and paths to the OOS generation. The customer response, OOS consequences, and OOS causes are further explained in the next sections.

4.1.1 Customers Response

According to Ehrenthal and Stölzle (2013), the customer response to OOS has been investigated from different perspectives (such as cognitive, affective, behavioral, and aggregated), as well as its antecedents (for instance, brand, product/category, store, shopper, and situational).

Understanding consumer behavior in the face to out-of-stock allows alignment of merchandising and inventory management policies (ZINN and LIU, 2001). The main responses of BM customers to OOS found in the literature were: substitute product, do not buy, buy in another store, and delay the purchase. Table 4.1 shows the BM customer responses to OOS, as well as their sources.

Table 4.1 – BM customers responses to OOS

CUSTOMER RESPONSE		AUTHORS
Substitute product (Not specified)		Campo et al. (2000); Zinn and Liu (2001); McKinnon et al (2007); Huang and Zhang (2016); Frontoni et al. (2017)
	Substitute product brand	Peckham (1963); Emmelhainz et al. (1991); Gruen et al. (2002); McKinnon et al (2007); Fernie and Grant (2008); Fernie and Sparks (2018); Corsten and Gruen (2003); ECR Europe (2003); Sloot et al. (2005); Lambert et al. (1998b); Son et al. (2019)
	Substitute product size of the same brand	Peckham (1963); Emmelhainz et al. (1991); Gruen et al. (2002); McKinnon et al (2007); Fernie and Grant (2008); Fernie and Sparks (2018); Corsten and Gruen (2003); ECR Europe (2003); Sloot et al. (2005); Lambert et al. (1998b); Son et al. (2019)
Do not buy		Peckham (1963); Emmelhainz et al. (1991); Campo et al. (2000); Gruen et al. (2002); McKinnon et al (2007); Fernie and Grant (2008); Fernie and Sparks (2018); Corsten and Gruen (2003); ECR Europe (2003); Huang and Zhang (2016); Frontoni et al. (2017); Sloot et al. (2005); Son et al. (2019); Zinn and Liu (2001)
Buy in another store		Campo et al. (2000); Zinn and Liu (2001); Gruen et al. (2002); McKinnon et al (2007); Fernie and Grant (2008); Fernie and Sparks (2018); Corsten and Gruen (2003); ECR Europe (2003); Huang and Zhang (2016); Frontoni et al. (2017); Sloot et al. (2005); Lambert et al. (1998b); Son et al. (2019)
Delay the purchase		Campo et al. (2000); Zinn and Liu (2001); Gruen et al. (2002); McKinnon et al (2007); Fernie and Grant (2008); Fernie and Sparks (2018); Corsten and Gruen (2003); ECR Europe (2003); Huang and Zhang (2016); Frontoni et al. (2017); Sloot et al. (2005); Son et al. (2019)

Source: by the author (2021)

According to Fitzsimons (2000, p.264), there are two primary forces that influence customers response to OOS:

- *the degree to which a consumer was personally committed to an out-of-stock alternative; and*
- *changes in the difficulty of making a decision due to a choice set shift caused by the out-of-stock.*

The substitution of the OOS product may involve a different size of the same item or a different product, whether from the same brand or not, that performs at or above the substituted product (LAMBERT et al., 1998b). Some authors (such as CAMPO et al., 2000; ZINN and LIU, 2001; McKINNON et al., 2007; FRONTONI et al., 2017) did not specify the type of substitution. Probably because understanding the involvement of the brand in the substitution process is of greater interest to the manufacturer, and not so much to the retailer.

Although a part of customers who face an OOS delay their purchase or substitute the product, they “are substantially less likely to return to the same store on the next shopping trip” (FITZSIMONS, 2000, p.264). This probability, which starts at 31% in the first moment, reaches 69% in the third experience, and can permanently keep away the customer from the store (ECR EUROPE, 2003). According to Gruen et al. (2002), the number of out-of-stock items on the customer's shopping list and the frequency with which they occur, influence the customer to change stores.

4.1.1.1 Online customer responses to OOS

Most of the extant research on OOS "is focused on the traditional offline store context". However, the online service has its characteristics, such as "high service expectations and access to abundant merchandise-related information at low search and switching costs" (DADZIE and WINSTON, 2007, p.20). Although with different characteristics, online customer responses to OOS are the same, as can be seen in Table 4.2.

Table 4.2 – Online customer responses to OOS

ONLINE CUSTOMER RESPONSE TO OOS		**AUTHORS**
Substitute product	Click on suggested substitute item online and buy in the same.	(DADZIE and WINSTON, 2007; CORSTEN and GRUEN, 2018)
Do not buy	Exit from the internet/switch intention.	(DADZIE and WINSTON, 2007; CORSTEN and GRUEN, 2018)
Buy in another online store	Switch to another website.	(DADZIE and WINSTON, 2007; CORSTEN and GRUEN, 2018)
Delay the purchase		(CORSTEN and GRUEN, 2018)

Source: by the author (2021)

However, the possibility of interacting with different channels in the same omni-channel retail shopping experience brings more alternatives to the customer, which can be seen in the next section.

4.1.1.2 Omni-channel Customer response to OOS

Ovezmyradov and Kurata (2019, p.210), highlight that in omni-channel retailing, "a customer’s visit might involve a physical store as well as virtual access to a store’s webpage via a computer or mobile phone". Therefore, the omni-channel customer response to OOS may imply a customer transit from one channel to another, according to his/her perception about the channel integration, eases for that, and his/her interest. In doing so, the omni-channel customer responses to OOS can be seen in the Table 4.3.

Table 4.3 – Omni-channel customer responses to OOS

RESPONSE	DESCRIPTION
Delay the purchase (backorder)	“Click and collect” - order online and pickup in-store.
	“Order in-store, deliver home” - request for delivery to home when available.
	Add stockout item to an online wish list to receive notification when it is available.
Store switching	Click on a link to alternative stores online and visit to buy or reserve online to buy.
	While shopping at one store, check the availability of preferred but stockout brand at another store and afterwards reserve or visit to buy the same.
Substitute	Click on suggested substitute brands online and buy a brand.
	Online check of availability of substitute brands at a nearby store and reserve to buy.

Source: Ovezmyradov and Kurata (2019, p.211)

In doing so, if the product is OOS in the physical store, for example, the customer can search on the website of the same retailer and request home delivery. The opposite is also true, if the product is OOS on the website, the customer can visit the physical store to find it.

4.1.2 OOS Consequences

Customer satisfaction in terms of availability most of the time results not only in maintenance, but in an increase in the level of sales (BALLOU, 2006). On the other hand, the OOS leads to a short- and long-term losses (SON et al, 2019). The OOS consequences are the reason why OOS is relevant, since it reveals its impact on the company's results. Table 4.4 presents the main OOS consequences found in the literature.

Table 4.4 – OOS consequences

OOS CONSEQUENCES	AUTHORS
Loss of sales	Gruen et al. (2002); Ehrenthal and Stölzle (2013); Corsten and Gruen (2003); Moussaoui et al. (2016); Frontoni et al. (2017); Lambert et al. (1998b)
Loss of customer (Dissatisfaction and reduced customer loyalty)	Gruen et al. (2002); Ehrenthal and Stölzle (2013); Corsten and Gruen (2003); Moussaoui et al. (2016); Frontoni et al. (2017); Peterson et al. (2019); Lambert et al. (1998b)
Loss of profit	Huang and Zhang (2016); Frontoni et al. (2017); Peterson et al. (2019)
Demand information distortion	Ehrenthal and Stölzle (2013); Corsten and Gruen (2003); Huang and Zhang (2016)

Source: by the author (2021)

When the customer decides to respond to OOS by buying the item at another store or not purchasing it anymore, the retailer faces a direct loss. In addition, substitute items tend to be smaller and/or cheaper than the original item (GRUEN et al., 2002). In such cases, retailer has short-term losses. However, in the long-term, they can become negative word-of-mouth and loss of market share (KIM and LENNON, 2011; SON et al, 2019).

Online retailing has different characteristics than offline and, therefore, some different OOS consequences. As well as in the offline, lost sales and demand distortion were mentioned as OOS consequences. However, other two new OOS consequences arise: basket abandonment and search rank impact. Table 4.5 shows these consequences and their sources.

Due to the ease of switching to the online store, instead of replacing only the missing item, the customer can abandon the whole basket he/she filled and intended to purchase online (CORSTEN and GRUEN, 2018).

Table 4.5 – Online OOS consequences

ONLINE OOS CONSEQUENCES	**AUHTORS**
Basket abandonment	Corsten and Gruen (2018)
Search rank impact	Corsten and Gruen (2018)

Source: Corsten and Guen (2018)

Fernie and Sparks (2019, p.232) highlight that "consumers will turn away if products they want are out of stock and another website selling similar products is only a click away". Regarding the search rank impact, product availability is an important factor used to rank the store. A "low OLA reduces search ranks, which in turn reduces page views and eventually reduces sales" (CORSTEN and GRUEN, 2018, p.48).

However, intentionally causing a stockout can be strategic or a necessity, such as redirect sales from one item to another with a higher margin or avoid losses or waste generation due to the expiration date of the product (GARCIA-ARCA et al., 2020). Nevertheless, it is necessary to compare what is gained by applying such strategies, with what is lost in image and possible purchase abandonment.

4.1.3 OOS Causes

The three main factors that affect the level of on-shelf-availability (OSA), causing the OOS are: replenishment, ordering, and forecasting/planning (GRUEN et al., 2002; McKINNON et al., 2007). Replenishment category is related to factors such as staff availability and motivation, replenishment frequency, depot availability, backroom clutter and limited shelf space. Ordering category, in turn, involves factors such as order lead-time and inventory accuracy. While the forecasting category, involves factors such as promotion, level of data sharing, rate of sale, and rate of new product introduction.

In addition to these three, there are other causes, such as shrinkage, shelf-filling, line discontinued, inbound logistics, use of planograms, nature of the packaging, and assortment density (McKINNON et al., 2007). Table 4.6**Erro! Fonte de referência não encontrada.** presents the main causes of OOS with source in the stores, DCs, suppliers and transport providers. A more detailed list of OOS causes in traditional retail can be seen in 'Appendix D' of this dissertation.

Table 4.6 – OOS causes in the BM retailing

SOURCE / **AUTHOR(S)**	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
STORE											
Ordering	x	x	x	x	x	x	x	x	x	x	x
Shelving/Replenishment	x	x	x	x	x	x	x	x	x	x	x
Storage/backroom messy	x	x	x			x				x	
Receiving					x	x	x				
Store management			x		x	x			x	x	
Forecasting	x	x	x	x	x	x	x	x	x	x	x
DC											
Short stock to fulfill the store	x					x					
Delivery failures				x	x			x		x	
Ordering failures			x	x	x	x	x	x	x	x	
SUPPLIER											
Ordering failures				x	x	x					
Production						x					
Low level service from supplier											x
Pick errors				x							
Planning	x					x		x		x	
Delivery failures				x	x						
Forecasting									x	x	
TRANSPORT PROVIDER											
Unreliable transport service								x			
OTHER	x	x	x	x							

Source: by the author (2020)

According to Gruen et al. (2002) the fastest moving items, i.e., those with the greater turnover are the most exposed to out-of-stock. For the same reason, promoted items tend to have a higher OOS rate than non-promoted items.

For Chuang et al. (2016, p.935), "poor store execution puts the supply chain and marketing strategy efforts at risk by compromising product availability".

4.1.3.1 Online OOS Causes

If on the one hand, in physical stores the customers realize the product availability by its physical presence on shelf, on the other hand, in online stores they realize it by the availability information on the website or app. Therefore, regardless of the product availability by the company in a suitable location to fulfill the customer orders, by not displaying the product on the website or providing incorrect information about its availability, they are equally perceived by the customer as OOS (CORSTEN and GRUEN, 2018). However, as the focus of this dissertation is the sources of the logistic processes for OOS, the only OOS cause considered in the online context that differs from traditional retail is inaccurate inventory, which is better explored in section 6.1.3.2.

4.2 OMNI-CHANNEL LOGISTICS CHALLENGES CLASSIFICATION

As previously presented in section 2.3.3, the omni-channel logistics challenges found in the bibliographic portfolio (BP) that was generated from the literature review were analyzed and grouped into five different dimensions: back-end fulfillment, last mile distribution, product returns, inventory and capacity management, and logistics information systems. These dimensions were then subdivided into categories in order to deepen their analysis and are presented below. The summary list of the omni-channel logistics challenges found here can be seen in 'Appendix B' of this dissertation. Below, each of the dimensions and their categories is further explored.

4.2.1 Back-end fulfillment

Using the existing logistics infrastructure to integrate traditional and online order fulfillment seems to be the most common decision in emerging OC management approach. However, this decision implies a redefinition of roles and restructuring of the distribution network, as well as a review of its previous processes (MELACINI et al., 2018). Integrated order fulfillment can be performed from a warehouse or from a store, and each of these decisions presents its challenges.

4.2.1.1 Store-fulfillment for online ordering

Although online order fulfillment at the store has significant advantages, such as allowing retailers to postpone investments in logistics facilities (RAI et al., 2019) and relatively lower transport costs due to proximity to customers (HÜBNER et al., 2016b), it can be also challenging. Restrictions of shelf space (HÜBNER et al., 2016b; HÜBNER et al., 2016c; SAHA and BHATTACHARYA, 2020; ARSLAN et al., 2020) and backroom space (ARSLAN et al., 2020; SAHA and BHATTACHARYA, 2020) were the store-fulfillment challenges most mentioned, probably due to high lease/rent expenses (SAHA and BHATTACHARYA, 2020). IT requirements (HÜBNER et al., 2016c; RAI et al., 2019; ARSLAN et al., 2020) to keep track of inventory transparence (HÜBNER et al., 2016b) and allowing data exchange (HÜBNER et al., 2016c) and inventory visibility in real-time (RAI et al., 2019) were also mentioned as relevant challenges.

Additional instore logistics, such as storage, picking, and shelf replenishment (HÜBNER et al., 2016b; RAI et al., 2019; ARSLAN et al., 2020) also appeared as challenges. Conflicting inventory allocation rights on sales floor, which is designed for displaying products (HÜBNER et al., 2016b) and decrease in commercial space (RAI et al., 2019) were other challenges mentioned. Finally, competition for on shelf products between customers and pickers (HÜBNER et al., 2016b; RAI et al., 2019) also emerged as a challenge.

4.2.1.2 Warehouse-fulfillment for online ordering

In the same way as store-fulfillment, warehouse-fulfillment also has advantages, such as greater efficiency of picking process (HÜBNER et al., 2016b) and larger assortments/item ranges than in-store (HÜBNER et al., 2016c).

However, combining small orders from the online consumer with large store replenishment orders is a great challenge (HÜBNER et al., 2016c; KEMBRO et al., 2018). This requires adjustment of the picking system (HÜBNER et al., 2016b), with an appropriate order flow coordinating and faster throughput times (KEMBRO et al., 2020). Another challenge is the longer average distances to the customer than stores (HÜBNER et al., 2016b), leading to an increase in order fulfillment time.

4.2.1.3 Static and dynamic allocation policies of the online orders fulfillment point

Although the location selected to handle online sales in most cases is defined a priority, i.e., from a specific warehouse or store, some authors have introduced the principle of postponing the allocation of online orders. In doing so, they proposed dynamic or quasi-dynamic allocation policies for fulfilling online orders. As a result, the allocation determination for each incoming online order is defined in real time (MELACINI et al., 2018). However, the challenge is managing multiple picking locations and channel-integrated inventories, "with real-time visibility of logistics assets, such as inventories and vehicles within the entire network" (MARCHET et al., 2018, p.18).

4.2.2 Last Mile Distribution

Hübner et al. (2016b) highlight that the order delivery may be the only time when the customer comes into personal contact with the retailer when shopping online. In addition, "the cost of last mile delivery accounts for up to 50 per cent of total SC cost" (HÜBNER et al., 2016c, p.236). Three of the main characteristics of the last mile distribution are the delivery mode (HÜBNER et al., 2016c), the delivery time and the delivery area (HÜBNER et al., 2016c; MELACINI et al., 2018). There are two predominant delivery mode concepts in omni-channel systems: home delivery and pick-up points (HÜBNER et al., 2016c; MELACINI et al., 2018).

4.2.2.1 Home delivery

In home delivery mode, the challenges are lead time, potential shipping fees and handling of bulky items (HÜBNER et al., 2016c). In the case of attended home deliveries, where the customer must be at home to receive the order, the challenge is the additional complexity of the operation (MELACINI et al., 2018). This is because vehicle routing becomes complex and costly, with dynamic timetable assignment (HÜBNER et al., 2016b). On the other hand, in unattended home deliveries, one of the main challenges is the loss of customer interaction, in addition to other challenges such as temperature requirements (in case of perishables) and theft at reception point (HÜBNER et al., 2016b). A more economical alternative to home delivery is to use the bulk shipping policy, where "each order waits for a full truckload of orders to the same area before being shipped". However, the challenge is a longer delivery lead-time, a practice that is most often frowned upon by customers (MELACINI et al., 2018, p.405).

4.2.2.2 Pick-up points

In delivery mode via pick-up points, one of the main challenges is precisely the definition of the set of pick-up points that will be made available for customers to choose when purchasing online (MELACINI et al., 2018). Similarly, as in the fulfillment points, in the pick-up points it is possible to use static or dynamic allocation policies (MELACINI et al., 2018). As a result, the challenge of dynamic allocation is similar, i.e., managing multiple pick-up locations, "with real-time visibility of logistics assets, such as inventories and vehicles within the entire network" (MARCHET et al., 2018, p.18). Pick-up in store is "often the ad hoc solution when a retailer wants to enter OC retailing quickly at a low initial cost" (HÜBNER et al., 2016b, p.239). For this delivery mode, two different concepts are used: click&collect and click&reserve (HÜBNER et al., 2016c). In click&reserve mode, when items are not shipped from the outlets, but booked online by a customer and picked up at the store later, the main challenges are the IT requirements and in-store picking efforts (HÜBNER et al., 2016c). On the other hand, in the click&collect delivery mode, the challenges are the difficulty to scale-up due to limited store space when located inside the store, and the larger investment to set up the additional facility, when at a point attached to the store (HÜBNER et al., 2016b). Another pick-up point used as the delivery mode in omni-channel systems are locker points, i.e., automatic lockers in easy-to-access locations and available 24/7 all year round (MELACINI et al., 2018). Its main challenge is the loss of interaction and synergy between the store and customers (HÜBNER et al., 2016b).

4.2.2.3 Delivery time and area

Omni-channel customers see delivery speed as an important service component, and demand for same-day delivery, or at least the day after or two days, has steadily increased. The main challenges in fast deliveries are processing costs and process complexity (HÜBNER et al., 2016c). Omni-channel logistics systems with orders fulfillment points and decentralized DCs has shorter average distances from consumers, influencing the delivery speed and potential frequency (WOLLENBURG et al., 2018). However, there are some challenges in adopting decentralized DCs, such as decentralized inventories, complex transshipment, and cross-docking policies for central DC deliveries (HÜBNER et al., 2016c).

4.2.3 Product Returns

In the product returns domain, many aspects can compromise the channels' performance, the challenge is to find ways to minimize the number of returns operations and to efficiently manage the return processes (DE BORBA et al., 2020; MELACINI et al., 2018; WEBER and WEISS, 2018). According to Bernon et al. (2016, p.595), "managing omni-channel returns networks increases returns channel complexity and requires high levels of integration". There are two management aspects related to returns that are highlighted by the literature: returns mode and integration across channels to process them (BERNON et al., 2016; DE BORBA et al., 2020; HÜBNER et al., 2016c; MELACINI et al., 2018).

4.2.3.1 Returns mode

It is related to the many forms the company can make the return operation available to the client (DE BORBA et al., 2020). One of the most critical challenges, according to Bernon et al. (2016) is the customer accessibility to return entry points, once it influences either the customer's choices, and also on the costs and complexity of managing returns modes. The determination of the number and location of these entry points is another great challenge (MELACINI et al., 2018). The instore handling effort when it is used as an entry point was also mentioned as a challenge (DE BORBA et al., 2020; HÜBNER et al., 2016c), as well as the number of visits required for collections at the customer's home, considering the need to check the product to be returned (BERNON et al., 2016). When using collection points as a return entry, poor communication between companies is pointed out as a challenge (BERNON et al., 2016; DE BORBA et al., 2020).

4.2.3.2 Returns processing

Related to the efforts needed so the return operation can be executed efficiently (DE BORBA et al., 2020). In return processing, the processes integration (BERNON et al., 2016; DE BORBA et al., 2020), the processing speed to reintegrate the product into stock (BERNON et al., 2016; DE BORBA et al., 2020) and the determination of the number and location of return processing centers (MELACINI et al., 2018) were mentioned as the most relevant challenges. Additional transport costs when returns are collected at the store and sent to DC to be processed were also mentioned as challenges (DE BORBA et al., 2020; HÜBNER et al., 2016c).

4.2.4 Inventory and Capacity Management

Inventory and capacity management alone are already a challenge in omni-channel networks, since keeping the right set and level of inventory affects customer satisfaction and sales (DERHAMI et al., 2020). For Hübner et al. (2016a) the purpose of the omni-channel integration is specially the inventory availability.

4.2.4.1 Assortment

The omni-channel allows a wider assortment of products than traditional retail alone, due to the space restrictions of the latter (HÜBNER et al., 2016a; HÜBNER et al., 2016b; HÜBNER et al., 2016c; MELACINI et al., 2018; KEMBRO et al., 2018). However, challenges such as space restrictions in the warehouse (HÜBNER et al., 2016a), a higher complexity in warehousing (KEMBRO et al., 2018), and an increase in the numbers and types of storage locations (KEMBRO et al., 2018) may arise.

4.2.4.2 Inventory Sharing (integration)

Pooling inventories across channels has its benefits such as a flexible and demand-driven inventory allocation (HÜBNER et al., 2016a) and total costs reductions (MELACINI et al., 2018; HÜBNER et al., 2016a). However, challenges such as conflicts between channels (MELACINI et al., 2018), higher space requirements and heterogeneity of product ranges (HÜBNER et al., 2016c) arise.

4.2.4.3 Inventory replenishment policy

Weber and Weiss (2018) highlight that a reliable fulfillment means ensuring product availability before the consumer places an order online. Therefore, one of the main challenges of replenishing inventory is to maintain product availability both for physical stores and for online purchases (HÜBNER et al., 2016a; HÜBNER et al., 2016c; WEBER and WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA and BHATTACHARYA, 2020). Another great challenge for inventory and capacity management is demand fluctuations, especially online sales due to their high dynamics and continuous growth (HÜBNER et al., 2016c; KEMBRO et al., 2018). Moreover, integrating store and online demands is a complex process, since their patterns are different, leading to a mismatch between replenishment forecasts and inventory holding (WOLLENBURG et al., 2018). Finally, balancing demand and capacity in order to reduce warehouse costs is also considered an important challenge in omni-channel systems (KEMBRO et al., 2020). A robust information system was also mentioned as a challenge for integrated inventory management (MELACINI et al., 2018), as well as the standardization and synchronization of availability information among channels and partners (WEBER and WEISS, 2018). Inventory record inaccuracy is also a relevant challenge, especially in the store, as it hinders inventory information throughout the omni-channel network (MELACINI et al., 2018; WOLLENBURG et al., 2018).

A further store inventory management challenge is the reinsertion of cancelled order products in click&collect sales (BERNON et al., 2016) or uncollected in click&reserve orders (SAHA and BHATTACHARYA, 2020).

4.2.4.4 Returns on inventory

According to Melacini et al. (2018), it is advisable to consider product return operations when setting an inventory replenishment policy, especially because these operations have a great influence on online channels. About the influence of returns in inventory management, the main challenges seen in the literature are the lack of data on returned items, which makes the inventory management difficult (WEBER and WEISS, 2018), additional operations of restocking the returned product (BERNON et al., 2016; DE BORBA et al., 2020) and the difficulty of forecasting the returned volume (DE BORBA et al., 2020). The misplacement of products that were bought and returned in different channels can also be cited (DE BORBA et al., 2020).

4.2.5 Logistics Information Systems

IT requirements have been mentioned as a challenge by almost all BP authors, so they also appear in almost every other dimension. For Weber and Weiss (2018, p.1), "many of the last-mile challenges experienced by the omni-channel grocery retailer stem from the inefficient management of information (data) along the supply chain". Therefore, omni-channel information systems can encompass two or more dimensions, precisely with the function of integrating them. These IT requirements emerge from the greater complexity and decentralization of omni-channel distribution strategies due to the number of nodes involved and the flows, both between and from them (KEMBRO and NORRMAN, 2019; HÜBNER et al., 2016a), as well as customer demand for greater information transparency (HÜBNER et al., 2016a).

According to Kembro and Norrman (2019), the biggest challenge of logistics information system in omni-channel strategies is to "track and trace a customer order through the whole process/network until final delivery", since the current system may not be meeting omni-channel requirements, such as flexibility, speed, and integration. Inventory real-time visibility is another relevant challenge that encompasses the entire omni-channel chain (KEMBRO and NORRMAN, 2019), mainly for store-based order fulfillment (HÜBNER et al., 2016c; WEBER and WEISS, 2018).

A third highlighted challenge was the information system support to "optimized decisions regarding which node (DC or store) an order should be picked and delivered from" (KEMBRO and NORRMAN, 2019, p.396). Dynamic fulfillment strategies, supplier drop-shipment (KEMBRO and NORRMAN, 2019; DIFRANCESCO et al., 2020; ARSLAN et al., 2020), and transshipments (HÜBNER et al., 2016c; KEMBRO and NORRMAN, 2019; DIFRANCESCO et al., 2020; ARSLAN et al., 2020), make these decisions even more complex, demanding even more from logistics information systems.

Finally, the data accuracy and system updating also are mentioned as important challenges of logistics information system (KEMBRO and NORRMAN). According to Wollenburg et al. (2018), "in general, high inventory inaccuracy exists at the store level", making it difficult to provide availability information to online order fulfillment points. A summary table of the omni-channel logistics challenges found here is presented in Appendix B.

4.3 CLOSING REMARKS OF CHAPTER 4

Since the main OOS causes in traditional and online retailing, as well as omni-channel logistics challenges were identified, they were cross-referenced with the omni-channel logistics processes identified in chapter 5 and used in chapter 6. Among the identified OOS causes, those related to the store as a source were used: ordering, replenishment, receiving, store management and forecasting. Regarding the DC as a source, only those related to the fulfillment of store orders and their delivery were used.

The omni-channel logistics challenges used were mainly those related to the inventory and capacity management dimension, i.e., the categories of assortment, inventory integration, replenishment policy, and returns on inventory. Both, the OOS causes and omni-channel logistics challenges used are presented in the respective sub-processes in which they were classified in section 6.1.2.

5 MODEL BASE PROCESS ARCHITECTURE

The "risks identification" is the first stage of risk management and aims to discover the relevant risks in a supply chain (KERN, 2012), in a comprehensive and structured way (RANGEL et al., 2015), to manage them proactively in the next stages (HALLIKAS et al, 2004). Although the Supply Chain Risks Management (SCRM) achieves most of its results with mitigation actions, only the identified risks can be assessed and forwarded. In addition, multiple sources of uncertainty in the supply chain make risk identification a broad and undefined task (KERN, 2012). For these reasons, risk identification is considered a fundamental and critical stage for SCRM, making subsequent stages highly dependent on its level of quality (HALLIKAS et al, 2004; KERN, 2012). Nonetheless, when efforts to identify risks are not directed, the use of limited resources for this becomes inefficient. Therefore, it is important to define observation fields based on "already known sources of risk and the most critical and vulnerable areas of the supply chain" (KERN, 2012, p.64). In doing so, the approach used for this purpose becomes relevant.

There is a range of tools and approaches that can be used to help identify risks. Some of them are more generic, such as cause and effect analysis - CEA, event tree analysis, fault tree analysis (WATERS, 2011; TUMMALLA and SCHOENHERR, 2011), failure mode and effect analysis - FMEA, checklists or check sheets (TUMMALLA and SCHOENHERR, 2011), analyses of historical data, brainstorming, process mapping, the likelihood–impact matrices, and scenario planning (WATERS, 2011). However, others are more specific to the supply chain environment, such as supply chain mapping and audit (WATERS, 2011; CHRISTOPHER, 2011; TUMMALLA and SCHOENHERR, 2011), critical path identification (WATERS, 2011; CHRISTOPHER, 2011), and relative importance to the supplier and relative importance to the customer (WATERS, 2011). The choice of appropriate approach, according to Waters (2011, p.107), depends on circumstances and, particularly, on the:

- *size and complexity of operations;*
- *organizational experience with risk management;*
- *type of information needed and already available;*
- *availability of resources, particularly people and time;*
- *levels of skills and knowledge.*

Some of these approaches explore past events to predict the likelihood of a new occurrence, some are based on the collection of opinions and others on the direct analysis of operational processes (WATERS, 2011).

In a supply chain context, risk management aims "to ensure that supply chains continue to work as planned, with smooth and uninterrupted flows of materials from initial suppliers through to final customers" (WATERS, 2011, p.86). According to Olson and Wu (2010), most of the supply chain risk literature divide the risk sources into internal and external. In this regard, external risk sources can be categorized into nature, political system, and competitor and market. On the other hand, internal risk sources can be categorized into available capacity, internal operation and information system. However, according to Christopher (2011), when a company is aware of its internal vulnerabilities, it can isolate the most relevant and critical threats. Thereby, although the researcher is aware of the existence of relevant external risks, this study emphasizes the internal risk sources of the omni-channel retailer.

According to Wieteska (2013), the most relevant internal risk factors that affect the supply chain are related to the infrastructure where their processes run, and to their control and management systems for these processes.

A very usual way to isolate the threats is to divide the company's entire logistics operation into a series of distinct processes and study their details, identifying their vulnerabilities (WATERS, 2011). These details include relationships, people, regulations, plans, and equipment, which supports the company's capacity to generate the interesting outcome (CHRISTOPHER, 2011), in this case, the product availability.

In this sense, a general procedure for identifying logistics risks can be structured in the following steps (WATERS, 2011, p.106):

a) *Defining the overall supply chain process.*
b) *Dividing this into a series of distinct, related operations.*
c) *Systematically considering the details of each operation.*
d) *Identifying the risks in each operation and their main features.*
e) *Describing the most significant risks in a register.*

According to Christopher (2011), a good way to start identifying the essential components required to generate the interest outcome is asking 'What are the processes which, if they failed, would seriously affect this outcome?'.

Based on the statements of Christopher (2011) and Waters (2011) and, because this study has a clear focus, i.e., to identify the internal risk factors that obstruct the product availability outcome, the identification of the processes-based risks proves to be the most suitable alternative.

5.1 THE MODEL’S OMNI-CHANNEL STRATEGY

Since the omni-channel logistics distribution architecture changes as a function of the distribution strategy, before starting its definition, it is necessary to clarify for which distribution strategy the risk identification model of this study is being built.

5.1.1 Store-based Omni-channel

The omni-channel retailing has two sides, the one that is perceived by the customers, through which they access the company to buy, pick-up their orders and/or return their products, and the one used by the company to fulfill the customers' orders. In the omni-channel, the fulfillment of customer orders can be done from three different nodes of the logistics network: store, DC, and/or supplier (HÜBNER et al., 2016c; ISHFAQ et al., 2016; KEMBRO and NORRMAN, 2020).

Regardless of the company's strategy for making omni-channel services available to consumers, a store-based omni-channel format fulfills all of its customers' orders from one or more of its stores. From there, orders can be made available to customers for pick-up at a store or locker, or they can be delivered to the customer's home, without mischaracterizing the store-based omni-channel strategy. In doing so, the main store-based omni-channel's characteristic is the fact that the store fulfills the walk-in and online customers from the same inventory, their own.

5.1.2 Model context classification

According to “Omni-channel Distribution Typology” by Hübner et al. (2016c, p.284), the omni-channel forward distribution served by this study are the combinations of the Types 1 and 4 or Types 1 and 6. In both combinations, physical stores serve walk-in customers (Type 1 classification) and can either be delivered to the customer's home from the store (Type 4 classification) or picked up by the customer at the store (Type 6 classification). However, for both Type 4 and Type 6, the inventory used to fulfill online orders must be from the store.

Regarding the omni-channel backward distribution, the model assumes the store-only return process, i.e., Type 5. However, this part of the model can be easily ignored, making the model able to serve all other types of omni-channel backward distribution, i.e., from 1 to 4, being Types 1 and 2 collected via CEP and delivered to the DCs, and Types 3 and 4 collected via physical stores, but dispatched to be processed on DCs (for more information see HÜBNER et al., 2016c, pp.272-287).

5.2 PROCESSES-BASED RISKS IDENTIFICATION METHOD

The awareness of the 'processes' importance for the business is not new, since there are mature initiatives in process improvement, such as Reengineering, Total Quality Management (TQM), Lean, and Six Sigma (AYERS and ODEGAARD, 2017; DUMAS et al., 2018). However, Business Process Management (BPM) takes the best of each of these initiatives and combines them with information technology capabilities in order to align business processes with the company's objectives (DUMAS et al., 2018). According to the authors, BPM is "the art and science of overseeing how work is performed in an organization to ensure consistent outcomes" (DUMAS et al., 2018, p.1). Thereby, the BPM includes "concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes" (WESKE, 2019, p.5). Its purpose is not to improve the individual activities, but "managing entire chains of events, activities, and decisions that ultimately add value to the organization, and its customers" (DUMAS et al., 2018, p.1). Similar to Supply Chain Risk Management (SCRM), Business Process Management (BPM) has a continuous improvement cycle. The BPM lifecycle is an overview of the implementation and managing processes method composed of a sequence of cyclical stages. The literature presents numerous models of the BPM lifecycle, with different quantities and names of stages (SZELAGOWSKI, 2018). According to Weske (2019), for instance, the stages of the Business Process Management lifecycle are: design and analysis, configuration, enactment, and evaluation. On the other hand, for Dumas et al. (2018), the stages are: identification, discovery, analysis, redesign, implementation, and monitoring. Although the stages names are mostly different, the objective is the same, identify failures, propose implementation improvements, and monitor results.

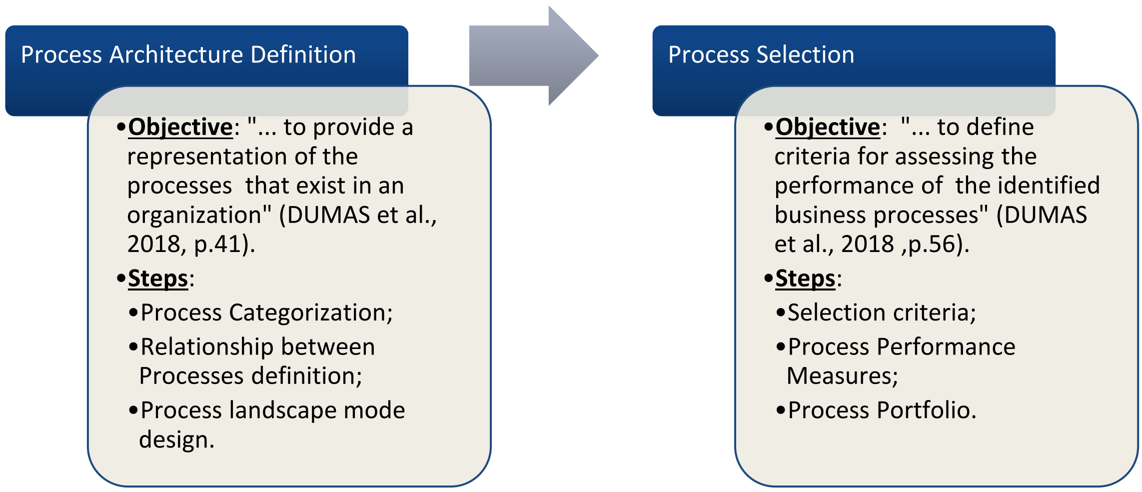
Since the interest of this study in BPM is to elaborate the architecture of the omni-channel logistic process to serve as a basis for the risk identification model, only the first stage of the BPM lifecycle, was used. According to Szelagowski (2018), in the literature, this stage often contains or is defined as planning, preparation, strategizing, identification, etc.

However, the BPM lifecycle which best suited the purpose of this study was the method by Dumas et al. (2018), in which the first stage is called "identification". The authors' statement that makes their position clear regarding the process identification stage is as follows (DUMAS et al., 2018, p.35):

> "Process identification refers to those management activities that aim to systematically define the set of business processes of an organization and establish clear criteria for selecting specific processes for improvement. The output of process identification is a process architecture, which represents the processes and their interrelations."

According to the authors, the organization should be aware and focus on the processes that create value or that have substantial problems. The logistics risk of OOS is both a threat to creating value and a substantial problem since it generates consequences for both the customer satisfaction side and the logistics processes' efficiency. To focus on key processes, Dumas et al. (2018, p.39) suggested seeking the answers to the following questions: (i) what processes are executed in the organization? and (ii) which ones should the organization focus on? To help answer these questions, the authors structured a processes identification method with two stages that were used in this study: process architecture definition, and process selection. Their objectives and steps are presented in Figure 5.1.

Figure 5.1 – Process Identification method



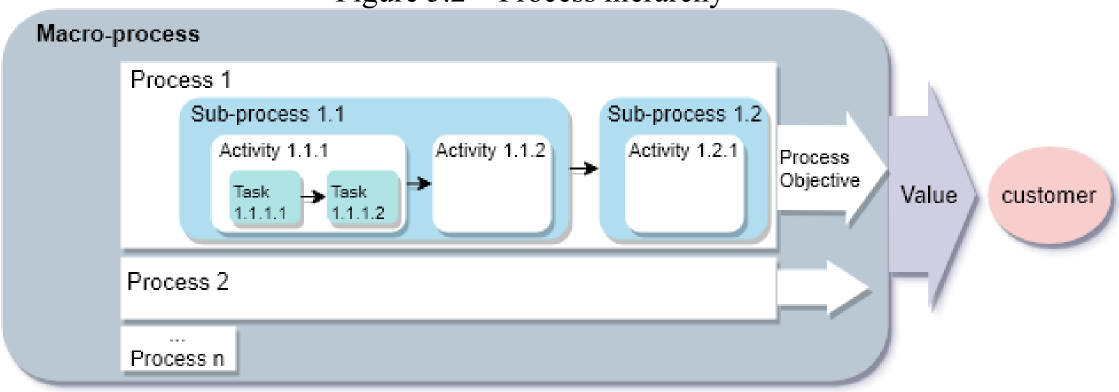
Source: from Dumas et al. (2018)

In order to establish a standard nomenclature for the different process layers during the decomposition step, the next section defines a process hierarchy.

5.2.1 The Processes Hierarchy Definition

The ‘decomposition’ defines a vertical or hierarchical relationship, where a process can be described in more detail in one or more sub-process (DUMAS et al., 2018). According to Gonçalves (2000a, p.7), process is "any activity or set of activities that receives an input, adds value to it and provides an output to a specific customer". On the other hand, for Dumas et al. (2018, p.27), process is "a collection of events, activities, and decisions that collectively lead to an outcome that brings value to an organization’s customers". In this sense, a process consists, in addition to activities, of events and decisions points. The 'events' differs to 'activities', as events "correspond to things that happen atomically, which means that they have no duration", while an activity refers to units of work. When an activity has only one work unit, it is called "task" (DUMAS et al., 2018). Figure 5.2 shows the process hierarchy adopted in this study.

Figure 5.2 – Process hierarchy



Source: based on Gonçalves (2000b) and Dumas et al. (2018)

From a hierarchical point of view, "processes can be aggregated into macro-processes and subdivided into sub-processes or groups of activities, and the most appropriate aggregation level depends on the analysis type that is intended to be done" (GONÇALVES, 2000b, p.10). Thus, a sub-process "represents a self-contained, composite activity that can be broken down into smaller units of work", while a task "is an activity capturing a unit of work that cannot be further broken down" (DUMAS et al., 2018, p.102).

5.2.2 Objectives-driven Process Identification Method

A risk is, by definition, an effect of uncertainty on business objectives, so the identification of a risk depends on the clarity of the objective (SHAH et al., 2017). In this study, the global objective to be observed is the "product availability" to customers, then the risk corresponding to it is the "out-of-stock". According to Shah et al. (2017), since the objective is established, the next step is to find assertions that obstruct the attainment of this objective.

In 1992, Ralph Keeney developed a methodology to support decision making, the Value Focused Thinking (VFT), focused on objectives instead of alternatives, where the purpose is to identify desirable decision opportunities and from there create the alternatives. For the author, an objective is "a statement of something that one wants to achieve in that decision context" (KEENEY, 1996, p. 538). The author further differentiates 'fundamental objectives' and 'means objectives', where a fundamental objective "concerns the ends that decision-makers value in a specific decision context" and the means objectives are “methods to achieve ends."

According to Keeney (1996), stating a fundamental objective explicitly requires the definition of at least three features: the **objective**, the **decision context,** and the **direction of preference**. Since the mean objectives are methods to achieve a fundamental objective, using the reverse process, named by Keeney as 'specification', it is possible to break a fundamental objective into logical parts. Thereby, an objectives hierarchy is formed and any alternative that influences one of the means objectives also influences the associated fundamental objective.

According to Shah et al. (2017), in the risk management context, the 'fundamental objective' of the VFT is the 'risk objective', while the 'means objectives', are 'risk factors’. Thus, risk factors are the means that determine the probability of the risk objective occurrence. As a result, the authors created a chain network of risk factors, where risk factors can be interrelated, contributing to the risk objective in a risk hierarchy.

5.3 IDENTIFICATION OF THE PROCESS IN FOCUS FROM SC

Since the process in focus in this work is a specific process of the omni-channel business, the processes identification method application occurred in two moments. First, identifying the focus process in the omni-channel supply chain, which is presented in this section. Second, identifying each of its sub-processes and its layers, which is presented in section 5.4.

5.3.1 The Process Architecture Definition

The purpose of the process architecture definition, which is the first step of Dumas et al.'s process identification (DUMAS et al., 2018), is to provide an organization's processes representation. For this, first, the processes categories are differentiated, then the relationships between the processes are described, and finally, a landscape with the representation of the top-level processes is defined.

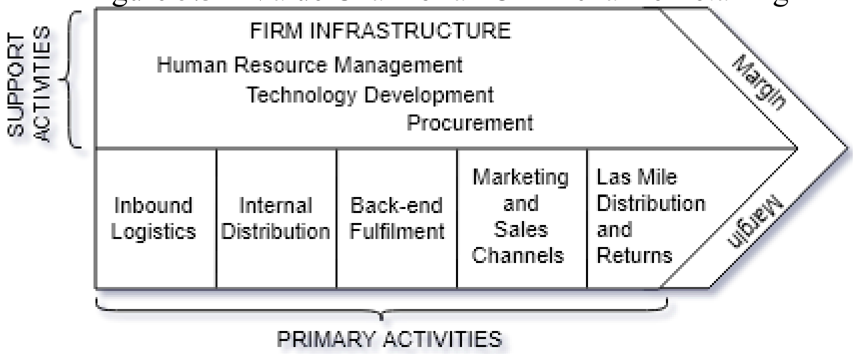
5.3.1.1 The Process Categorization

The processes categorization seeks to identify and enumerate the main processes of the company, and establish their hierarchical nature. Thus, it is expected to define the processes of interest in this study. In this regard, a process can be classified into core, support or management process.

According to Porter (1998, p.36), "every firm is a collection of activities that performed to design, produce, market, deliver, and support its product", named by the author of "value chain". Thus, at the same time that it delivers value to the customer through products and services, a value chain delivers margin as a result for the company. This collection of activities that composes a company extends from the understanding of the customer wants, to the delivery of product or service to him/her (GONÇALVES, 2000b). In the BPM literature a value chain is composed of business processes. According to Weske (2019, p.5), a business process consists of a "set of activities that are performed in coordination in an organizational and technical environment" with the purpose to realize a business goal. Dumas et al. (2018, p.6) reinforce that, in addition to the activities, the business process also comprises of events and decisions points inter-related and involves "a number of actors and objects, which collectively lead to an outcome, that is of value to at least one customer".

Therefore, according to Porter's original value chain model, the value activities can be divided into two broad categories: primary and support activities. Primary activities are directly linked to the flow and production of the organization's goods and services, while support activities support primary activities with various functions throughout the company (PORTER, 1998). Considering that logistics distribution (described by Porter as "outbound logistics" and "service") in omni-channel retailing can be divided into Back-End Fulfillment and Last Mile Distribution, the latter includes customer returns (HÜBNER et al., 2016b), an adaptation of Porter's Value Chain for Omni-channel retailing can be made, shown in Figure 5.3.

Figure 5.3 – Value Chain of an Omni-channel retailing



Source: adapted from Porter (1998) and based on the Hübner et al. (2016b).

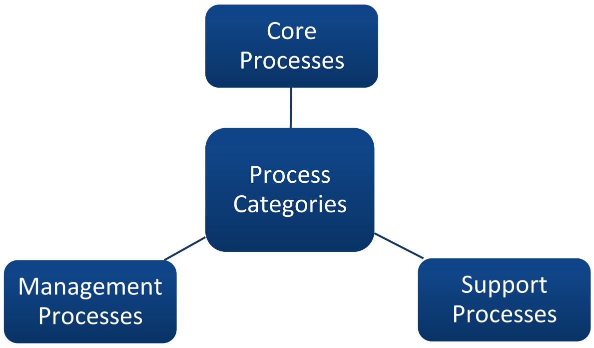
Porter's primary and support activities were mentioned under different names in the literature BPM. Examples for this are the "core process" by Dumas et al. (2018) and "customer processes" by Gonçalves (2000a) referring to Porter's "primary activities", and "organizational processes" by Gonçalves (2000a) referring to Porter's "support activities".

The reason for replacing the term "activities" with the term "processes" is, according to the authors (namely GONÇALVES, 2000a; and DUMAS et al., 2018), because process means a set of activities with the purpose of delivering value to a customer. Therefore, the term "processes" serves the same purpose established by Porter in the value chain. Later, a third category was added, "management processes", responsible for providing directions, rules, and practices for primary and support processes (GONÇALVES, 2000a; DUMAS et al., 2018). Thereby, Figure 5.4 shows the process categories.

Applying this concept from an overview of the Supply Chain to the specific section of business logistics, the focus of this work, i.e., the process that drives the product from DC to store shelf, it is possible to understand the influence of the wider section on the smaller section.

Thus, the supply chain management and support processes influence its core processes, just as the retailer management and support processes influence its core processes, and the latter are all influenced by the supply chain processes.

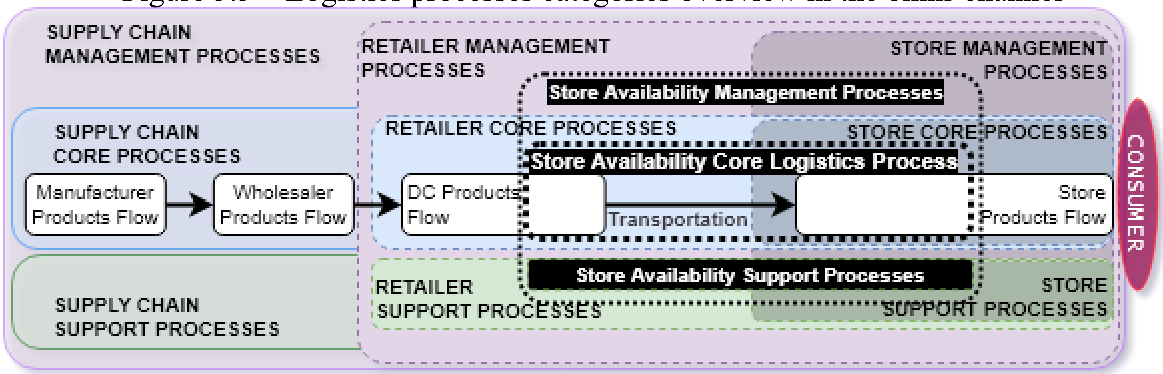
Figure 5.4 – the three process categories



Source: adapted from Dumas et al. (2018)

This rule also applies from the retailer processes to the focus process, i.e., the Store Availability Logistics Process (SAP). Figure 5.5 shows the relationships between the management, support and core processes, from the supply chain to this study focus process.

Figure 5.5 – Logistics processes categories overview in the omni-channel



Source: by the author (2021)

In this regard, the core processes are defined as being the product flow processes (PORTER, 1998; GONÇALVES, 2000a), the management processes are responsible for managing them (GONÇALVES, 2000a; DUMAS et al, 2018), and the other processes for supporting them (PORTER, 1998; GONÇALVES, 2000a; DUMAS et al., 2018).

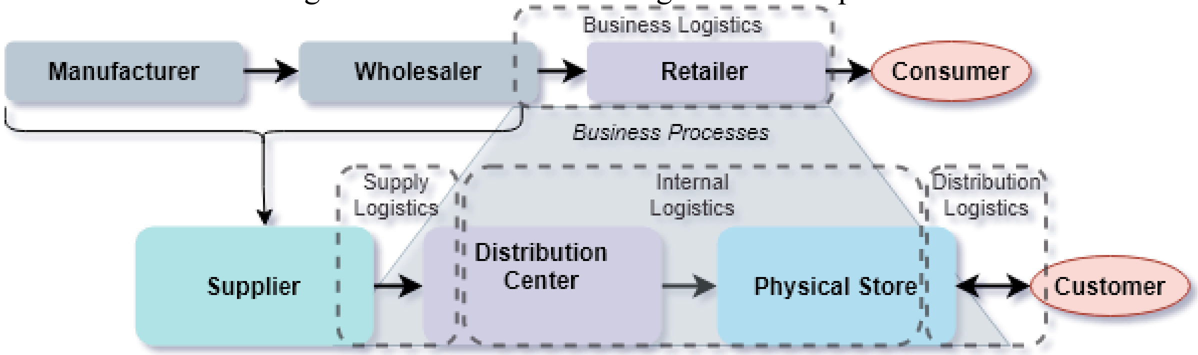
5.3.1.2 Definition of the relationship between Process

According to Dumas et al. (2018), from the perspective of the process architecture, there are three types of relationships between processes: sequence, decomposition, and specialization. The ‘**sequence’** defines a horizontal relationship, where the output of one process is the input of the subsequent process. According to Gonçalves (2000a), a company can have more than one core process, however, a core process is part of only one company. In doing so, in a supply chain, its components' interface connects their core processes in a supplier/customer relationship. Thus, as seen in Figure 5.5, in a generic distribution channel, a manufacturer has its core processes followed by a wholesaler's core processes, which are followed by the retailer's core processes until it reaches the end-customer.

As stated earlier, **'decomposition'** defines a vertical or hierarchical relationship, where a process can be described in more detail in one or more sub-processes. According to Ballou (2006), the product flow in business logistics can be divided into two stages: supply logistics and distribution logistics. For Bowersox and Closs (2009), in addition to the distribution and supply logistics, there is the manufacturing support logistics stage. The distribution logistics stage encompasses customer order fulfillment activities, while the supply logistics stage encompasses the purchase of suppliers and the organization of goods upon receipt. On the other hand, the manufacturing support logistics stage encompasses the inventory management as it flows through the company and is under its control (BOWERSOX and CLOSS, 2009). However, the "manufacturing support logistics" for retailing is the "internal logistics". In this regard, internal logistics is responsible for strategically allocating the inventory in the customer fulfillment points, whether online or walk-in customers. Thereby, in the business logistics context, internal logistics is the stage in the focus of this study.

Nonetheless, there is still confusion about the scope of internal logistics. Wollenburg et al. (2018), for example, were emphatic that the logistics of the omni-channel retail network can be divided into inbound, warehousing and distribution logistics. However, when mentioning the scope of the internal logistics network the authors included, in addition to warehousing and internal transportation between DCs and stores, also delivery to customers, a process belonging to the distribution phase according to Ballou (2006) and Bowersox and Closs (2009). Although retail internal logistics is not clearly defined in the literature, its two extremes, i.e., downstream and upstream, are. Upstream of the internal logistics is the supply logistics which, according to Bowersox and Closs (2009, p.46), encompasses "activities related to the products and materials purchase from external suppliers". On the other hand, downstream of internal logistics is the distribution logistics which, according to the authors, encompasses "activities related to the provision of customer services". Therefore, there is a logistics interval between the supplier delivery and the customer order, which in retail means the strategic inventory allocation, whether in-store or DCs, corresponding to internal logistics. Figure 5.6 shows the sequence of the three business logistic stages.

Figure 5.6 – The Business Logistics Decomposition



Source: by the author (2021)

Wrong inventory allocation decisions are relevant causes of out-of-stock, and DCs are an important part of this strategy.

Regarding **'specialization'**, generic processes may have variations due to differences between involved products, services, customers and suppliers. The multifaceted characteristic of omni-channel retailing, for example, allows the online orders fulfillment from different nodes of the logistics network, such as DCs (centralized or not), suppliers (drop-shipment strategies), and physical stores (HÜBNER et al., 2016c). In doing so, this important logistics function that is the online order fulfillment, determines another important logistics function, the inventory allocation. Thus, from the product availability point of view for online order fulfillment, there are at least three different inventory allocation points, which use similar activities to allocate them, but with variations according to issues such as structure, distance, and capacity.

5.3.1.3 The Process Landscape

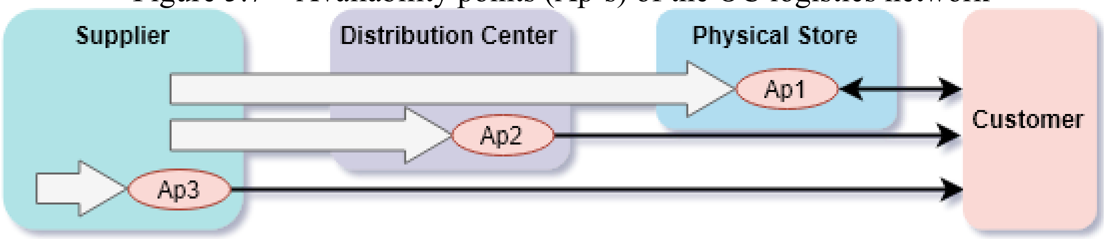
The distribution logistics of the retailer performs the main objective of the entire supply chain and also of the retailer, i.e., the product delivery to the customer and the product availability is a vital part. From a product flow perspective, logistics manages the movement and warehousing of the product from the initial shipment of the product by the supplier to the delivery of the product to the customer (BOWERSOX and CLOSS, 2009).

However, availability, as an important customer service element, is positioned at the different retail chain points that operate in customer order fulfillment, whether they are walk-in or online customers. The walk-in customer is fulfilled exclusively in the physical stores, through shelf product availability, the point where the customer accesses, chooses and picks up the merchandise (DIFRANCESCO et al., 2021; SHAH et al., 2020). On the other hand, online orders can be fulfilled by suppliers (on behalf of the retailer), by retailer's DCs, or physical stores (HÜBNER et al., 2016c; ISHFAQ et al., 2016; KEMBRO and NORRMAN, 2020).

While it is often possible to purchase from the supplier or transfer product from other locations in the network after the customer's order has been placed, this usually increases lead time and poses risks of delayed order delivery. Regardless, the products are forwarded to one of the pre-established order fulfillment points.

In doing so, there can be up to three different customer order fulfillment points in an omni-channel logistics network. Figure 5.7 shows the three different Ap's in the OC logistics network.

Figure 5.7 – Availability points (Ap's) of the OC logistics network



Source: by the author (2021)

For the purpose of this work, the customer order fulfillment points, both walk-in and online, were called "availability points" (Ap), and can be as follows:

a) ***Store Shelf Availability Point (Ap1)*** *- used mainly by traditional retailer that starts with the omni-channel strategy, since it can serve both walk-in and online customers without major additional investments (FERNIE et al., 2010; HÜBNER et al., 2016b).*
b) ***DC Availability Point (Ap2)*** *– the most used in omni-channel strategies, Ap2 fulfills online orders and shares the DC's stock with the transfers to stores and, in some cases, other DCs ((HÜBNER et al., 2016c).*
c) ***Supplier Availability Point (Ap3)*** *- less common, AP3 fulfills online orders in drop shipping strategies, in which online orders are fulfilled directly from the supplier's stock (HÜBNER et al., 2016c; ISHFAQ et al., 2016; KEMBRO and NORRMAN, 2020).*

5.3.2 The Process Selection

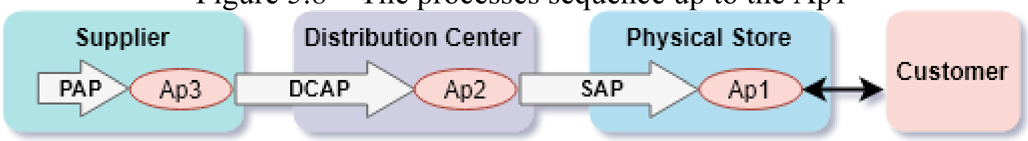
Although the objective here is to identify the omni-channel logistics processes related to the shelf availability (the Ap1 in Figure 5.7), according to Nickols (1998) the process boundaries must be set or established within the desired analysis context, not simply identified. This becomes even more true when the goal is to build a generic model, as is the case in this study.

A method to establish process boundaries is "looking for places where state changes, hand-offs, and transfers of custody or ownership occur" (NICKOLS, 1998, p.18). The set of activities that come together to keep the product available on the store shelf can be a process that crosses the entire omni-channel logistics network. The involvement of different managers and facilities in a single process makes it even more complex to manage.

Furthermore, as seen earlier, in omni-channel strategies, online orders can be fulfilled from DCs and even from suppliers. Thereby, the supplier's inventory (the Ap3 in Figure 5.7) can fulfill the retailer's customer online orders at the same time as it fulfills the retailer's DC orders. By the same token, the retailer's DC inventory (the Ap2 in Figure 5.7) can fulfill the customer's online orders at the same time it fulfills the store orders.

In doing so, it was considered that there are three processes responsible for maintaining the inventory of the Ap1, Ap2 and Ap3, namely Store Availability Process (SAP), DC Availability Process (DCAP), and Supplier Availability Process (PAP), respectively. Therefore, these processes operate in sequence in the omni-channel logistics network, with the objective of making the product available on the store shelf, i.e., in Ap1. Figure 5.8 shows this configuration.

Figure 5.8 – The processes sequence up to the Ap1



Source: by the author (2021)

However, according to most literature on retail out-of-stock, the main source of out-of-stock is in the store. Shelf replenishment issues, for example, range from 25% (GRUEN and CORSTEN, 2007) to 45% (GARCIA-ARCA et al, 2020) of the OOS. Store ordering issues, in turn, range from 47% (GRUEN and CORSTEN, 2007) to 61.5% (AASTRUP and KOTZAB,

2009) of the OOS. On the other hand, the DC as a source of OOS, range from 1.3% (AASTRUP and KOTZAB, 2009) to 15% (FERNIE and GRANT, 2008) of the OOS situations. Suppliers as source of OOS emerged with values that range 0.2% (AASTRUP and KOTZAB, 2009) to 30% (FERNIE and GRANT, 2008; GARCIA-ARCA et al, 2020). With this in mind, it was chosen to focus on SAP, which covers between 70% to 99.8% of the retail OOS situations mentioned in the literature.

5.4 THE STORE AVAILABILITY PROCESS (SAP)

As mentioned before, the application of the process identification method took place in two moments. In the first moment, to identify the omni-channel supply chain focus process, the SAP, which has already been done in the section 5.3. In the second moment, identifying each of its sub-processes and its layers, which are covered in this section.

5.4.1 The SAP Architecture Definition

The architecture definition purpose in this section is to provide a representation of the SAP's sub-processes. The steps are the same as those previously used for this in section 5.3, namely:

- *SAP's categorization,*
- *Sub-processes relationship definition and the*
- *SAP landscape.*

5.4.1.1 The Sub-Processes Categorization

The SAP is, in effect, the entire set of activities involved in the effort to make the product available on the shelf of a store from the inventory available on a DC. In doing so, within this context, are the product flow activities, the activities that support the latter, and the activities that manage all the others. Therefore, the SAP can be categorized into:

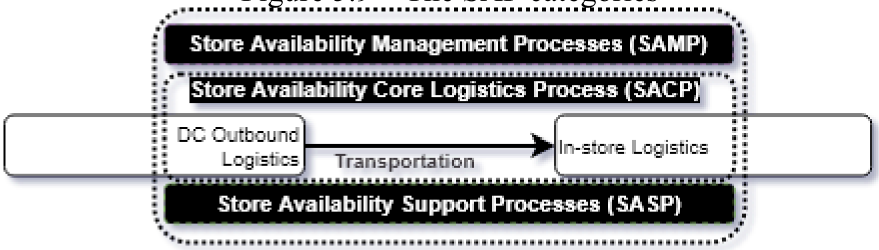
a) ***Store Availability Core Process (SACP)****: is the part of SAP directly responsible for the product flow, i.e., from the Ap2 to Ap1 (see Figure 5.8), and ranges from the store orders picking activity at the DC to shelves replenishment activity in-store.*

b) ***Store Availability Management Process (SAMP)****: is the part of SAP responsible for planning the SACP, establishing the workforce and procedures, as well as their management.*

c) ***Store Availability Support Process (SASP)****: is the part of SAP that supports the SACP to reach its objective, i.e., the product availability on the shelves.*

Considering the above, Figure 5.9 shows these three SAP categories and how they relate to each other:

Figure 5.9 – The SAP categories



Source: by the author (2021)

Please note in Figure 5.9 that SAP does not cover all DC activities and not all store activities, which will be better explained in the sequence. However, either the SACP, SASP or SAMP, cover the same flow range, with SAMP managing the other two. Next, each of the SAP categories is decomposed into sub-processes and further detailed.

5.4.1.2 SAP Decomposition and Relationship between its Sub-Processes

The SACP's Sub-processes

In order to allow for greater detailing of the SACP's sub-processes functionality, it was decomposed into sub-processes and then into activities.

For this purpose, the definitions of 'fundamental' and 'means' objectives from Keeney (1996) were used (see section 5.2.2). According to the author, stating a fundamental objective explicitly requires the definition of at least three features, which for the SAP were defined as follows:

a) ***Fundamental objective****: product availability;*

b) ***Decision context****: product available on the store shelves (to fulfill both the walk-in and the online customers);*

c) ***Direction of preference**: availability maximization within the interest range established by the company (or OOS minimization).*

According to Nickols (1998, p.18), a way to establish process boundaries, in this case, sub-processes, is "looking for places where state changes, hand-offs, and transfers of custody or ownership occur". In this sense, the 'means objectives' are positioned on the sub-process boundaries, therefore, the sub-processes constitute the activities between the means objectives identified within the SACP.

Since the product usually pauses, however briefly, and is handled (BARTHOLDI and HACKMAN, 2019) in the store backroom, the 'backroom product availability' was considered a 'mean objective'. This is because the product unavailable in the backroom for store replenishment, will probably imply OOS on the shelves as well. Thus, the first SAP's Sub-process is the **'Store Floor Sub-process' (SFS)**, placed between the 'backroom product availability' and 'product availability on the shelf'.

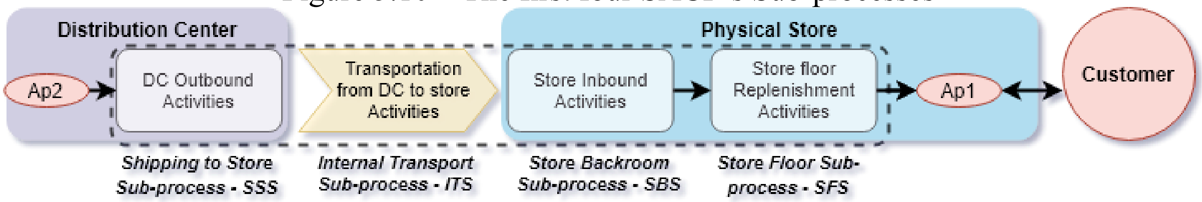
Following the same chain of thought, the transfer of custody between carrier and the store, was also considered a 'mean objective', where failures on delivery can cause OOS in the backroom. Thus, the second SACP's Sub-process is the **'Store Backroom Sub-process' (SBS)**, placed between the 'cargo delivery' and 'backroom product availability'.

The transfer of custody between DC and carrier represents another 'mean objective', since the 'dispatching failures' by the DC can cause 'incomplete deliveries' by the carrier. So, the third SACP's Sub-process is the **'Internal Transportation Sub-process' (ITS)**, placed between the DC ‘cargo dispatching’ and ‘cargo delivery’ at the store.

The last 'mean objective' of the SACP starts from its upstream limit, i.e., Ap2, where is allocated the DC inventory, representing the DC product availability. Thereby, the fourth SACP's Sub-process is the **'Shipping to Store Sub-process' (SSS)**, which is placed between the DC storage and DC cargo dispatching to the store. However, maintaining the DC's product availability is outside the scope of SAP and, consequently, of SACP.

In doing so, four SACP's sub-processes were identified: store floor, store backroom, internal delivery, and shipping to store. These sub-processes and their sequencing are presented in Figure 5.10.

Figure 5.10 – The first four SACP's Sub-processes



Source: by the author (2021)

Although backward logistics does not have the function of making the product available to customers like the four sub-processes mentioned above, it influences the store inventory level as the products are returned and reintegrated into its inventory. In doing so, one more sub-process was added to SACP: Store Return Sub-process (SRS). Each of the five SACP's sub-processes is further detailed below.

a) ***Store Floor Sub-process (SFS)*** *- The SFS is composed by two activities: picking and shelf replenishment. The picking involves the shelf review and products picking in the backroom. The shelf replenishment, in turn, involves traveling from the backroom to the store floor and the put-away of the product on shelves (MAGALHÃES, 2017).*

b) ***Store Backroom Sub-process (SBS)*** *- The SBS encompasses two activities: merchandise receiving and storage. The merchandise receiving includes tasks such as products inspection and preparation, and receiving regularization (LEVY et al, 2014; MAGALHÃES, 2017; BARTHOLDI and BACKMANN, 2019). The storage, in turn, involves traveling from the receiving area to the storage location, and the products put-away (MAGALHÃES, 2017; BARTHOLDI and BACKMANN, 2019)*

c) ***Store Return Sub-process (SRS)*** *– the SRS encompasses three activities: sort/test, refurbishment and disposal. The sort and test are the phase in which the product is tested and classified according to its conditions. Products classified as able to be refurbished, go through this process, otherwise, they are sent for disposal (BERNON et al., 2016; ANG and TAN, 2018).*

d) ***Internal Transportation Sub-process (ITS)*** *- The ITS involves the internal transportation from the DC to the stores (WATERS, 2003; WOLLENBURG et al., 2018;*

RAI et al., 2019), and has three activities: loading the order on the DC ramp, displacement from the DC to the store and delivering the order in the store ramp.

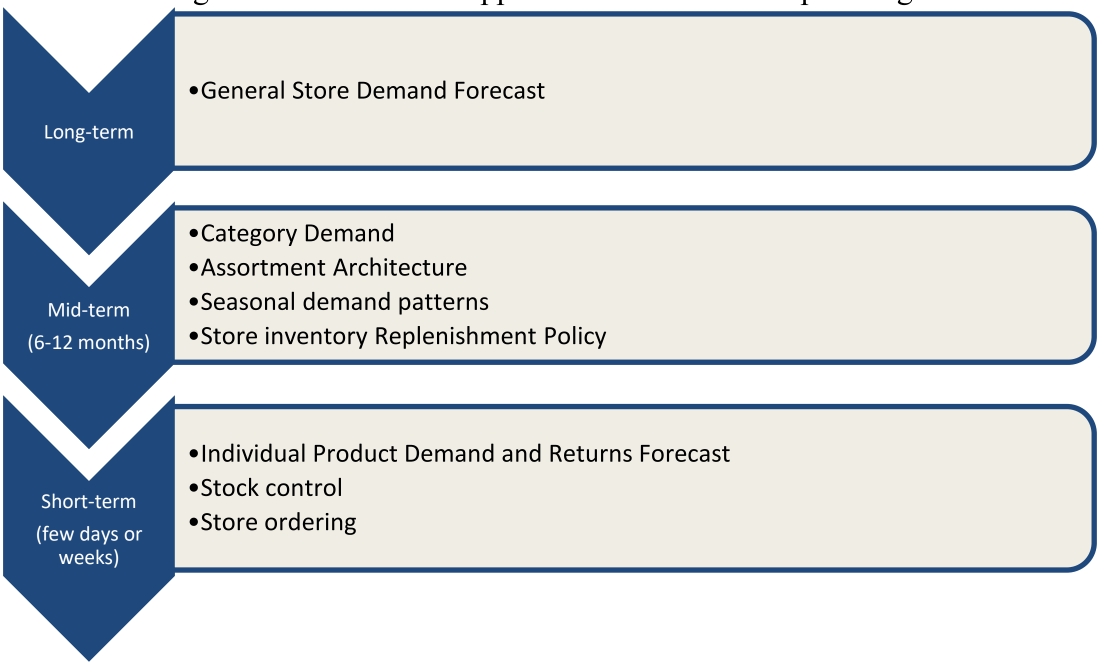
e) ***Shipping to Store Sub-process (SSS)*** *- The SSS covers the DC outbound activities, ranging from the receiving and processing the store order, to picking, packing and shipping of the store orders. Thus, the SSS is divided into three activities: order processing, order-picking, and order-packaging. The order processing involves receiving the store orders, verifying the available stock and producing pick lists to order-picking. On the other hand, order-picking activity involves tasks such as traveling to the location, searching for and extracting the products, in addition to paperwork and others. Finally, the order-packaging activity involves tasks such as order-checking, products packaging, and shipping the packages. The latter means the transfer of responsibility from the DC to the carrier for the packages to be sent to the store (BARTHOLDI and HACKMAN, 2019).*

The SASP's Sub-processes

If the core sub-processes encompass a set of activities involved with the flow of product availability on the shelf for the external customers, then the support sub-processes encompass a set of activities for overall company performance. In doing so, the support sub-processes are all the other sub-processes necessary for the proper functioning of the core sub-processes, with the exception of the management sub-processes. According to Levy and Weitz (2012), merchandise planning process involves decisions such as forecasting category sales, developing an assortment plan, determining appropriate inventory and product availability, allocating merchandise for stores, buying merchandise, and monitoring and evaluating performance and making adjustments.

For Fleischmann et al. (2005), the core activities are connected by information flows, which flow in the opposite direction to the flow of the products. According to the authors, the main horizontal information flows go upstream, involving customer orders, sales forecasts and internal orders for warehouse replenishment. Therefore, the relevant support sub-processes are those through which decisions and information related to products and market, drive the flow of products. Figure 5.11 presents the support activities to SACP found in the literature, based on the three main authors who explored the topic.

Figure 5.11 – SACP's support activities and their planning horizons



Source: Based on Fleischmann et al. (2005), Hübner et al. (2013), Levy et al. (2014) and Shang et al. (2020).

a) Support Activities based on Long-term planning:

- ***General store demand forecast** - the long-term forecasts sales are related to whole product range, since it is not possible to estimate them for each product, which "includes dependencies between existent product lines and future product developments" (FLEISCHMANN et al., 2005, p.88). Its function is to provide information to define the network design.*

b) Support Activities based on Mid-term planning:

- ***Category Demand Forecast** - since the product categories of the store are selected, the categories depth is defined from the consumer perspective. Demand forecasting per category sets the parameters for all other mid-term and short-term store planning. It is "usually calculated on a weekly or monthly basis for one year or less", and includes scheduling of marketing events and promotion (FLEISCHMANN et al, 2005, p.89).*
- ***Assortment Architecture** - is defined based on product and store specific issues, resulting in the definition of the allocation of products on the shelves (HÜBNER et al., 2013). According to Ayers and Odegaard (2017, p.43), "the business excellence requires savvy merchandise selection, targeting*

attractive customers, logistics skills, and collaboration with upstream and downstream trading partners".

- ***Seasonal demand patterns** – it influences the negotiation with suppliers, as well as the definitions of workforce and capacity at different points in the retail network (FLEISCHMANN et al., 2005; HÜBNER et al., 2013).*
- ***Store Inventory Replenishment Policy** - involves decisions such as to pull or push inventories from DC to stores. The 'pulling' strategy means generating inventory orders "at the store level on the basis of sales data captured by POS terminals". On the other hand, the 'pushing' strategy means to allocate inventory in the store based on the expected demand (LEVY et al., 2014, p.278).*

c) *Support Activities based on Short-term planning*

- ***Demand Forecasting Activities** - Considering a demand-based system, the demand forecast is the first and main information that a company needs to have (CHRISTOPHER, 2011; FLEISCHMANN et al., 2005; BALLOU, 2006; BOWERSOX and CLOSS, 2009). Short-term demand forecasting focuses on the individual product and adjusting inventory levels on a daily or weekly basis according to expected short-term effects and other planning decisions (HÜBNER et al., 2013).*
- ***Stock Control Activities** - The stock control has a high level of dependency on the stock recording from several others sub-processes, otherwise, it will pass the wrong information to the ordering subprocess.*
    - ***Stock adjustment activity** - It is responsible for stock accuracy, receiving information from both inbound and outbound inventory transactions, making the necessary adjustments (MERCADO, 2007).*
    - ***Inventory counting activity** - Since failures can occur in the records of inventory transactions, as well as in the execution of core processes, this sub-process is concerned with carrying out inventory counts in order to identify and eliminate the causes of discrepancies, as well as update the amount of registered inventory (MERCADO, 2007).*

- ***Store Ordering Activities*** *- Order planning includes determining order quantities and times against delivery frequency. It is responsible for balancing the inventory needs and available resources, such as vehicles, storage space and personnel, deciding and forwarding orders to the DC (HÜBNER et al., 2013). The demand forecasting sub-process provides to the store ordering sub-process with information about what, how much, when and where products probably will be required by customers. Based on that and with information about the quantity and location of the real stock that the company has, provided by the stock control sub-process, it generates orders and forwards it to the DC.*
- ***Return Forecasting Activities*** *- the use of stores as a processing returns point in omni-channel strategies leads to an imbalance in the stores' inventory if these volumes are not taken into account (DE BORBA et al., 2020). Therefore, as online sales increase, returns tend to increase as well, making forecasting returns a prerequisite for proper inventory maintenance (SHANG et al., 2020).*

Although the long- and mid-term planning involves relevant decisions with greater scope, they are more punctual decisions, not sub-processes. So, they are included as inputs. The only exception was the assortment architecture, which due to the dynamics of assortment decisions in omni-channel strategies, where there is a constant balancing and complementarity of the physical store and online store assortment (GARCIA-ARCA et al., 2020), was considered a sub-process.

Therefore, the SASP's Sub-Processes defined here were five: Assortment Architecture Sub-process (AAS), Store Ordering Sub-process (SOS), Stock Control Sub-process (SCS), Return Forecasting Sub-process (RFS), and Demand Forecasting Sub-process (DFS).

The SAMP's Sub-processes

According to Dumas et al. (2018, p.41), management processes "provide directions, rules, and practices for the core and support processes", which include, among others, strategic planning. Therefore, it includes information and decision processes and their vertical decomposition refers to the planning and allocation of scarce resources (GONÇALVES, 2000a). For Hübner et al (2013), a vertical distinction of planning tasks into long-, mid- and short-term can make it easier to see the importance and planning horizon of the processes. In this regard, the Demand and Supply Chain Planning (DSCP) framework developed by Hübner et al (2013) was used as a basis and adapted for the omni-channel environment, covering the entire SAP. Since each different node involved in the SACP has its management, procedures, and staff, the SAMP has been divided according to these nodes. Thus, the 'In-store Logistics Management' and 'DC Outbound Logistics Management' emerged.

Although internal transportation cannot be characterized as a node, but as a link, it also has its management, procedures, and staff. In doing so, the 'Internal Transportation Logistics Management' was also defined as part of the SAMP.

On the other hand, the SASP's management was divided into two groups, namely 'Inventory Management', which includes the SOS and SCS, and 'Demand Management', including the AAS, RFS, and DFS.

a) In-store Logistics Activities Management

Store long-term planning encompasses, among others, the strategic planning of its layout, which determines the space productivity, shapes the instore logistics processes, and sizes its capacity, both at the sales point and backroom. In addition, it defines the store location considering the accessibility of trucks with DC deliveries (HÜBNER et al., 2013).

On the other hand, store mid-term planning encompasses the personnel and logistics planning of the store, where (HÜBNER et al., 2013):

- *Personnel planning seeks to balance the workforce with expected customers frequency and in-store logistics activities, and;*
- *Instore logistics planning determines the cycles and windows of replenishment, seeking to balance the required on-shelf service levels and the instore logistics processes efficiency.*

Finally, short-term store planning encompasses personnel scheduling and short-term in-store logistics management plans, where (HÜBNER et al., 2013):

- *Personnel scheduling determines the schedules and responsibilities of staff to cover the in-store logistics on a weekly or daily basis, and;*
- *Short-term in-store logistics management plans the shelves replenishment and the sequencing of tasks related to the physical flow of products.*

b) DC Outbound Logistics Activities Management

The strategic warehouse design includes inbound and outbound logistics activities (HÜBNER et al., 2013). However, only outbound logistics activities of the warehouse are part of the SACP. In this regard, similar to the store's long-term planning, the DC's long-term planning encompasses the dimensioning and layout of the picking and dispatch area.

On the other hand, the warehouse's medium-term planning covers its capacity, personnel, and issues related to distribution planning. The distribution planning encompasses the distribution mode, order patterns, and allocation by product categories, dispatch unit selection, and packaging selection (HÜBNER et al., 2013), which are further detailed below:

- *Distribution mode includes decisions about specific flow types, such as direct store delivery, cross-docking, use of central or regional warehouses, or combinations of these.*
- *The order patterns and allocations are related to product characteristics and aggregation for economic and ease advantages.*
- *The selecting shipping units defines the granularity of possible order sizes, such as full pallet, cartons, or units.*
- *The packaging selection defines the use of reusable transportation packaging.*

Finally, short-term planning in DC outbound activities covers the allocation of short-term personnel resources and the sequence and release times of picking orders (HÜBNER et al., 2013).

c) Internal Transportation Logistics Activities Management

Long-term transport planning is concerned with designing the vehicle maneuvering areas and access ramp both at the DC outbound and at the store inbound. It also determines the transport mode and decides whether or not to outsource it and its extension. Mid-term transport planning covers decisions about delivery frequencies and master outbound route planning, along with mid-term utilization rate of outsourced and in-house transport services. Short-term transport planning involves the products flow execution between DC and store, where transport capacities and availability of vehicles, and personnel are considered (HÜBNER et al., 2013).

d) Inventory Management

Inventory management involves inventory planning, control and feedback on planning (CHING, 2000). According to Toomey (2000, p.1), inventory management "must be based on the product, the customer, and the process (either manufactured or purchased) that makes the product available". For Waters (2003, p.7), the inventory manager "makes decisions for policies, activities, and procedures to make sure the right amount of each item is held in stock at any time".

e) Demand Management

Typically, long-term demand forecasts are not under logistics management but under marketing management. However, both work together, each with its contribution, i.e., the marketing tracking the market and the logistics analyzing time series based on historical sales data (BALLOU, 2006). According to Mentzer and Moon (2004), 'demand management' function includes issues such as internal and external information sharing (such as marketing initiatives and promotions), assessing customer and product profitability (involving assortment definitions), and sales and operations planning (S&OP) process (such as sales forecasting, planning, and replanning).

5.4.1.3 The SAP Landscape

Since the core, management and support sub-processes that compose the Store Availability Process were established, it is possible to visualize the connection between them by node involved in it. The first and main SAP's node is precisely the store, where 7 of its 10 sub-processes are located:

SACP's Sub-processes:

- *Store Floor Sub-process (SFS)*
- *Store Backroom Sub-process (SBS)*
- *Store Returns Sub-process (SRS)*

SASP's Sub-process:

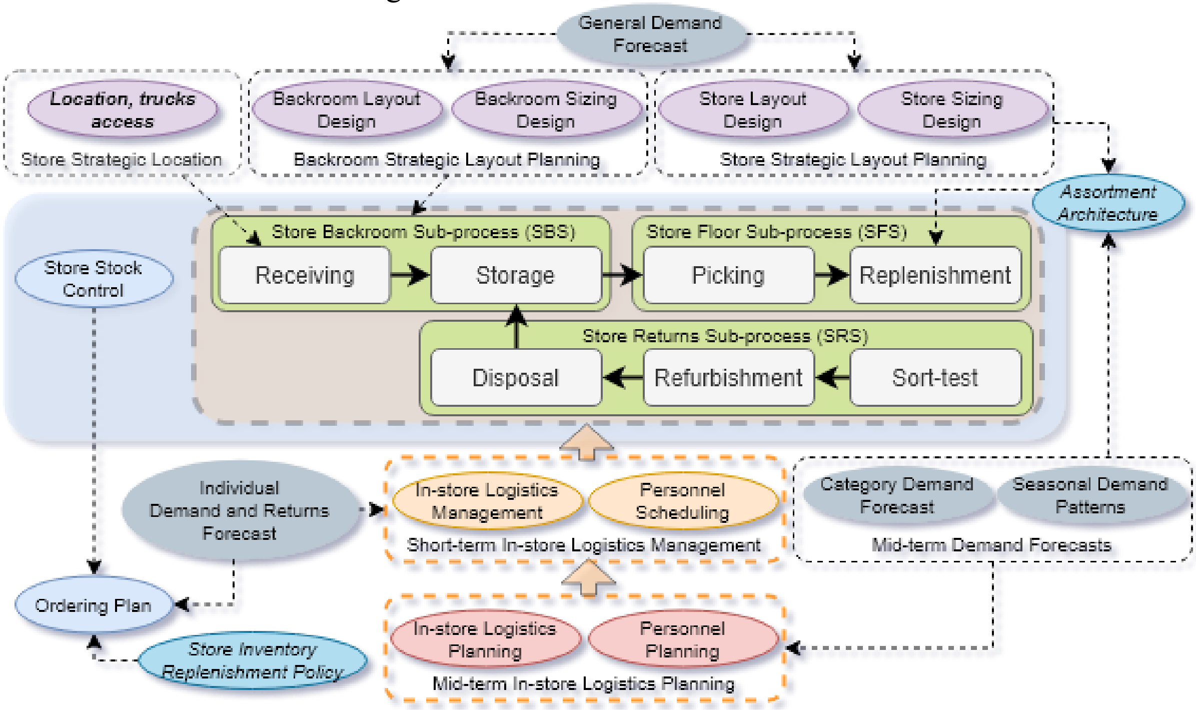
- *Assortment Architecture (AAS)*
- *Demand and Return Forecasting (DFS and RFS)*
- *Stock Control (SCS)*
- *Store Ordering (SOS)*

The store node is managed by In-store Logistics Management and is indirectly influenced by:

- *Store Inventory Replenishment Policy*
- *Store and Backroom Strategic Planning*
- *Store Strategic Location*

Figure 5.12 shows these connections.

Figure 5.12 – Store node infrastructure



Source: by the author (2021)

The second and last node directly involved with SAP is the DC, more specifically, the DC outbound logistics, where the following sub-process was located:

SACP's Sub-process:

- *Shipping to Store Sub-process (SSS)*

The DC node is managed by DC Outbound Logistics Management and is indirectly influenced by:

- *Store Ordering Sub-process (SOS)*
- *Picking and Dispatching Strategic Planning*
- *Mid-term Distribution Planning*

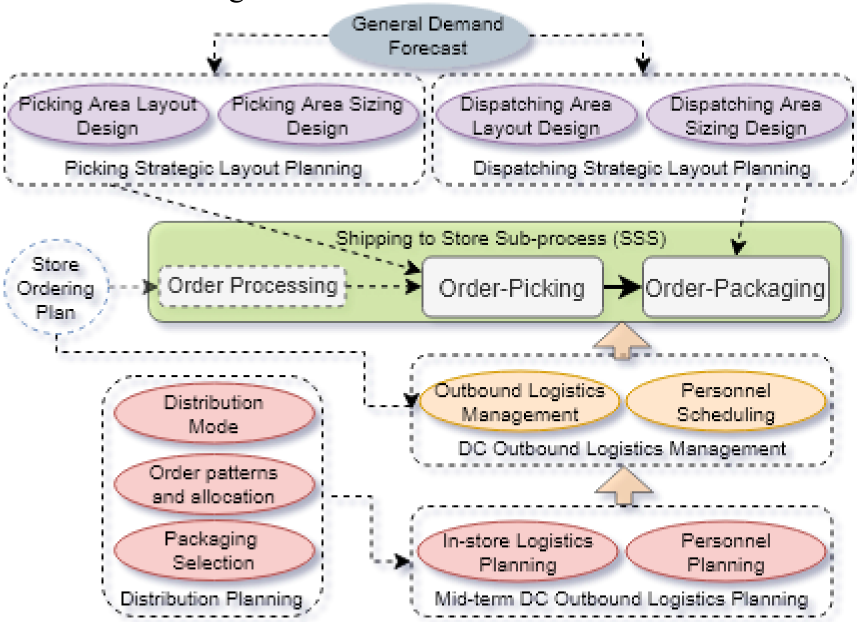
Figure 5.13 shows these connections.

Although the internal transportation phase is not a node, it has its own infrastructure, where a single subprocess is located:

SACP's Sub-process:

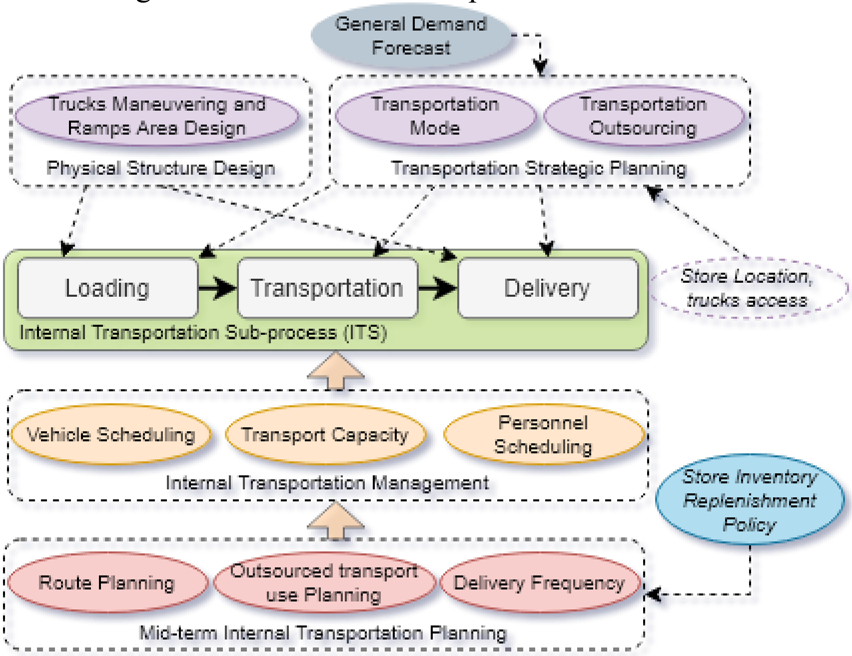
- *Internal Transportation Sub-process (ITS)*

Figure 5.13 – DC node infrastructure



Source: by the author (2021)

Figure 5.14 – Internal Transportation infrastructure



Source: by the author (2021)

The internal transportation phase is managed by Internal Transportation Management and is indirectly influenced by:

- *Store Inventory Replenishment Policy*
- *Store Strategic Location*

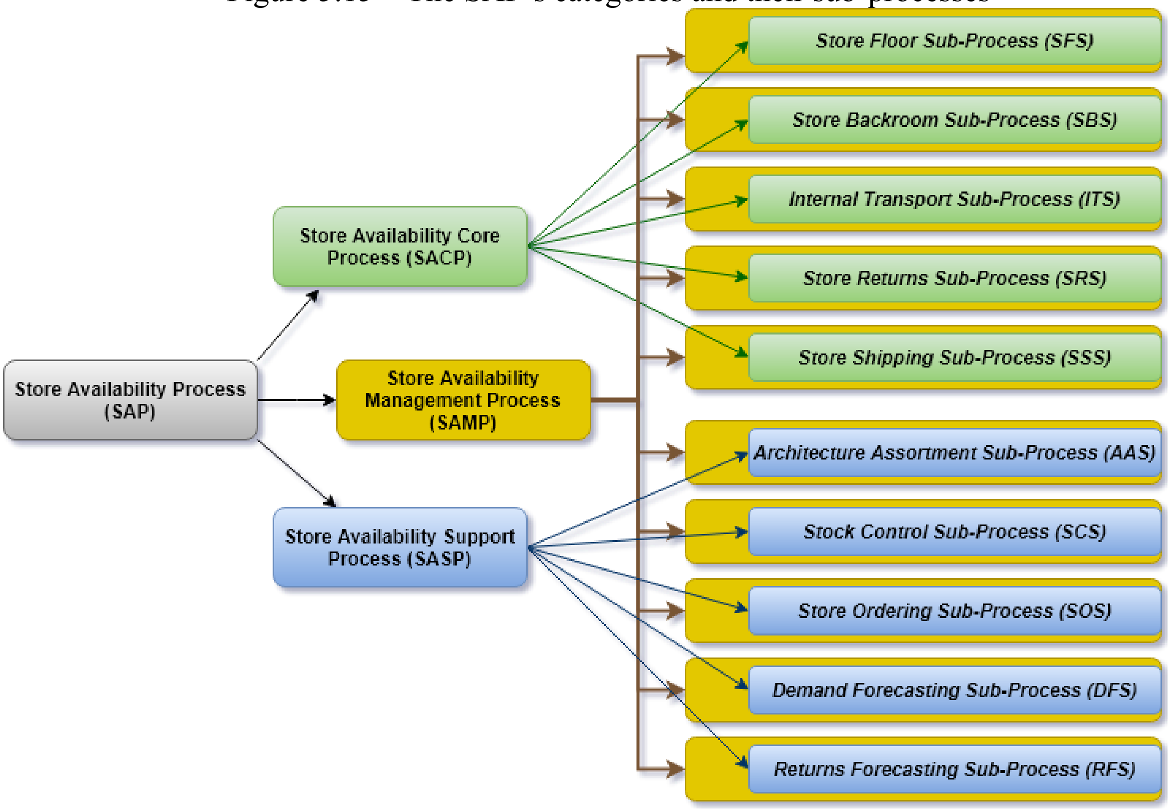
- *Transportation Strategic Planning*
- *Physical Structure Design*

Figure 5.14 shows these connections.

5.4.2 The SAP Sub-processes Selection

Ten sub-processes were selected to take part in the SAP which are represented according to their category of origin in Figure 5.15.

Figure 5.15 – The SAP's categories and their sub-processes



Source: by the author (2021)

Since the SAP, the base process of this model was defined and its sub-processes identified, the next step was to start developing the model from them.

6 RISK IDENTIFICATION MODEL DEVELOPMENT

Since the OOS causes in the retail and the omni-channel logistics challenges have been identified, and the base process architecture has been defined, it is time to build the risk identification model. First, the sub-processes causal diagrams are structured individually, and then they are all brought together in a general model.

6.1 THE OOS RISK IDENTIFICATION

Up to this point, the SAP and the SFS, which is the last SAP's sub-process, have been treated as generators of the 'fundamental objective', as well as their sub-processes as generators of the 'means objectives'. However, from this point on, the focus shifts to the ‘risk’ perspective. The concern is the 'risk objective' that can be generated by SAP and SFS, as well as the 'risk factors' that can be generated by the other SAP's sub-processes. Table 6.1 shows the 'means objectives', which refer to the desired outcomes in each sub-process, as well as the 'risk factors' corresponding to each of them, which refer to their outcome risks.

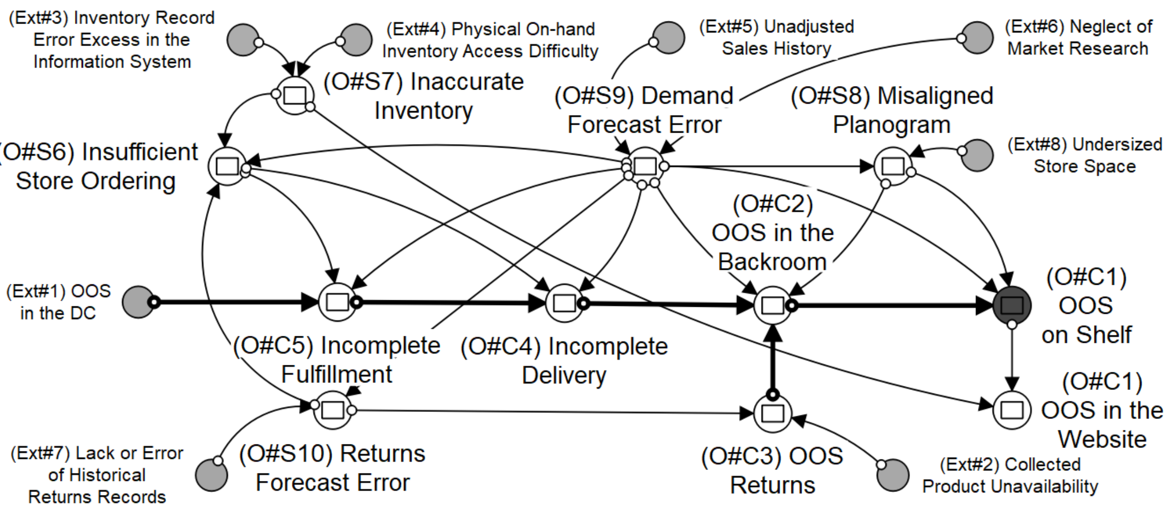
Table 6.1 – SAP’s Sub-processes and their desired and risk outcomes

ID	*SUB-PROCESS*		*MEANS OBJECTIVES*	*RISK FACTORS*
C1	SFS	Store Floor	Shelf Product Availability	OOS on Shelf
C2	SBS	Store Backroom	Backroom Product Availability	OOS in the Backroom
C3	SRS	Store Returns	Returns Availability	Return Unavailability
C4	ITS	Internal Transportation	Full Delivery	Incomplete Delivery
C5	SSS	Shipping to Store	Full Fulfillment	Incomplete Fulfillment
S6	SOS	Store Ordering	Store Aligned Orders Placement	Insufficient Store Ordering
S7	SCS	Stock Control	Accurate Inventory	Inaccurate Inventory
S8	AAS	Assortment Architecture	Store Aligned Planogram	Misaligned Planogram
S9	DFS	Demand Forecast	Demand Forecast	Demand Forecast Error
S10	RFS	Returns Forecast	Returns Forecast	Returns Forecast Error

Source: by the author (2021)

Considering the SAP's sub-processes sequence and relationship presented in the sections 5.4.1.2 and 5.4.1.3, it was possible to set up the first SAP's causal diagram representation, which worked as a driver for the individual configuration of each sub-process. Figure 6.1 shows the SAP's causal diagram representation.

Figure 6.1 – The SAP's causal diagram representation



Source: by the author (2021)

The arrows in Figure 6.1 indicate the direction of the influence of one risk factor over another. The gray circles represent the risk factors external to the model, while the white circles are the internal risk factors, which represent the outputs of the model's sub-processes. In the center, linked with a thicker arrow, are the product flow sub-processes, with the black circle representing the model's risk objective. These same rules apply to the other causal diagrams presented in this study.

Please note in Figure 6.1 that, in addition to the ten SAP sub-processes listed in Table 6.1, eight external risk factors were included that, although not part of SAP, have a direct influence on some of its sub-processes. These external risk factors are better explained as the sub-processes are presented. The same occurs with the 'OOS on the website', which is explained as a consequence of the 'inaccurate inventory' of the SCS.

6.1.1 The OOS Risks in the SAMP

When starting the sub-processes analysis, a pattern was identified regarding their management. This led to the establishment of a common structure that serves all of them, however, it is influenced by the characteristics of each one individually. This meets the process specialization attribute by Dumas et al. (2018, p.43), which states that there may be "several variants of a generic process". Thus, a SAMP's OOS Risks generic structure was defined for meeting each sub-process of the SACP and SASP.

In this section, the arguments for each of the six issues that compose the generic SAMP (G-SAMP) are presented. The theoretical basis that supports them is presented in the sections of each sub-process in the sequence. Since the categories of internal sources of risk are the available capacity, internal operation, and information system (OLSON and WU, 2010), these were used to organize the way how the SAMP issues reach the sub-processes. Thus, the issues related to the operational execution were converged on a central issue: execution. On the other hand, available capacity and information systems were converged on a second central issue: capacity. For some of the SAP's subprocesses, the capacity to operate is related to available space and layout, for the others the capacity depends more on information system specifications than on space or layout. Some sub-processes capacity is represented by space and layout, in others by information system specifications. Since the 'execution' and 'capacity' are the two gears that make the sub-processes work and generate the desired outcomes, the threats to them are respectively 'execution error' and 'insufficient capacity'.

The first and most comprehensive management issue related to OOS Risks in store-based OC identified was the company's awareness of OOS Risks. When establishing a risk tolerance policy, an organization needs to know its goals, its initial attitude towards risks, its capacity to manage them and absorb a potential loss related to taking them, as well as the costs and benefits in managing them (FRASER and SIMKINS, 2010). Only then the organization will be able to establish the means by which it uses its available resources and abilities to face adverse consequences, characterizing its risks coping capacity (JÜTTNER, 2005; RITCHIE and BRINDLEY, 2007; WATERS, 2011). According to Ayers and Odegaard (2017, p.107), "vague higher-level but immeasurable goals [...] may exist in any company, but these are seldom translated into consistent specifications for operations". Hence the importance of establishing clear measurement rules and OOS boundary targets, as well as policies to encourage managers to achieve them. Indeed, before a decision taken by the company is implemented, there should be a pause to ask the question: “how might this decision affect the risk profile of the business?” (CHRISTOPHER, 2018, p.23).

In this regard, the first potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

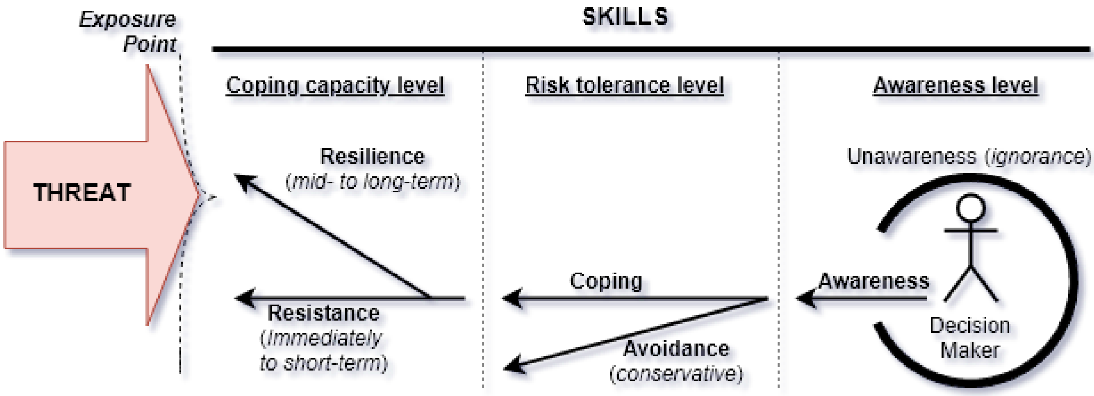
- *QCx[4].1: Is the company aware about its attitude towards OOS risk, as well as its measurement rules, targets, limits, and coping policies?*

Thus, assigning proper frequency with which the OOS information must be recorded and determining its degree of disaggregation by product variety then becomes strategic (McKINNON et al., 2007). The company's lack of clarity about OOS hits all core and support sub-processes, since they are all within the same company.

However, the company's top management does not have a direct scope of execution, although an organizational perspective promotes, in addition to objectivity in measurement, also the commitment of managers and employees involved in the systematic search for actions to reduce OOS events (MOUSSAOUI et al, 2016; GARCIA-ARCA et al., 2020).

Thereby, since the company has clearly determined its attitude towards OOS risks, and established the measurement rules, targets and limits, it needs to communicate and encourage managers to achieve them (WATERS, 2011). Figure 6.2 illustrates the path from a manager ignorance status of the existence of a threat to risk awareness, tolerance, and attitude in facing it.

Figure 6.2 – From risk awareness to coping capacity of OC manager



Source: by the author (2021)

[4] The 'x' here and in the next five questions, means that this question is adjusted for each sub-process and therefore varies in each of them, while keeping the same basis. So, this question in sub-process C1, for example, is expressed as QC1.1.

Taking the path described above is an action that must be encouraged and monitored by the company. Thus, the second potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

- *QCx.2: Is there an absence or insufficiency of awareness, direction and motivation of the manager in managing OOS risks?*

Although the manager is aware and motivated by OOS risks, they are not exactly the ones who carry out the procedures for the logistics activities. So, managers need to maintain his/her staff aware, motivated and trained (WATERS, 2011). A staff ignorant of the importance of OOS to company profitability, as well as proper logistics procedures, will continue to promote OOS unknowingly.

Therefore, the staff is one of the main means by which a manager manages OOS risk. Thus, the third potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

- *QCx.3: Is there an absence or insufficiency of awareness, direction and motivation of staff about the OOS risks and their participation in them?*

Although operating staff are aware and motivated about OOS risks importance, without proper procedures they are unlikely to be able to meet the off-the-shelf availability targets set by the company. Thus, the fourth potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

- *QCx.4: Are the sub-process procedures defined, aligned with the specific demands of omni-channel logistics and properly explained to the store staff?*

Another important issue is the sub-process execution planning, since it is necessary to adapt resources to demands for example, daily, weekly, monthly and even annual seasonality. Thus, the fifth potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

- *QCx.5: Is the manager planning short-term logistics execution, scheduling the staff according to information of demand forecast and seasonality patterns, and considering both the online and the offline demand?*

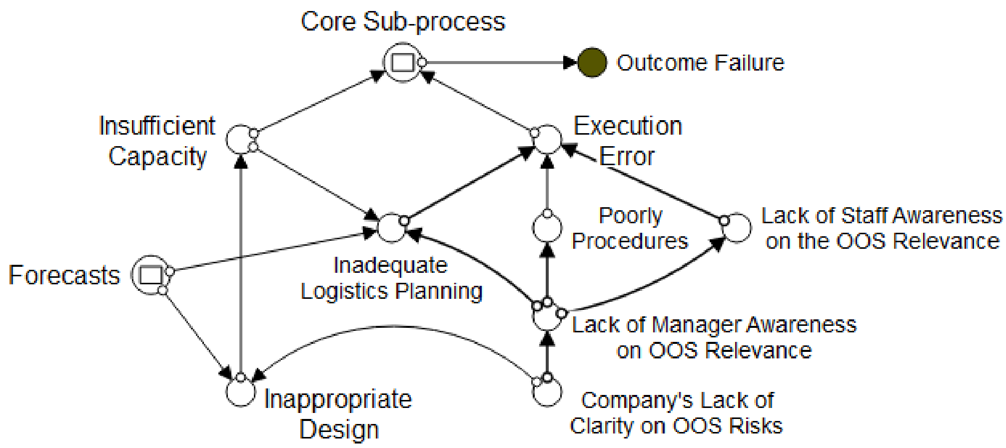
These last three questions, i.e., on lack of staff awareness, poor procedures and inadequate planning, converge to a possible execution error.

However, although the staff, procedures, and planning are all aligned, space restrictions hinder the expected outcome from being generated. In doing so, another comprehensive management issue related to OOS Risks in store-based OC was identified, the inappropriate design. Thus, the sixth potential OOS risk cause in the G-SAMP emerges, which can be identified by answering the following question:

- *QCx.6: Is the company concerned about adjusting the distribution or production of new spaces according to changes, whether in strategy or sales behavior, as well as constantly adjusting layouts to processes?*

This last issue directly implies insufficient capacities for the execution of subprocesses. Since the six basic issues which compose the G-SAMP were formulated, it is possible to connect them, creating a causal diagram, which is shown in Figure 6.3.

Figure 6.3 – Generic Store Availability Management Process (G-SAMP)



Source: by the author (2021)

Summing up the G-SAMP, the absence or insufficiency of the company's clarity about OOS risks will probably cause the same effect on the manager's awareness level about OOS risks. The latter can cause three other negative effects: lack of staff awareness, poor procedures, and inadequate logistics planning. Consequently, any of the above three negative effects, or a combination of them, can cause sub-process execution errors, which in turn can cause sub-process outcome delivery failures.

On the other hand, an inappropriate design, which can be caused either by the company's lack of clarity about OOS risks or by forecasts failures, can still result in an infrastructure with insufficient capacity to execute the sub-process, also compromising its outcome. Logistics planning is based on demand or return forecasts. Depending on the sub-process and the infrastructure capacity, failures in these forecasts and space restrictions can also lead to inadequate logistics planning.

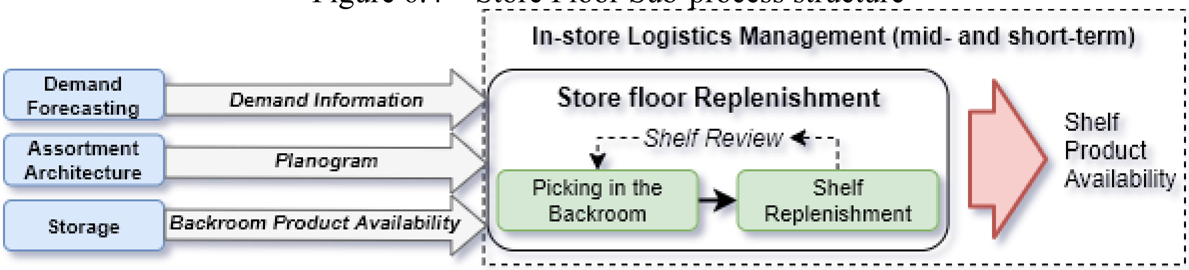
6.1.2 The OOS Risks in the SACP's Sub-Processes

In order to set up the causal diagram of the core SACP subprocesses, in this section, elements were extracted from the Chapters 4 and 5. The objective is to bring consistency to the causal diagram of risk factors of the SACP subprocesses.

6.1.2.1 The OOS Logistics Risks Identification in the SFS

The Store Floor Sub-process (SFS) ranges from the shelf review and organizing to product picking and shelf replenishment. Its input resources are shelf capacity, established by the planogram, and backroom stock availability, as well as the demand information used for workforce planning and scheduling. Figure 6.4 shows the SFS structure.

Figure 6.4 – Store Floor Sub-process structure



Source: by the author (2021)

Its planning and execution are managed by the in-store logistics management with mid- and short-term decisions related to in-store logistics procedures and personnel. On the other hand, its output is the most important outcome of this study, i.e., the shelf product availability.

As previously explained, availability can only be considered a valid result if it has at least the following three attributes met:

- ***On place*** *- product placed in the planned location, in an accessible and organized way;*
- ***On time*** *- according to the planned process deadline;*
- ***In suitability*** *- no damage, not expired, with the suitable packaging.*

Therefore, if any of the three attributes is not met for a given product, it is considered as OOS.

The Causes of OOS Logistics Risks of the Retail in the SFS

In the omni-channel typology explored in this study, the OOS materializes on the shelf. It is precisely in the SFS that the greatest probabilities of its occurrence are located.

The manager awareness and motivation were mentioned on issues such as the lack of managerial emphasis on the importance of OSS (MOUSSAOUI et al., 2016), insufficient store hours authorized for shelf replenishment (ETTOUZANI et al., 2012; CORSTEN and GRUEN, 2003), lack of leadership (ETTOUZANI et al., 2012), staff unavailable for replenishment activities (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013; Mc KINNON et al., 2007) and item not replenished by an external staff (EHRENTHAL and STÖLZLE, 2013), as well as managers turnover (MOUSSAOUI et al., 2016).

On the other hand, staff awareness emerged from issues such as lack of motivation (Mc KINNON et al., 2007), absenteeism (EHRENTHAL and STÖLZLE, 2013), lack of replenishment training (ETTOUZANI et al., 2012) and turnover (MOUSSAOUI et al., 2016).

Poor in-store logistics procedures were also mentioned, such as the lack of a proper replenishment trigger (TAYLOR and FAWCETT, 2001; CORSTEN and GRUEN, 2003; GRUEN et al., 2002), low replenishment frequency (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003), minimally sophisticated tracking and shelving systems (MOUSSAOUI et al., 2016) or lack of one (EHRENTHAL and STÖLZLE, 2013), product with no sale condition and not detected (McKINNON et al., 2007), stockout item substituted by another item unnecessarily on shelf, product in a secondary place in the store and featured item different from standard item (EHRENTHAL and STÖLZLE, 2013).

Finally, general errors that may have been caused by both the lack of staff motivation and the poor procedures were mentioned, such as general failures (AASTRUP and KOTZAB, 2009) or replenishment delays (CORSTEN and GRUEN, 2003), staff did not notice or report stockout (EHRENTHAL and STÖLZLE, 2013), poor shelf maintenance (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003), product placement in non-compliance with the planogram (EHRENTHAL and STÖLZLE, 2013; CORSTEN and GRUEN, 2003), misplaced item, sell-by date expiration, inappropriate handling, secondary packaging not removed, promotional shelf empty or not replenished (EHRENTHAL and STÖLZLE), messy shelf (Mc KINNON et al., 2007), and inadequate shelf labeling (EHRENTHAL and STÖLZLE, 2013), as well as picking failures (McKINNON et al., 2007) and backroom stock not replenished (TAYLOR and FAWCETT, 2001).

The Omni-channel Logistics Challenges in the SFS

The three omni-channel logistics challenges identified within the SFS in this study were: additional in-store logistics (HÜBNER et al., 2016b; RAI et al., 2019; ARSLAN et al., 2020), competition for on shelf products between customers and pickers (HÜBNER et al., 2016b; RAI et al., 2019), and conflicts between channels (MELACINI et al., 2018).

In this regard, additional in-store logistics refers to the effort to replenish shelves that fulfill not only the walk-in customer but also online orders. On the other hand, the space in front of the shelves that was already divided between walk-in customers and stockers is now also shared with the online order pickers. Finally, the conflicts between channels can lead the in-store logistics manager to prioritize the walk-in customers to the detriment of online orders.

In light of the above, none of the aforementioned causes of OOS logistics risks in retail within the SFS should be disregarded, as they were even intensified by the increase in the turnover of goods on the shelves.

The architecture of the OOS Logistics Risks of the OC in SFS

Considering the OOS causes and OC logistics challenges in the SFS mentioned above, the G-SAMP questions adjusted to the SFS were as follows:

QC1.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the store floor logistics operation importance, considering different channels being fulfilled from the same structure?

QC1.2: Is there an absence or insufficiency of awareness, direction and motivation of the in-store logistics manager in managing shelves OOS risks?

QC1.3: Is there an absence or insufficiency of awareness, direction and motivation of replenishment staff about the OOS risks on shelf and their participation in organizing and maintaining them?

QC1.4: Are the replenishment procedures defined, aligned with the specific demands of omni-channel logistics and properly explained to the replenishment staff, as well as the prioritization between walk-in customer demand and online orders demand established?

QC1.5: Is the in-store logistics manager planning short-term replenishment execution, scheduling the replenishment staff according to information of demand forecast and seasonality patterns, and considering both the online and the offline demand?

QC1.6: Is the company concerned about adjusting the store floor sizing and layout according to the changes brought about by the store-based omni-channel strategy, adapting and adjusting to the alignment of the assortment and sales volume for both online and offline?

The 'risk objective' of SFS, which is also the 'risk objective' of the whole Store Availability Process (SAP), is the OOS on the shelf (O#C1). Internally, it can emerge from replenishment execution errors (IE#C1), caused by one or more elements specified in the SAMP questions, or by insufficient store floor capacity (IS#C1), due to its inappropriate size and/or layout. Externally, its 'risk factors' can arise from the SBS, due to a OOS in the backroom (O#C2), from the AAS, due to a misaligned planogram (O#S8), and/or from the DFS, due to a demand forecast errors (O#S9). The causal structure elements of the SFS are shown in Table 6.2.

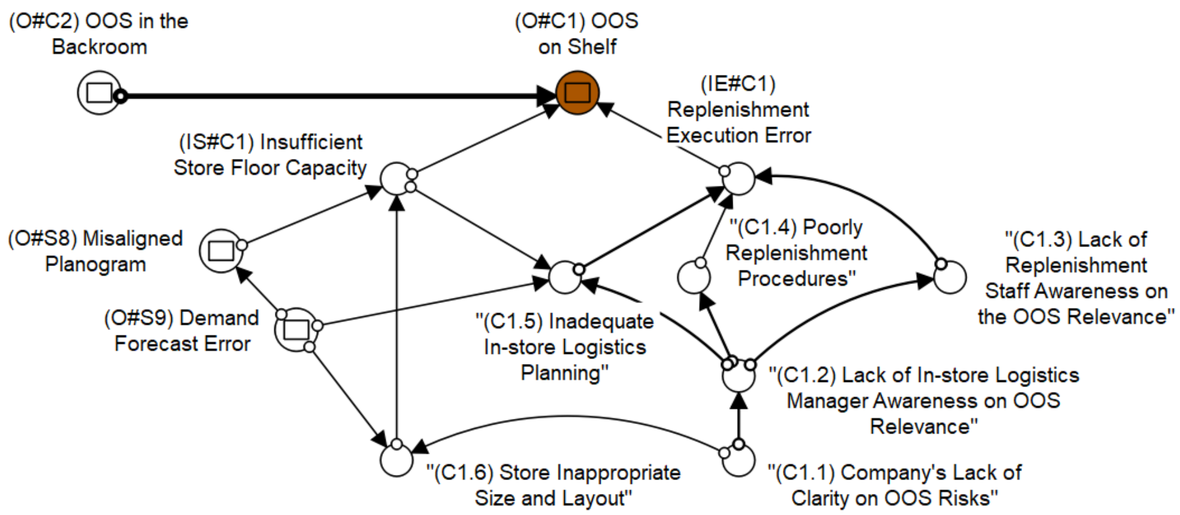
Table 6.2 – Causal structure elements of the SFS

Status	ID	Risk Factor
Input Failure	O#C2	OOS in the Backroom
	O#S8	Misaligned Planogram
	O#S9	Demand Forecast Errors
Internal Error	IE#C1	Replenishment Execution Error
		C1.1 Company's Lack of Clarity on OOS Risks
		C1.2 Lack of In-store Logistics Manager Awareness on OOS Relevance
		C1.3 Lack of Replenishment Staff Awareness on the OOS Relevance
		C1.4 Poorly Replenishment Procedures
		C1.5 Inadequate In-store Logistics Planning
	IS#C1	Insufficient Store Floor Capacity
		C1.6 Inappropriate Store Size and Layout
Output Failure	O#C1	OOS on Shelf

Source: by the author (2021)

Concerning to the relationship between the risk factors in the SFS, the same structure explained in the G-SAMP (Figure 6.17), remains here. The only exception is the addition of one more risk factor: misaligned planogram (O#S8). The latter is influenced by demand forecasting error and generates insufficient store floor capacity, which in turn can cause the OOS on the shelf. Figure 6.5 presents the relationship between the causal structure elements of the SFS shown in Table 6.2.

Figure 6.5 – Causal diagram of the SFS



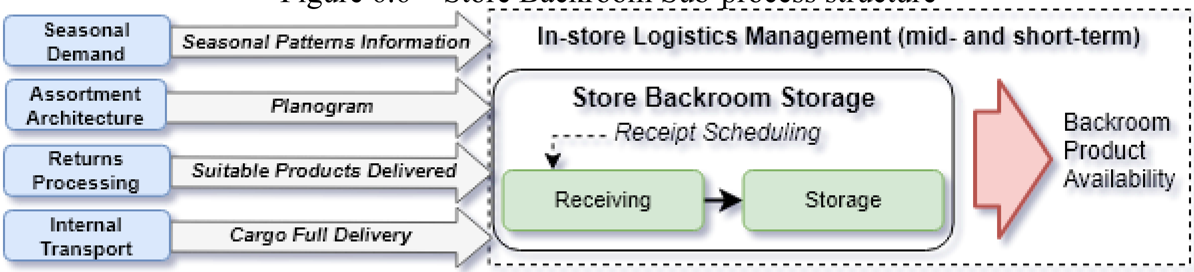
Source: by the author (2021)

Thus, a misaligned planogram and the demand forecast errors represent threats to the stock availability on the shelf. Without stock in the backroom, it is not possible to replenish the shelf as the stock in it runs out. If the planogram is misaligned, it can cause insufficient shelf space to accommodate the necessary replenishment interval, even if the manager increases the frequency of this activity. Finally, the demand forecast error represents a threat, as the busy hours of customers in the store, as well as their behavior by category, affect the staff's schedule. The next 'core sub-process' to be explored is the SBS.

6.1.2.2 The OOS Logistics Risks Identification in the SBS

The Store Backroom Sub-process (SBS) ranges from scheduling and executing the receipt of DC deliveries to regularizing and putting away products in their specified locations. Its inputs resources are storage capacity, which is a reflex of the planogram of the store, products delivered by internal transport and product from customer returns and order cancellations, as well as demand seasonality pattern information of personnel planning and space allocation by product categories. Figure 6.6 shows the SBS structure.

Figure 6.6 – Store Backroom Sub-process structure



Source: by the author (2021)

By the same token that SFS, the SBS planning and execution are managed by the in-store logistics management with mid- and short-term decisions related to in-store logistics procedures and personnel. On the other hand, its output and also the outcome to be delivered to the SFS is the backroom product availability.

Reinforcing that, for the same reason as the 'on shelf availability', the backroom availability can only be considered a valid result if it has on place, on time, and is suitable. Thus, if any of the three attributes are not met for a given product, it is considered as a backroom OOS.

The Causes of OOS Logistics Risks of the Retail in the SBS

The OOS causes in the SBS range from failures in receiving products, such as scheduling delivery (ECR EUROPE, 2003), to receiving the cargo, product conference, and product preparation with delay in quality control, as well as storage failures, such as items still stocked in product-received area (EHRENTHAL and STÖLZLE, 2013).

The backroom space availability (Mc KINNON et al., 2007), with congested (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; FERNIE and GRANT, 2008) and messy backroom, making product tracking difficult (EHRENTHAL and STÖLZLE, 2013; MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; Mc KINNON et al., 2007; GRUEN et al., 2002) were also mentioned as OOS causes in the SBS.

The Omni-channel Logistics Challenges in the SBS

Two omni-channel logistics challenges related to SBS were found both caused by the increase in product returns due to online sales: re-stocking the returned product (BERNON et al., 2016; DE BORBA et al., 2020) and misplaced product inventory (DE BORBA et al., 2020). With the returned products processing in the store, the products considered salable are redirected for re-stocking in the backroom, causing re-work and problems because they usually return with individual packages.

The architecture of the OOS Logistics Risks of the OC in SBS

Considering the OOS causes and OC logistics challenges in the SBS mentioned above, the G-SAMP questions adjusted to the SBS were as follows:

QC2.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the backroom logistics operation importance, considering the relevance of its supporting role in the maintenance of stocks on the shelf?

QC2.2: Is there an absence or insufficiency of awareness, direction, and motivation of the in-store logistics manager to manage the adequacy and organization of the backroom in order to avoid OOS risks due to misplaced products and delays in procedures?

QC2.3: Is there an absence or insufficiency of awareness, direction, and motivation of the receiving and storage staff about the OOS risks in the backroom and their participation in them?

QC2.4: Are receipt and storage procedures defined, aligned with the seasonal demand patterns specific to the omni-channel strategy, and properly explained to store staff?

QC2.5: Is the in-store logistics manager planning the short-term receipt and storage executions, scheduling the staff according to information of demand forecast and seasonality patterns, and considering both the online and the offline demand?

QC2.6: Is the company concerned about adjusting the backroom sizing and layout according to the changes brought about by the store-based omni-channel strategy, adapting to the impact caused by the alignment of the assortment and sales volume both online and offline in the store?

The 'risk objective' of the SBS, is the OOS in the backroom (O#C2). Internally, it can be emerged from storage execution errors (IE#C2), caused by one or more elements here specified in the SAMP questions, or by insufficient backroom capacity (IS#C2), due to its inappropriate size and/or layout. Externally, its 'risk factors' can arise from the SRS, due to an unavailability of expected return (O#C3), from the ITS, due to an incomplete delivery (O#C4), from the AAS, due to a misaligned planogram (O#S8), and/or from DFS, due to demand forecast errors (O#S9). The causal structure elements of the SBS are shown in Table 6.3.

Table 6.3 – Causal structure elements of the SBS

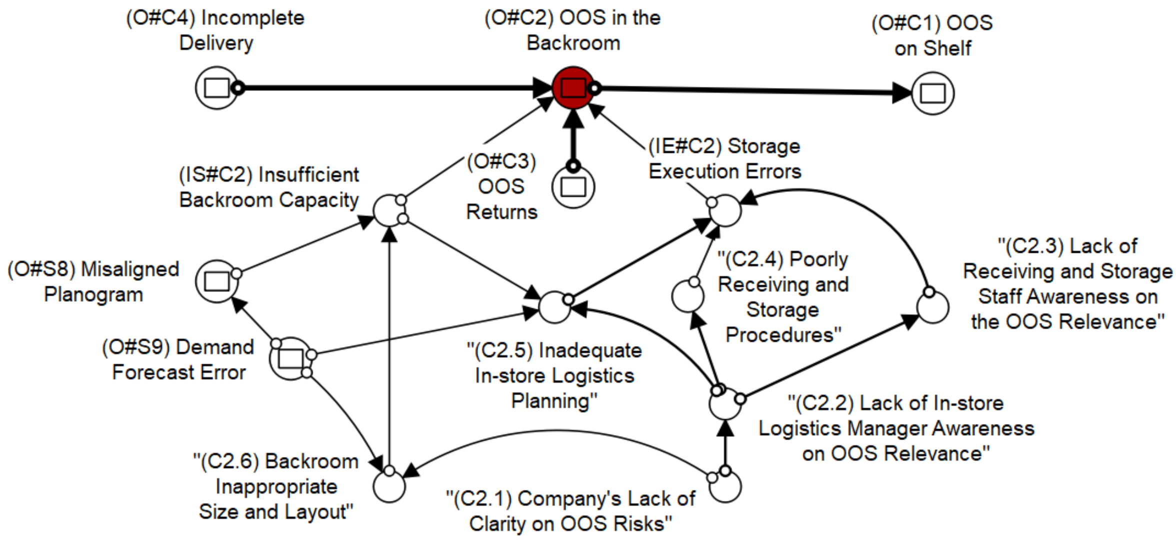
Status	ID	Risk Factors	
Input Failure	O#C3	Return Unavailability	
	O#C4	Incomplete Delivery	
	O#S8	Misaligned Planogram	
	O#S9	Demand Forecast Errors	
Internal Error	IE#C2	Storage Execution Errors	
		C2.1	Company's Lack of Clarity on OOS Risks
		C2.2	Lack of In-store Logistics Manager Awareness on OOS Relevance
		C2.3	Lack of Receiving and Storage Staff Awareness on the OOS Relevance
		C2.4	Poorly Receiving and Storage Procedures

		C2.5 Inadequate In-store Logistics Planning
	IS#C2	Insufficient Backroom Capacity
		C2.6 Backroom Inappropriate Size and Layout
Output Failure	O#C2	OOS in the Backroom

Source: by the author (2021)

The behavior of the G-SAMP in the SBS is the same explained in the Figure 6.3 and the SBS output failure is the 'OOS in the Backroom'. In addition to G-SAMP, the return unavailability, an incomplete delivery, an inadequate backroom infrastructure, and the demand forecast errors represent threats to the stock availability in the backroom. Figure 6.7 presents the relationship between the causal structure elements of the SBS shown in Table 6.3.

Figure 6.7 – Causal diagram of the SBS



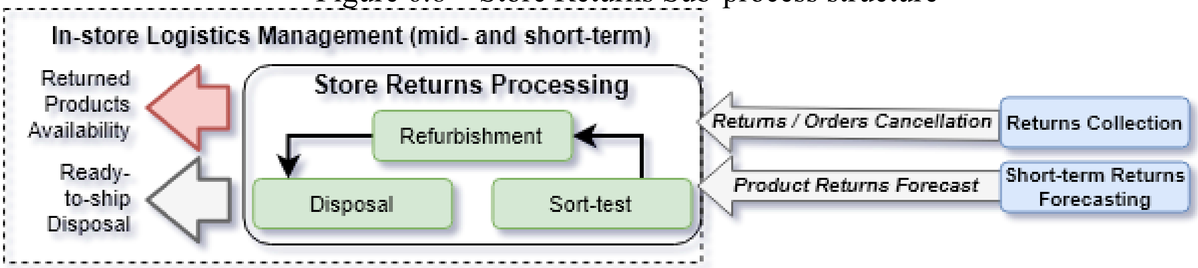
Source: by the author (2021)

The unavailable returns mean that, according to returns forecasts, the product was expected in the backroom at that time, which, for some reason, did not happen. The incomplete deliveries by carriers, in turn, whether by delivery delay, by missing, exchanged, or damaged products cause, the products not to be in the desired place and time. On the other hand, a misaligned planogram can result in increased product turnover on the shelves, requiring more backroom space to support replenishment. If the backroom space is insufficient, it becomes crowded and congested, making it difficult to locate and access products. Finally, the demand forecast error represents a threat, as the seasonal peaks require more attention and planning, affecting backroom occupancy and staff scheduling.

6.1.2.3 The OOS Logistics Risks Identification in the SRS

The Store Returns Sub-process (SRS) extends from the returned products receipt at the store, to sort-test that defines the return destination, refurbish of suitable products or disposal of unsuitable ones. Its input resources are the capacity generated from the backroom layout and size, the returns forecast, and the returns collected from customers and/or from order cancellation. Figure 6.8 shows the SRS structure.

Figure 6.8 – Store Returns Sub-process structure



Source: by the author (2021)

By the same token that SFS and SBS, the SRS planning and execution is managed by the in-store logistics management with mid- and short-term decisions related to in-store logistics procedures and personnel. On the other hand, one of its outputs, which is of interest for this study, is the availability of the suitable product for storage, therefore, an SBS input.

The product returns are an emergent issue of omni-channel retailing. Therefore, it has not been mentioned as an OOS cause by traditional retailing literature.

The Omni-channel Logistics Challenges in the SRS

If, on the one hand, the ease of returning purchases is a competitive advantage that becomes a factor in the online customer's purchase decision, on the other hand, generous return policies imply a much higher percentage of product returns than in traditional retail (AYERS and ODEGAARD, 2017). Thereby, returns processing was mentioned as an omni-channel logistics challenge on issues such as reinserting products from canceled orders (BERNON et al., 2016; SAHA and BHATTACHARYA, 2020), the backroom space constraints to do so (ARSLAN et al., 2020; SAHA and BHATTACHARYA, 2020) and the increased in-store logistics effort to handle returns (DE BORBA et al., 2020; HÜBNER et al., 2016c).

The Architecture of the OOS Logistics Risks of the OC in SRS

Considering the OOS causes and OC logistics challenges in the SRS mentioned above, the G-SAMP questions adjusted to the SBS were as follows:

QC3.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the returns logistics operation influence, considering the impact of reinserting returned products on store inventory levels?

QC3.2: Is there an absence or insufficiency of awareness, direction and motivation of the in-store logistics manager to manage the returned products reinsertion, balancing the store inventory level and avoiding OOS situations?

QC3.3: Is there an absence or insufficiency of awareness, direction and motivation of the returns processing staff about the OOS risks involving product returns and their participation in them?

QC3.4: Are the returns processing procedures defined, aligned with the specific demands of omni-channel logistics, considering the minimum level of product suitability and meeting the deadlines expected for its availability, as well as properly explained to the returns processing staff?

QC3.5: Is the in-store logistics manager planning the short-term returns processing execution, scheduling the staff according to information of returns forecast?

QC3.6: Is the company concerned about establishing a specific and adequate area and layout for processing returns, as well as considering the evolution of online sales in the mid- and long-term, which could lead to an increase in returns?

The 'risk objective' of the SRS is the return unavailability (O#C3). Internally, it can emerge from returns processing execution errors (IE#C3), caused by one or more elements here specified in the SAMP questions, or by insufficient returns processing area capacity (IS#C3), due to its inappropriate size and/or layout. Externally, its 'risk factors' can arise from the RFS, due to returns forecast errors (O#S10) and/or from a sub-process external to SAP, therefore outside the scope of this model, the collected product unavailability from returns or orders canceled (Ext#2). The causal structure elements of the SRS are shown in Table 6.4.

Table 6.4 – Causal structure elements of the SRS

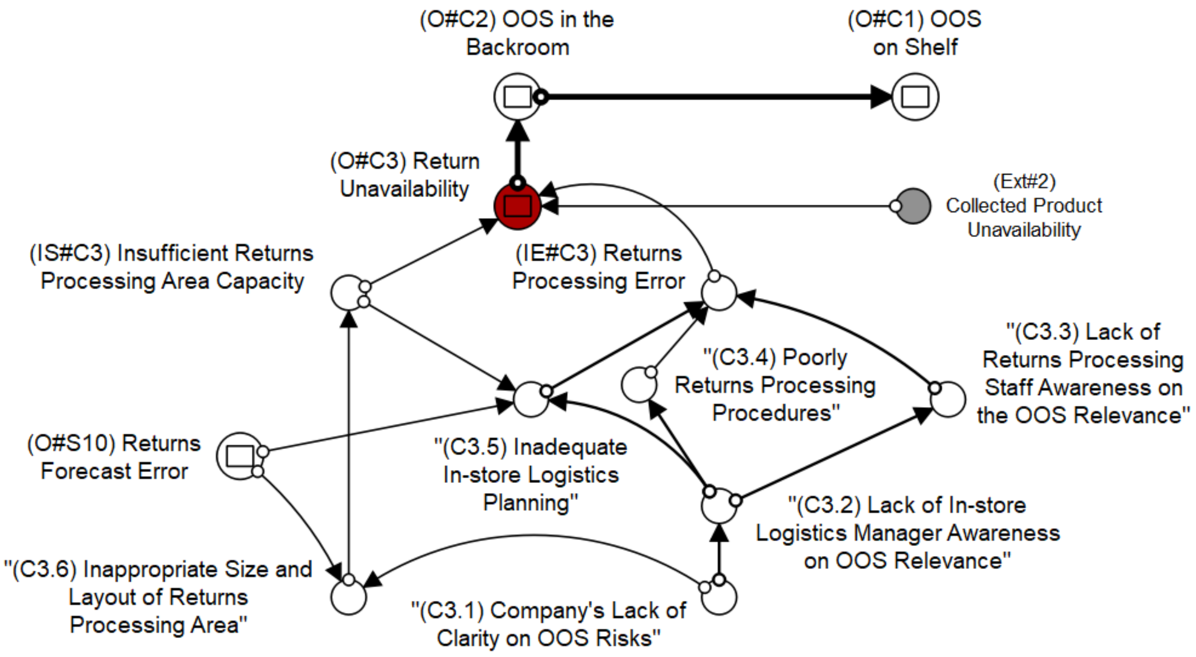
Status	ID	Risk Factors
Input Failure	O#S10	Returns Forecast Error
	Ext#2	Collected Product Unavailability from returns or orders cancellation
Internal Error	IE#C3	Returns Processing Error
		C3.1 Company's Lack of Clarity on OOS Risks
		C3.2 Lack of In-store Logistics Manager Awareness on OOS Relevance
		C3.3 Lack of Returns Processing Staff Awareness on the OOS Relevance
		C3.4 Poorly Returns Processing Procedures
		C3.5 Inadequate In-store Logistics Planning
	IS#C3	Insufficient Returns Processing Area Capacity
		C3.6 Inappropriate Size and Layout of Returns Processing Area
Output Failure	O#C3	Return Unavailability

Source: by the author (2021)

The behavior of the G-SAMP in the SRS is the same explained in the Figure 6.16 and the SRS output failure is the 'returned product unavailability'. In addition to G-SAMP, the collected product unavailability from returns or orders cancellation and returns forecast errors represent threats to the returned product availability for stock reintegration. Figure 6.9 presents the relationship between the causal structure elements of the SBS shown in Table 6.4.

The sub-process of returns processing sets and communicates a deadline to sort-test the products collected, which is expected by the backroom storage and, consequently, by the store floor replenishment. This deadline is defined based on the collection plan, which in case of failure, makes the expected product unavailable to be processed.

Figure 6.9 – Causal diagram of the SRS



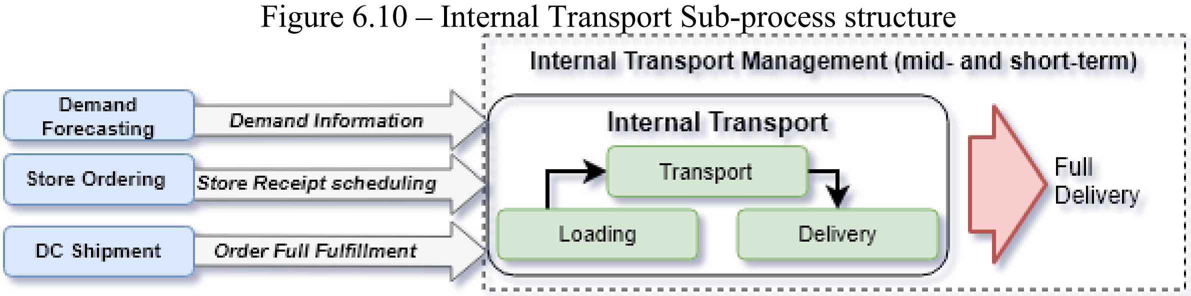
Source: by the author (2021)

On the other hand, the return forecast error poses a threat, as processing planning uses it for staff and capacity scheduling.

6.1.2.4 The OOS Logistics Risks Identification in the ITS

The Internal Transportation Sub-process (ITS) ranges from loading store orders on the DC to transport and delivery to the store. Its input resources are the ready-to-ship products on the DC and store receipt scheduling information for personnel planning and vehicle scheduling purposes. Figure 6.10 shows the structure of ITS.

Figure 6.10 – Internal Transport Sub-process structure



Source: by the author (2021)

The ITS planning and execution is managed by the transport logistics management with mid- and short-term decisions related to transport logistics procedures and personnel scheduling, and they are influenced by long-term planning. Its output and also the outcome to be delivered to the SBS is the full delivery to the store.

The Causes of OOS Logistics Risks of the Retail in the ITS

The OOS causes found in the ITS, range from cargo transport packaging issues, such as item damaged during delivery and wrong item arrangement on pallets, to transport service quality issues, such as delivery delays (EHRENTHAL and STÖLZLE, 2013), unreliable transportation service (TAYLOR and FAWCETT, 2001), delivery of wrong quantities (EHRENTHAL and STÖLZLE, 2013) and other general transport issues (CORSTEN and GRUEN, 2003). Interface and monitoring issues, such as wrong shipment received, ramps occupied, delays caused by congested roads, undelivered item, and inaccurate consignment (EHRENTHAL and STÖLZLE, 2013), were also mentioned as OOS causes in the ITS.

The Omni-channel Logistics Challenges in the ITS

Although transport issues were mentioned as omni-channel logistics challenge (namely LAFKIHI et al., 2019), there was an opposite position that stated that "internal transport flows are not affected by omni-channel retail" (RAI et al., 2019, p.12), it was adopted in this study.

The architecture of the OOS Logistics Risks of the OC in ITS

Considering the OOS causes and OC logistics challenges in the ITS mentioned above, the G-SAMP questions adjusted to the ITS were as follows:

QC4.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the internal transportation logistics operation influence?

QC4.2: Is there an absence or insufficiency of awareness, direction and motivation of the transportation manager to better ensure full delivery of orders from the DC store in order to avoid store OOS?

In case of outsourced transportation, is the manager taking the same precautions when selecting carriers, clarifying the rules and establishing effective means of measuring the outsourcer's results in order to preserve products and delivery times, and thus avoid OOS?

QC4.3: Is there an absence or insufficiency of awareness, direction and motivation of the transportation staff about the OOS risks involving their role in the sub-process in avoiding them?

QC4.4: Are the transport procedures defined, aligned with the specific demands of omni-channel logistics, maintaining the integrity of the products and meeting the delivery deadlines for store orders in order to avoid OOS?

In case of outsourced transportation, are the transportation procedures properly registered and clarified to them, so that the results can be measured and their fragilities identified, even if the sub-process is being performed by a third party?

QC4.5: Is the transportation manager planning the transportation execution, scheduling the staff according to the store ordering planning and demand forecast?

In case of outsourced transportation, is the manager communicating with the third party, establishing adequate means for the flow of information, so that the planning performed by the carrier achieves the same results idealized by the company?

QC4.6: Is the company concerned about establishing a specific and adequate area and layout for loading and unloading activities at the transport interfaces with both the DC and the store, as well as considering the possible increase in the store total sales in the mid- and long-term, which could lead to a change in the type and size of vehicles?

The 'risk objective' of the ITS is the incomplete delivery (O#C4). Internally, it can emerge from delivery execution errors (IE#C4), caused by one or more elements specified in the SAMP questions, or by insufficient transportation capacity (IS#C4), due to the inappropriate size and/or specification vehicles, as well as the inappropriate size and/or layout of the loading and unloading docks. Externally, its 'risk factors' can arise from SSS, due to an incomplete orders fulfillment by the DC (O#C5), from SOS, due to insufficient store ordering (O#S6), and/or from DFS, due to errors of demand forecast (O#S9). The causal structure elements of the ITS are shown in Table 6.5.

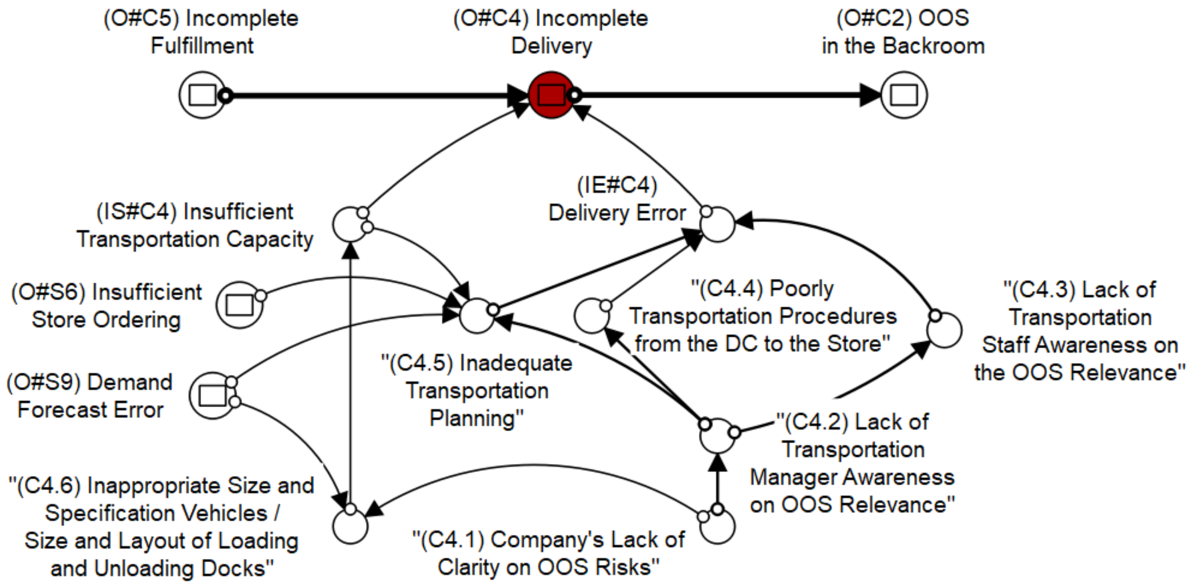
Table 6.5 – Causal structure elements of the ITS

Status	ID	Risk Factors	
Input Failure	O#C5	Incomplete Fulfillment	
	O#S6	Insufficient Store Ordering	
	O#S9	Demand Forecast Error	
Internal Error	IE#C4	Delivery Error	
		C4.1	Company's Lack of Clarity on OOS Risks
		C4.2	Lack of Transportation Manager Awareness on OOS Relevance
		C4.3	Lack of Transportation Staff Awareness on the OOS Relevance
		C4.4	Poorly Transportation Procedures from the DC to the Store
		C4.5	Inadequate Transportation Planning
	IS#C4	Insufficient Transportation Capacity	
		C4.6.1	Inappropriate Size and Specification Vehicles
		C4.6.2	Inappropriate Size and Layout of Loading and Unloading Docks
Output Failure	O#C4	Incomplete Delivery	

Source: by the author (2021)

In addition to G-SAMP (Figure 6.3), the insufficient store ordering can cause inadequate transportation planning in the ITS. Figure 6.11 presents the relationship between the causal structure elements of the ITS shown in Table 6.5.

Figure 6.11 – Causal diagram of the ITS



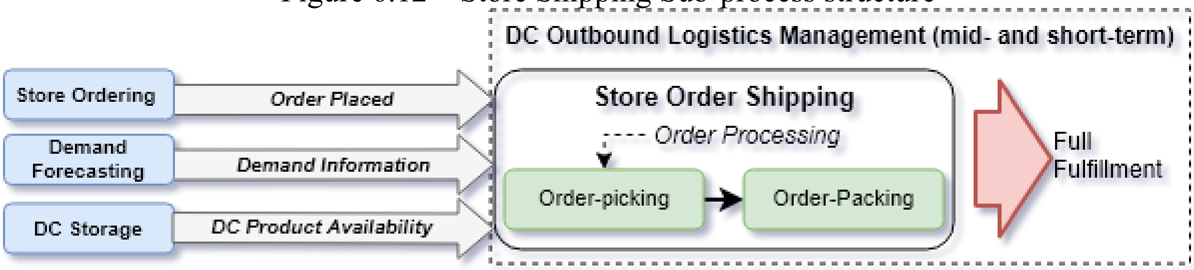
Source: by the author (2021)

This is because undersized orders generate planning with fewer resources and, in the case of emergency orders, it may not be possible to deliver them on time.

6.1.2.5 The OOS Logistics Risks Identification in the SSS

The Store Shipping Sub-process (SSS) ranges from receiving and processing store orders to picking, packaging, and dispatching. Its input resources are the store order planning and product availability on the DC to fulfill store orders, as well as demand forecast information for personnel planning and outbound logistics procedures purposes. Figure 6.12 shows the structure of SSS.

Figure 6.12 – Store Shipping Sub-process structure



Source: by the author (2021)

The SSS planning and execution is managed by the DC outbound logistics management with mid- and short-term decisions related to outbound logistics procedures and personnel scheduling. On the other hand, its output and also the outcome to be delivered to the ITS is the order full fulfillment.

The Causes of OOS Logistics Risks of the Retail in the SSS

The OOS causes generated in the SSS range from general distribution problems (AASTRUP and KOTZAB, 2009), to DC pick errors (TAYLOR and FAWCETT, 2001), shipping errors (CORSTEN and GRUEN, 2003) and late delivery from the DC to the store (TAYLOR and FAWCETT, 2001).

The Omni-channel Logistics Challenges in the SSS

The main omni-channel logistics challenge in the SSS is the picking integration of online and store order into strategies in which customer online orders are fulfilled from the DC

(HÜBNER et al., 2016b; HÜBNER et al., 2016c; MELACINI et al., 2018; KEMBRO et al., 2018). However, the picking configuration for this study is in-store, so no relevant omni-channel logistics challenges were found in SSS.

The architecture of the OOS Logistics Risks of the OC in SSS

Considering the OOS causes and OC logistics challenges in the SSS mentioned above, the G-SAMP questions adjusted to the SSS were as follows:

QC5.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the DC outbound logistics operation importance in this one, considering the impact of errors and delays in the store orders fulfillment?

QC5.2: Is there an absence or insufficiency of awareness, direction and motivation of the DC outbound logistics manager in managing store order fulfillment to avoid OOS risks in the store?

QC5.3: Is there an absence or insufficiency of awareness, direction and motivation of DC outbound logistics staff about the OOS risks in the store and their participation in maintaining them?

QC5.4: Are the DC outbound logistics procedures defined, aligned with the specifications required by the store and properly explained to the picking and dispatching staffs?

QC5.5: Is the DC Outbound Logistics Manager planning the short-term picking, packaging, and dispatching operations and scheduling his/her staffs according to demand forecast information and seasonal patterns?

QC5.6: Is the company concerned about adjusting the DC's picking and dispatching areas sizing and layout according to the changes brought about by the store-based omni-channel strategy, adapting and adjusting to the alignment of the assortment and sales volume both online and offline?

The 'risk objective' of the SSS is the incomplete store orders fulfillment by the DC (O#C5). Internally, it can emerge from shipping execution errors (IE#C5), caused by one or more elements specified in the SAMP questions, or by insufficient DC outbound logistics capacity (IS#C5), due to its inappropriate size and/or layout. Externally, its 'risk factors' can arise from SOS, due to an insufficient store ordering (O#S6), from DFS, due to a demand forecast errors (O#S9), and/or from a sub-process external to SAP, therefore outside the scope of this model, the OOS in the DC (Ext#1). The causal structure elements of the SSS are shown in Table 6.6.

Table 6.6 – Causal structure elements of the SSS

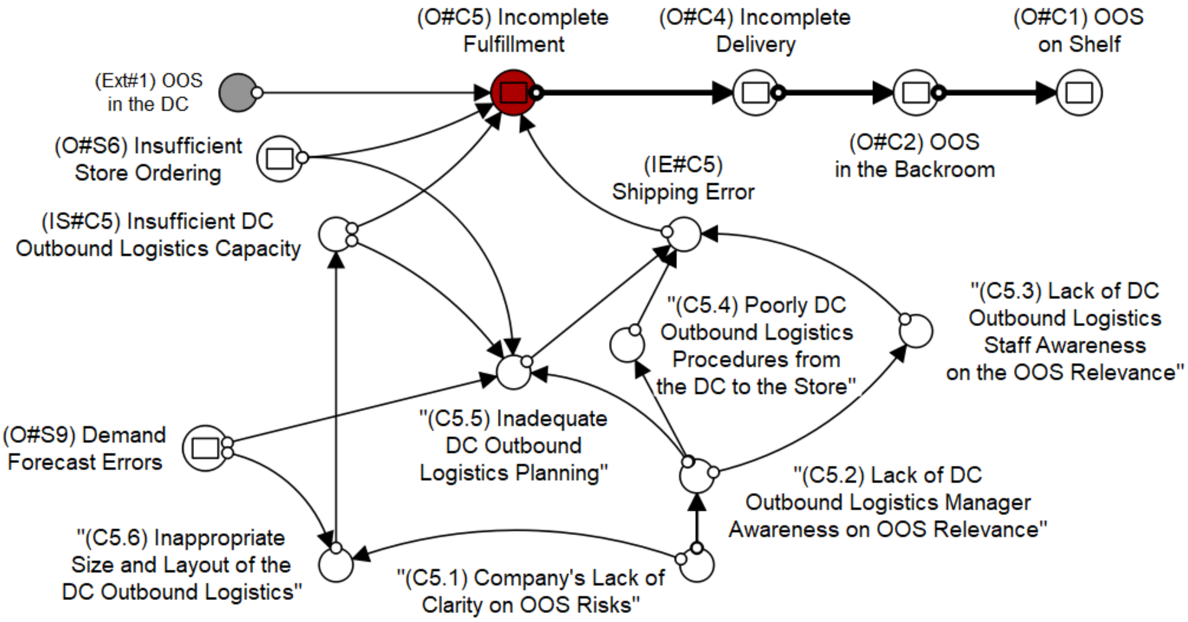
Status	ID	Risk Factors	
Input Failure	O#S6	Insufficient Store Ordering	
	O#S9	Demand Forecast Errors	
	Ext#1	OOS in the DC	
Internal Error	IE#C5	Shipping Error	
		C5.1	Company's Lack of Clarity on OOS Risks
		C5.2	Lack of DC Outbound Logistics Manager Awareness on OOS Relevance
		C5.3	Lack of DC Outbound Logistics Staff Awareness on the OOS Relevance
		C5.4	Poorly DC Outbound Logistics Procedures from the DC to the Store
		C5.5	Inadequate DC Outbound Logistics Planning
	IS#C5	Insufficient DC Outbound Logistics Capacity	
		C5.6	Inappropriate Size and Layout of the DC Outbound Logistics
Output Failure	O#C5	Incomplete Fulfillment	

Source: by the author (2021)

The SSS behaves very similarly to ITS, including the influence of the insufficient store ordering. However, it now affects the outbound logistics of the DC. Figure 6.13 presents the relationship between the causal structure elements of the SSS shown in Table 6.6.

As a result, insufficient DC outbound logistics capacity and/or shipping errors can cause incomplete fulfillments, incomplete deliveries, resulting in OOS in the backroom, and ultimately cause a shortage of stock on store shelves. An important risk factor in the SSS, which is outside the SAP scope, is the OOS in the DC.

Figure 6.13 – Causal diagram of the SSS



Source: by the author (2021)

It is quite simple to understand that, regardless of the success of all SAP sub-processes, without stocks on the DC, a new stock source would be needed.

6.1.3 The Support Sub-Processes' OOS Risks

Supporting sub-processes influence one or more core sub-processes, and most of them depend more on information systems than on physical spaces. Therefore, their capacities are scaled by the system resources to meet their needs, and not by the size and layout of the spaces they occupy. Despite this, they have their own management and also use the G-SAMP framework. All of them are detailed below.

6.1.3.1 The OOS Logistics Risks Identification in the SOS

The Store Ordering Sub-process (SOS) ranges from the stock review to placing orders with the replenishment needs of the store to be shipped by DC. Its inputs are demand forecast, returns forecast, and accurate stock value information. Figure 6.14 shows the SOS structure.

Figure 6.14 – Store Ordering Sub-process structure

Source: by the author (2021)

On the other hand, its output and also the outcome to be delivered to the SSS is the orders placement aligned with the store.

The Causes of OOS Logistics Risks of the Retail in the SOS

Most of OOS causes in the SOS emerges from procedures issues, such as delivery frequency mismatch (Mc KINNON et al., 2007), decisions of orders made by intuition rather than data (MOUSSAOUI et al., 2016), lack of coordination with the advertising, the inability to optimize the trade-off between OOS and wastage (ETTOUZANI et al., 2012) and wrong or short quantity order (CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013; MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; AASTRUP and KOTZAB, 2009; GRUEN et al., 2002). Lack of inventory real-time visibility for ordering (ETTOUZANI et al., 2012), the existence of backorders (MOUSSAOUI et al., 2016), minimum order quantity or value not met and ordering system error (EHRENTHAL and STÖLZLE, 2013) were also mentioned.

Some of the mentioned OOS causes in the SOS originate from staff issues, such as late placed orders (MOUSSAOUI et al., 2016; ETTOUZANI et al., 2012; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013; AASTRUP and KOTZAB, 2009; GRUEN et al., 2002), no orders placed (TAYLOR and FAWCETT, 2001; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013), inaccurate system reorder level (EHRENTHAL and STÖLZLE, 2013), and typos in manual orders (EHRENTHAL and STÖLZLE, 2013).

The Omni-channel Logistics Challenges in the SOS

A single and important logistics challenge was identified in SOS, the mismatch between replenishment forecasts and inventory holding (WOLLENBURG et al., 2018). The reasons range from the difference between the purchasing habits of online and walk-in customers, to the inexistence or difficulty in forecasting returns.

The architecture of the OOS Logistics Risks of the OC in SOS

Considering the OOS causes and OC logistics challenges in the SOS mentioned above, the G-SAMP questions adjusted to the SOS were as follows:

QC6.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the store ordering operation relevance in this one, considering the different characteristics of each channel and the complexity of their integrations?

QS6.2: Is there an absence or insufficiency of awareness, direction and motivation of the inventory manager on OOS risks caused by store ordering failures?

QS6.3: Is there an absence or insufficiency of awareness, direction and motivation of the store ordering staff about OOS risks and their role in it?

QS6.4: Are store ordering procedures defined, aligned with planned inventory level and store replenishment policy, considering different techniques for different product categories and deducting return forecasts from the demand forecast?

QS6.5: Is the inventory manager planning the short- and mid-term store ordering activities execution and scheduling the staff according to the demand forecast and seasonal patterns, as well as considering the space restrictions and the marketing events and promotions?

QS6.6: Does the company's information system have the essential functionalities for analyzing the store's stock replenishment, such as the functionalities of forecasting, optimizing stock levels, promotion management and assortment management (KEMBRO and NORRMAN, 2019)?

The 'risk objective' of the SOS is the insufficient store ordering (O#S6). Internally, it can emerge from ordering execution errors (IE#S6), caused by one or more elements specified in the SAMP questions, or by insufficient inventory analysis resources in the information system (IS#S6), due to an inadequate information system. Externally, its 'risk factors' can arise from SCS, due to inaccurate inventory (O#S7), from DFS, due to a demand forecast errors

(O#S9), and/or from RFS, due to returns forecast errors (O#S10). The causal structure elements of the SOS are shown in Table 6.7.

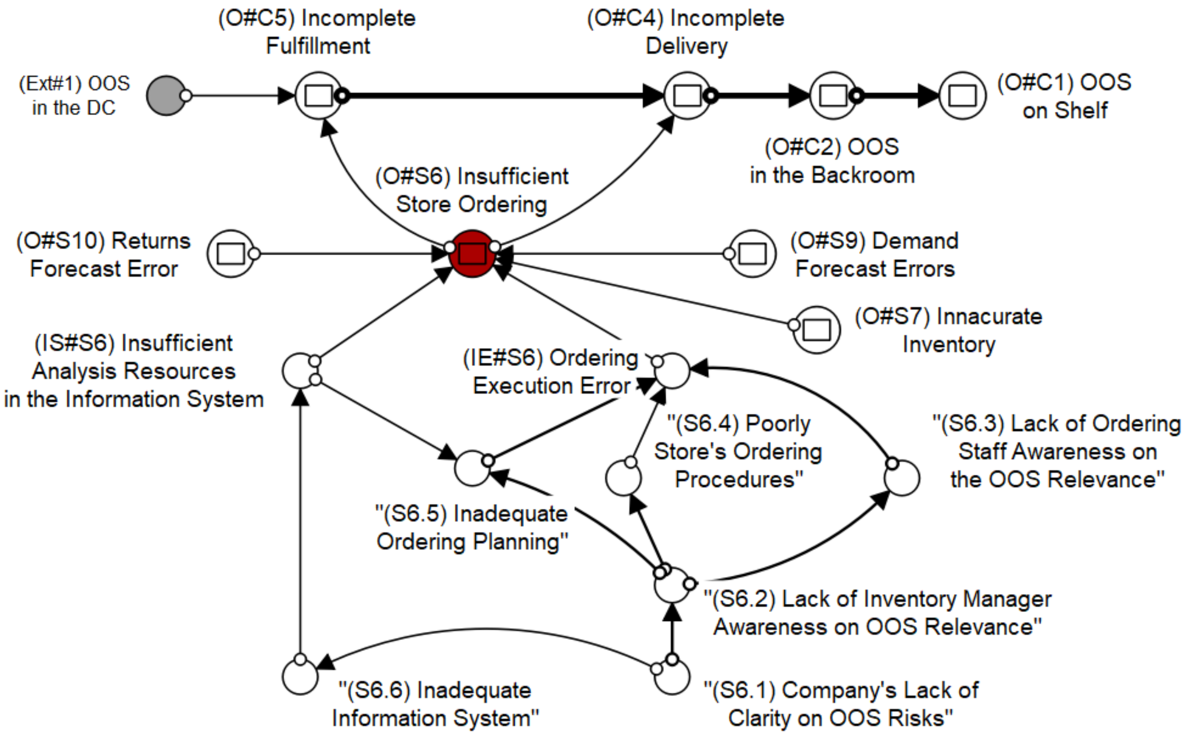
Table 6.7 – Causal structure elements of the SOS

Status	ID	Risk Factors
Input Failure	O#S7	Inaccurate Inventory
	O#S9	Demand Forecast Error
	O#S10	Returns Forecast Error
Internal Error	IE#S6	Ordering Execution Error
		S6.1 Company's Lack of Clarity on OOS Risks
		S6.2 Lack of Inventory Manager Awareness on OOS Relevance
		S6.3 Lack of Ordering Staff Awareness on the OOS Relevance
		S6.4 Poorly Store's Ordering Procedures
		S6.5 Inadequate Ordering Planning
	IS#S6	Insufficient Analysis Resources in the Information System
		S6.6 Inadequate Information System
Output Failure	O#S6	Insufficient Store Ordering

Source: by the author (2021)

As mentioned earlier, SOS has its own management, so G-SAMP applies here.

Figure 6.15 – Causal diagram of the SOS



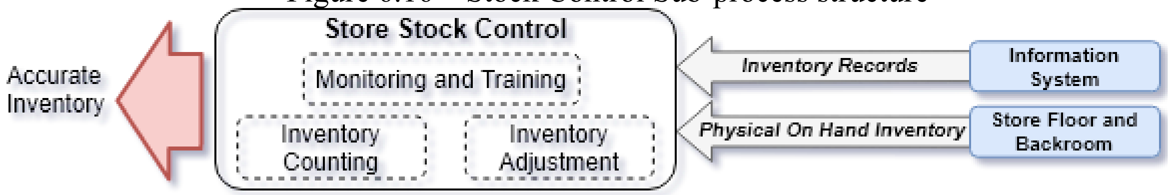
Source: by the author (2021)

However, demand forecast errors hit it in a different way. This is because the demand forecast is used as an important resource to generate the order batch calculation from store to DC, as well as the return forecast, which must be deducted from the final calculation. Figure 6.15 presents the relationship between the causal structure elements of the SOS shown in Table 6.7. In this way, insufficient store ordering drives incomplete fulfillments, which causes incomplete deliveries, causing OOS in the backroom and, ultimately, generating OOS on the shelves.

6.1.3.2 The OOS Logistics Risks Identification in the SCS

The Stock Control Sub-process (SCS) oversees the accuracy of store stock values through continuous monitoring of inventory in and out records, as well as periodic counting and checking of physical products against its information in the system. Therefore, its inputs are the store inventory record via the information system and the physical on-hand inventory access. Figure 6.16 shows the SCS structure.

Figure 6.16 – Stock Control Sub-process structure



Source: by the author (2021)

On the other hand, the SCS output is the accurate inventory information. For this purpose, stock differences are thoroughly investigated.

The Causes of OOS Logistics Risks of the Retail in the SCS

The OOS causes in the SCS range from the general inventory inaccuracy (NOVAES, 2007; ECR EUROPE, 2003), to the inventory records inaccuracy (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013). Such inaccuracies were cited either as caused by unidentified shrinkage of stock (MOUSSAOUI et al., 2016; ECR EUROPE, 2003; EHRENTHAL and STÖLZLE, 2013; Mc KINNON et al., 2007; FERNIE and GRANT, 2008), or specific issues, such as theft (CORSTEN and GRUEN, 2003; Mc KINNON et al., 2007; FERNIE and GRANT, 2008), processing errors, accounting mistakes (Mc KINNON et al., 2007; FERNIE and GRANT, 2008), and incorrect scan of products at checkout (CORSTEN and GRUEN, 2003; Mc KINNON et al., 2007; FERNIE and GRANT, 2008; MOUSSAOUI et al., 2016).

The Omni-channel Logistics Challenges in the SCS

The greatest omni-channel logistics challenge in the SCS is the standardization and synchronization of availability information among channels and partners (WEBER and WEISS, 2018). However, this is only possible with the stock values accuracy guarantee (KEMBRO and NORRMAN), which is not easy on omni-channel retailing, since it involves multiple points of in and out of inventory records, with an even greater amount of inventory handling (MELACINI et al., 2018; WOLLENBURG et al., 2018). Even if the stocks accuracy is achieved, the inventory real-time visibility is, in this context, a prerequisite (HÜBNER et al., 2016c; KEMBRO and NORRMAN, 2019; WEBER and WEISS, 2018). In this regard, a robust information system is required (MELACINI et al., 2018), not just to keep track of inventory transparency (HÜBNER et al., 2016b), but to allow data exchange (HÜBNER et al., 2016c).

The architecture of the OOS Logistics Risks of the OC in SCS

Considering the OOS causes and OC logistics challenges in the SCS mentioned above, the G-SAMP questions adjusted to the SCS were as follows:

QC7.1: Is the company clear about its attitude towards OOS risk, with well-defined measurement rules, goals, limits and coping policies, and is it aware of the inventory accuracy relevance in this one, considering the need for a robust information system with the essential functionalities required by the store-base omni-channel?

QS7.2: Is there an absence or insufficiency of awareness, direction and motivation of the inventory manager on OOS risks caused by the inaccurate inventory and the relevance of the stock control in its management?

QS7.3: Is there an absence or insufficiency of awareness, direction and motivation of the stock control staff about OOS risks and their role in it?

QS7.4: Are stock control procedures defined, aligned with the inventory accuracy level required by the store-based omni-channel strategy, and properly explained to both the stock control staff and to other staffs involved with inventory in/out records?

Does the company have strict inventory controls and do cyclical inventory counts, considering priority products and categories, investigating the causes of registration errors, as well as monitoring and training the staff involved with inventory entry/exit records?

QS7.5: Is the inventory manager planning the short- and mid-term stock control activities execution and scheduling the staff according to the inventory discrepancy level and at dates and times that interfere as little as possible with the proper functioning of essential store activities?

QS7.6: Does the company's inventory information system have the essential functionalities needed for omni-channel, such as integration capacity, flexible platforms for updating software and adding nodes, synchronization and data accuracy (KEMBRO and NORRMAN, 2019), as well as to verify the inventory location in the several sub-processes of the SAP in real time?

The SCS is not exactly the cause of store inaccurate inventory. Instead, its function is to identify and to adjust the inventory discrepancies. However, failures in it allows the permanence or even the worsening of these.

The 'risk objective' of the SCS is the inaccurate inventory (O#S7). Internally, it can emerge from stock control execution errors (IE#S7), caused by one or more elements specified in the SAMP questions, or by insufficient stock control resources (IS#S7), due to an inadequate information system. Externally, its 'risk factors' can arise from two sub-processes external to SAP, therefore outside the scope of this model, namely, the inventory record error excess in the information system made by users (Ext#3), and/or the physical on-hand inventory access difficulty due to messy backroom (Ext#4).

The causal structure elements of the SCS are shown in Table 6.8. In addition to G-SAMP, SCS is influenced by two external risk factors, which have already been mentioned above.

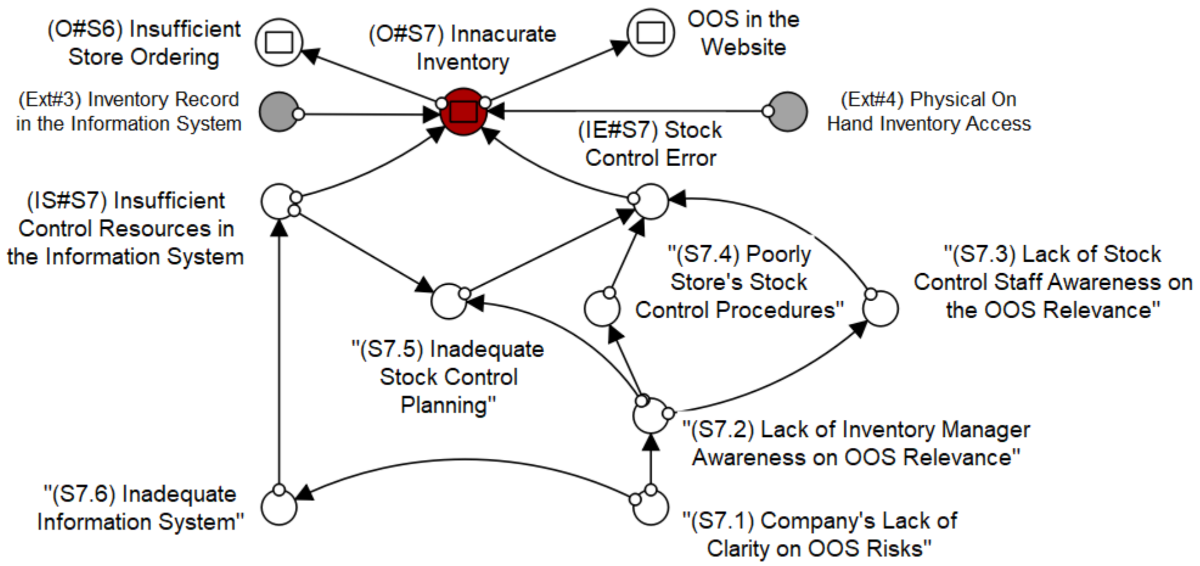
Table 6.8 – Causal structure elements of the SCS

Status	ID	OOS Cause	
Input Failure	Ext#3	Inventory Record Error Excess in the Information System	
	Ext#4	Physical On-hand Inventory Access Difficulty	
Internal Error	IE#S7	Stock Control Error	
		S7.1	Company's Lack of Clarity on OOS Risks
		S7.2	Lack of Inventory Manager Awareness on OOS Relevance
		S7.3	Lack of Stock Control Staff Awareness on the OOS Relevance
		S7.4	Poorly Store's Stock Control Procedures
		S7.5	Inadequate Stock Control Planning
	IS#S7	Insufficient Control Resources in the Information System	
		S7.6	Inadequate Information System
Output Failure	O#S7	Inaccurate Inventory	

Source: by the author (2021)

However, in addition to the insufficient order in the store, the inaccurate inventory affects all other activities of the company that depend on accurate inventory information. Figure 6.17 presents the relationship between the causal structure elements of the SCS shown in Table 6.8.

Figure 6.17 – Causal diagram of the SCS



Source: by the author (2021)

Inaccurate inventory can generate the OOS in the online store. This is because the availability in this environment is a reference based on the information system, if the inventory information is less than the real inventory, the company will report a lack of stock, even having the product.

6.1.3.3 The OOS Logistics Risks Identification in the AAS

As previously mentioned, assortment architecture is defined based on product and store specific issues, resulting in the definition of the allocation of products on the shelves (HÜBNER et al., 2013). Its input resources are information about store size and layout, and demand forecast information for both individual and category products, as well as information on seasonal patterns. Figure 6.18 shows the structure of the Assortment Architecture Subprocess (AAS).

Figure 6.18 – Assortment Architecture Sub-process structure

Source: by the author (2021)

As suggested by Mentzer and Moon (2004), issues such as assessing customer and product profitability, providing forecasts, rationalizing products and customers, and managing capacity should be performed by a 'demand management' function. In doing so, the AAS' planning and execution are managed by the demand manager, with mid- and short-term decisions related to these issues. The authors also suggested that a multifunctional group should execute it, namely the S&OP (Sales and Operation Planning) staff.

On the other hand, AAS' output and also the outcome to be delivered to the SFS is the Store Planogram. A planogram is a visual representation of the placement of products in the store (LEVY et al., 2014). According to Mattar (2011, p.436), a planogram "standardizes the product display in stores, creating a visual identity, increasing the products assortment and improving inventory management". However, the main characteristic of the assortment architecture for in-store logistics management is the allocating shelf space by product, which determines the shelf replenishment frequency (HÜBNER et al., 2013). According to Levy et al. (2014), "a simple rule of thumb for allocating space is to allocate on the basis of the merchandise's sales", however the gross margin per store square foot should also be considered.

Therefore, an undersized space for a product represents an OOS risk for it, while an oversized space, decreases the shelf space available for other products (GARCIA-ARCA et al., 2020).

The Causes of OOS Logistics Risks of the Retail in the AAS

Planogram problems were mentioned by several authors (CORSTEN and GRUEN, 2003; Mc KINNON et al., 2007), some of them referring to inadequate shelf space allocated to the product (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013; Mc KINNON et al., 2007; GRUEN et al., 2002), others to the large number of SKUs in the assortment (MOUSSAOUI et al., 2016; CORSTEN and GRUEN, 2003), or by ignore the turnover of fastmoving products (MOUSSAOUI et al., 2016). Very similar products placed side by side on the shelf (Mc KINNON et al., 2007), outdated delisted products data (ECR EUROPE, 2003; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013) and master data error, such as data of product physical dimensions and case pack size (MOUSSAOUI et al., 2016; ECR EUROPE, 2003; EHRENTHAL and STÖLZLE, 2013) were also mentioned.

The Omni-channel Logistics Challenges in the AAS

The store shelves sharing between walk-in and online customers in the omni-channel retail poses some logistics challenges for the AAS. The shelf space restrictions, considering the increase in total sales fulfilled by the store due to the online sales inclusion is the first and main challenge in the AAS (HÜBNER et al., 2016b; HÜBNER et al., 2016c; SAHA and BHATTACHARYA, 2020; ARSLAN et al., 2020). For this reason, assortment decisions maker of the store needs to consider the balance between the new inventory turnover and the old available shelf space, this being the second logistics challenge in the AAS (KEMBRO et al., 2020). This new balancing should prioritize the shelf maintenance (HÜBNER et al., 2016b; RAI et al., 2019) rather than commercial agreements (RAI et al., 2019).

The architecture of the OOS Logistics Risks of the OC in AAS

Considering the OOS causes and OC logistics challenges in the AAS mentioned above, the G-SAMP questions adjusted to the AAS were as follows:

QC1: Is the company clear about its attitude towards OOS risk, as well as its measurement rules, targets, limits and coping policies, and is it aware of the assortment architecture relevance, considering its direct impact on OOS on the shelves?

QS8.2: Is there an absence or insufficiency of awareness, direction and motivation of demand manager on the OOS risks caused by a misaligned planogram?

QS8.3: Is there an absence or insufficiency of awareness, direction and motivation of the S&OP staff, responsible for aligning the assortment architecture, about OOS risks and their role in it?

Similar to the store floor, the backroom also has space restrictions, however, its occupation occurs differently. While the shelf must follow the planogram where each product has its own space, in the backroom remains only the stock that did not fit on the shelves, like a buffer. While its relationship to assortment architecture is indirect, as shelf inventory turns increase without an equivalent increase in space, the greater the store dependence on backroom space. The congested and messy backroom was mentioned as an OOS cause because if the product cannot be tracked, it cannot be replenished, becoming an OOS in the backroom, albeit temporarily.

QS8.4: Are assortment architecture procedures defined, aligned with the desired store image, considering the shelves layout and the target stock levels in the store, as well as a possible backroom overload due to insufficient shelf space (GARCIA-ARCA et al., 2020)?

QS8.5: Is the assortment architecture planning the short- and mid-term assortment alignment in a dynamic way, according to demand variations, considering seasonality, trends, promotions, new product launches and old product withdrawals?

QS8.6: Does the company's information system have the essential functionalities for analyzing the store's assortment, containing information such as store's overall capacity, product's packaging dimensions and individual demand forecast (GARCIA-ARCA et al., 2020)?

The 'risk objective' of the AAS is the planogram misalignment (O#S8). Internally, it can emerge from assortment architecture definition errors (IE#S8), caused by one or more elements specified in the SAMP questions, or by insufficient analysis resources to assortment architecture definition (IS#S8), due to an inadequate information system. Externally, its 'risk factors' can arise from DFS, due to a demand forecast errors (O#S9), and/or from an external sub-process, the undersized store space (Ext#8). The causal structure elements of the AAS are shown in Table 6.9.

Table 6.9 – Causal structure elements of the AAS

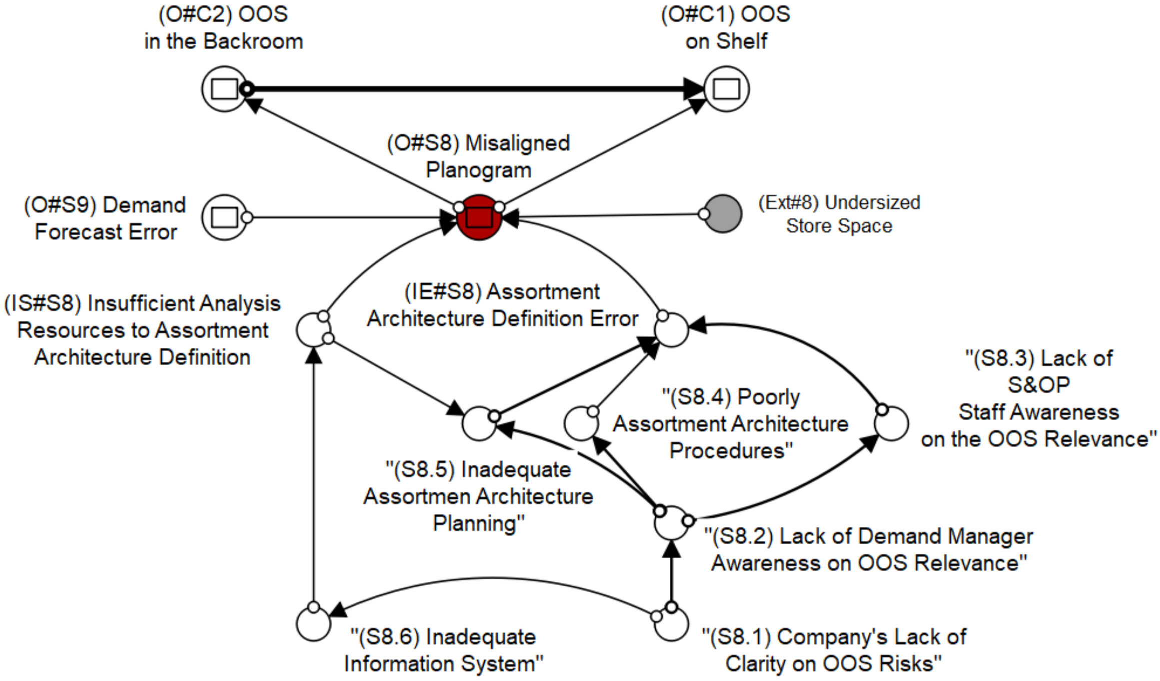
Status	ID	Risk Factors	
Input Failure	O#S9	Demand Forecast Error	
	Ext#8	Undersized Store Space	
Internal Error	IE#S8	Assortment Architecture Definition Error	
		S8.1	Company's Lack of Clarity on OOS Risks
		S8.2	Lack of Demand Manager Awareness on OOS Relevance
		S8.3	Lack of S&OP Staff Awareness on the OOS Relevance
		S8.4	Poorly Assortment Architecture Procedures
		S8.5	Inadequate Assortment Architecture Planning
	IS#S8	Insufficient Analysis Resources to Assortment Architecture Definition	
		S8.6	Inadequate Information System
Output Failure	O#S8	Misaligned Planogram	

Source: by the author (2021)

The AAS directly affects SFS and indirectly affects SBS, as can be seen above in the description of the relationship of these two sub-processes. In addition to G-SAMP, AAS is influenced by store space sizing and demand forecast information. An undersized store space and/or demand forecasting errors can cause misaligned planograms. This is because the assortment architecture uses both information to define the space per product on the shelves. Figure 6.19 presents the relationship between the causal structure elements of the AAS shown in Table 6.9.

Therefore, demand forecasts larger than the real ones, can cause oversizing for some products, reducing the available space to be distributed to others. On the other hand, lower-than-real demand forecasts can cause an undersizing, requiring greater frequency of replenishment, and larger backroom space to support it. Both cases can result in OOS on the shelf, either directly or indirectly.

Figure 6.19 – Causal diagram of the AAS



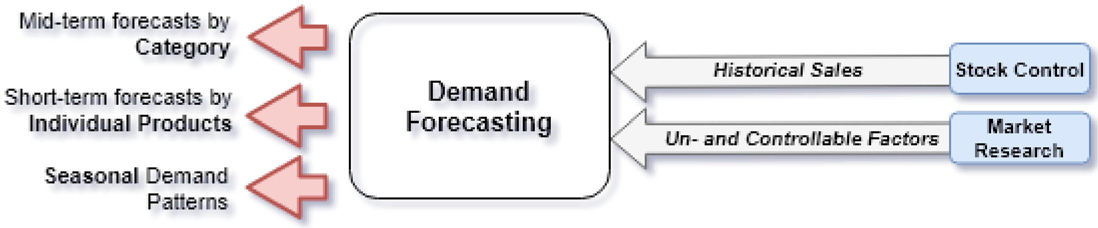
Source: by the author (2021)

6.1.3.4 The OOS Logistics Risks Identification in the DFS

The Demand Forecast Sub-process (DFS) typically uses the historical sales information and extrapolate it, "on the assumption that the factors affecting item sales in the past will be the same and have the same effect in the future" (LEVY et al., 2014, p.327). In the short-term, historical sales information is relatively sufficient. However, most of the relevant seasonality patterns are only identified in the mid- to long-term. On the other hand, as forecasts move away from sales information, the greater is the exposure to new influencing factors, which may be controllable, such as the opening and closing of stores, special promotions and category repositioning, or uncontrollable, such as weather, general economic conditions and new product launches (LEVY et al., 2014). Thus, it is necessary to consider them. Figure 6.20 shows the DFS structure.

Similar to the AAS, following the Mentzer and Moon's (2004) suggestion, DFS is managed by the 'demand management' function. Therefore, DFS' planning and execution is managed by the demand manager, with mid- and short-term decisions related to demand forecasting and executed by the S&OP staff.

Figure 6.20 – Demand Forecasting Sub-process structure



Source: by the author (2021)

On the other hand, the DFS outputs are short-term forecasts by individual products, mid-term forecasts by category, and seasonal demand pattern information. This information is vitally relevant for making short-, mid- and long-term decisions and serves as an input to almost all of the company's sub-processes.

The Causes of OOS Logistics Risks of the Retail in the DFS

The OOS causes in the DFS range from the failures of demand forecasts by category, such as increased demand volatility (ETTOUZANI et al., 2012; CORSTEN and GRUEN, 2003), inability to react to late changes (ETTOUZANI et al., 2012; ECR EUROPE, 2003), different product category characteristics (MOUSSAOUI et al., 2016; ETTOUZANI et al., 2012), price alignment strategies (ETTOUZANI et al., 2012), to seasonality forecasts failures (NOVAES, 2007; MOUSSAOUI et al., 2016; ETTOUZANI et al., 2012), and demand forecasts for individual products, such as misjudged demand (GRUEN et al., 2002) and inaccurate forecast of standard items (MOUSSAOUI et al., 2016; ETTOUZANI et al., 2012; TAYLOR and FAWCETT, 2001; ECR EUROPE, 2003; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013).

Demand distortion failures caused by OOS, such as demand autocorrelation (MOUSSAOUI et al., 2016) and lack of visibility of off-shelf space or lost sales, as well as failures in inventory and visibility information sharing, such as insufficient resources to analyze data (ETTOUZANI et al., 2012), ineffective processes to estimate promotions and launches (MOUSSAOUI et al., 2016; ETTOUZANI et al., 2012; CORSTEN and GRUEN, 2003; EHRENTHAL and STÖLZLE, 2013; AASTRUP and KOTZAB, 2009), level of data sharing (Mc KINNON et al., 2007) and off shelf space database inadequacy (ETTOUZANI et al., 2012) were also mentioned.

The Omni-channel Logistics Challenges in the DFS

The main logistics challenge for the DFS in the omni-channel retailing is certainly to maintain correct forecasts for channels with different characteristics integrated in the same fulfillment point, i.e., on the store shelf (HÜBNER et al., 2016a; HÜBNER et al., 2016c; WEBER and WEISS, 2018; WOLLENBURG et al., 2018; ERIKSSON et al., 2019; SAHA and BHATTACHARYA, 2020). If, on the one hand, walk-in customers have a more predictable buying behavior, on the other hand, due to the ease of access, online customer buying behavior is more scattered and irregular, causing greater fluctuations in demand (HÜBNER et al., 2016c; KEMBRO et al., 2018).

The Architecture of the OOS Logistics Risks of the OC in DFS

Considering the OOS causes and OC logistics challenges in the DFS mentioned above, the G-SAMP questions adjusted to the DFS were as follows:

QC9.1: Is the company clear about its attitude towards OOS risk, as well as its measurement rules, goals, limits and coping policies, and is it aware of the relevance of the demand forecast, considering all the scope it has in the most important decisions from the company?

QS9.2: Is there an absence or insufficiency of awareness, direction and motivation of demand manager on OOS risks caused by inaccurate demand forecasting and the extent of its impact on results across the enterprise?

QS9.3: Is there an absence or insufficiency of awareness, direction and motivation of the S&OP staff about OOS risks and their role in it?

The inability to forecast demand within acceptable error levels due to various reasons, including the difference between the behavior of the channels, has been strongly mentioned in both the omni-channel retail literature and the traditional retail literature as a challenge and cause of OOS. Therefore, the first potential OOS risk cause in the DFS related to demand forecasting procedures can be identified by answering the following question:

QS9.4-1: Are demand forecasting procedures defined, aligned with the accuracy level required by the omni-channel strategy, considering the different characteristics of online and offline sales, and properly explained to the demand forecasting staff?

Another recurring DFS issue is the impact that lost sales, for a variety of reasons, including OOS, have on the demand forecast calculation. This is because, the short-term demand forecast basis is the historical sales information. Therefore, considering that lost sales are the part of the customer effective demand that was suppressed, by not considering them the same part of the demand will probably not be met again. And since there was a demand forecast error before, the cause of the previous error joins this one, forming a negative reinforcement loop. Therefore, a second potential OOS risk cause in the DFS related to demand forecasting procedure can be identified by answering the following question:

QS9.4-2: Is the company able to estimate lost sales by product and then aggregate them to actual sales data and consider them as effective demand?

QS9.5: Are the demand managers planning the short- and mid-term demand forecasting, considering seasonality, promotions, new product launches and trends (GARCIA-ARCA et al., 2020)?

QS9.6: Does the company have the means, with sufficient quantity and quality of data, to separately and properly estimate the demand of online and walk-in customers, and still operate them in an integrated manner?

The 'risk objective' of the DFS is the demand forecast error (O#S9). Internally, it can emerge from demand forecast execution errors (IE#S9), caused by one or more elements specified in the SAMP questions, or by insufficient analysis resources to forecast the demand (IS#S9), due to an inadequate information system. Externally, its 'risk factors' can arise from two sub-processes external to SAP, therefore outside the scope of this model, namely, unadjusted sales history according to the lost sales (Ext#5), and/or the neglect of market research in determining trends and market movements (Ext#6). The causal structure elements of the AAS are shown in Table 6.10.

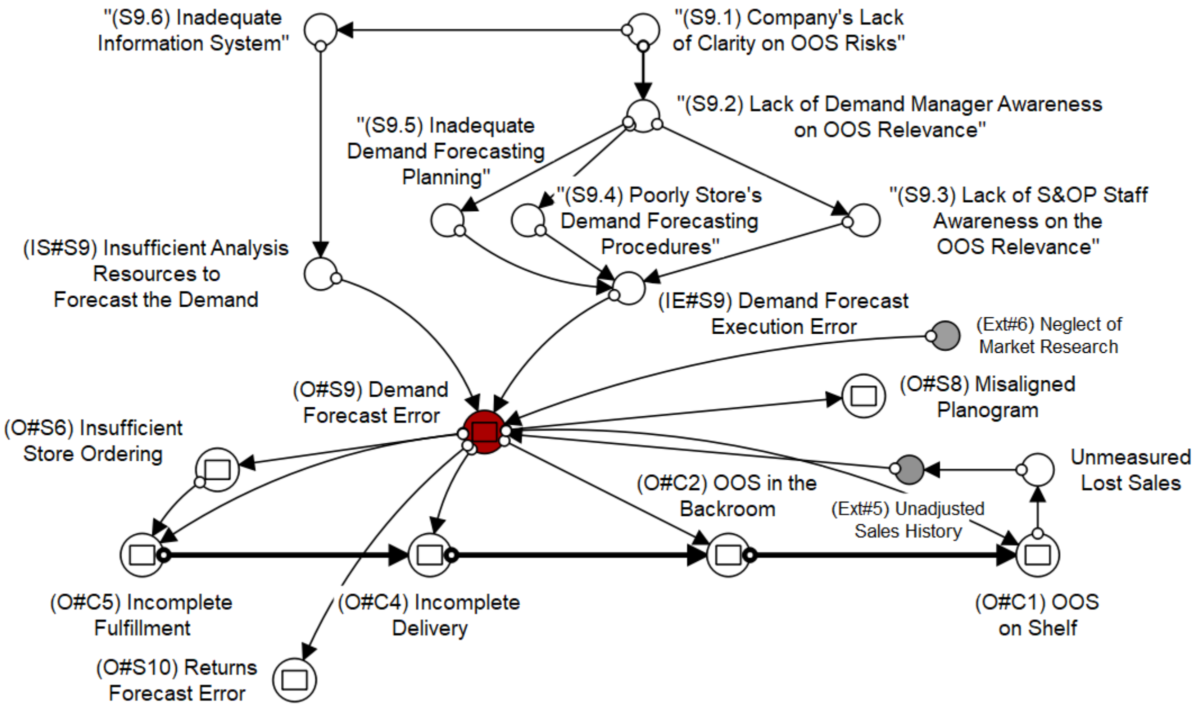
Table 6.10 – Causal structure elements of the DFS

Status	ID	OOS Cause
Input Failure	Ext#5	Unadjusted Sales History
	Ext#6	Neglect of Market Research
Internal Error	IE#S9	Demand Forecast Execution Error
		S9.1 Company's Lack of Clarity on OOS Risks
		S9.2 Lack of Demand Manager Awareness on OOS Relevance
		S9.3 Lack of S&OP Staff Awareness on the OOS Relevance
		S9.4 Poorly Store's Demand Forecasting Procedures
		S9.5 Inadequate Demand Forecasting Planning
	IS#S9	Insufficient Analysis Resources to Forecast the Demand
		S9.6 Inadequate Information System
Output Failure	O#S9	Demand Forecast Error

Source: by the author (2021)

A demand forecast error can affect almost every SAP's sub-process as it is used for planning by most of them. As mentioned earlier, some of them use it as a resource to generate their result, namely, SOS, RFS and AAS. Figure 6.21 presents the relationship between the causal structure elements of the DFS shown in Table 6.10.

Figure 6.21 – Causal diagram of the DFS



Source: by the author (2021)

In addition to G-SAMP, DFS uses historical sales information and market information collected by marketing. Therefore, unadjusted sales information and neglect of market research can cause demand forecasting errors. An important consideration is the impact of lost sales information when not added to historical sales information, which will be used as the basis for demand forecast calculation.

6.1.3.5 The OOS Logistics Risks Identification in the RFS

When the influx of returns increase compared to sales, forecasting returns becomes a prerequisite for determining the store order quantity (SHANG et al., 2020). This is because "online customers return a much larger percentage of their purchases than occurs with the traditional in-store customer" (AYERS and ODEGAARD, 2017, p. 104). In doing so, in the same way that the short-term demands forecasting, the short-term returns forecasting uses historical data. However, sales and returns data, on the understanding that the factors that drove returns in the past will do so again in the future and they are directly related to the quantity sold (TOKTAY et al., 2004). Figure 6.22 shows the RFS structure.

Figure 6.22 – Returns Forecast Sub-process structure

Source: by the author (2021)

Since the RFS is a type of forecast, it is also managed by the 'demand manager', with mid- and short-term decisions related to returns forecasting and executed by the S&OP staff. On the other hand, its output is the short-term returns forecasts by individual products.

The returns forecasting is an emergent issue of the omni-channel retailing. Therefore, it has not been mentioned as an OOS cause by traditional retailing literature.

The Omni-channel Logistics Challenges in the RFS

Return forecasting was mentioned as an omni-channel logistics challenge due to the difficulty of forecasting returned products (DE BORBA et al., 2020), precisely because of the lack of historical data on these returns (WEBER and WEISS, 2018). Another reason that makes it a challenge is the speed to reintegrate the product into stock (BERNON et al., 2016; DE BORBA et al., 2020), since after being collected, the products need to be tested, classified and refurbished before being delivered to stock.

The Architecture of the OOS Logistics Risks of the OC in RFS

Considering the OOS causes and OC logistics challenges in the RFS mentioned above, the G-SAMP questions adjusted to the RFS were as follows:

QC10.1: Is the company clear about its attitude towards OOS risk, as well as its measurement rules, targets, limits and coping policies, and is it aware of the returns forecast relevance, considering its direct impact on inventory levels?

QS10.2: Is there an absence or insufficiency of awareness, direction and motivation of the demand manager on OOS risks caused by the lack or inaccurate returns forecast and the extent of its impact on the store's inventory level?

QS10.3: Is there an absence or insufficiency of awareness, direction and motivation of the S&OP staff about OOS risks and their role in it?

QS10.4: Are returns forecasting procedures defined, aligned with the accuracy level required by the omni-channel strategy, considering the demand forecasting and the different characteristics of online and offline sales, and properly explained to the demand forecasting staff?

QS10.5: Is the demand manager planning the short- and mid-term returns forecasting, considering seasonality, promotions, new product launches and trends (GARCIA- ARCA et al., 2020)?

QS10.6: Does the company have the means, with sufficient quantity and quality of data, to properly estimate customer returns?

The 'risk objective' of the RFS is the returns forecast error (O#S10). Internally, it can emerge from returns forecast execution errors (IE#S10), caused by one or more elements specified in the SAMP questions, or by insufficient analysis resources to forecast the returns (IS#S10), due to an inadequate information system. Externally, its 'risk factors' can arise from

DFS, due to a demand forecast errors (O#S9), and/or from a sub-process external to SAP, therefore outside the scope of this model, namely, the lack or error of historical returns records (Ext#7). The causal structure elements of the RFS are shown in Table 6.11.

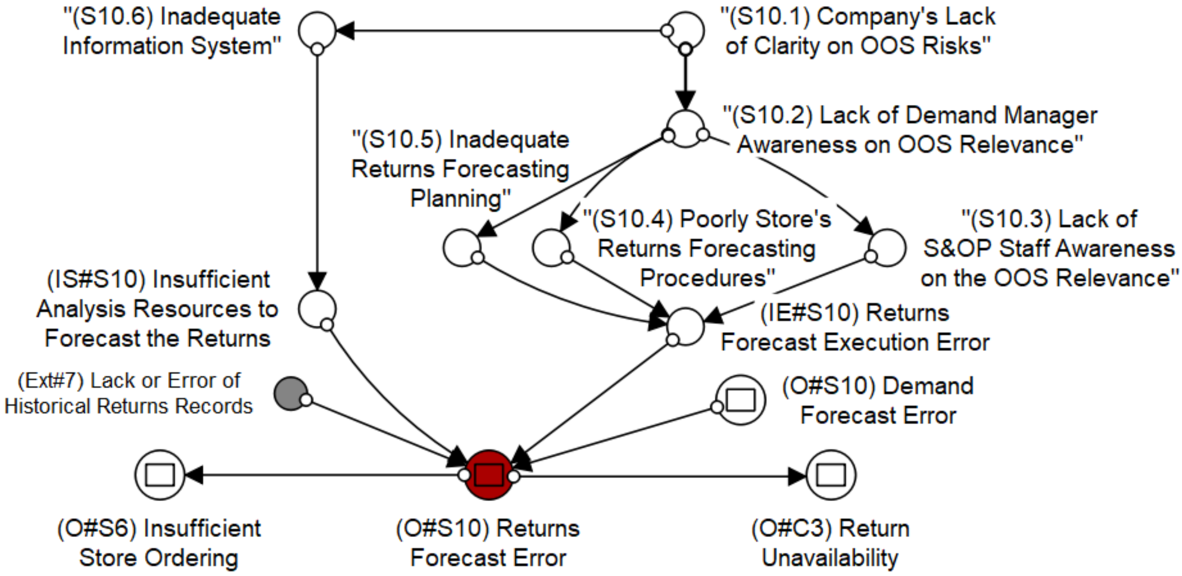
Table 6.11 – Causal structure elements of the RFS

Status	ID	OOS Cause
Input Failure	O#S9	Demand Forecast Error
	Ext#7	Lack or Error of Historical Returns Records
Internal Error	IE#S10	Returns Forecast Execution Error
		S10.1 Company's Lack of Clarity on OOS Risks
		S10.2 Lack of Demand Manager Awareness on OOS Relevance
		S10.3 Lack of S&OP Staff Awareness on the OOS Relevance
		S10.4 Poorly Store's Returns Forecasting Procedures
		S10.5 Inadequate Returns Forecasting Planning
	IS#S10	Insufficient Analysis Resources to Forecast the Returns
		S10.6 Inadequate Information System
Output Failure	O#S10	Returns Forecast Error

Source: by the author (2021)

In addition to G-SAMP, the RFS uses the demand forecast information to the return forecast calculation, since the latter is generally estimated as a percentage of sales.

Figure 6.23 – Causal diagram of the RFS



Source: by the author (2021)

Thus, demand forecast errors can cause return forecast errors. To estimate the return forecast, the RFS also uses the historical returns records, which when wrong, reflect in its calculation. Figure 6.23 presents the relationship between the causal structure elements of the RFS shown in Table 6.11.

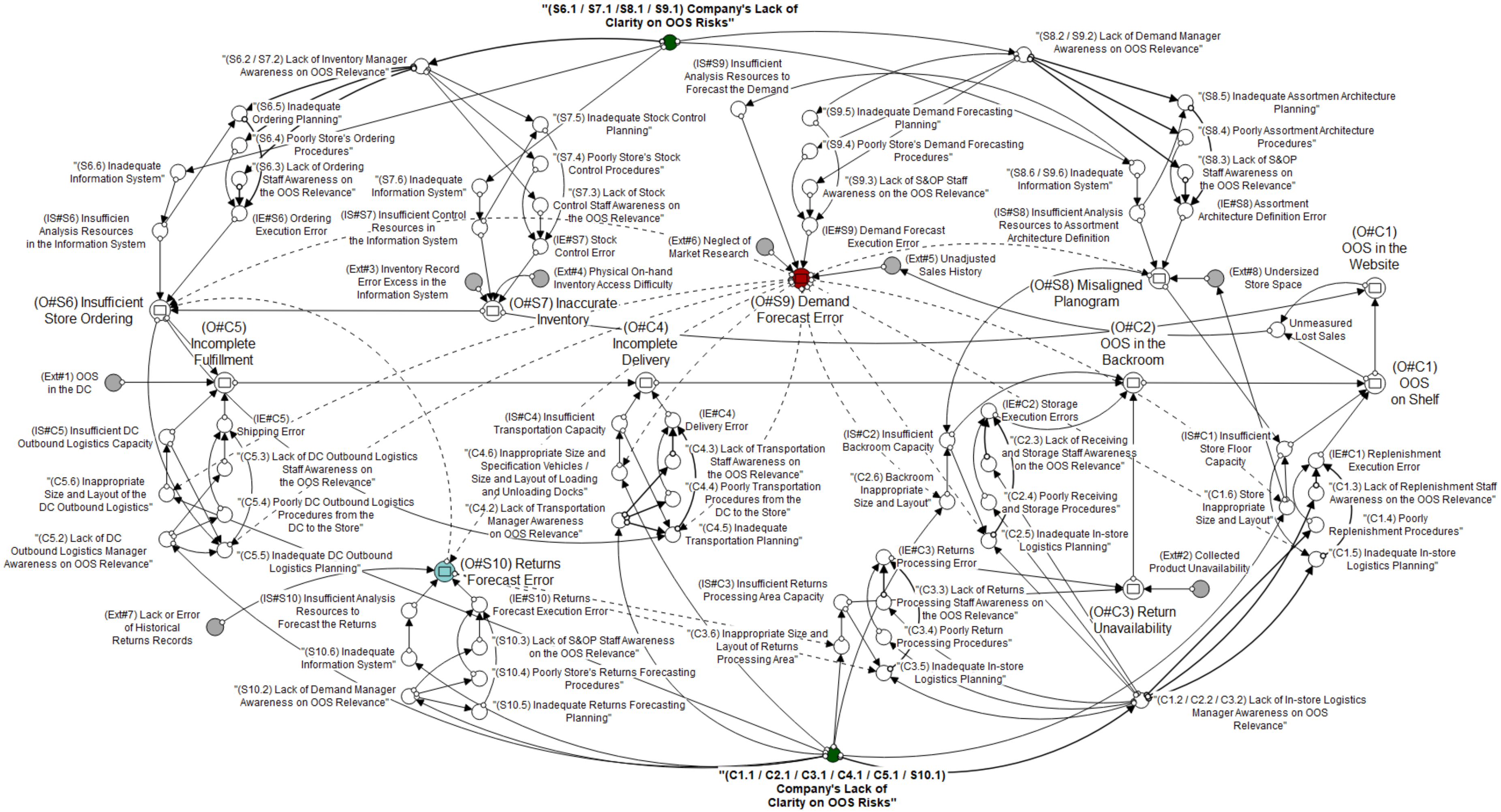
Return forecast errors can cause insufficient store ordering, since the SOS uses the return forecast to calculate order batches. Thus, return forecasts larger than the real returns can cause unavailability of the product returned when it is expected and does not arrive, and unbalanced inventory levels. On the other hand, returns forecasting can cause delays in returns processing and, consequently, unavailability of returns, since it is used for SRS planning.

6.2 THE MODEL OVERVIEW

According to Neto and Pureza (2012, p.170), a model must be “sufficiently detailed to catch the essential elements and represent the real system”, but also “sufficiently simplified to be tractable through analysis methods and known resolutions”. Thus, the model overview is relevant to understanding the relationship between the various sub-processes which compose the SAP and how they connect. According to Christopher (2018, p.7), the more inter-connections and inter-dependencies in a network, the greater is the "possibility for a failure in one part of the network to have a knock-on effect across the network as a whole", named by author as 'contagion risk'. For the author, "one source of contagion risk is in the design of the network itself". Regarding to that, the most comprehensive risk factors identified in this work were two: the company's lack of clarity about OOS risks and demand forecasting errors.

The company's lack of clarity about OOS risks affects all sub-processes involved with the SAP. This is because managers from all internal areas are responsible for directing staffs, establishing process procedures and planning them. And these managers follow, or should follow, the company's norms and beliefs, planning and prioritizing accordingly. In doing so, if OOS risk management is not a priority, it is up to the manager to be aware of and prioritize it, and this extends across the entire company. The company's lack of clarity about OOS risks also influences the strategic decisions about the areas design where the processes operate. This is because the dimensioning and layout of these areas define other prioritizing criteria, such as the store's image, for example, not considering the specifics of OOS risk management. This can result in under- or over-sized spaces, affecting the capacity vs. productivity balance in each process that requires optimized spaces to operate.

Figure 6.24 – Model Overview



Source: by the author (2021)

On the other hand, long-term demand forecast errors similarly influence the areas sizing and layout, since these areas are designed to receive the processes according to the expected demand. Mid-term demand forecast errors, in turn, affect the mid-term planning of the processes and can also affect the assortment architecture. Seasonal demand patterns are used to plan the distribution of space between categories on the store floor and in the backroom, as well as transportation decisions such as type and size of vehicles and the store's replenishment cycle. Finally, short-term demand is used to plan the processes resources, such as staff, as well as to calculate store order batch sizes. The lack of manager's awareness of OOS relevance is the next most comprehensive OOS risk factor, reaching all of the sub-processes that are under the same management. As stated earlier, managers are responsible for directing staff, establishing process procedures, and planning them, affecting the internal effectiveness of processes. Among managers, the in-store logistics manager is the one with the greatest reach, with three sub-processes under his/her command, and is located in the most sensitive area to OOS, i.e., in the store. This manager also manages or influences, depending on the company's structure, all SAP's support sub-processes. Figure 6.24 shows the model overview. Next, the main feedbacks of the model are presented.

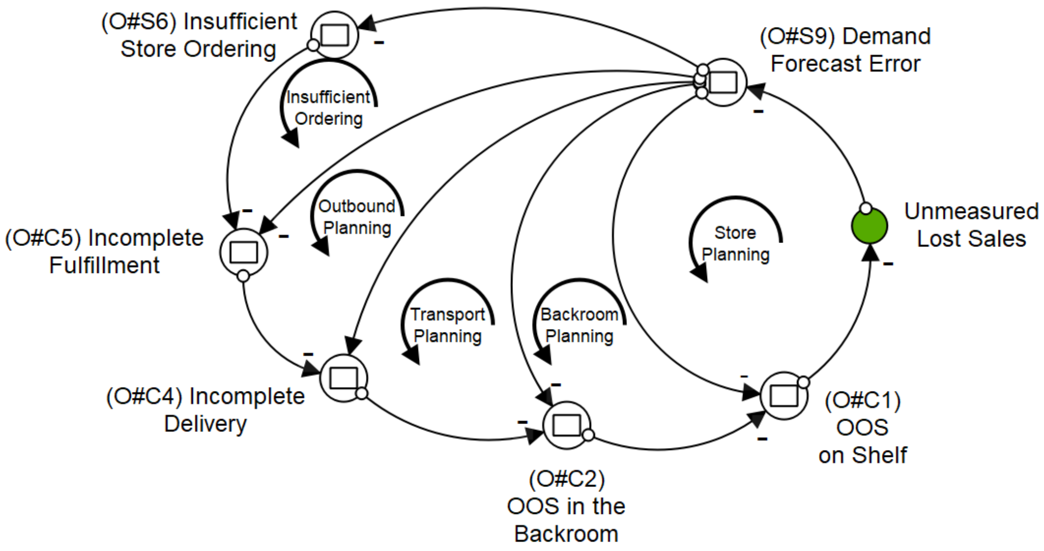
6.2.1 Model's Feedbacks

Dynamic complexity arises not only from the number of agents and possible combinations in a system, but from the interactions between them over time, with their feedbacks and delays (STERMAN, 2000). Thus, understanding the model's main interactions and feedbacks, allows to identify the possible consequences of each risk factor. In doing so, three feedback systems were identified in the model.

The relationship between demand forecast and an OOS event triggers the largest feedback network in the model, somehow involving the entire core process (see Figure 6.25). This is because all its sub-processes use the demand information to plan the workforce and other necessary resources.

However, it is the store ordering sub-process that depends entirely on this information, which does not reduce the importance of the demand information for the other sub-processes. Although the product reaches the sub-processes as planned, if there are not enough resources to operate it, the desired result is compromised, which can generate a OOS situation. What makes this relationship (between demand forecast and OOS situation) a feedback, is the lost sale, which, if not computed in the demand forecast, compromises the entire planning of sub-processes and also of store orders (see Figure 6.25).

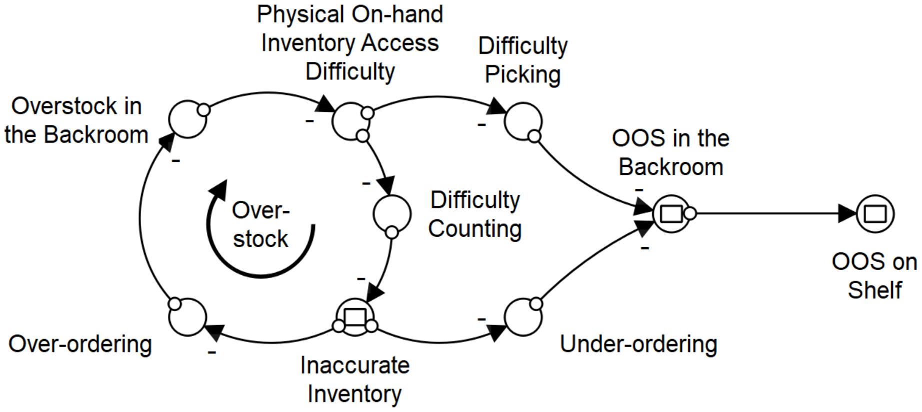
Figure 6.25 – Demand Forecasting Causal Loop Diagram



Source: by the author (2021)

Inaccurate inventory, in turn, directly impacts the batch size calculation for orders from the store to the DC, since the existing inventory is subtracted from the demand, among other considerations. Figure 6.26 shows this behavior.

Figure 6.26 – Inaccurate Inventory Causal Loop Diagram

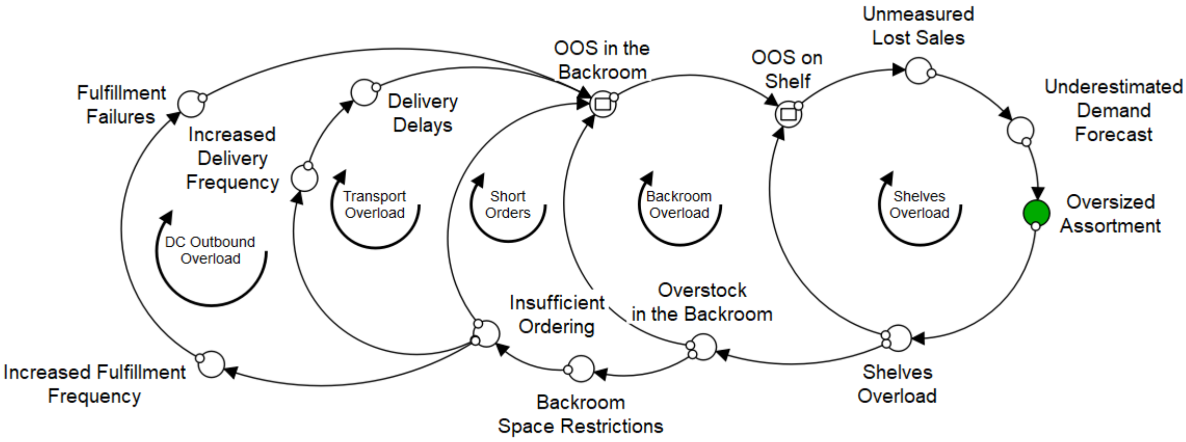


Source: by the author (2021)

Physical stocks greater than those of the information system, cause over-ordering, which causes overstock in the backroom and access to products difficult. This product picking difficulty gives the impression of OOS in the backroom, which causes OOS on the shelves. This same difficulty in accessing products causes difficulty in counting by the stock control staff, accumulating stock errors. On the other hand, if the physical stock is smaller than that of the company's information system, the store ordering staff will order undersized batches, causing OOS in the backroom and, consequently, on the shelf.

The third and final feedback system identified here was the oversized assortment, which triggers a cascading reaction that runs from store shelves to the DC's outbound subprocess. Figure 6.27 shows this behavior, and each of them is further explained below.

Figure 6.27 – Oversized Assortment Causal Loop Diagram



Source: by the author (2021)

Shelves Overload - In case of an oversized assortment, the shelves quickly become overloaded, causing an overload of the replenishment staff, which increases the OOS possibility on the shelves. The OOS converts into lost sales, which if not measured leads to underestimated demand forecasts. With the decreased demand, the marketing area may understand that there is more space available to increase the assortment, causing an even greater overload of shelves and replenishment, and so on.

Backroom Overload - this is an extension of the shelves overload, since it requires a greater support from the backroom, which consequently also becomes overloaded. With the backroom crowed, the replenishment staff has difficulty finding products, generating a false impression of OOS in the backroom, which causes OOS on shelf, and so on, until marketing understands that it can further increase the assortment, restarting a new cycle.

Short Orders and Transport Overload - with the backroom crowed, the store ordering staff are forced to reduce the order batches to the DC, underutilizing the vehicles capacity and increasing the frequency of travels between DC and store, which can cause delivery delays. These delays can cause OOS in the backroom, which can cause OOS on the shelf, generating sales losses, which if unmeasured, imply an underestimated demand forecast and a stimulus to a possible increase in the assortment.

DC Outbound Overload - the same overload caused in the transport by the orders frequency increase from the store occurs in the DC outbound logistics with the increased fulfillment frequency, which can cause fulfillment failures, such as picking errors, handling damage and delays. As a result, there may be OOS in the backroom and on the shelf, generating sales losses, underestimated demand forecast, and so on.

6.3 THE BORDER OF THE MODEL

What comes next? In risk management, risks need to be identified, classified, measured, prioritized and then mitigated. As in the business world scenarios change constantly, once the risks are mitigated, they are then monitored, and the cycle starts again and again. From the model developed in this dissertation, the manager becomes aware of the out-of-stock risk factors in the store-based omni-channel. And based on it, a list of risk factors can be produced, relating the model's risk factors to the company's reality.

Once it has a list of likely out-of-stock risk factors in hand, it is possible to classify them qualitatively. Several authors of the supply chain risk management suggest qualitative approaches in this point of the risk management. Manuj and Mentzer (2008), for instance, suggest creating a "profile" for each of the identified risk factors. Figure 6.28 shows an adaptation of the authors' suggestion to the theme of this dissertation.

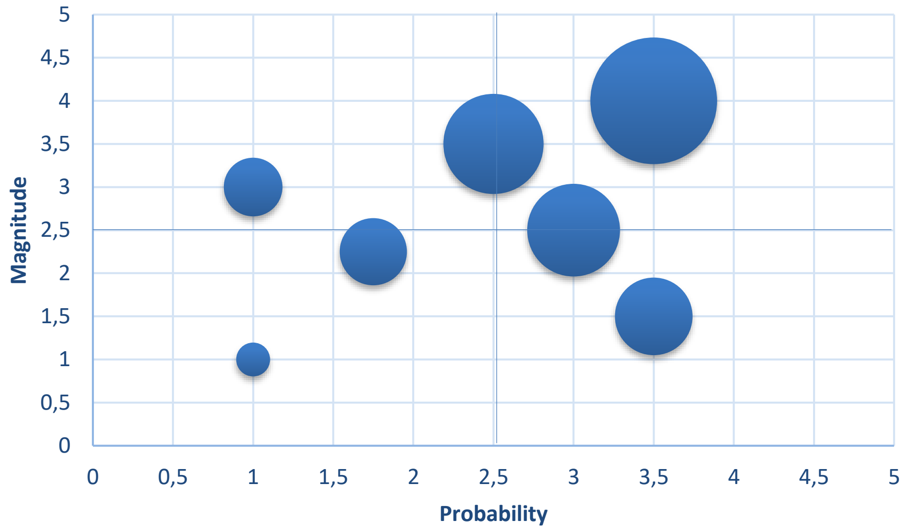
Figure 6.28 – Creating Risk Profiles

Risk Category	**Description of the Risk Factor**	**Atomistic/ holistic**	**Qualitative/ Quantitative**	**Internal/External source/both**
Risk factor 1				
Risk factor 2				
...				
Risk factor n				

Source: adapted from Manuj and Mentzer (2008, p.145)

In this sense, holistic means that the risk factor has high significance and relationship complexity with other factors, while atomistic has less. On the other hand, quantitative risk factors are measurable, while qualitative ones are subjective, such as lack of accuracy, reliability and precision. Finally, internal and external means the manager's degree of control over the risk factor. Another example is the Risk Map presented by Fraser and Simkins (2010, p.173) which is, according to the authors, “one of the most widely described ways to present the greatest risks that an organization faces”. Figure 6.29 shows an example Risk Map.

Figure 6.29 – Example of Risk Map



Source: adapted from Fraser and Simkins (2010, p.173)

The vertical axis shows the potential impact of the risk and the horizontal axis shows the estimated likelihood of the risk occurring, both usually on a scale from 1 (low) to 5 (high). The map is often divided into four quadrants. These scores are usually a position of the manager and can be based on their experience or opinion.

Conversely, the model can be also upgraded from the "conceptual realm of diagrams to a fully specified formal model, complete with equations, parameters, and initial conditions" for simulation purposes (STERMAN, 2000, p.103).

However, from the conceptual realm to formalization of the simulation model, the model's structure departs from the modeler's hypotheses, in this case the researcher's, for the parameters of the real world, requiring empirical data to do so (ROBINSON, 2008).

7 DISCUSSION AND FINAL CONSIDERATIONS

The next topics discuss the main findings of the model and highlight the final considerations of this dissertation.

7.1 DISCUSSION

As far as is known, a few studies on OOS have been carried out using feedback loops, such as the study by Chuang et al. (2016), for example. The authors used feedback loops to explain an experimental framework for detecting abnormal operations and responding to possible shelf OOS by sending auditors to correct empty shelves and incorrect inventory records. However, such a framework was not intended to explain the causal relationships of OOS. Thus, the discussion brings the support from the OOS literature to the findings of this model, although it represents its interconnected parts and not the support of the causal models as a whole.

Lost sales feedback on demand forecast:

The negative feedback from not considering the lost sales information in the demand forecast and the consequent errors of this in the other sub-processes was a relevant finding of the model. This evidence corroborates the findings of Ehrenthal and Stolzle (2013, p.65) in an investigation of the causes of OOS that the "persistent stockouts distort demand in an unobservable way". This is because, according to the authors, lost sales cannot be observed from inventory systems or sales data. Jain et al. (2015) called this not observed demand 'censored demand'. This phenomenon was also mentioned by Derhami et al. (2020, p.4) who highlighted the importance of distinguishing demand shares from sales shares, since sales are subject to product availability. In doing so, "sales logs are skewed relative to actual demand".

However, this explains the error in forecasting demand based on sales data, but not explain the negative feedback generated from it. The findings of this study show that demand forecast errors directly affect the store ordering and indirectly the other sub-processes involved in the effort to make the product available on the shelves. Thus, demand forecast errors can cause more OOS, distorting demand information and consequently causing more demand forecast errors, and so on. This phenomenon has been called 'OOS perpetuation' by several authors. For Moussaoui et al. (2016), most forecasting systems use historical sales data, which only captures fulfilled demand. When an OOS is generated from this limitation "future forecasts will again underestimate actual demand and cause more OOS", causing a self-perpetuating effect of the OOS (MOUSSAOUI et al, 2016, p.519). Therefore, "this vicious cycle illustrates the self-perpetuating effect of OOS and is exacerbated by demand autocorrelation" (MOUSSAOUI et al, 2016, p.525).

This perpetual effect of OOS is mainly through store orders, evidence supported by Corsten and Gruen (2003). According to the authors, retailers typically examine the sales history of the product to reorder it. Thus, "if the out-of-stock has not been detected, then the buying decision will most likely be too low to meet the normal customer demand" (CORSTEN and GRUEN, 2003, p.608). Poor ordering practices were indicated by Moussaoui et al. (2016, p.520) as critical drivers of store OOS, where stores not order sufficient inventory or place their orders too late, ending up "running out-of-stock before the next scheduled delivery". Thus, insufficient store ordering cause OOS in the store backroom, consequently causing OOS on the shelves. In doing so, a new OOS situation occurs, initiating new negative feedback via demand forecast error and so on.

As mentioned above, demand forecast error also indirectly affects distribution subprocesses, since managers use demand information to plan them. This is supported by Ehrenthal et al. (2014). According to the authors, when distorted demand signals are sent, induced by out-of-stocks, the distribution is also planned in a distorted way. This can lead to an inadequate labor supply, on the wrong days and times, for the distribution processes. In this regard, Mou et al. (2018), highlighted that the demand estimate is fundamental for retail store operations, constituting a relevant input not only for inventory management, but also for labor.

Inaccurate inventory feedback loop on OOS in the backroom:

The inaccurate inventory feedback loop was another important finding of the model. The discrepancy between system records and actual inventory levels, whether up or down, ends up affecting the system's balance, causing, albeit in different ways, OOS situations. This is supported by Kok and Shang (2007, p.186), who stated that “the direct effect of inventory record inaccuracy is losses resulting from ineffective inventory order decisions". According to Mou et al. (2018), system records higher than actual inventory can cause "stock freezing", where no orders are triggered, because it is believed that there is enough inventory. On the other hand, according to Kok and Shang (2007), system records lower than the actual inventory imply unnecessary orders, leading to an overload backroom. According to Grubor et al. (2017), backroom overload makes it more difficult for employees to find products to replenish on shelves. To correct the inaccurate inventory and identify process problems, both Kok and Shang (2007) and Mou et al. (2018) mentioned cycle counting as a process for verifying inventory accuracy. However, just as overloaded backroom makes the replenishment process difficult, it also makes the counting process difficult.

Oversized assortment feedback on sub-processes operation:

Finally, another finding was the shelves overload feedback loop, which is an inconsistency result of the shelf capacity with product demand. This is supported by Garcia-Arca et al. (2020). According to the authors, the misalignment of a product's shelf capacity with its demand can increase the risk of OOS events, since it increases the frequency, urgency, and, consequently, the workload of the replenishment process. The feedback loop occurs, however, due to the reflection of OOS on demand information and, consequently, on assortment choices. This corroborates Ehrenthal et al. (2014), who stated that incorrect demand information leads to poor assortment choices, since the retailer considers demand equal to actual sales and, accordingly, misallocating shelf space. However, this feedback loop probably extends as overloading the shelves leads to overloading backroom. This is consistent with Eroglu et al. (2011). According to the authors, the smaller the shelf space dedicated to a product in relation to its rotation, the greater the need for backroom space to support it. This is because it is necessary for this product to be replenished repeatedly until the DC sends a new shipment. Mou et al. (2018) also noted that delivered items that do not immediately fit on shelves are typically stocked in the backroom for later replenishment, effectively acting as a buffer between store deliveries and shelf space. For Moussaoui et al. (2016, p.521), "larger replenishment quantities will translate into more product temporarily stored in the backroom", exacerbating the backroom effect. As a result, according to Grubor et al. (2017), backroom overload makes it more difficult for employees to find the products and replenish shelves, thus causing OOS.

From a backroom overload, the problem extends to previous sub-processes, i.e., transport and DC outbound logistics, overloading them causing a ripple effect. This is supported by Garcia-Arca et al. (2020). According to the authors, the retailer organizes the DC and transport systems to fulfill the stores taking into account, among others, the capacity restrictions and resources availability (such as store storage capacity, number of workers, truck capacity and/or vehicles availability). Thus, resources restrictions lead to delays and execution errors.

7.2 FINAL CONSIDERATIONS

It is correct to say that an identified risk, if not mitigated, does not produce any value for the company. But it is also clear that if a risk is not identified, it does not exist and therefore cannot be mitigated by the company. Therefore, the simple awareness of its existence already results in a certain vigilance on the part of managers, even though a formal management process has not been applied. It is not trying to measure the level of importance of each stage of risk management here, but clarifying that only a complete risk management cycle will produce greater value, starting with adequate risk identification.

It is important to highlight the originality and topicality of the study. According to the literature review findings, no studies were produced on the subject, only discussions involving omni-channel logistics and some emerging risks, which attest to its originality. Furthermore, the topicality of the research theme can be verified by the literature review results, which evinced that the omni-channel logistics theme began to be explored just over five years ago.

In order to achieve the main objective of this dissertation, i.e., the development of the model, it was necessary to fulfill four specific objectives beforehand. The first of them pointed out research gaps and allowed the refinement of the problem from a general sphere to a specific context and phenomenon, which was achieved through the literature review. The second specific objective aimed to define a basic process of the omni-channel logistics operation, through which it was possible to map the risk factors. This objective was achieved by delivering Store Availability Processes, categorized into a core, support and management processes. The third specific objective, in turn, supported the building of the conceptual model, providing the causes of out-of-stock in traditional retail, which were used as a basis for defining the out-of-stock risk factors in the omni-channel. This objective was achieved by delivering the main out-of-stock causes summary list in Chapter 4 and the detailed list in Appendix D. The fourth and last specific objective aimed to deliver a list of omni-channel logistics challenges in order to spur insights into new emerging out-of-stock risk factors in a store-based omni-channel strategy. This objective was achieved by the delivery of this list, detailed in Chapter 4 and summarized in Appendix B.

Regarding the main objective, it was fulfilled by means of a causal diagram model which covers the entire scope of the proposed context, i.e., the Store Availability Process. Not only was the overall causal diagram model delivered but also details about each sub-process, as well as the analysis of the main causal loops found. The latter allows reflecting on possible negative reinforces between the out-of-stock as a 'risk objective' and its 'risk factors'. Other negative reinforces were found, such as the oversized assortment, which affects directly the store shelves overload, indirectly overloading all other core sub-processes of the SAP. Inaccurate inventory was also identified as a risk factor that causes, on the one hand, overstock making it difficult to pick and count products in the backroom. Under-ordering also causes out-of-stock in the backroom. Both cause out-of-stock on the shelves.

This study contributed to both the scientific community and the practitioners on logistics, especially those who work with retail, either directly or indirectly.

For the scientific community, the contributions were multiple. The main objective was the model, which was the starting point on the path to omni-channel out-of-stock risk management, aiming its mitigation. Not only for the delivery of its result, but for the building method that can inspire other researchers in similar studies. It required innovation and complex contexts due to scarce literature. According to Martins (2012, p.14), "by manipulating the model the scientist starts to simulate, [...] appropriating reality without, however, manipulating it". The specific objectives fulfillment also had their share of contribution to the scientific community. The literature review, for example, delivered systematic research on the theme, presenting its method, findings, and analysis. However, its main contribution was the many research questions on the topic formulated for use in further research. These research questions went far beyond the scope of the context of this dissertation, bringing together the challenges in the most important areas of omni-channel logistics and presenting research questions that instigate reflection in its most varied aspects. Chapter 4 contributed to the scientific community by providing two comprehensive and up-to-date lists. The first, the out-of-stock causes list in traditional retail found in the literature on the subject. The second, the omni-channel logistics challenges list, results of an in-depth analysis of the articles found in the literature review. Both can provide enough elements to guide researchers in further studies on their subjects.

Another relevant contribution was the omni-channel logistics process definition. Although it was structured considering the model requirements, it represents a robust architecture involving the product and information flows in an omni-channel context, as well as the management of these processes. The perspective of the decision horizon was also considered, where the long-, mid- and short-term management were examined, as well as their connection with the logistics operation in this context. This architecture can be used for the most diverse studies involving retail logistics, as well as for the construction of simulation models.

From the researcher's point of view, the greatest and main contribution for the practitioners on retail logistics is the delivery of the model of logistics risks of out-of-stock in a store-based omni-channel strategy. The operational changes when a traditional or online pure retailer adopts the omni-channel strategy are significant. Since it is a customer-centered strategy, the out-of-stock is one of the first reflections of the mastery lack of the strategy and also quickly and easily perceived by the customer. According to Sterman (2000), causal diagrams are simply maps that consist of variables connected by arrows in a relation cause and effect. Causal diagrams are easily read, which does not take away its value but adds to it by allowing better visualization of complex systems. With the model developed by this study, retail logistics practitioners can direct not only their strategic decisions to realign the size and layout of areas, but also reassess their planning, procedures, and staff guidelines to avoid out-of-stock.

The up-to-date list of causes of out-of-stock in traditional retail can support not only traditional retailers, but also online retailers in their decision making. On the other hand, the omni-channel logistics challenge list serves as a warning to logistics managers in the most varied aspects of their decision-making about adopting such a strategy, or to what they need to direct more attention to.

The research suggested here are precisely those that can cover the limitations of this study. Therefore, the first suggestion is to apply the model in an empirical study. This would add even more credit to the model, allowing for tweaks that would make it easier to use. Another important consideration and also suggested here is the extent of coverage of a store's inventory by the inventory of other stores in the company, even in store-based strategies, for online order fulfillment, through transshipments.

Another suggestion is the adaptation of this model to DC-based online order fulfillment and/or drop shipping from the suppliers. This would expand the range of omni-channel strategies to take advantage of the tool and allow comparisons of significance and the amount of risk in each of them. With this, managers would be better equipped with highly relevant information for strategic decision-making.

Although the logistics activities that were outside the framework of the model are responsible for a smaller part of the out-of-stock risks (GRUEN and CORSTEN, 2007; FERNIE and GRANT, 2008; AASTRUP and KOTZAB, 2009; GARCIA-ARCA et al, 2020), namely the DC availability process (Ap2), it is suggested that further research explore this context. The argument is that the systems dynamics perspective can present new information regarding feedbacks and radial importance of out-of-stock causes from this context.

Although the conviction that internal threats are the most relevant and critical for the company was adopted in this study (CHRISTOPHER, 2011), another suggestion is to expand the model to consider external threats. This is supported by the emergence of impacting natural risks, such as the COVID-19 pandemic, for example.

Last but not least, a study from the perspective of the effects of out-of-stock risks is also suggested, since here it was focused on the perspective of the causes of these risks.

Many other further research suggestions on the theme of omni-channel logistics risks, which were not related to the out-of-stock, but produced from the literature review, were made available in Appendix B of this dissertation.

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APPENDIX A – Bibliographic Portfolio of the Literature Review

ORDER	AUTHOR(S)	TITLE	JOURNAL	YEAR
1	Hübner, A. Kuhn, H. Wollenburg, J.	Last mile fulfilment and distribution in omni-channel grocery retailing: A strategic planning framework	International Journal of Retail & Distribution Management	2016
2	Bernon, M. Cullen, J. Gorst, J.	Online retail returns management: Integration within an omni-channel distribution context	International Journal of Physical Distribution & Logistics Management	2016
3	Ishfaq, R. Defee, C.C. Gibson, B.	Realignment of the physical distribution process in omni-channel fulfillment	International Journal of Physical Distribution & Logistics Management	2016
4	Hübner, A. Holzapfel, A. Kuhn, H.	Distribution systems in omni-channel retailing	Business Research	2016
5	Hübner, A. Wollenburg, J. Holzapfel, A.	Retail logistics in the transition from multi-channel to omni-channel	International Journal of Physical Distribution & Logistics Management	2016
6	Lim, S.F.W.T. Rabinovich, E. Rogers, D.S. Laseter, T.M.	Last-mile supply network distribution in omni-channel retailing: A configuration-based typology	Foundations and Trends in Technology, Information and Operations Management	2016
7	Murfield, M. Boone, C.A. Rutner, P. Thomas, R.	Investigating logistics service quality in omni-channel retailing	International Journal of Physical Distribution & Logistics Management	2017

8	Melacini, M. Tappia, E.	A Critical Comparison of Alternative Distribution Configurations in Omni-Channel Retailing in Terms of Cost and Greenhouse Gas Emissions	Sustainability	2018
9	Kembro, J.H. Norrman, A Eriksson, E.	Adapting warehouse operations and design to omni-channel logistics : A literature review and research agenda	International Journal of Physical Distribution & Logistics Management	2018
10	Marchet, G. Melacini, M. Perotti, S. Rasini, M. Tappia, E.	Business logistics models in omni-channel: a classification framework and empirical analysis	International Journal of Physical Distribution & Logistics Management	2018
11	Ang, A. Tan, A.	Designing reverse logistics network in an omni-channel environment in Asia	LogForum	2018
12	Melacini, M. Perotti, S. Rasini, M. Tappia, E.	E-fulfilment and distribution in omni-channel retailing: a systematic literature review	International Journal of Physical Distribution & Logistics Management	2018
13	Wollenburg, J. Hübner, A. Kuhn, H. Trautrims, A.	From bricks-and-mortar to bricks-and-clicks : Logistics networks in omni-channel grocery retailing	International Journal of Physical Distribution & Logistics Management	2018
14	Weber, A.N. Badenhorst-Weiss, J.A.	The last-mile logistical challenges of an omni-channel grocery retailer: A South African perspective	Journal of Transport and Supply Chain Management	2018
15	Eriksson, E. Norrman, A Kembro, J.H.	Contextual adaptation of omni-channel grocery retailers' online fulfilment centres	International Journal of Retail & Distribution Management	2019

16	Kembro, J.H. Norrman, A	Exploring trends, implications and challenges for logistics information systems in omni-channels: Swedish retailers' perception	International Journal of Retail & Distribution Management	2019
17	Lafkihi, M. Pan, S. Ballot, E.	Freight transportation service procurement: A literature review and future research opportunities in omni-channel E-commerce	Transportation Research Part E	2019
18	Rai, H. B. Verlinde, S. Macharis, C. Schoutteet, P. Vanhaverbeke, L.	Logistics outsourcing in omni-channel retail: State of practice and service recommendations	International Journal of Physical Distribution & Logistics Management	2019
19	Freichel, S.L.K. Wörtge, J.K. Wollenburg, J.	The role of packaging in omni-channel fashion retail supply chains – How can packaging contribute to logistics efficiency?	Logistics Research	2020
20	Kembro, J.H. Norrman, A	Warehouse configuration in omni-channel retailing: a multiple case study	International Journal of Physical Distribution & Logistics Management	2019
21	Derhami, S. Montreuil, B. Bau, G.	Assessing product availability in omni-channel retail networks in the presence of on-demand inventory transshipment and product substitution	Omega	2020
22	Saha, K. Bhattacharya, S.	Buy online and pick up in-store': Implications for the store inventory	European Journal of Operational Research	2020
23	Janjevic, M. Merchán, D. Winkenbach, M.	Designing multi-tier, multi-service-level, and multi-modal last-mile distribution networks for omni-channel operations	European Journal of Operational Research	2020

24	Arslan, A.N. Klibi, W. Montreuil, B.	Distribution network deployment for omni-channel retailing	European Journal of Operational Research	2020
25	Prabhuram, T. Rajmohan, M. Johnson, R.R.	Performance evaluation of Omni channel distribution network configurations using multi criteria decision making techniques	Annals of Operations Research	2020
26	De Borba, J.L.G. Magalhães, M.R. Filgueiras, R.S. Bouzon, M.	Barriers in omni-channel retailing returns: a conceptual framework	International Journal of Retail & Distribution Management	2020
27	Difrancesco, R.M. van Schilt, I.M. Winkenbach, M.	Optimal in-store fulfillment policies for online orders in an omni-channel retail environment	European Journal of Operational Research	2021

Source: by the author (2021).

APPENDIX B – Omni-channel Logistics Challenges Classification

Dimensions / Categories / Challenges		Sources
1 - Back-end Fulfillment		
1.1 - Store-fulfillment for online ordering		
	Restrictions of shelf space	(Hübner *et al.*, 2016b; Hübner *et al.*, 2016c; Saha and Bhattacharya, 2020; Arslan *et al.*, 2020)
	Restrictions of backroom space	(Arslan *et al.*, 2020; Saha and Bhattacharya, 2020)
	IT requirements to keep track of inventory transparency; conflicting inventory allocation rights on sales floor	(Hübner *et al.*, 2016b)
	IT requirements to allow data exchange	(Hübner *et al.*, 2016c)
	Inventory visibility in real-time; decrease in commercial space	(Rai *et al.*, 2019)
	Additional in-store logistics	(Hübner *et al.*, 2016b; Rai *et al.*, 2019; Arslan *et al.*, 2020)
	Competition for on shelf products between customers and pickers	(Hübner *et al.*, 2016b; Rai *et al.*, 2019)
1.2 - Warehouse-fulfillment for online ordering		
	Combining small orders from online consumer with large store replenishment orders	(Hübner *et al.*, 2016c; Kembro *et al.*, 2018)
	Adjustment of picking system	(Hübner *et al.*, 2016b; Kembro *et al.*, 2020)
	Longer average distances to customer than stores	(Hübner *et al.*, 2016b)
1.3 - Static and dynamic allocation policies		
	Managing multiple picking locations; channel-integrated inventories	(Marchet *et al.*, 2018).
2 - Last Mile Distribution		
2.1 - Home delivery		
	Lead time; potential shipping fees; handling of bulky items	(Hübner *et al.*, 2016c)
	Additional complexity in attended home deliveries	(Melacini *et al.*, 2018)
	Dynamic timetable assignment; loss of customer interaction in unattended home deliveries; temperature requirements for perishables; theft at reception point	(Hübner *et al.*, 2016b)
2.2 - Pick-up points		
	Definition of the set of pick-up points	(Melacini *et al.*, 2018)
	IT requirements for *click&reserve*; in-store picking efforts for click&reserve; difficulty to scale-up in click&collect; investment to set up additional facility	(Hübner *et al.*, 2016b)
	Loss of interaction and synergy between the store and customers while using lockers	(Hübner *et al.*, 2016b; Melacini *et al.*, 2018)
2.3 - Delivery time and area		

Processing costs; process complexity	(Hübner *et al.*, 2016c)
Decentralized inventories; complex transshipment; cross-docking policies for central DC deliveries	(Hübner *et al.*, 2016c; Wollenburg *et al.*, 2018)
3 - Product Returns	
3.1 - Returns mode	
Customer accessibility to return entry points; visits required for collections at the customer's home	(Bernon *et al.*, 2016).
Determination of the number and location of entry points	(Melacini *et al.*, 2018)
In-store handling effort	(De Borba *et al.*, 2020; Hübner *et al.*, 2016c)
Poor communication in collection points	(Bernon *et al.*, 2016; De Borba *et al.*, 2020)
3.2 - Returns processing	
Processes integration; speed to reintegrate the product into stock	(Bernon *et al.*, 2016; De Borba *et al.*, 2020)
Determination of number and location of return processing centers	(Melacini *et al.*, 2018)
Additional transport costs	(Hübner *et al.*, 2016c)
4 - Inventory and capacity management	
4.1 - Assortment	
Space restrictions in the warehouse	(Hübner *et al.*, 2016a)
Higher complexity in warehousing; increase in the numbers and types of storage locations	(Kembro *et al.*, 2018)
4.2 - Inventory sharing	
Conflicts between channels	(Melacini *et al.*, 2018)
Higher space requirements; heterogeneity of product ranges	(Hübner *et al.*, 2016c)
4.3 - Inventory replenishment policy	
Maintaining product availability for physical and online stores	(Hübner *et al.*, 2016a; Hübner *et al.*, 2016c; Weber and Weiss, 2018; Wollenburg *et al.*, 2018; Eriksson *et al.*, 2019; Saha and Bhattacharya, 2020)
Demand fluctuations	(Hübner *et al.*, 2016c; Kembro *et al.*, 2018)
Mismatch between replenishment forecasts and inventory holding	(Wollenburg *et al.*, 2018)
Balancing demand and capacity	(Kembro *et al.*, 2020)
Robust information system	(Melacini *et al.*, 2018)
Standardization and synchronization of availability information among channels and partners	(Weber and Weiss, 2018)
Inventory record inaccuracy	(Melacini *et al.*, 2018; Wollenburg *et al.*, 2018)
Reinsertion of cancelled order products	(Bernon *et al.*, 2016; Saha and Bhattacharya, 2020)

4.4 - Returns on inventory	
Lack of data on returned items	(Weber and Weiss, 2018)
Restocking the returned product	(Bernon *et al.*, 2016; De Borba *et al.*, 2020)
Difficulty of forecasting the returned volume; misplacement of products	(De Borba *et al.*, 2020)
5 - Logistics Information Systems	
5.1 - Logistics Information Systems	
Capability to track and trace a customer order through the whole process/network until final delivery; need for real-time visibility of inventory across the network; decisions regarding which node an order should be picked and delivered from; data accuracy; system updating; securing competence; change management; investments	(Kembro and Norrman, 2019)

Source: by the author (2021).

APPENDIX C – Research Agenda on Omni-channel Logistics Risks

Dimension	Category	Research Questions
Back-end Fulfilment		
	Store-fulfillment for online ordering	What are the logistics risks when adopting online order picking from physical store shelves in omni-channel retailing strategies?
	Warehouse-fulfillment for online ordering	What are the logistics risks when adopting online order picking from a warehouse integrated in omni-channel retailing strategies?
	Static and dynamic allocation policies of the online orders fulfillment point	What are the logistics risks when adopting dynamic allocation policy of the online orders fulfillment point in omni-channel retailing strategies?
Last Mile Distribution		
	Home delivery	What are the logistics risks when offering home delivery service for online orders in omni-channel retailing strategies?
	Pick-up points	What are the logistics risks when offering online order delivery service from the different pick-up points, such as stores and lockers, in omni-channel retailing strategies?
	Delivery time and area	What are the logistics risks when defining the speed and coverage area of online order delivery services in omni-channel retailing strategies?
Product Returns		
	Returns mode	What are the logistics risks when designing the product returns mode of online orders, such as in stores and home collection, in omni-channel retailing strategies?
	Returns processing	What are the logistics risks when establishing the processing points for returned products derived from online orders in omni-channel retailing strategies?
Inventory and capacity management		
	Assortment	What are the logistics risks when defining different assortment for online and physical stores in omni-channel retailing strategies?

	Inventory sharing	What are the logistics risks when sharing inventories between the physical stores sales and online orders, whether from a store or warehouse integrated, in omni-channel retailing strategies?
	Inventory replenishment policy	What are the out-of-stock or over-stock logistics risks when establishing the inventory replenishment policies and designing the logistics network capacities in omni-channel retailing strategies?
	Returns on inventory	What are the inventory imbalance risks resulting from the increase of product returns due to online sales, whether in physical stores or warehouses, in omni-channel retailing strategies?
Logistics Information Systems		
		What are the logistics risks when designing logistics information systems to support decision-making, control, and order and inventory visibility across the logistics network in omni-channel retailing strategies?

Source: by the author (2021)

APPENDIX D – OOS causes by source in traditional retailing

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
STORE	*	*	*	*	*	*	*	*	*	*	*
Ordering	*	*	*	*	*	*	*	*	*	*	*
Order planning	*			*	*	*				*	
Short quantity	*			*		*				*	
Inaccurate system reorder level					*						
Lack of coordination with advertising									*		
Ordering decisions on intuition rather than data										*	
Placed order	*			*	*	*		*	*	*	
Placed late	*			*	*	*			*	*	
No order placed					*	*		*			
Wrong quantity order					*	*					
Manual ordering mistake, such as transposed digits					*						
Minimum order quantity or value not met					*						
Order transmission problems										*	
Ordering system error					*						
Backorders						*					
No real-time visibility of ordering									*		
Inventory inaccuracy/handling		*	*		*	*	*			*	*
Shrinkage		*	*		*		*			*	

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
Theft		*	*			*					
Processing errors, accounting mistakes and pricing discrepancies		*	*								
Scan items incorrectly on checkout						*				*	
Inventory records inaccuracy (IRI)					*	*				*	
Item damage / not in saleable condition					*	*	*			*	
Sell-by date expired					*						
Inappropriate handling					*						
Misplaced item;					*						
Inaccurate inventory management					*			*			
Delivery frequency			*								
Shelving/Replenishment	*	*	*	*	*	*	*	*	*	*	*
Shelf issues	*		*		*						
Messy (false impression for repositories and customers)			*								
Product without sales condition and not detected			*		*						
Stockout item substituted by another item;					*						
Inadequate shelf labeling											
Placement					*						
Product in secondary place of the store					*						
Featured item differs from standard item					*						
Lack of a proper trigger	*					*		*			
Planning	*		*		*	*	*			*	*
Planograms failures			*			*					
Inadequate shelf space allocated	*		*		*	*				*	

SOURCE			Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
		Confusion among resembling products			*								
		Delisted by store					*	*	*				
		Master data error - product physical dimensions, bill of materials, case pack size, and pallet capacity					*		*			*	
		Large number of SKUs in assortment						*				*	
		Fast-moving items vs shelf space										*	
		Dispute for shelf space											*
	Failure of in-store replenishment process					*	*	*			*	*	
		Item not trackable (store and backroom);					*						
		Staff did not notice stockout;					*						
		Staff did not report stockout;					*						
		Secondary packaging not removed					*						
		Placement not compliant to planogram					*						
		Low replenishment frequency						*				*	
		Late replenishment						*					
		No shelf filling						*					
		Bad execution of planogram						*					
		Poor shelf maintenance										*	
	Picking failures				*								
Storage failures			*	*	*			*				*	
	Backroom issues		*	*	*			*				*	
		Messy (difficulty finding products)	*		*			*				*	

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
Congested (accumulating online demand and self-service)		*				*				*	
Depot availability			*								
Minimally sophisticated tracking and shelving systems										*	
Receiving					*	*	*				
Ramps occupied;					*						
Wrong shipment received;					*						
Poor quality shipment discovered during receipt;					*						
Inappropriate handling;					*						
Delay in quality control;					*						
Absence of staff;					*						
Problems with handheld scanners and other such devices for inventory control;					*						
Miscellaneous other problems					*						
Delivery (receiving) schedule (Ex.: Saturdays and Sundays)							*				
Items still in goods-received (not Storage);					*						
Store management			*		*	*			*	*	
Lack of store management leadership									*		
Staff motivation			*								
Staff unavailable			*		*	*				*	
Insufficient store hours authorized for shelf replenishment						*			*		
Item not replenished by external staff (rag jobber);					*						
Lack of replenishment training									*		
Lack of managerial emphasis on the importance of OSA										*	

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
Manager turnover										*	
Forecasting	*	*	*	*	*	*	*	*	*	*	*
Misjudged demand	*										
Scan items incorrectly on checkout (false demand history)		*	*								
Ineffective processes for estimating promotions and launches				*	*	*			*	*	
Level of data sharing			*								
Inaccurate forecast of standard items					*	*	*	*	*	*	
Increasing demand volatility						*			*		
Inability to react to late changes							*		*		
Price alignment strategies									*		
Different characteristics of product category and seasonality									*	*	
No visibility of store off-shelf space or lost sales									*		
Insufficient resources to analyze data									*		
Inability of retailers to optimize the tradeoff between OSA and wastage in chilled									*		
Off shelf space database inadequate									*		
Demand autocorrelation (real demand is distorted by lack of inventory)										*	
Temporal variation of retail demand (seasonality)											*
DC	*	*	*	*	*	*	*	*	*	*	
Short stock to fulfill the store order	*					*					
Delivery failures				*	*			*		*	

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
Unreliable transportation				*							
Item not delivered					*						
Inaccurate consignment;					*						
Delivery delay					*			*			
Delivery of wrong quantities;					*						
Item damage during delivery;					*					*	
Wrong item arrangement on pallets					*						
Store order lead time impacts duration of OOS											
Ordering failures			*	*	*	*	*	*	*	*	
Order transmission problems to supplier					*						
Late order at supplier					*	*					
Supplier minimum order quantity not met					*						
Supplier minimum order value not met					*						
Order placed for next delivery					*						
Insufficient ordering						*					
No order						*					
Wrong order						*					
Backorder						*					
Sell-by date expired;					*						
Inaccurate inventory records;					*	*					
Item damage;					*						
Shrinkage;					*	*				*	
Problems with supplier integration / reliability					*		*				

SOURCE	Gruen et al. (2002)	Fernie and Grant (2008)	McKinnon et al (2007)	Aastrup and Kotzab (2009)	Ehrenthal and Stölzle (2013)	Corsten and Gruen (2003)	ECR Europe (2003)	Taylor and Fawcett (2001)	Ettouzani et al. (2012)	Moussaoui et al. (2016)	Novaes (2007)
Book-stocks						*					
Inaccurate inventory/handling failures			*								
Inaccurate data						*					
Inaccurate forecast						*					
Pick errors			*	*				*	*	*	
Shipping						*				*	
Loading						*					
SUPPLIER	*	*		*	*	*	*	*	*	*	*
Ordering failures				*	*	*					
Inaccurate forecast of standard item;					*	*					
Inaccurate forecast of promotional items;					*						
Order transmission problems to direct supplier;					*						
Late order at direct supplier;					*	*					
Direct supplier minimum order quantity not meta;					*						
Direct supplier minimum order value not met					*						
Inaccurate inventory / records						*					
No order						*					
Wrong order						*					
Backorder						*					
Production						*					
Packaging, raw material and ingredients unavailable						*					
Low level service from supplier											*

SOURCE	**Gruen et al. (2002)**	**Fernie and Grant (2008)**	**McKinnon et al (2007)**	**Aastrup and Kotzab (2009)**	**Ehrenthal and Stölzle (2013)**	**Corsten and Gruen (2003)**	**ECR Europe (2003)**	**Taylor and Fawcett (2001)**	**Ettouzani et al. (2012)**	**Moussaoui et al. (2016)**	**Novaes (2007)**
- Pick errors				*							
- Planning	*					*		*		*	
- - Catalog update failure	*										
- - Short stock or stockout to fulfill the DC order	*							*			
- - New item or discontinued						*					
- - Communications						*					
- - Promotions and pricings decisions						*					
- - Advertising and display planning						*					
- Delivery failures				*	*						
- - Item damage during transportation from supplier					*						
- - Delay					*						
- Forecasting									*	*	
- - Store management forward buying leading to erroneous demand									*		
- - Poor forecasting										*	
TRANSPORT PROVIDER								*			
- Unreliable transportation service								*			
OTHER	*	*	*	*							

Source: by the author (2021)