

Supply Chain Optimization Strategies for Cold Chain Products in the Live-Streaming E-commerce Model: A Case Study of Salmon

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Abstract. This paper concentrates on strategies for optimizing the supply chain of cold chain products within the context of live-streaming e-commerce. Salmon is selected as a representative case for detailed examination. In comparison to conventional sales models, live-streaming e-commerce is plagued by a consistently high rate of returns that has also become a staple feature of this new sales channel. Salmon requires a very high level of temperature control in all the stages of logistics, so that the same process of returning to the initial process that is applied in regular goods causes the degradation of the quality of salmon to take place at a very high rate. Subsequently, it renders the product reseller inappropriate. In a bid to manage this situation, the proposed paper follows a case study approach in order to develop a systematic inquiry. The framework covers two important dimensions, including the forward supply chain and the reverse supply chain. On the basis of this two-dimensional analysis, the given paper proposes specific improvements to each of the corresponding angles. Also, the article promotes the creation of a real-time information-sharing hub to enable two-way communication in supply chain management.

Keywords: Supply Chain, Live-Streaming E-commerce, High Return Rate, Cold Chain Products, Salmon

1. Introduction

With the rapid development of the internet, live-streaming e-commerce has rapidly emerged as a novel business model in China, demonstrating significant commercial potential. Although consumers can access more tangible and interactive services while watching live streams, they are also undeniably influenced by this special shopping scene, generating a strong desire to consume and making impulsive purchases. Hence, many consumers choose to return the goods after receiving them.

This situation has had a huge impact on products that require cold chain transportation. Even if these products are returned in good condition, once they are out of the temperature-controlled environment for a period of time, they cannot be resold as first-quality products. Moreover, orders in the live-streaming e-commerce model are often highly explosive, and the amount of returns involved

is even larger. As a typical example of aquatic cold chain products, the problem of high return rates is seriously restricting the healthy development of salmon in the live-streaming e-commerce field.

It is against this background that this paper will use a case study method, specifically the salmon supply chain, to discuss how it can be best reduced to minimize the loss and operation cost of cold chain products in light of the high returns rate of the live streaming e-commerce powered by supply chain optimization.

Theoretically, the supply chain optimization theory of salmon is increased and serves as a reference to any other product possessing specialized characteristics in this paper. Practically, the paper will provide particular realistic optimization scripts to live-streaming e-commerce merchants selling salmon as a way of cutting down on the costs of sale and operation risks in the eyes of the supply chain.

2. Theoretical framework and literature review

2.1. Literature review

In recent years, with the rapid development of live-streaming e-commerce and the continuous expansion of the cold chain product market, scholarly research on live-streaming e-commerce, quality control of cold chain products, and reverse logistics and returns management has gradually increased. The following section reviews relevant literature from three thematic perspectives.

2.1.1. High return rates in live-streaming

Scholars such as Duan et al. have found that, compared to traditional sales models, while the shopping environment provided by live-streaming e-commerce is more conducive to stimulating consumer purchasing desires, it is also more prone to inducing return behaviors [1]. Shi et al. point out that when streamers use exaggerated language frequently, it can actually backfire—making consumers reflect on their purchase decisions [2].

Such a marketing intuition is helpful in explaining consumer motivation behind a purchase. But the current research mostly dwells on the issue of consumer psychology and has not yet reported on the issue of high return rates and their effects on the real supply chain operations.

2.1.2. Cold chain products quality control

Speaking about cold chain products, researchers always refer to salmon as an example. Yu and his team have found out that fatty acids of salmon begin to break down and oxidation starts increasing rapidly when salmon experiences repeated temperature changes [3]. As Cheng et al. have pointed out, the maintenance of the salmon's quality is of utmost significance depending on the preservation techniques [4].

This notwithstanding, the greater part of this research remains within the lab. Scholars are inclined to concentrate on theoretical and technical aspects, whereas practical scenarios of returns have not been given much consideration.

2.1.3. Reverse logistics and returns management

According to Anandhabalaji, V, reverse logistics is one of the puzzle pieces that must be taken into consideration when it comes to achieving economic targets under the umbrella of sustainable development [5]. According to a study by Bian and Xiao, returns management is a pertinent topic in

the operation of the supply chain because it affects the profitability and the attitudes of consumers [6].

These arguments highlight the reason why the rational return process is important. Nevertheless, the majority of the available research remains at the stage of individual actions in the process. What is lacking is further exploration of how reverse logistics networks can actually be customized to meet the special needs of cold chain products.

Overall, recent research is mostly focused on separate parts of the supply chain, but it does not give much attention to the peculiarities of the situation in live-streaming online shopping and the special features of salmon. A lack of systematic investigation of an extensive supply chain optimization framework is quite remarkable.

2.2. Theoretical framework

The analytical tools mostly used in this paper include Supply Chain Collaboration Theory and the Information Asymmetry Theory.

Supply Chain Collaboration Theory will be used to refer to business operations performed by different nodes in a supply chain to attain collaborative operation. This theory is applied in this article, wherein it is observed that there is no link-up and collaboration between the forward supply chain and the reverse supply chain, and even among different stages of the reverse supply chain.

Information Asymmetry Theory describes the phenomenon where the market efficiency is reduced due to the difference in information possession between the two parties in a transaction. This article applies this theory to demonstrate the phenomenon of two-way information non-transparency that occurs in the forward and reverse supply chains, which will have a destructive impact on the balance of the entire supply chain. Based on this, this article proposes the establishment of an information-sharing platform to achieve the optimization strategy of two-way collaboration.

3. Problem analysis

The report from MOWI indicates that the global supply of salmon in 2023 was 3.8 million tons, and it showed a stable growth trend in various regions around the world, which can be seen in Figure 1 [7]. At the same time, with the continuous growth in the demand for salmon, it has gradually gained a significant position in the live-streaming e-commerce market.

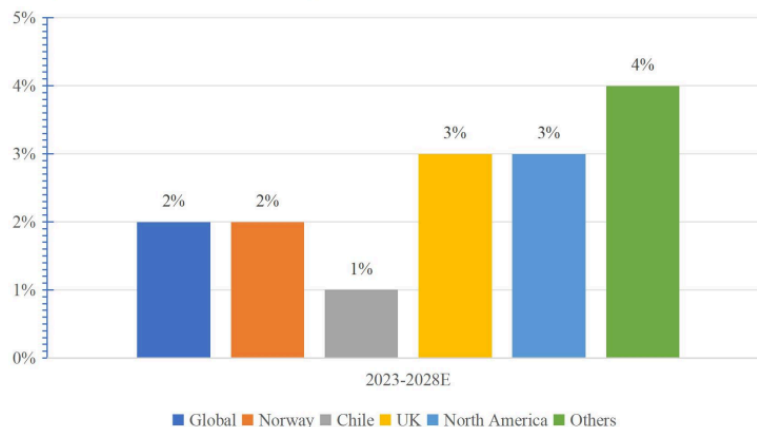


Figure 1. The forecast of the compound annual growth rate for global and regional Atlantic salmon farming from 2023 to 2028

Data from: Salmon Farming Industry Handbook 2024

Although on the surface the high return rates originate at the consumer end, their destructive impact goes far beyond this. It will feed back to every link in the supply chain and even the entire industry [8]. Therefore, when analyzing the problem, this paper starts from the perspectives of both the forward supply chain and the reverse supply chain. The former focuses on the sales and procurement process, while the latter pays attention to the return processing process, achieving a two-way collaborative consideration.

3.1. Forward supply chain

3.1.1. Product quality issues

The source of the forward supply chain lies in the procurement stage. If the quality of the goods provided by the supplier is problematic, it will directly affect the smooth operation of the entire supply chain in the subsequent stage. During the monitoring period of "Double 11", the China Consumers Association found that there were approximately 1,565,203 instances of negative information related to "live-streamed sales" [9]. As the live-streaming e-commerce sector becomes increasingly crowded, incidents such as quality defects occur frequently. This is precisely the main reason for online consumers to return goods. Figure 2 shows that 55% of online shoppers return products due to defects or poor quality in 2025 [10]. After receiving the goods, many consumers will find that the salmon has a dull color or loose texture, which does not match their expectations, and thus choose to return them. This directly affects the normal operation of the supply chain.

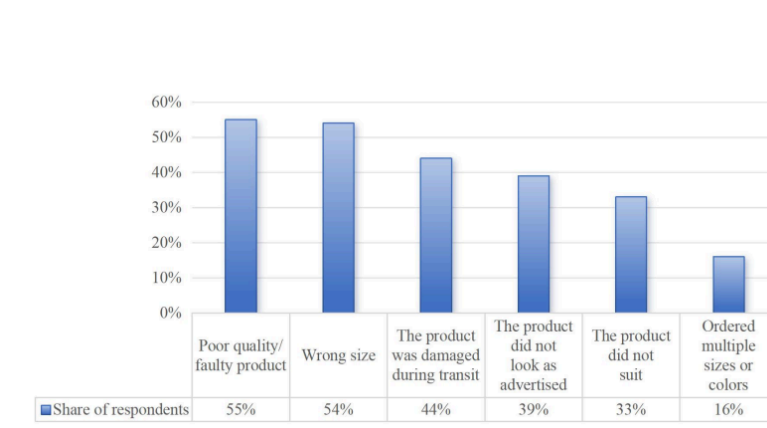


Figure 2. Reasons for returning online purchases according to shoppers worldwide in 2025

Data from: Statista Research Department

3.1.2. Consumer impulsive buying behavior

In the sales process of the forward supply chain, the unique interactivity and immediacy of live-streaming e-commerce have brought consumers an extremely immersive experience. Meanwhile, streamers, as the core role of live streaming, are well-versed in consumer psychology and excel at using various provocative language techniques, such as "the freshest", "absolutely", "first", etc., which increase the tendency of consumers to make impulsive purchases.

In this situation, impulsive purchase behavior may very likely lead consumers to have a regretful mentality after the purchase and return the goods, causing abnormal inventory turnover in the supply

chain. The prepared inventory predicted based on normal sales conditions may be accumulated due to a large number of returns, affecting the logistics efficiency of the supply chain and significantly increasing the overall cost of the supply chain.

3.2. Reverse supply chain

Due to the unique internal structure of salmon flesh, its rate of spoilage is closely related to temperature, and it spoils more easily than ordinary fresh meat [11]. The fluidity of the reverse supply chain processes is therefore very justified in terms of re-operation of a forward supply chain. The general goods return process mainly involves three major stages: return application, logistics pick-up, and inspection and acceptance, which can most likely be installed in a sequence. The time cost of each step can be increased by a number of reasons, and this is a challenge to the cost control and reuse of the supply chain resources.

3.2.1. Return application stage

Salmon enter the reverse supply chain at a stage that is known as the return application. In cases where consumers enter a return application online, not all consumers know how to do it; thus, they must waste some time identifying the entry point and filling in the information, etc. Furthermore, not every consumer is aware on how to store salmon, or have the low-temperature storage conditions. This will result in a scenario of the salmon already going bad in the hands of consumers. This situation is not only an aspect of loss of products, but also a shortage of products that are qualified to be distributed further in terms of the supply chain, posing difficulties to the rhythm of the reverse supply chain process.

3.2.2. Logistics pickup stage

Typically, the logistics pickup stage is usually handled by third-party logistics companies or the merchants themselves. It serves a communication purpose among consumers and merchants in the reverse supply chain. Logistics companies will be obliged to organize special refrigerated cars and facilities, which will pick up salmon from the customers. Nevertheless, there are scarce sources of logistics. In any case where the pickup is not in time, or the operation is not performed correctly, the change in temperatures will hasten the process of spoilage of salmon and make the reverse supply chain less effective and stable in the transportation process.

3.2.3. Inspection and acceptance stage

The inspection and acceptance stage is the last phase of the reverse supply chain, besides acting as a pre-requirement to the product to be reintroduced into the forward supply chain. Merchants must have professional testing equipment and staff to undertake quality tests on the returned salmon. Under the circumstances of inspection, when the salmon becomes extremely damaged, the merchant should pay the worth of a product and the costs of shipping as well; whereas, when the quality is satisfactory to sell salmon on the secondary market, the merchant should repack the salmon and sell it, and such process will be accompanied by time and expenses as well. Therefore, conducting this phase at the end will bring great uncertainty. This will affect the accuracy of market demand prediction by the supply chain upstream and downstream, thereby impacting the coordinated operation of the entire supply chain.

3.3. Information asymmetry between forward and reverse supply chains

The priorities of the forward and reverse supply chain are completely different, which directly leads to a very real problem - the information between the two sides is often asymmetric. To cite an example, within the forward supply chain process, the merchants are unable to get timely information on the number of goods returned and whether they are resold. The reverse supply chain also makes the party dealing with the returns wait longer before understanding the volume of purchases and sales made. The information possessed by either party is disjointed, and neither party is able to have a clear picture. Such a block of information will not allow accurate prediction, which will play an important role in the balance and effectiveness of the whole supply chain.

4. Optimization strategies

4.1. Forward supply chain management

4.1.1. Requiring merchants to provide detailed product information for salmon

Merchants should be required to provide relevant documents, including food business licenses, purchase records, and quality inspection reports. The platform should verify the authenticity of this information clearly. Otherwise, during live streaming, merchants must proactively display important product information such as the origin, fishing time, nutritional content, etc., so that consumers can fully understand the product features. With transparent information, the number of returns due to a lack of understanding will naturally decrease.

4.1.2. Standardizing streamers' language in live-streaming

The platform should establish strict standards for the language used by the streamers, strictly prohibiting the use of absolute terms and ambiguous expressions. Additionally, there is a need to train the streamers more and organize specific staff members to ensure that false or even exaggerated adverts are not carried out frequently in the live material. To the streamers who do not follow the rules of language, some punitive measures should be applied like issuing warnings and fines. Such plans will ensure that the consumers do not receive unrealistic expectations regarding the product.

4.1.3. Forecasting salmon demand accurately

The process of demand forecasting is among the key activities in supply chain streamlining. The study by Kot, S. , and Grondys, K. suggests that correct quantitative forecasting can assist in managing the procurement and warehousing among other processes and operations [12]. Under the condition of the technological era, the platforms have the opportunity to employ big data and smart algorithms to provide the demand forecasting and return items for salmon, and thus help merchants and their suppliers to build stable relationships. This method is also important in ensuring an acceptable number of inventory and ensuring the quality and consistency of the supply of salmon.

4.2. Reverse supply chain management

4.2.1. Streamlining the returns application process

In the case of a cold-chain product such as salmon, a one-day return will impact the quality of the product by a given level. Thus, the product is best kept safe by letting consumers access the goods in the most expedited manner. The platforms must therefore streamline their application systems returns by locating application entry points on the high-unity position on both the live-stream page and the product detail page. The approach cuts down a chain of unneeded processes, hence it saves on time wasted by salmon in the hands of consumers.

4.2.2. Supplying simple preservation equipment

The merchants should prominently show the storage conditions and procedures of salmon on the product page or the packaging so that the consumers would acquire appropriate knowledge of the safekeeping processes in a timely manner. Concurrently, to make sure that consumers are able to store salmon at home, merchants ought to supply ice packs and insulated bags depending on the quantity and specifications of salmon to slow down the process of salmon spoiling and minimize further losses due to improper use of salmon by consumers.

4.2.3. Choosing the proper place of returns transfer warehouses

The scholars have discovered that proper location selection of the warehouse can contribute greatly to the efficiency of the supply chain operations [13]. Due to the perishable nature of the salmon, the choice of the returns transfer warehouses should be as near to the market or transportation centers as practical, in order to exercise effective use of refrigeration vehicles in the transportation of the goods and allow the redistribution or recycling process of rejected products to be carried out at high speed.

4.2.4. Planning of effective returns receiving and inspection processes

The merchants can combine the logistics pickup with inspection and acceptance instead of returning goods to merchants, all the way on to be redistributed. With the placement of professional equipment and personnel at the pickup point or returning depot products may be evaluated as soon as they reach the consumer end in case they are earned as resellable. In this manner, it is possible to establish the groundwork of the further procedures to the fullest extent.

4.3. Coordinated management of forward and reverse supply chains

The platform can take the lead in establishing a real-time information sharing platform to uniformly manage both the forward and reverse processes. Once the data confirming that the returned goods can be resold is synchronized, it can be directly managed together with the normal inventory. Thus, instead of waiting until all the goods return to the merchants, they can be diverted in the intermediate stage. The logistics company can also adjust the transportation routes and vehicle dispatching in real time to ensure that the salmon can be delivered to the new sales location as soon as possible.

5. Conclusion

This paper takes the issue of salmon returns in the live-stream e-commerce model as the entry point, and analyzes the problem from both the forward supply chain and the reverse supply chain perspectives. In the forward supply chain, the quality of the goods and consumer impulsive purchasing affect the operation status of the entire supply chain in direct; in the reverse supply chain, the three stages in the general return process increase the time cost, preventing the supply chain from forming a cyclic process. For the above problems, in this paper, the author respectively proposes improvement measures in two aspects.

This article takes the salmon supply chain as the research object, which is representative among cold chain products. However, its applicability to other types of cold chain products remains to be explored. In addition, the return logistics transportation of salmon requires analysis based on specific regional differences. Factors such as climate conditions, consumption preferences, and the level of logistics infrastructure construction will all have specific impacts on the salmon supply chain.

Future research can expand the scope even further, not only focusing on salmon, but also paying attention to other cold-chain products, and taking regional differences into account as well. Only in this way can more universal optimization solutions be derived. And with the development of technology, it is expected that artificial intelligence will be used to integrate the forward process and the reverse process organically, achieving full-chain temperature control and enhancing the optimization effect of the supply chain.

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