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SIMULATING REVERSE LOGISTICS IN THE FASHION INDUSTRY: A CASE STUDY FOR A UK FOOTWEAR COMPANY

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ABSTRACT

We report on a case study of a footwear retailer in the UK, experiencing a higher rate of returns during the pandemic and needing support with the operational planning of its reverse logistics processes. We use semi-structured interviews to derive an understanding of the problem addressed with simulation modelling. Operational concerns about the costs related to product returns were raised in the interviews. Hence the simulation model focuses on this aspect by exploring the number of staff to returns ratio to achieve the targeted percentage of returned items processed within a certain number of working days. We conclude that other fashion companies might benefit from reviewing their reverse logistics operations especially in anticipation of escalating product returns.

Keywords: Reverse Logistics; Fashion Industry; Discrete event Simulation;

1 INTRODUCTION

The online retail channel has seen a huge growth in the last decade (Cullinane et al 2019), estimated to account for approximately one quarter of the 2022 overall UK retail market according to the Mintel marketing intelligence agency. This trend was accelerated even more during the pandemic (McKinsey 2021). The increase in online retail has resulted in high product returns, which according to Cullinane et al 2019, ranges globally between 20-60%, depending on specific product characteristics. High return rates related to reverse logistics affects the operational logistics processes of retail companies, and ultimately their financial ability to cope with the additional stock in the product sale cycle (McKinsey, 2021).

The aim of this study is to examine reverse logistics practices in the fashion industry through a UK footwear retailer case study. The studied company is one of the major players in the footwear retail industry in the UK, with about 1,300 employees and annual revenue of £130 million in 2019-2020. This study will contribute towards our understanding of the UK fashion industry management of reverse logistics, and their perspective toward tackling environmental issues. Reverse logistics was defined by Rogers and Tibben-Lembke (1999, p.2) as “the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal”. Reverse logistics has gained importance due to political, environmental, and economical concerns (Sasikumar and Kannan, 2008a, 2008b, 2009; Difrancesco et al, 2018; Janeiro et al., 2020). Environmental considerations are of particular interest in reverse logistics (Agrawal et al, 2015).

We use a combination of qualitative (semi-structured interviews) and quantitative analytics (discrete event simulation) to understand the management and role of reverse logistics activities in the fashion retail industry. As a contribution to literature, this combined approach offers a more systematic means for the identification of factors that affect the management of reverse logistics. Interview results offered a better understanding of the context of study and provided a focus for the simulation model which are the internal operations of reverse logistics. The simulation model explores the number of staff to returns ratio needed to achieve the targeted percentage of returned items processed within a certain number of working days, which was an operational decision identified as important during the interviews. This type of modelling has not been reported in the fashion industry.

The remainder of this paper is structured as follows. Section 2 provides a brief review of the literature of simulation in reverse logistics. This is followed by a brief description of the methodology in Section 3. Section 4 is dedicated to findings from the qualitative research and simulation analysis, respectively. The final section discusses the study findings and limitations as well as directions for future research.

2 SIMULATION LITERATURE IN REVERSE LOGISTICS

Simulation modelling is an efficient tool used to gain deeper understanding in the operations of the supply chain as well as to identify and solve several problems as it can deal with the variability, interconnectedness, and complexity of systems (Tako and Robinson 2012, Persson and Saccani, 2009). A recent review of literature on the use of quantitative models of green supply chain models found that simulation is the second most widely used tool (Becerra et al, 2021).

There are several simulation techniques such as Monte Carlo Simulation, Agent-based Simulation, Continuous Simulation, Hybrid Simulation, among which, System Dynamics (SD) and Discrete Event Simulation (DES) are two simulation modelling approaches that are commonly used in logistics and supply chain management to help in decision making (Tako and Robinson, 2012). The authors indicate that DES is more frequently used for strategic to operational/tactical level supply chain issues as compared to SD among 127 published journal articles between 1996 to 2006. Agnusdei et al (2019) reviewed 78 papers using simulation tools in studying closed-loop supply chains. The authors comment that DES is suitable to model logistics processes at operational level including more detailed analysis and individual characteristics of the parts of the system, while SD is more suitable to carry out analysis at “higher abstraction levels” due to its ability to capture the complex dynamics resulting from the interaction of the multiple actors in the system. Becerra et al (2021) identify that DES models are used more frequently to study sustainable inventory management systems in green supply chains.

Within reverse logistics, DES combined with other methods (heuristics, genetic algorithms, tabu search, neural network, etc.) has been noted to be the most widely used simulation approach to tackle multiple problems related to uncertainty, network design, inventory control, production planning and control (Abid and Mhada, 2021). The same authors state that DES has an advantage over other analytical methods, in that it facilitates the development of stochastic models, where parameters can be easily altered to evaluate the impact of changes on system performance (Abid and Mhada, 2021).

3 METHODOLOGY

We use a mixed methods approach combining qualitative and quantitative research methods applied to a case study of a fashion footwear company. Combining qualitative and quantitative research methods is beneficial to ensure that analysis of the problem from different perspectives takes place and better more relevant outcomes can be achieved for decision making (Kotiadis and Mingers 2006; Howick and Ackerman, 2011; Callaghan et al 2021). The study was undertaken over a period of two months and led by the first author, an MSc student. The actual company’s name is not revealed for confidentiality purposes.

The qualitative study undertakes analysis based on secondary and primary data and it aims to gain a general understanding of reverse logistics practices and issues faced in the fashion retail sector and the case study company. Secondary data from academic journals, books, industry reports, and company's website is gathered to provide a background. Semi-structured interviews were the main method used for primary data collection. The aim was to understand the reverse logistics process, key drivers and strategic priorities placed by the case study company in managing it. We carried out 6 interviews with employees from different positions within the company, ranging from the CEO, logistics and distribution manager, e-commerce manager to operatives and warehouse staff. Besides interviews, observation of the reverse logistics operation of the company also took place to gain understanding of the process in order to model it. The qualitative aspect of the study supported the process of simulation modelling and in particular supporting the data collection needs, which will be described in greater detail in the next section.

In terms of quantitative research, this study uses discrete event simulation (DES) to model the company's reverse logistics process specifically at their Distribution Centre (DC) to assist the company in planning its operations by evaluating several scenarios of product returns. We chose to use DES to build the model as it is considered a suitable tool for modelling the behaviour of operational logistics supply chain systems, where operations are represented as a series of events (Abid et al, 2019). SIMUL8 is the software used.

4 STUDY FINDINGS

4.1 The key findings from the semi-structured interviews

The studied company is a major player in the footwear retail industry in the UK and operates various channels for both the domestic and international markets. They own UK standalone stores, concessions in major global department stores such as Topshop, House of Fraser, and John Lewis, and franchised stores and concessions in 10 countries around the world. Beside outlets, they run their own website with shipping options to over 130 different countries. They also supply products to major e-tailers and sell to other retailers on a wholesale basis.

One of the main reverse logistics drivers is regulatory pressure. The regulation on returns and refund is part of the consumer protection law, which states that businesses must allow customers to return the goods purchasing online, via mail and telephone within 28 days from the date of receiving (UK Government, n.d.). Reverse logistics is a requisite activity for organisations such as this, where the company recovers the value of the returned products. They operate a high level of quality control in both forward and reverse logistics when inspecting and sorting returned shoes so as to maximise the number of products that can be resold at full price.

The company's average return rate on an item basis is about 30% across different categories and across the year, which is slightly higher in comparison with 25% return rate of the fashion industry in general and similar to the return rate (30%) of the footwear sector (Interactive Media in Retail Group, 2020). One reason for the high return rate in the footwear sector is due to the challenge of standardising the sizes of products. There are various forms and styles of shoes such as trainers, high heels, and boots, as well as various shoes manufacturers, which makes size standardisation in manufacturing products difficult. The return figure of the company is different across countries, with Germany being the highest of 70% to 80% due to high customer standards. The online channel generates higher returns rate than the offline channel, with the rate being 35%. The obvious reason is that customers do not have a chance to try on products as they do in store. Secondly, it becomes a learned behaviour of customers, in which they are getting familiar and confident in returning products purchased online. There is a minimal fluctuation in the return rate throughout the year, in which autumn-winter season experiences higher return rate than spring-summer season. The return rate at the time of the study was about 32% in spring-summer and 36% in autumn-winter. It is believed to be affected by the pandemic.

The fashion retailer places great emphasis on the speed of the returns process influenced by third-party logistics providers as well as technology and infrastructure. The fashion company experiences the efficient-responsive trade-off in working with carriers. From their perspective, it is essential to have a smooth flow of returns in order to avoid inconsistency in returns volume between days and to quickly process refunds to customers. The company accepts all returns from customers provided that returns are made within the return time window. The reason behind this is to maximise customer satisfaction and avoid disputable situations. The returns to stores are collected by the company's trucks that deliver new orders to stores, whereas others are consolidated by a third-party logistics and dispatched directly to the company's Distribution Centre (DC).

At the time of the study, summer 2021, the reverse logistics process at the DC was paper-based. When returned items arrive at the DC, there was no electronic system to scan the product and automatically trigger a notification of receipt to customers. Additionally, checking returns forms and capturing data are also done manually. This in turn limits the transparency in the reverse supply chain and creates extra efforts in the customer service and logistics department to handle customer enquiries about their returns and refunds. Another obstacle involves sales partners such as Zalando and Asos, where they have very strict KPIs on returns management. For example, customers should receive their refund within 48 hours from when the parcels is scanned back into their return network. In some circumstances such as long-distance travel between other countries and the UK, the policy does not apply for the fashion retailer.

The DC receives on average around 3,500 returned items per week. Delivery of returns regularly arrives at the warehouse after 5 to 7 days, sometimes 10 to 15 days. The refund window offered by the company is 5 working days from receiving the returned items. Currently, the company finds its reverse logistics operations efficient enough to meet the refund window. However, there are days that they receive a large quantity of returns, up to 8,000 returned items, due to returns consolidation of carriers or general delays in the logistics network, which affects the normal operation in the distribution facility. Although this is a rare situation, the scheduling and allocation of staff needs to be planned in advance to address the issue effectively.

Inspection and sorting is the main activity of the fashion retailer in operating reverse logistics, which is performed by the quality control team at the centralised DC. Parcels are opened and checked individually. Depending on the quality of the returned items, they are sorted into three categories: prime stock, which will be resold at full price; sub-standard stock, which will be resold at discount price; and those which cannot be resold at stores will be sold to third-party market traders or donated to charity. If there is no issue with the shoes, they will be cleaned, repacked, and restocked. If there are some problems such as labelling, remedial action will be carried out and shoes will be restocked after this work. After that, the team inspect the returns paperwork, highlight the item being returned and the reasons for returns, and pass the paperwork to customer service department to process the refund. From the activities outlined above, sorting and disposition activities are managed in-house and centralised at the retailer's Distribution Centre (DC), while collection activity is managed partly in-house and partly outsourced to third-party logistics.

The manual processing of returns makes reverse logistics labour intensive and time-consuming.

> *"Despite the full automation in delivery process, or forward logistics, when it comes to reverse logistics, there are still someone sitting there on a packing bench opening in, looking at the condition of the item and deciding where it will go. There is no way of getting around that manual element." – Warehouse Operative*

The company is flexible in allocating human resources for processing returns.

> *"It is very often for small operation like we have here to move your staff to where you need them. There is not fixed number of people in quality control team just doing the web returns because we can have heavy in-take days (deliveries from suppliers), then we put more people on doing the in-take. That is the biggest priority for the business." - Head of Logistics*

4.2 The simulation

The data collected from the qualitative analysis assisted in developing the simulation model, with further inputs provided by the Head of Logistics, who helped us to identify the simulation model objective. The model focused on determining the number of staff required at each stage in the reverse logistics process in order to ensure 95% of returned parcels to the DC are processed within 3 working days. The 3-day time is set as a reverse logistics KPI to finish inspection, sorting, and disposition so as to spare time for paperwork and refund activities. Table 1 presents the model inputs and outputs as indicators to achieve the objective.

Table 1. Model Key Inputs and Performance Indicators (KPIs)

Key inputs	The number of returned items arriving at the DC (range = 3,500; 8,000) The number of staff performing each reverse logistics activity (handling staff range = 3-5; quality control staff range = 4-12)
Outputs (Responses)	To determine the achievement of objectives: • The percentage of items processed within 3 working days (= items completed within 3 working days/total number of items received) • The mean total processing time (from unloading to restocking) To identify reasons for failure of achieving objectives: • Queuing time at each activity: mean, minimum and maximum • Staff utilisation • Time-series of hourly throughput • Histogram of hourly throughput: mean, standard deviation, minimum and maximum • Time-series of total processing time • Histogram of total processing time: mean, standard deviation, minimum and maximum

Figure 1 presents the simulation model of the retailers reverse logistics process.

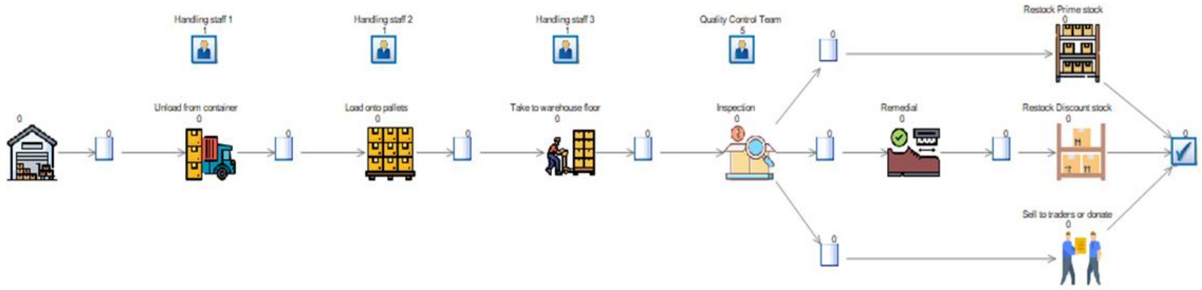

Figure 1 Simul8 model of reverse logistics for the retailer

We introduced the following assumptions and simplifications to our model.
Assumptions:

- Only one batch of returned items arrives at the DC on a Monday.
- Physical operation staff will take 50 returned items to warehouse floor at a time. The same will be applied to items being restocked after checking.
- The ability and productivity of all staff are equal, and all staff have the same working schedule.

Simplifications:

- Travel time of staff within the DC, except for moving stock to warehouse floor and restocking, is not included.
- Uncertainty in operations such as equipment failure or break time are not considered.
- Instead of modelling the operations through a long period with several intakes of returns, only one intake of return is examined and becomes the basis for other scenarios.

Referring to the data used to build the model, the main issue faced was that data regarding the time to complete activities were not recorded by the company, these were estimated during on-site visits and relevant distributions were fitted using the StatFit software. Table 2 presents the main distributions and key data inputs included in the model. Activities in the DC are numbered from 1 to 8. The data used for the model were collected through semi-structured interviews, on-site visits, and email communications with the company's management. The conceptual model's content, assumptions, and simplifications were checked with the CEO and head of logistics and found to be sensible.

Table 2. Model Distributions and other inputs. All times are in minutes unless otherwise stated.

Component	***Attribute***	
Simulation run time	5 days (Monday to Friday) 8 hours per day from 8am to 4pm	
Arrival of returned items		
Quantity	Batch arrival (3500)	
Arrival time	8:30 am Monday	
Activities (time to complete)		
(1) Unloading items from container	Erlang (mean=0.05, k=5)	1 physical operation staff
(2) Stacking items onto pallets	Erlang (mean=0.1, k=5)	1 physical operation staff
(3) Taking items to warehouse floor	Beta (min=3, max=5, $alpha_1$=1, $alpha_2$=4) Perform task after collecting 50 items	1 physical operation staff
(4) Inspection and Sorting (10 workstations)	Triangular (min=1, mode=1.5, max=2.5)	4 quality control staff
(5) Remedial (3 workstations)	Beta (min=5, max=10, $alpha_1$=1, $alpha_2$=1)	
(6) Restocking as prime stock	Beta (min=10, max=15, $alpha_1$=1, $alpha_2$=3) Perform task after collecting 50 items	3 physical operation staff. Each staff has to finish activities (1), (2), (3) before starting activities (6), (7).
(7) Restocking as discount stock	Beta (min=10, max=15, $alpha_1$=1, $alpha_2$=3) Perform task after collecting 50 items	
(8) Selling to traders or donation	Fixed (0)	
Number of resources		
Physical operation staff	3	
Quality control staff	4	

Four scenarios were considered important for the model based on the interviews with company staff. The results of the experiments are presented in Table 5 below. The results show that the main model objective can be achieved with 3 physical operation staff and 5 or 6 quality control staff for 3,500 returned items (scenarios 1 or 2); 4 or 5 physical operation staff and 12 quality control staff for 8,000 returned items (scenarios 3 or 4). We statistically compared the pairs of scenarios (scenario 1 vs 2 and scenario 3 vs 4) using the standard T-test and the paired t-test where appropriate to determine which scenario is better than another. The comparisons show that the percentage of items processed within 3 working days in scenario 1 is less than that in scenario 2, whereas the mean total processing time in scenario 1 is greater than that in scenario 2. We found no significant difference in the results between scenarios 3 and 4, as shown in Table 5. Based on the experiments and findings, we can draw the following conclusions:

- Increasing the number of quality control staff improves the percentage of items processed within 3 working days and the mean total processing time significantly.
- For normal quantity of returns (3,500 returned items), 95% of items processed within 3 working days can be achieved with 3 physical operation staff and 5 quality control staff.
- For high quantity of returns (8,000 returned items), 95% of items processed within 3 working days can be achieved with 4 physical operation staff and 12 quality control staff.

Table 5. Experimentation (10 Replications)

	Scenario			
	1	**2**	**3**	**4**
Experimental Factors				
Number of returned items	3,500	3,500	8,000	8,000
Total handling staff	3	3	4	5
Activity (1)	1	1	1	1
Activity (2)	1	1	1	1
Activity (3)	1	1	2	3
Activity (6), (7)	Pooled resource	Pooled resource	Pooled resource	Pooled resource
Total quality control staff	5	6	12	12
Responses				
% Items processed within 3 working days - Mean	94.48	100	96.12	96.05
95% CI	(93.77, 95.20)	(100, 100)	(95.32, 96.93)	(95.35, 96.74)
Mean total processing time	826.56	699.87	797.42	800.94
95% CI	819.44, 833.69)	(691.76, 707.98)	(792.73, 802.12)	(797.10, 804.78)

5 DISCUSSION AND CONCLUSIONS

This paper provides a mixed methods, qualitative and quantitative (simulation) study of the reverse logistics process of a fashion retailer. We believe this is the first modelling study to focus on the reverse logistics process of the fashion retail industry. We study the inhouse operational process of the company's reverse logistics with the view to identifying areas for improvement. The computer model and the process of developing it provide an opportunity to extend our understanding of this context. Below we discuss the empirical findings of our study and position it within the literature around the context area.

Five main activities constitute the reverse logistics process in the fashion retail industry, which include: mitigation, gatekeeping, collection, sorting, and disposition (de Leeuw et al., 2016; Cullinane and Cullinane, 2021). This is roughly similar to the reverse logistics process of the studied company. Mitigation is not mentioned as an important activity in the literature; however, the fashion retailer focuses on this step to reduce product return rates. In particular, they aim to provide production information as detailed as possible on website, collect online customer feedback about the products through their website, and analyse reasons for product returns to acknowledge the problems and find suitable solutions. In contrast, literature considers gatekeeping as the most critical stage as it could reduce the number of returns by choosing specific item that are allowed into the reverse flow (Cullinane and Cullinane, 2021). Meanwhile, the studied company accepts all returns from customers. This could affect the manageability and profitability of the reverse logistics according to theory, but as the company emphasises decent customer service, gatekeeping is not an option they consider. Future studies for fashion retailers could consider including mitigation and gatekeeping as behaviours affecting sales. This could be more suitable to model using an agent based modelling approach or considering a hybrid simulation model.

Collection of returned items can be performed in three ways: directly from customers, by the company itself, or via third-party logistics companies (Lambert et al, 2011). Our empirical findings show that most of the collection activities are handled by third-party logistics providers, including international returns and online national returns. The company collects and transports the returned items only by its own truck fleet for in-store returns. This is a more economical solution for the company when they do not have enough resources and it is not part of their core competencies. They offer customers several collection options, which has been proved by an exploratory study by de Leeuw et al. (2016), to increase customer satisfaction and boost repurchase intention.

Sorting is the next step in the process, which can be performed at centralised or decentralised facilities (de Leeuw et al., 2016). Decentralised sorting at stores or drop-off locations could increase the speed of processing returns; however, it requires skilled staff at each location for inspection and assessment of returned items. The studied company has a quality control team based in the DC managing the inspection and sorting activities. Having a centralised facility to process returns can help business in minimising cost of processing returns (Loomba and Nakashima, 2012), standardising the operations and reducing labour costs for inspection (de Leeuw et al., 2016).

The last activity is disposition, which can take various forms such as reuse, repair, refurbish, recycling, and disposal (Agrawal et al, 2015). Theory stated that this stage involves the most important goal of organisations, which is recapturing product value (Lambert et al, 2011; Mollenkopf et al, 2011). This corresponds well to the fashion retailer. The company restock the items that are qualified for sale at either full price or discount price, and their objective is to maximise the percentage of returned items that can be resold at full price. They do not deal with recycling but sell unwanted items to an expert in the field.

Our simulation model represents the main activities of the company's reverse logistics operations, sorting and disposition activities,. The model simulates the operations from the delivery of returns at the DC to the restocking of returned and refurbished items before being sold to the market again, providing recommendations to the company about the number of return items that can be processed and the handling and quality control staff, in order to ensure that the returns can be processed within the set time targets (3 working days). The simulation model could be improved by incorporating collection activities to evaluate the retailer's whole process of reverse logistics, however, more data, which are not available, would be needed such as quantity of returns managed by third-party logistics, transportation time to deliver returns to DC, distance between stores and DC, etc, hence these were not included.

This study has been useful for the company to help understand and inform their plans in further developing their reverse logistics process. The qualitative study identified the current practices and areas of uncertainty around which reverse logistics process could be improved. We then homed in with a more detailed simulation model that focused on the staff resources needed on achieving return time targets.

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