Building self-organizing logistics systems

Prospects for reverse logistics

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***Abstract*—Due to the significant growth in manufacturing environment disruptions and customer demand variability, logistics services have concurrently witnessed a disturbing increase in customer returns as part of the reverse logistics system. This paper proposes the use of the Vanguard Method approach for logistics services design that can reduce reverse logistics caused by forward logistics inefficiencies. A case study of a UK manufacturing company has been undertaken using semi-structured interviews and observations. The results show that the Vanguard Method has a direct impact on reducing reverse logistics by building a self-organizing logistics system that learns from reverse logistics cases analysis and continuous customer demand analysis. The value of this paper is the incorporation of forward logistics systems design with reduced reverse logistics in a manufacturing setting by transferring the customer knowledge across the boundaries of the firm throughout the supply chain to enhance logistics function.**

Keywords—reverse logistics; forward logistics design; logistics operations; the Vanguard Method; manufacturing logistics

I. INTRODUCTION

Due to the recent explosive growth in demand for logistics services, associated with business environment variability and uncertainty, many organizations are now attempting to build highly effective logistics services systems that can deal with and learn from uncertainties [1]. Although these attempts are widely documented in literature, they are merely focused on operational mathematical models and simulations to achieve customer satisfaction and business goals [2]. In this context, many manufacturers have given attention to reverse product flows as they have realized in many cases that this is becoming an unavoidable cost of inefficient forward logistics design [3]. Reverse logistics usually reduce manufacturers' current assets as it lowers returned products inventory value, and it lengthens order cycle time due to reshipping of ordered items. It also causes organizations to lose sales and thus sales revenues [4]. In the last decade, the amount of reverse logistics was found to be 12 percent of the total products sales in the US [5], and this have worsen in the UK as most companies are experiencing up to 30 percent product returns by their customers, and that the total cost of retail reverse logistics is valued at 6 billion British Pounds every year [6]. Arising from this, it is imperative for manufacturing organizations to develop self-organizing logistics services that can learn from reverse logistics on how they can be reduced. However, several authors suggest that building such logistics systems, which can learn from reverse logistics cases, require profound shifts in, both, the nature of operational work based on the development of organic systems, and a decentralized decision making approach to focus on customer demands[7,8].

This paper aims at closing the aforementioned gap by proposing the use of systems engineering approach expressed as "the Vanguard Method" [9] for the design of forward logistics services system to reduce reverse logistics. The reverse logistics addressed in this paper are those returned materials or products that are caused by lack of supportive information, human errors, demand incorrect handling, not understanding the customer demand, or simply caused by inefficient design of the forward logistics operations. This research inquiry uses a case study research design in one of the UK's manufacturing firms post-the vanguard method application in its logistics system. In the next section, a literature review account is presented about logistics services focused on reverse logistics. This is followed by a presentation of the Vanguard Method's philosophy and methodology. Finally, the case study results and conclusions are presented.

II. FORWARD-REVERSE LOGISTICS SYSTEMS

Rogers and Tibben-Lembke[10] define reverse logistics as "the process of planning, implementing, and controlling the efficient flow of materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin". It is because of the nature of reverse logistics, as depicted by the definition presented above, most manufacturers view reverse logistics as nuisance due to the significant organizational resources spent on returned products[2]. As a result, several studies have attempted to redesign manufacturing logistics systems to achieve cost savings and to stay in compliance with legislative requirements of environmental degradation[11,12]. For example, Chang and Liao[13] presented routing strategies that can design forward distribution in line with reverse logistics activities with the aim of reducing the operating cost of transportation and increasing competitive advantage. Also, Piplani and Saraswat[14] developed a mathematical model to optimise the reverse logistics in a repair and refurbishment network by determining which facilities are to be used in both forward and reverse flows of modular products. Similarly, Salema et al. [15] derived a mixed-integer programming model for designing reverse logistics network based on the location of warehouse to optimise the forward logistics function and to reduce the cost of handling returned products. However, there is severe lack in the current literature on empirical research or tools that link designing forward logistics systems with reverse logistics improvement through learning from reverse logistics cases. This has been perceived by Chang and Liao[13] as a sub-optimal behaviour that can cause organizations to lose market competitive advantage and reduce financial profits. One of the crucial pillars for building a successful forward logistics function that can reduce reverse logistics is reflected by the work of Lin and Pikarrinen[16]. Accordin to them, the active involvement of customer demands and requirements into the forward logistics service design is of paramount importance to improve the overall logistics system of the company by translating customer' requirements into logistics operations design. Subsequently, logistic services need a market-responsive supply chain design that is capable of understanding customer requirements in the forward logistics, and then absorbing any product returns' demand volatility and uncertainty [17]. This highlights the importance of having a well-designed team-based logistics service, where providing core team members with specific traits such as, open communication, decision making ability, and an environment where team members can develop willingness to contribute to organizational success, is vital for achieving a market-responsive supply chain.

III. THE VANGUARD METHOD

Logistics services are complex systems by nature, as they are composed of huge bundle of processes, information, policies, technologies, people and product flows. Generally speaking, interconnections between the complex system parts are essential for effective processing of operations. Therefore, if logistics services are viewed from a reductionist perspective of its parts, discontinuous forces of silo working would prevent efficient handling of forward logistics and, therefore, would hinder logistics service learning of why products are returning to the supply chain. This conceptualization gave initiation to the work of Seddon[18], described here as the Vanguard Method, of implementing systems design principles into service delivery systems. The Vanguard Method is, therefore, centered on three core elements: interrelationships, dynamics, and wholeness [9,19,20].

The Vanguard Method is based on redesigning service operations around customer demand instead of functional hierarchies [9]. Customer demand understanding process begins with analyzing customer demands over a period of time to collect information about what customers want and expect and what matters to them most. The need for analyzing customer demands stems from the fact that a comprehensive understanding of the transformation processes in the logistics service system needs to be unequivocally presented before interpretations about the situation are made [19]. Customer demand is analyzed on the basis of two different types usually available in logistics services [18]. First, value demand- is what the logistics system has been established to serve and what the customers want which is of value to them. Second, failure demand- is the demand that the logistics system was not able to serve due to the lack of information or supporting operations. The findings of customer demand analysis phase help to explore all the possible ways through which a better flow of processes can be designed against customer demand. This is followed by redesigning the processes flow charts taking what have been learned considering the customer "wants" and then mapping out the new logistics service system design. The most fruitful way to make full use of the Vanguard Method concept is through the use of a team who is basically from the people facing the problem at work and using the system [21].

Typically, the new logistics service design is focused on minimizing non-value adding activities from a customer point of view. The new design is used in an experimental environment by using the new model after it has been discussed with the people doing the work. The new processes are induced gradually with careful observation of both employees reaction to it and customer feedback. The processes are tested, re-designed and re-tested again to make sure that customers get the best possible service before going fully live in the logistics system. However, to design against customer demand is to be more responsive by providing a solution for customer demands at the first time of delivery, thus being more productive [9]. Therefore, the Vanguard Method focus is shifted from conventional service measures (i.e. targets and statistics) towards the percentage of first time delivery service, exactly as customer wanted [22]. This is supplemented with the managers' continuous endeavor to further improve logistics operations to reduce, and ultimately prevent, repeated failure demands.

The Vanguard Method integrates the decision-making processes with the work itself [20]. This way allows for more control on logistics processes because data is in the hands of the people doing the work, and provides ability and creativity in responding to the logistics system's surrounding environment [19]. However, the success of the Vanguard Method is based on achieving economies from understanding the flow of the work, and not from the scale of production (i.e. quantity of transactions). Measures used are built in so they automatically tell you what is happening. These measures are usually centered on the concept of how good the service is in achieving the purpose and absorbing the demand variety. When demand variety is absorbed logistics productivity increases. The Vanguard Method absorbs variety by making intelligent use of the empowered employees [20]. The result is a self-organizing system [9]. The above philosophy usually follows three main practical steps of "check-plan-do" for implementation. These steps are explained below and summarized in Table I.

A. Check

A specially formed team, called the check team, from the workplace records and analyze customer demands to understand what customers expect and want from the logistics system and what matters to them most, they need to be able to use views of different people involved in the problematic system. Once the team understands the type of demand received and how capable the system is to respond to it, it can start to map the flow of processes in the system.

B. Plan

The check team redesigns the logistics processes flow charts taking what have been learned considering the customer "wants" and then mapping out the new service system design. Typically, this stage is focused on minimizing non-value adding activities from a customer point of view.

C. Do

At this final stage the new design is used in an experimental environment with the check team using the new model after it has been discussed with the people doing the work. The new processes are induced gradually with careful observation of both employees' reaction to it and customers feedback. The processes are tested, re-designed and re-tested again to make sure that customers get the best possible service before going fully live.

TABLE I. THREE STAGES OF VANGUARD METHOD

Stages in Process	**Stages Activities**	
	What is it?	***What does it do?***
•Check	An analysis of the what and why of the current system	Provides an understanding of the system as it is and identifies waste and the causes of waste.
•Plan	Exploration of potential solutions to eliminate waste	Provides a framework to establish what the purpose of the system should be and how the flow of work can be improved to meet it.
•Do	Implementation of solutions incrementally and by experiment	Gradual introduction of changes whilst still considering further improvement. Continue to review changes, Work with managers on their changing role.

Adapted from Jackson et al. [20].

IV. RESEARCH METHODOLOGY

This research inquiry uses a case study research design. The use of case studies in logistics services research is an enabler for the causal depth required for understanding the real domain of logistics operations and its performance [23]. The case study took place in a roof windows manufacturing company in the UK. The company produces a wide range of roof windows, blinds, and electronic accessories to customers. At the time of the study, 108 employees were available at the logistics operations department of which 67 employees work in the operations call center; receiving customer demands and coordinating between customers, warehouse, and logistics drivers for orders deliveries. The reverse logistics addressed in this study are those returned materials, items, or products that are avoidable by any organisation; caused by lack of supportive information, human errors, demand incorrect handling, not understanding the customer demand, or simply caused by inefficient design of the forward logistics operations. Data were mainly collected through in-depth interviews and observations at the logistics operations department. Ten in-depth interviews were conducted with logistics directors, middle managers, and operations employees. Interviews were tape recorded and transcribed as soon as the interviews were completed. The 'thematic analysis' approach [24,25] was used to analyze the data. The results from this analysis were two central themes that are presented in Table II.

TABLE II. THEMATIC ANALYIS

Codes	**Thematic Analysis**	
	Issues discussed and basic themes	***Central themes***
•Received demand •Continious •Failure •value	•Demand classification •Absorb demand variation •Demand understanding	Customer demand analysis
•Error •Analyse •learn	•Reverse logistics Causes exploration •Learning from reverse cases •Sources of inefficiencies •Building better logistics	Reverse logistics analysis

V. RESULTS

Results from the in-depth interviews analysis were supplemented by the use of research site observations of how the logistics operations are currently being done. The two themes achieved are presented below:

A. CUSTOMER DEMAND ANALYSIS

This theme refers to the predictability achieved at the logistics operations department as a result of the customer continuous demand analysis. This process is presented in Fig. 1 below. It was evident in the findings that getting customer clean information with full details about what the customer exactly wants, during customer first contact, is significantly important in reducing reverse logistics and improving the whole supply chain performance. For this purpose, the operations call center employees used to ask customer to provide full details about addresses, contact details, order types, quantities, any special orders or customizations, and information of when and how the customer wants the delivery of orders. To confirm that this was received and understood well by the warehouse and logistics drivers, the operations call center employees used to email full details of orders to warehouse. This was followed up by a phone call to make sure the message was received correctly with any supplemental details as they become available. Furthermore, the operations call center found it necessary in some cases to have a conference call joining the customer, call center, and warehouse people for better transfer of information. Interviewees stated that customer clean information was used as the guarantee to deliver the right order when and how the customer wants it. It was also recognized that passing clean information to drivers and other logistics employees was at the top of their priorities to prevent any incorrect orders deliveries or items rejection. Interviewees have also revealed that customer demand analysis was an enabler to forecast the most common demands coming in to the logistics system and, because of that, they were better able to design and deliver high quality logistics services to the customers. They have explained that demand analysis and categorization was a powerful source to learn demand seasonal trends (i.e., certain types of products are more required at certain time of the year). Due to this clarity on demand trends, the manufacturer was able to execute crucial improvement task to their logistic operations by enhancing readiness against customer demands by better knowing how much to stock and what to stock into their distribution center; improving forward logistics by making the right products available.

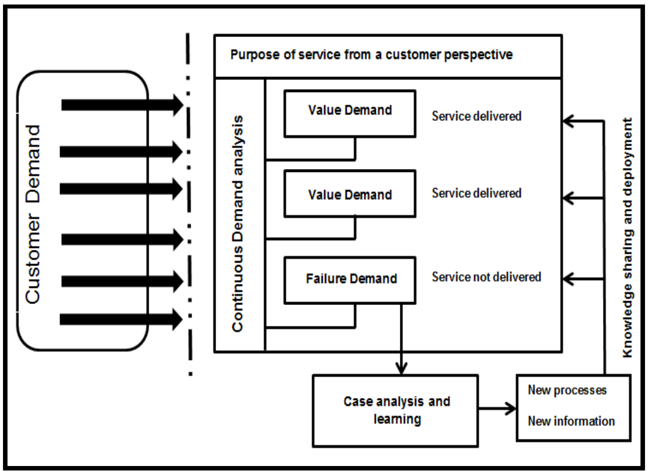

Fig.1. Continuous demand analysis

B. Reverse Logistics Analysis

This theme portrays the role of the Vanguard Method in creating a logistics service design that can learn from reverse logistics analysis. The research results illustrate the importance of recording and logging any failure demand (i.e. reverse logistics of incorrect deliveries or returned products) received into the IT system used. Interviewees indicated that this was done in the belief that employees are required to continuously improve their existing logistic operations by challenging the current processes to learn on how they can be improved. To make the learning process possible, the Vanguard Method redesign team at the logistics operations office of the case study company used to deeply investigate each reverse logistics case received. Consequently, this helped the team in identifying potential causes of the reverse logistic case. Fig.2 explains the process of reverse logistics cases analysis and knowledge generation process found at the logistics services operations of the case study company.

With this activity, team members were able to propose immediate corrective measures to be taken in order to avoid the same problem in the future and to minimize the number of unnecessary reverse logistics cases. It was evident at the logistics operations department that logged failure demands are shared and discussed among logistics employees on weekly basis to ensure learning about the system. In fact, interviewees viewed the focus on reverse logistics, specially the rare problems, as a rich source of information for the organization to improve its logistic operations, and also vital for the organization to stick to its working purpose, from a customer perspective.

VI. Discussion and Conclusion

Reverse logistics continue to have a major impact on manufacturing organizations' bottom line. The results show that the Vanguard Method has created dramatic changes in the management of inventory control systems at the research site due to the continuous customer demand analysis. It was emphasized by Seddon and Brand [26] that customer demand is central in the Vanguard Method redesign phase. This is seen as contradictory to many service redesign projects where the customer engagement is often not given enough room in the logistics service reengineering projects. Taking customer into account, at the case study company, ensured that learning is meaningful, which signal that learning is directed to the strategic goals of the organization by continuously seeking to improve the logistics services. Pedler el al. [27] viewed this as an essential step for building a self-organizing system where effective engagement of customers will simultaneously build internal capabilities of adaptability to surrounding environment.

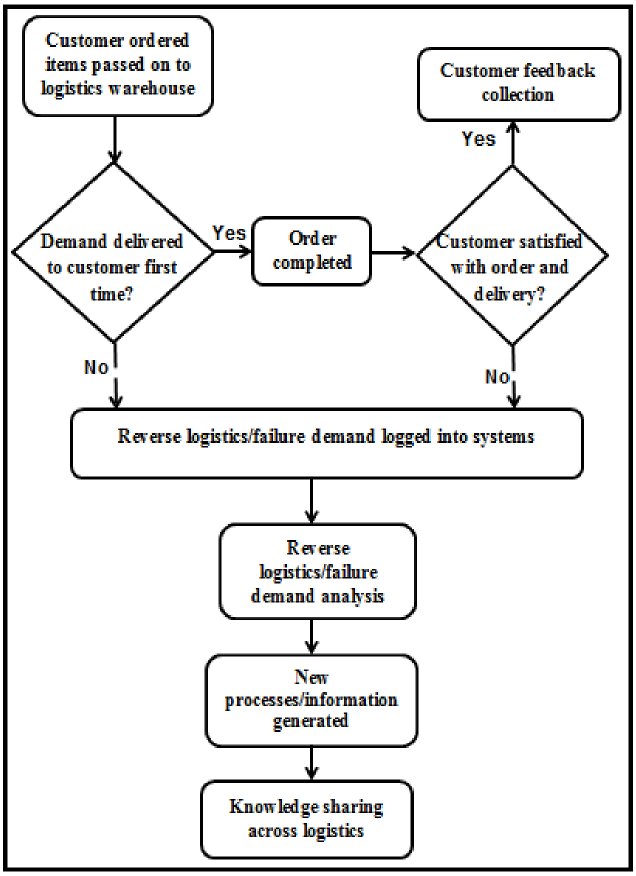

Fig.2. Reverse logistics cases analysis

Due to continuous demand analysis and learning from customer, logistics managers were supported by the new working system to focus their attention on the most wanted products and, therefore, stocked their distribution centers with the most wanted products at the right quantities. This has resulted in preparing the logistics service operations with the necessary information and products to satisfy the customer demands by building a responsive logistics system. For this particular reason, many of the factors that have caused reverse logistics cases have been removed. Furthermore, it is evident by the results that logistics employees recognized interaction with customers as an essential self-organizing activity, and that they count on this activity to create informal learning. In support of these findings, Theoharakis and Hooley [28] explain that it is only through interaction with customers that organizational members would be able to expand their knowledge on what the organization still need to learn about its external environment. Mechanistic top-down structures, which emphasize standardization, the elimination of variation, and leaders continuous monitoring, were not found at the logistics system of the case study company. In fact, leaders were viewed as part of the logistics workforce as they had an active role in supporting employees when a problem is faced. Leaders can enhance logistics performance by maintaining a tendency of employees to feel equally valued within their environment, while also maintaining a tendency of different employees to collate in diverse teams [29].

It could also be elicited from results that the Vanguard Method approach recognizes the importance of random events and failures as a self-organizing opportunity. These opportunities are achieved at the logistics systems of the case study company through decentralized, team-based informal structures. Team work has been found to lead knowledge sharing and learning emergence from reverse logistics due to the quality of decisions made on received failures. These views are shared by Larson et al. [30] who link learning-oriented behavior of organizations during chaos with information sharing across team members. Taking logistics services learning level, the logistics system studied was able to absorb the aforementioned failure of inefficient forward logistics system and unnecessary reverse logistics. For this to happen, logistics services systems had to become adaptive systems often referred to as ‘organic structures’ introduced by Burns and Stalker [31]. It was recognized in this theme that it was possible for employees to reduce reverse logistics and demand failures as they are given enough time to make work decisions. However, individuals having the right tools, tend to learn better from acute stressors if they have enough time to think and analyze the situation after the stressor. In addition, it is suggested that employees were trusted when working on received reverse logistics cases and other failure demands. As a result, employees would naturally build a sense of freedom and responsibility [22]. Giving employees’ freedom to act on the logistics system suggests that a loose orientation by leaders would be essential to activate latent learning capabilities to face reverse logistics.

Finally, the current research findings have some prominent research contributions to the literature of forward and reverse logistics service design. First, majority of the current literature on logistics services design is heavily focused on mathematical modelling that neglect the critical role of customer in the design and development process of these services [16]. This research work has introduced a novel logistics service design approach, based on customer demand involvement, which can significantly enhance forward logistics efficiency and reduce reverse logistics by promoting two different dimensions for learning from logistics demand-driven analysis. These dimensions are: customer demand analysis, and reverse logistics analysis. It is argued in this paper that effective logistics service design, which can learn from and reduce reverse logistics, is possible following the Vanguard Method approach. Second, in many research studies customer knowledge and information is viewed as intra-organizational phenomenon where the sharing of knowledge happens between the organizational departments [32], however, the presented logistics service design in this paper transfers the customer knowledge across the boundaries of the firm throughout the supply chain to enhance logistics function. Finally, since the Vanguard Method approach builds a system that is adaptive to demand volatility, the present paper introduces important insights where reverse logistics are simultaneously considered with forward logistics design coupled with demand uncertainty. This has not yet been addressed adequately in the current literature [1].

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