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Hybrid Push/Pull Strategies for a Footwear Production System

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Abstract

The economic development strategy of Ethiopia targets the export of light manufacturing industries in which the footwear sector has been accorded top priority. However, the production systems of the Ethiopian footwear firms are characterized by large inventories, unreliable supply of raw material, larger lead time, and low productivity. Writers argue that the production systems of companies typically operate under push/pull strategies that are discussed as contradictory concepts in the literature.

However, neither one is always better than the other. Hence, it is necessary to select processes where push or pull or both are the most favorable options. As a result, it is prudent to discuss their merits and demerits and propose appropriate push/pull hybrid for a manufacturing firm. However, this conception is not applied within a footwear firm business scenario. Thus, this research primarily discusses the concepts of push/pull approaches, and their individual strengths and weaknesses through rigorous literature review. Secondly, the research provides an empirical study to design push/pull strategies for a footwear firm with a special reference to the conditions of Ethiopian footwear firms. As a method, the push/pull boundary selection criteria recommended in the literature has been used within the context of the footwear production system. Finally in conclusion, hybrid pull/push strategies are more valuable to control the production systems of a footwear firm.

Keywords: Hybrid push/pull boundary, footwear firms, production systems

1. Introduction and the Research Background

The Ethiopian government wants to establish the highest manufacturing capability in Africa (Tesfaye *et al*, 2016) to join the rank of middle income countries by the year 2025 (Yitagesu *et al*, 2015). Three main strategies have been selected for selecting the needed industry policy. Agriculture-led industrialization with import substitution and export promotion industries with the selection of horticulture for agriculture, cement and leather for import substitution and export promotion industries have been used as typical exemplary indicators. The economic development strategy of the country targets to the export of light manufacturing industries based on its comparative advantages (Tesfaye *et al*, 2014). Ethiopia is the leading producer of livestock in Africa and is ranked 10th in the world (Gebreeyesus & Mohnen, 2011). The Ethiopian footwear (EF) sector is expected to create great impact to the export market (Tesfaye *et al*, 2014). However, the production system of these firms is characterized by large inventories, unreliable supply of raw material, larger manufacturing lead time, and low productivity (Tesfaye *et al.*, 2014). Production systems typically operate under push and/or pull systems (Prakash & Feng, 2011; Wang, 2012). Many authors (e.g. Richards & Singh, 2014; Ramachandran *et al*, n.d; and Diamantidis *et al.*, 2016) noted that as push and pull systems are contradictory, their hybrid can provide higher performances than their individual applications.

Various authors (e.g. Pan *et al.*, 2004; Prakash & Feng, 2011; Richards & Singh, 2014; Ramachandran *et al*, n.d) studied hybrid push/ pull concepts. However, Ramachandran *et al* (n.d) indicated that the push/pull boundary selection depends upon the specific nature of the production system. Nevertheless, none of the existing literature provides an empirical evidence of the pull/push strategy for a footwear company. Thus, the aim of this research is to develop hybrid pull/push strategies for the Ethiopian Footwear firms to improve their production system. To design this push/pull interface, this research first discusses the features of the pull and the push systems, pinpoints their strengths and weaknesses, and finally proposes a suitable push/pull strategy based on the specific production system characteristics of the EF production system. Accordingly, the approach to the present research can be framed as shown in figure 1.

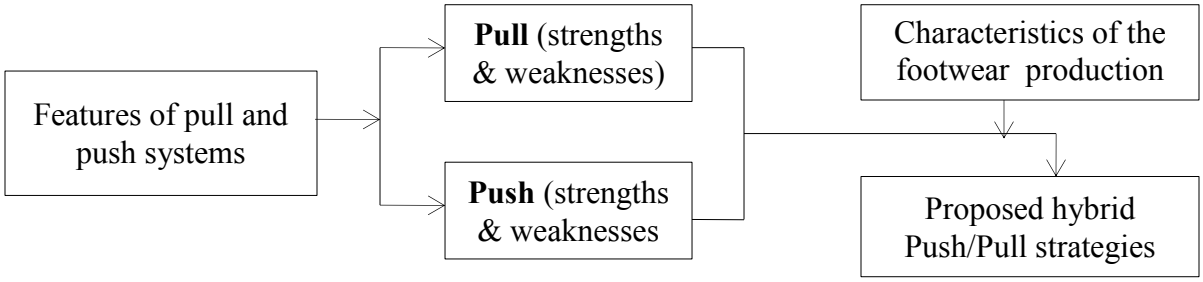

Figure 1 Approach to the present research

2. Features of Pull and Push Systems

The existing global business systems have brought some challenges for the firms of the developing countries (Loop, 2003). The main challenges

are the increasing customer expectations and the increasing requirements for quality processes and products (Lemma, 2014).

Service levels are assured by increasing or decreasing materials inventory levels (Pan *et al.,* 2004). Moreover, companies have to strengthen their processes and supply products of reliable quality at reduced delivery time (Singh & Garg, 2011; Msimangira & Tesha, 2014). Hence, to control their production system efficiently, companies have to design competitive production control mechanisms (O'Sullivan, 2009; Atkinson, 2013). Production control mechanisms can be divided into push system and pull system (Prakash & Feng, 2011; Wang, 2012).

Pull and push systems were widely discussed by many scholars (e.g. Lee, 1998; Lindeke, 2005; Diamantidis *et al.,* 2016). Many authors (such as Richards & Singh, 2014; Ramachandran *et al* (n.d); and Diamantidis *et al.,* 2016) noted that push and pull systems are contradictory concepts. A push–pull system describes the movement of a product or information between two subjects. A push system is distinguished by a ***make to stock*** environment where as a pull system is characterized by ***a make to order*** (Ramachandran *et al*., n.d; Pan *et al.,* 2004). A pull system moves materials in the production line ***only when needed*** where as the push system is ***based on forecasts*** (Pan *et al.,* 2004; Mazahir *et al*., 2011; Singh & Garg, 2011). Wang (2012) posited that in a push system, ***releases are scheduled*** and in a pull system ***releases are authorized.*** There is a usual

trend to relating a push system to the technique of material requirement planning and pull system to just-in-time production philosophy (for instance see Lindeke, 2005). MRP (Materials Requirements Planning) is the basic process of translating a production schedule for an end product (Master Production Schedule) to a set of time based requirements for all of the subassemblies and parts needed to make that set of finished goods. JIT (Just-in-Time) seeks to deliver the right amount of product at the right time. The goal is to reduce WIP (work-in-process) inventories to an absolute minimum.

As stated above, pull systems and push systems are entirely conflicting approaches. Neither one is always better than the other (Ramachandran *et al,* n.d) and neither seems to be sufficient on its own (Lindeke, 2005). Their hybrid approach can provide higher performances (Richards & Singh, 2014; Ramachandran *et al* (n.d); and Diamantidis *et al.,* 2016). Before designing appropriate push/pull hybrid strategies for a manufacturing company, Pan (2004) recommended the need to understand their individual strength and weaknesses and take the most appropriate pieces from each. Hence, section 2.2 discusses the individual strengths and weaknesses of the two aspects (push or pull) to consider the most appropriate benefit from each one when they are applied in conjugation.

2.2 Strengths and Weaknesses of Push System

Various sources (e.g. Lindeke, 2005; Mazahir *et al*., 2011, Wang, 2012) have been reviewed and the following strengths and weaknesses of the push system have been identified.

Key Strengths of Push System

- It provides a considerable advantage when there is variation in sales it can be predict the same with accurate forecasts.
- It helps managers to plan and control production activities
- Requires intricate knowledge of production times and product flow
- Can lead to economies of scale in purchasing and production
- Allows for the planning and completion of complex assemblies as sub-components are delivered only by scheduled need
- It provides buffer stock, availability of user-friendly software, savings on investments of designing pull type setup times
- Work in process (WIP) is used as a means of absorbing uncertainties in processes and the changes in the demand

Key Weaknesses of the Push System

- Its success may be jeopardized by demand uncertainty and can lead to excessive inventories
- Can generate large quantities of scrap before errors are discovered
- Requires diligence to maintain effective product flow
- Requires maintenance of large and complex databases

- It may lead to starvation and excessive stocks simultaneously at the different stages because of the imbalance of stocks between various stages.
- It may lead to conditions where, manufacture employs excessive capacities of equipment and/or manpower.

2.3 Strengths and Weaknesses of Pull System

In the similar fashion, various sources (such as Lindeke, 2005; Mazahir *et al*., 2011, Wang, 2012) have been reviewed to identify the following strengths and weaknesses of the pull system.

Key Strengths of the Pull System

- It reduces inventories to a minimum level as Kanban is often used to control the flow of materials.
- It saves direct inventory holding costs and it increases quality and improves plant efficiency.
- As the result of the Kanban system, workers use less time and raw materials on only what is needed, thus the processes are more transparent and safer.
- In pull system, each piece has a definite place to go which in turn allows immediate feedbacks

- It requires small stocks of WIP to attain same throughput as equivalent push system.

Key Weaknesses of the Pull System

- Every job is a 'high stress' rush order. This problem is highly noticeable when pull system is used at the upstream stages of the supply chain.
- It demands balanced systems of the different workstations in the production system.
- As it is specific order based, setup times will be higher and greatly impact throughput
- The system requires a very hands-on management style; otherwise any problem dissatisfies both internal and external customers.
- Pull systems are less sensitive to errors in WIP level

Hence, for their proficient operation and for the optimization of their overall system, and to solve problems related to supply unreliability, high inventory level, production delays, and low productivity, companies (particularly the EF firms) should put their utmost efforts to grasp the aforementioned advantages from the two systems through designing suitable push/pull strategies (Bonney *et al*., 1999 & Van Hoek, 2001), as discussed below in section3.

3. Proposed Hybrid Push/Pull Strategies for a Footwear Production Systems

The boundary, the physical point that separates (decouples) the activities in the value chain of the footwear production system, have been identified based on criteria proposed by Ramachandran *et al.* (n.d). The "customization point" and the "bottleneck operation" as criteria are used in this research. As these authors noted, the setting of the push/ pull boundary depends upon the unique nature of the production system. The footwear production system is depicted in figure 2.

For economic advantages, footwear companies purchase the finished leather in large quantities when there is excess supply during the Ethiopian holidays and stores them in their storehouse. The size of purchase depends upon the forecasted values. Most of the components parts are also purchased in large quantities from abroad. Hence, the purchase of the raw materials (finished leather and component parts) is fulfilled by a push strategy.

Only when demanded, production manager requests the raw material (the leather and the component parts) from the store and transfers them to the cutting process. That is, the cutting department inquires materials only when needed. Hence, at this interface, there should be a pull strategy. In some incidences, raw materials may not exist in the store when demanded.

In this particular case, it takes long lead time to purchase the raw materials from the market. This by itself justifies that a push system have to be used between the tanneries and the company's store (see figure 2).

In the cutting department, the company cuts the different parts of the upper of the shoes. The operator cuts the leather using metal strip knives into pieces of various styles that will be threaded together to form the upper at the later stage. Just at the cutting process, the production environment shifts from make to stock to make to order (a Customization point). This implies that processes before the cutting process incorporates push production systems.

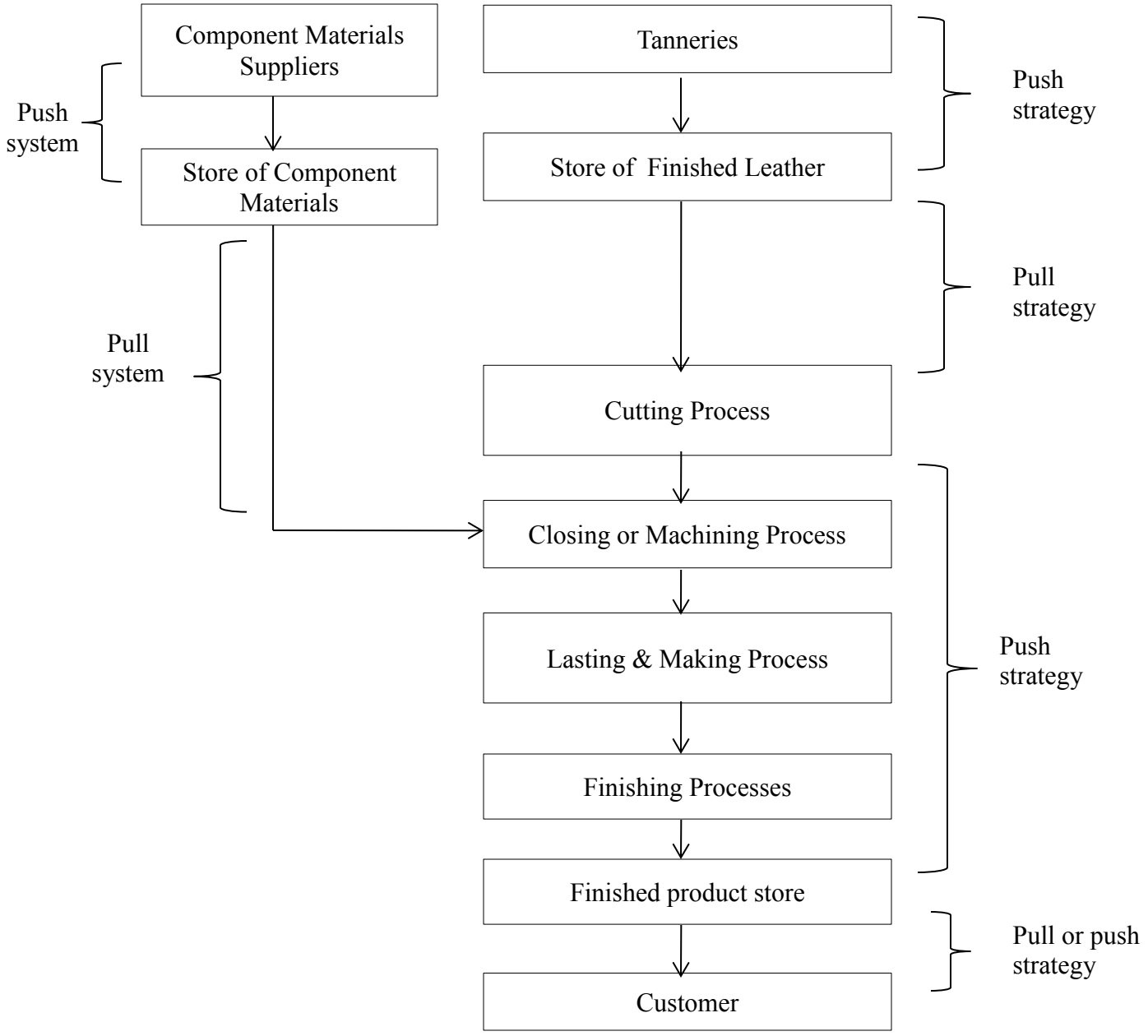

Figure 2 The proposed hybrid push-pull strategies for a footwear production systems

With regards to the bottleneck criteria, processes before the bottleneck stages should constantly feed it to make it busy to avoid starvation of the

bottleneck operations. Both the “Closing and Machining Process” and the “Lasting & Making Process” are bottleneck operations.

In the closing or machining department, the component pieces are sewn together to form the completed upper. To the finished upper, various edge treatments are done for giving an attractive appearance. Eyelets are also inserted in order to accommodate the laces in the finished shoes.

In the lasting and the making department, a last (a plastic shape that simulates the foot shape) is used to mold the finished uppers into a shape of foot which will later be attached to the insole rib. Then, the welt is sewn onto the shoe through the rib. The upper and all the surplus materials are trimmed off the seam. The sole is then attached to the welt and both are stitched together. The heel is then attached which completes the "making" of the shoe.

Hence, the cutting operation should continuously supply cut out pieces to the Closing and Machining Process. The Closing & Machining Process should never be starved. From this view point, the cutting process should feed the Closing & Machining Process with a push strategy. In a similar way, the closing and making process should continuously deliver material to the lasting & the making department (another bottleneck operation). Processes after the bottleneck operations need to have push strategies

Ramachandran *et al.* (n.d). Hence, between the lasting & the making department and the finishing process, the company has to use a push strategy.

In this department, the companies perform trimming and polishing operations to smoothen the sole edge and heel of the shoe. Moreover, staining, and waxing processes are performed to waterproof and attractively finish the shoes. Different types of patterns can also be marked on the surface to give it a craft finished look.

From the finishing process onwards, the company should use a pull system as the material can only be delivered to customer delivery time requirements. However, if the company produces based on marketing forecasts (as it can be possible in certain cases), then it should use a push strategy.

4. Conclusion

Ethiopia has accorded huge emphasis to the development of its leather sector in general and its footwear sub-sector in particular. However, the production systems of these companies are characterized by large inventories, unreliable supply of raw material, larger lead time, and low productivity. Literatures recommended a hybrid push/push strategies for companies to solve their production system problems. The pull and push

systems were widely discussed in literatures, yet it has not been applied in the footwear production systems. Accordingly, this study indicates that the upstream stages (such as material purchasing) of a footwear production should be monitored by a push strategy. This study also identifies that the interface between the raw material (and the component parts) store and the cutting department have to be controlled by a pull philosophy. Furthermore, from the closing or the machining process to the stage of finished product store, the process has to be managed by the push strategy. Finally, if the company produces for a customer order, it should use a pull system to deliver the finished products from the store to the customer. However, if the company produces for forecasts, it should use a push strategy to ship the finished products to the targeted markets. Finally, this research is theoretically useful as it unveiling the conflicting features of the push/pull systems and empirically it proves that hybrid pull/push strategies are more valuable to control the production systems of a footwear firm.

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