

Supply chain the T-shirt with circular economy approach. Case study in Ecuador.

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Abstract

At present, the circular economy approach is manifested in the supply chain as a closed cycle, where waste from some productions is used to elaborate new derivatives. In this context, the diagnosis of the Ecuadorian shirt supply chain is developed and the possible uses of the waste are identified. A checklist is used for the evaluation of integration, descriptive statistics (Fashion) and inferential statistics (Correlations, contingency). The results of this research are: the low level of integration of the chain under study with a value of 1.4; where the variables of greatest weakness are: strategy, information, purchases and inventory. This work presents a practical value, because it is used to improve the actors of the textile industry in that country.

1. Introduction

At the global level, changes are manifested in the way of managing and shaping business. Now, the center is not to make a product but to make a profit by making some of its parts. From this is inferred the need for interconnection between several companies, entities, organizations (actors). Along with the new production forms that are approaching: the development of new materials, the elaboration and sale of customized projects to the needs of the clients, as well as the three D technology (Chan et al., 2016; Oppenheimer, 2015). This framed in information technologies, communications and knowledge infer the need for the development of international supply chains (Bearzotti, 2018), where the opportunity for improvement focuses on the sustainability of the resources that move to through their flows from the client to the supplier or inverse (Cespón, Castro, Curbelo, & Varela, 2015).

To do this, a philosophy circular economy develops, although not very modern for its concepts, if its new application (Homrich, Galvão, Abadia, & Carvalho, 2018). The main thing is how economies develop in closed production cycles (MacArthur, 2017). Where the fundamental object is focused on: recycling, reusing, repairing and remanufacturing (Las 4) where green supply chain is needed (Moktadir, Rahman, Rahman, Ali, & Paul, 2018).

In the Ecuador, a group of weaknesses¹ in the issue of supply chains are reflected, which are:

- ✓ High inventories of raw material for working alone in the market due to the lack of adaptation to supply and demand.
- ✓ Products with little variety, and low added value for the customer.
- ✓ Deficiencies to enter the national and international market for their independent work.
- ✓ Absence of relationship between actors with the same or different functions.
- ✓ Low determination of customer needs, so there is a high whiplash effect of the demand.
- ✓ Little efficiency in the internal processes of companies that influences the high prices of some products.

¹ They are identified in the framework of the Strategic Collaborative Planning Model in Supply Chains under the conditions of Ecuador, led by MsC. Erik Orozco from the Universidad Técnica del Norte, Ecuador.

- ✓ Production planning is concentrated at the operational level and, to a lesser extent, at the tactical level.
- ✓ Little waste byproducts, which influence the low expression of closed production cycles.
- ✓ Many wastes, due to the high presence of natural resources that sometimes burn to eliminate their waste producing a large ecological footprint.
- ✓ There is inertia at the time of a change in MSMEs and in some companies before the market.

From this element, the need for the application of the Integration Model to influence the improvement of competitiveness in Ecuador and boost the economy. The objective of this work is the diagnosis of the Ecuadorian shirt supply chain is developed and the possible uses of the waste are identified, where it is enriched with the identification of possible by-products from waste of the elaboration of t-shirts.

2. Materials and methods

The Supply Chain Strategic Collaborative Planning Model (MPCECS), applied to textile chains and the implementation process, contribute to the chains development in the Ecuadorian. It consists of three stages and 11 steps that integrate a tools group that facilitate the implementation of collaborative planning and control at a strategic level in supply chains, with the study of 59 models and tools. In this work, the stages related to the diagnosis of integration and the definition of strategies are applied. Is added to this, the analysis of other productions from textile waste in a circular economy approach. Seven dimensions are redefined: Strategy (D1), Information (D2), Planning (D3), Purchasing (D4), Inventory (D5), Transport (D6) and Performance (D7).

The MPCECS purpose was to determine the Collaborative Planning Level (NPC) in the textile supply chain actors, in order to analyze the integration chain level, to design strategies types (interrelation Matrix between the NPC of the proposed strategies) (Sablón Cossío et al., 2017). The matrix allows the strategy approach, depending on the NPC in which the chain take place. The NPC is calculated using a checklist of 91 questions.

To test relationships between the variables, the *Tau-b* statistics of *Kendall* and Spearman were used as alternatives to the *Pearson* coefficient for ordinal variables and with their corresponding significance levels. (Pardo Merino & Ruiz Diaz, 2006). These relationships sought to explain, on the one hand, the relationships between the ordinal

variables CD_n , in order to determine if the companies work in a similar way among all of them. On the other hand, explain if the formed clusters managed to explain some type of relationship of collaborative performance (CS) with the variables percentage of the sales that are obtained product of the marketing of T-shirts (G1) and the size of the company (G2).

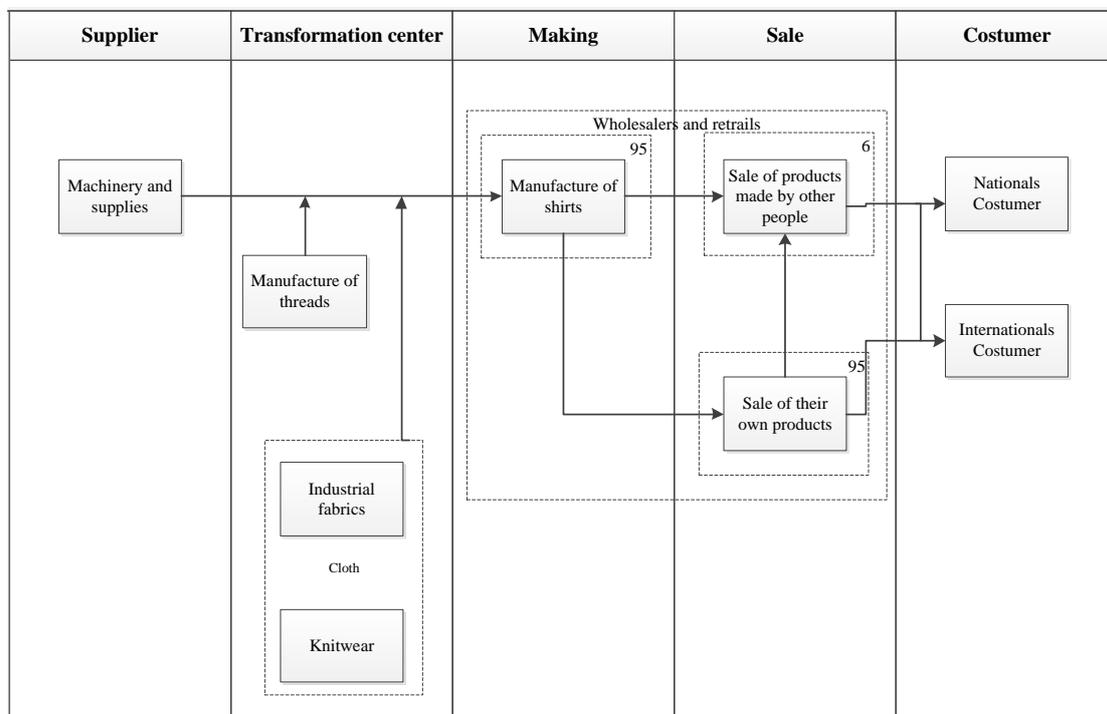
The possible uses of waste from the manufacture of T-shirts are identified.

3. Results

Characterization of the textile supply chain of the Ecuador.

The chain has five links and 109 actors, it is classified as: input suppliers, raw material suppliers, transformation center, confection, distribution and customers, figure 1.

Figure 1 : Textile supply chain of Ecuador



Within the commercialization there are two classifications: that of wholesalers who sell their products in large volumes and supply other actors, on the other hand, we find the minorities that are the ones that come directly to the client and are dedicated to selling in small quantities. This can be at a national level and also at the international level, but there is little international sales due to the low collaboration between the chain's actors.

The suppliers of inputs supply machinery and raw materials, there is only one actor within the area under study. The fabric is the main raw material that is used for the manufacture of shirts, quality and easy access depends on the success of the actors who are dedicated to the transformation of this. These can be industrial fabrics or knitted fabrics. Within this

link is also the manufacture and yarns, these are used by the manufacturers for the confection. The center of transformation is of great importance within the chain, because you get the basic product, the shirts.

Of the population, 82.24% (88 companies) are engaged in the manufacture of T-shirts, which reaffirmed the importance of this product for textile industries in the area. Of these, 54.5% (48 companies) and 45.5% (40 companies) were classified as small and medium enterprises, respectively. When observing the percentage that represents the production of this item within the total production, it was observed that the chain has two large groups of companies with medians that are located in the ranges of 21-30% and 71-80 % of sales, figure 2 and 3.

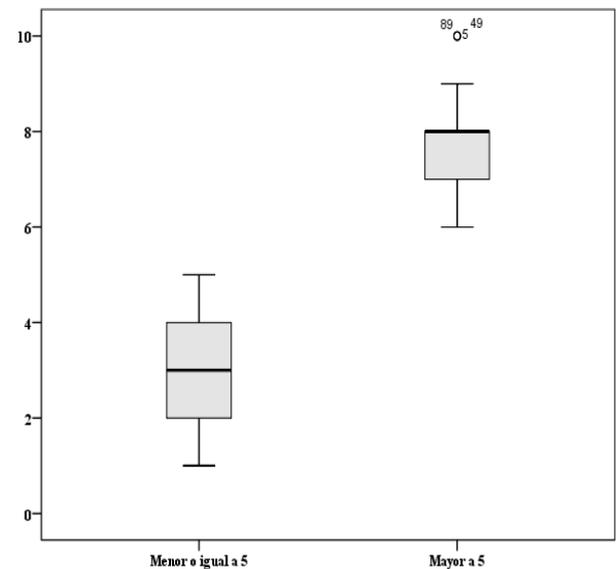
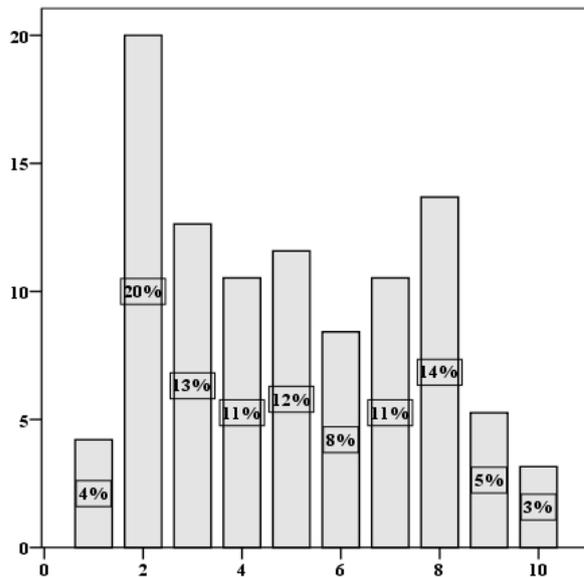


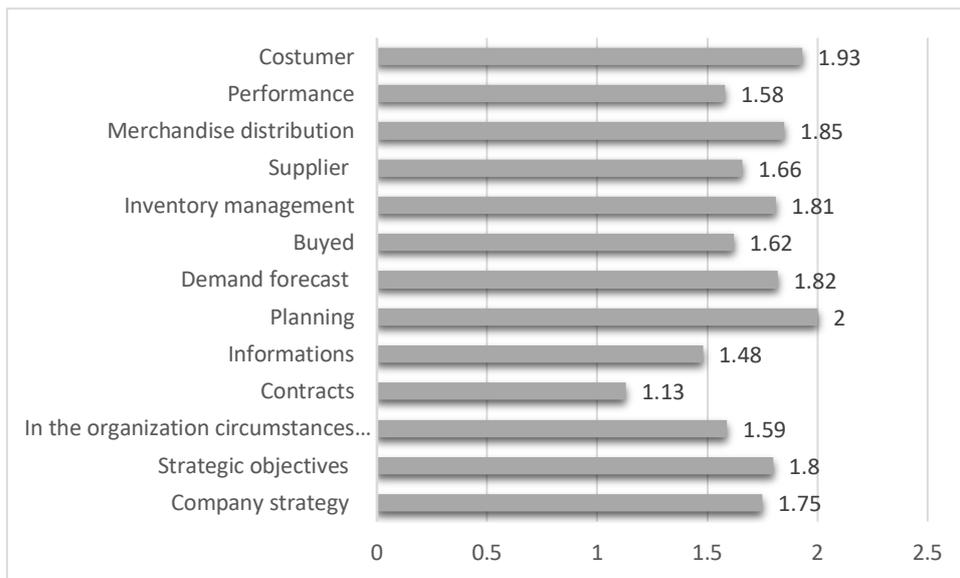
Figure 2: Histogram of absolute frequencies by category

Figure 3: Box diagram filtered in two categories.

Checklist results of the Strategic Collaborative Planning Model in Supply Chain

In the chain actors checking, results of low levels in the performance variables evaluation, in the company's average evaluation, in the contracts (1,13), in information (1,48), performance (1,58), in the organization circumstances formulation (1,59), in bought (1,62), in suppliers (1,66), in the company strategy (1,75), in strategic objectives (1,80), in the inventory management (1,81), in the demand forecast (1,82), in the merchandise distribution (1,85), and in customers (1,93), in plans, were obtained (2,00), (figure 4).

Figure 4: Current status of each Strategic Collaborative Supply Chain Planning Model.



The Supply chain the T-shirt presents a value of 1,4; which represents a low level, tabl3 1.

Table 1: Results of the dimensions.

Dimensions D_i	M_{o_n}	Subdimensions (SDi)	Evaluations D_n	P_n	$P_n * M_{o_n}$
Estrategic	1	Company strategy The strategic objectives In the formulation of scenarios in the organization	Very low	0,10	0,10
Informations	1	The contracts are Information	Very low	0,10	0,10
Planning	2	The plans Demand forecasts	Low	0,30	0,60
Purchases	1	The purchases	Very low	0,10	0,10
Inventory	1	The inventory management Suppliers	Very low	0,10	0,10
Transport	2	The distribution of the merchandise	Low	0,10	0,20
Performance	1	There are indicators Customers	Very low	0,20	0,20
$NPC_{CS} = \sum_{n=1}^7 P_n * M_{o_n}$					1.40

The level of integration of the companies is analyzed, and they are grouped by the value of the scale, Figure 5. It is evident that there is a 16% in the medium level and 84% in the low level, which represents the highest percentage.

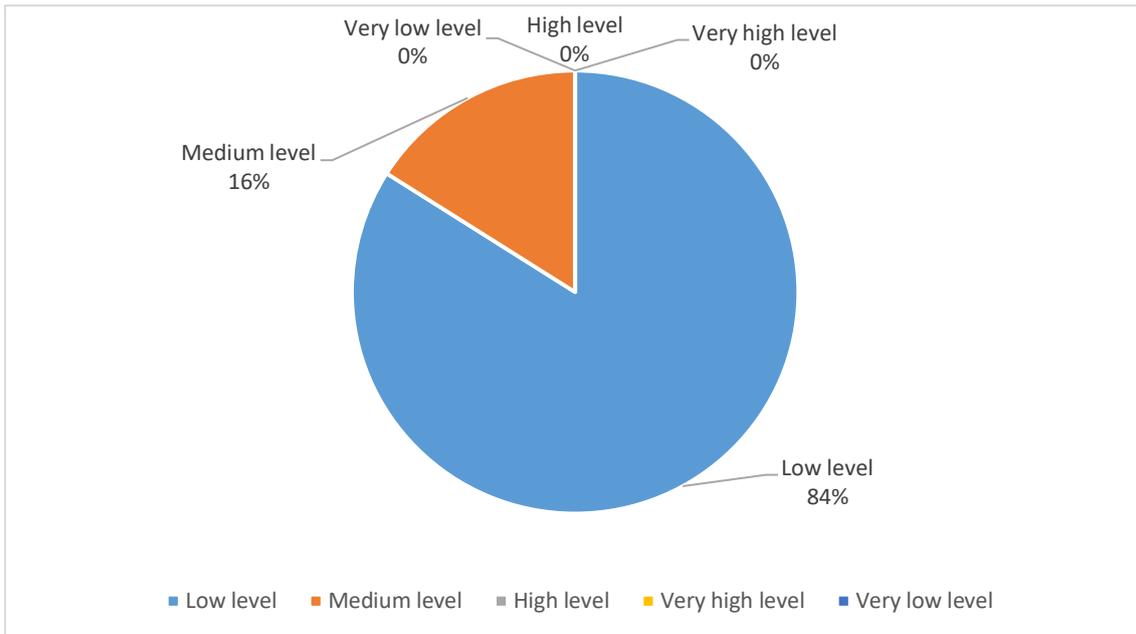


Figure 5: List of companies in the simple.

The values estimated in the correlation analysis for the statistics Tau_b of Kendall and Rho of Spearman highlighted positive relationships that were evaluated between significant and moderate when behaving superior to 0.5 and below 0.84. The exception was in the Transport dimension (CD6) that correlated very weakly with the rest of the dimensions, even so, it was decided to keep for the subsequent analyzes, Table 2.

Table 2: Correlations the kendall y spearman.

	CD ₁		CD ₂		CD ₃		CD ₄		CD ₅		CD ₆		CD ₇	
CD ₁	1,00 ^a	1,00 ^b	,577**	,587**	,642**	,665**	,674**	,686**	,682**	,707**	,206*	,211*	,551**	,574**
CD ₂	,577**	,587**	1,00	1,00	,622**	,647**	,719**	,742**	,642**	,665**	,062	,065	,642**	,673**
CD ₃	,642**	,665**	,622**	,647**	1,00	1,00	,566**	,593**	,593**	,620**	,215*	,227*	,528**	,561**
CD ₄	,674**	,686**	,719**	,742**	,566**	,593**	1,00	1,00	,794**	,816**	,112	,114	,702**	,731**
CD ₅	,682**	,707**	,642**	,665**	,593**	,620**	,794**	,816**	1,00	1,00	,145	,152	,530**	,572**
CD ₆	,206*	,211*	,062	,065	,215*	,227*	,112	,114	,145	,152	1,00	1,00	,065	,068
CD ₇	,551**	,574**	,642**	,673**	,528**	,561**	,702**	,731**	,530**	,572**	,065	,068	1,00	1,00

a: Tau_b de Kendall

b: Rho de Spearman

** La correlación es significativa al nivel 0,01 (bilateral)

* La correlación es significativa al nivel 0,05 (bilateral)

There are highly significant correlations of 0.794 (Kendall's Tau_b) and 0.816 (Spearman's Rho) between purchases and inventory; and vice versa the same relation is fulfilled at the level 0.01. This relationship is evident, the more inventory there is, the lower the purchase, although there are other factors that influence the possible quantity to be produced.

In the case of the significant correlation at the 0.05 level, the relationship between transport and the chain strategy is shown, as well as planning. In the case of transport, it represents between 20 and 30% of the logistics costs in a business in Latin America (APIC², 2018), so its planning and strategy is essential because it directly depends on the profits of the industry textile at the place of study.

Stage of the integration level among actors

The Supply chain the T-shirt, Ecuador has a low integration level, so it is located in the negotiations stage. Because of this result, strategies should be geared towards negotiation among actors. The joint strategies focus on: discussion focused on cost leadership; differentiation and approach or niche.

The joint objectives focus on customer satisfaction:

- ✓ Raise the level of integration to 3 to improve the competitiveness of the chain.
- ✓ Increase the variety of textile products to influence the level of service.
- ✓ Increase the value added to customer needs through more preferred fabrics by the customer and manufacturing methods with the goal of increasing the use value of the shirts.

In the centers of transformation is where there is the greatest waste of fabric, fundamental perima material, specifically in the cutting operation. The waste percentage is 10% for each shirt. This value is a constant concern of the employers in seeking a use for these pieces of cloth, and a new use in crafts is defined. The production of handicrafts is a significant line in the merchants of the area.

3. Discussion

In studies conducted on the topic of circular economy, it delves into: the types of energies used, the possible by-products to be developed, the value of each product / service, the people who are satisfied with them, the financial alternatives, the 4 Rs and the value chain (Korhonen, Nuur, Feldmann, & Birkie, 2018). In this work this concept begins, only in the analysis of the use of waste, so it is in its first stage. Due to this, this philosophy is applied only partially. It is added the study of the supply chain, which in its last stage of integration is located the generation of value in the actors of the same. The check list is

² The association for supply chain management.

readjusted Heyes, Sharmina, Mendoza, Gallego-Schmid, and Azapagic (2017) for the study of the circular economy.

4. Conclusions

This work is carried out holistically and with a focus on the supply chain, a trend with little boom in Ecuador despite the need for its application. The chain under study is at a low level of development, which infers the need for continuity of work. It is necessary to continue the study of the circular economy as a way to achieve a green supply chain.

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Biographies

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