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Assessing the impact of B2C e-commerce in the apparel industry: a logistics perspective

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Purpose: *The significance and pervasiveness of B2C e-commerce raise the question about its impact on employment under a social sustainability perspective. This study is aims to quantify the labour demand in logistics comparing the e-commerce order fulfilment process and the traditional brick-and-mortar one.*

Methodology: *An activity-based model is developed to represent a traditional retailer that both operates online and offline within the apparel industry in the Italian context. The working time related to an average single piece of apparel has been derived for each manual activity performed along the distribution chain.*

Findings: *Results are determined by the development of representative scenarios and the main variables affecting the employment are identified. Evidence shows that e-commerce requires more labour than brick-and mortar retail either in the traditional configuration of home delivery or delivery to parcel lockers. The decisive phase is the last-mile delivery, which requires the majority of labour time, both because of driving time and the consignment itself.*

Originality: *The main originality of the work lies in the perspective adopted to study the employment impacts of B2C e-commerce, providing an analytical contribution to the social sustainability literature of logistics.*

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1 Introduction

Electronic commerce has been a powerful force shaping economy and society from its introduction in the mid-90s. Nowadays, the Italian e-commerce market has reached almost a value of € 32 billion characterized by an always increasing yearly trend (B2c eCommerce Observatory, Politecnico di Milano, 2020). The e-commerce introduction brings along a cascade of innovative business practices, which are drastically changing the relationship between companies and their customers. The logistics field is not excluded from this revolution: in fact, it results being one of the key enablers for the successful implementation of e-commerce transactions, especially business-to-consumer. The shift in business practices is deeply affecting how companies conduct their operations. This has raised many concerns on sustainability. The extant literature has been dominated by scientific studies on the implications that e-commerce has on logistics from an environmental and economic point of view, which are the two of the three pillars of sustainability. On the other hand, the third pillar (i.e., the social one) seems to have been overshadowed by the preponderance of the other two, even if the field has recently witnessed a gain in traction among logistics researchers. Social sustainability is a broad concept characterized by different facades, having employment equity as one of its core elements. Labour is a key vector for the distribution of income that allows people livelihood, but its benefits are not only limited to money and economic growth, ranging from psycho-social welfare to social integration (i.e., paid work that provides social status) (Griessler et al. 2005). Therefore, employment results in being a crucial determinant of social equity and stability, highly affecting the lives of both present and future generations. The present study contributes to the social sustainability literature of logistics by providing evidence on how business-to-consumer (B2C) e-commerce affects occupation from a logistics perspective.

2 Literature review

Two streams of literature on “social sustainability in logistics” and “e-commerce employment effects” emerged from the analysis. Employment is the bridge between the

two topics. Indeed, it is a key element to assess social sustainability initiatives, and, at the same time, it is a widely studied variable in macroeconomics to examine growth.

The problem of how e-commerce, and more in general information and communication technologies, affects employment from an economic perspective is broadly investigated within the extant literature. Many authors argue that its introduction has not negatively affected firm and industry level employment (Pantea et al. 2014; Pantea et al. 2017; Biagi and Falk 2017). However, none of these studies adopts a logistics perspective on the social sustainability problem. Researchers agree on the fact that logistics social sustainability has received less and scarce attention compared to the environmental and economic ones (Perez-Fortes et al. 2011; You et al. 2011; Pishvaee et al. 2012; Boukherroub et al. 2014; Sarkis et al. 2010; Jung 2017; Kumar et al. 2019).

Social sustainability expressed in terms of job creation and stability has been considered when designing a sustainable supply-chain (Perez-Fortes et al. 2011, You et al. 2011, Pishvaee et al. 2012, Boukherroub et al. 2014). Drivers' satisfaction, traffic, noise, and accidents emerged as the recurrent terms to evaluate social sustainability in logistics (Hesse 2002, Anderson et al. 2005, Browne et al. 2012, Bates et al. 2018). Logistics activities that received more attention in terms of social sustainability impacts are urban freight transport and last-mile delivery (Behrends et al., 2008; Buldeo Rai et al., 2017; Buldeo Rai, van Lier et al., 2017; Shi et al., 2019; Bates et al., 2018; Buldeo Rai et al., 2018). Here, crowd logistics emerged as one of the most relevant topics for employment-related studies due to the poor social protection of crowd workers. Few empirical and analytical studies on logistics employment have emerged. In one of the most relevant, Zacharias et al. (2015) assess the number of workers needed for different last-mile delivery modes in China to evaluate their social sustainability.

De Vera (2006) and Hesse (2002) emphasize the importance of customer distribution characteristics (customer density), purchasing habits (small size and high-frequency orders), and behaviours as relevant factors influencing e-commerce occupational impacts in logistics. These new habits are inevitably changing business processes, causing value chain reconfigurations (e.g., disintermediation and reintermediation phenomena), and consequently affecting industries employment levels (De Vera 2006). However, disintermediation along the supply chain does not always mean the perfect

substitution of the traditional channel, since e-commerce may redefine new roles for intermediaries (Anderson 2003). On the other hand, Americo et al. (2018) claim that e-commerce penetration is correlated with decreasing employment within the traditional retail industry, but the study does not account for e-commerce-related occupation. Other authors focused on e-commerce effects on the geographical distribution of jobs, and they agree on its role as a social growth engine for both rural and metropolitan areas. For instance, Lin et al. (2019) claim that e-commerce is a catalyst for rural areas development in China providing work within the distribution sector. Others point out that it may be a driving force for logistics employment growth in metropolitan areas due to the large number of orders to be fulfilled at a high service level (Anderson et al. 2003). Considering warehousing activities, e-commerce often requires the picking and assembly of the orders within the warehouse. Hence, differences in labour requirements are highlighted by Loewen (2018) when activities need to manage single or few pieces instead of cases or pallets.

The theme of e-commerce and employment is mostly approached by economic literature. While qualitative considerations on how e-commerce may affect logistics labour emerged in the form of intuitions or hypothetical implications, literature has not empirically tested such hypotheses yet. Indeed, e-commerce social sustainability in logistics was identified as an under-researched area, characterized by a dearth of quantitative and analytical studies on employment.

3 Research objective

This study has the objective to fill the identified research gap by developing a model to compare the labour time requirements of the online and offline order-fulfilment processes within the apparel industry adopting a logistics perspective. The reason supporting the selection of a single industry is that the logistics context is highly influenced by the features of the product sold (e.g., its weight, value, or packaging), and by customer behaviours and habits, which deeply vary among different industries. Consequently, these factors influence the labour requirements. For instance, return rates of the apparel industry are on average much higher compared to other sectors and they

can reach 30% of products sold online (Ghezzi et al. 2012). Moreover, the relevance of the apparel industry within the e-commerce B2c market is witnessed by its Italian value of around € 3.3 billion in 2019 with a compound annual growth rate of 22% in the last 5 years (B2c eCommerce Observatory, 2019). In addition, this industry is an interesting case to study the complementarities between the online and the offline channel, where points of sale are integrated within the online order-fulfilment process as picking and/or collection point. Indeed, traditional apparel retailers are operating multichannel and omnichannel strategies to increase their competitiveness (Luo et al. 2015). The wide variety of distribution channels proposed by retailers is shaping new logistics challenges and complexities. For instance, the click-and-collect phenomenon, where the customer buys online and collects the order at the retailer's physical store, is becoming widespread and it reached a 25% penetration of online clothing sales in 2016 in the UK (Allen et al. 2018). It reduces the risk of failed home deliveries, the last-mile costs, and it induces the customer to visit the shop, which frequently translates into other in-store sales. Hence, the relevance of the apparel industry B2c e-commerce market and the aforementioned logistics complexities (e.g., high incidence of returns or click-and-collect delivery mode) make it an interesting case study to understand logistics occupational dynamics.

Therefore, the research question the present work addresses is:

RQ: What is the occupational impact of both the online and the offline order fulfilment processes under a logistics perspective?

Specifying further, this work aims at analysing which are the main parameters determining the employment of logistics activities in both the online and offline channels, and how their variation affects the labour demanded by each process. Moreover, different perspectives have been adopted to understand the level of involvement of different types of workers and players.

4 Methodology

The methodology adopted to develop the model is deployed in three phases:

- Definition of the purchasing processes (1st step).
- Modelling the occupational impact for each phase and activity within the model (2nd step).
- Application of the model (3rd step).

The first step consists of identifying the most significant order-fulfilment processes of the apparel industry and their phases. The representative merchant for the model is a traditional retailer, which simultaneously operates both physical stores and an online B2c e-commerce website. Then, adopting an activity-based approach, similar to the one proposed by Mangiaracina et al. (2016) and Giuffrida et al. (2019), the main order-fulfilment phases for each purchasing process, and their constituting logistics activities were identified. The model considers all the logistics phases and activities performed to fulfil a single flat-garment order that has been already placed by a customer, meaning that pre-sale and sale activities are excluded from the scope of this work. Relying on a literature review, case studies, and secondary sources (e.g., specialized logistics websites, videos representing typical operations) the downstream logistics process from the merchant warehouse were mapped. Suppliers and their shipments to the central warehouse are excluded. Moreover, tasks that are automated as well as customers' actions are not included in this analysis, since the focus is only on activities requiring manual labour. Home-delivery, parcel locker delivery, and click-and-collect were identified as three different configurations for the e-commerce purchasing mode, while traditional brick-and-mortar retail is the offline channel. The analysis eventually reaches the post-sale service to customers. More details are presented in section 5 describing the model design.

The second step involves the modelling of the occupational impact measured in seconds per item for each phase and single activity identified in the first step. A literature review, case studies, and secondary sources such as industry/logistics reports, specialized logistics and apparel retailer websites support the identification of the main contextual data within the model. The outcomes of this phase are the working time per item of each

individual activity and the selection of the data to describe the reference case for the model application.

The third stage involves applying the model to an average case, which is representative of the apparel industry context in Italy. Then, a sensitivity analysis was performed by varying key input parameters to investigate the dynamics affecting employment.

5 Model

This section deals with a brief explanation of the logistics flow underpinning each identified fulfilment process. For each configuration, the representative flow of products starts from the stock of clothes stored in the merchant's central warehouse reserve area, which is shared between both the online and offline channel.

5.1 Order-fulfilment phases

The order-fulfilment phases of the e-commerce channel, for both parcel locker and home delivery, are adapted from Mangiaracina et al. 2016:

- *Order picking and assembly*: this phase begins with the reception of the order within the merchant's warehouse and it ends with the express courier picking-up the parcels. It includes the replenishment of the forward picking area, picking (low-level and in batches), sorting, packing, and shipment preparation activities.
- *Delivery*: it deals with the long-haul shipment and activities in hubs managed by a third-party logistics provider.
- *Last-mile delivery*: this phase consists of the courier performing the last leg of the logistics chain to complete the delivery of the parcel at the customer's house or the collection locker, depending on the process under examination. It mainly consists of the time spent to drive on the streets to reach the point of destination and to consign the parcel.
- *Post-sale*: it starts with two possible product return modes, which are home-collection and pick-up point (i.e., locker) collection and it ends with the product storing in the merchant warehouse.

Click-and-collect (C&C) offers the customers the possibility to order and pay online and pick-up the product in the store. Hence, the order-fulfilment phases differ from the ones

presented before, because the flow includes the merchant's point of sale (PoS). Moreover, the model considers both the picking and assembly of the order in-store or within the warehouse depending on the availability of the order within the PoS depot. Thus, the order fulfilment phases identified are (adapted from Giuffrida et al., 2019):

- *Store replenishment*: this whole phase is performed only within the store-picking configuration. The phase starts with the reception of the replenishment order from the store and ends with the replenishment of the PoS storeroom and shelves.
- *Order picking and assembly*: if the order is not already stored within the point of sale, order picking and assembly are performed as previously described within the warehouse and shipped to the store together with its replenishment order.
- *Product pick-up*: it includes the salesperson interacting with the customer, picking-up of the product within the PoS warehouse, and delivering it to the customer.
- *Post-sale*: the assumption is that the customer buying through the click-and-collect mode returns the product to the store where she collected it. The salesman checks the integrity of the item and eventually stores it within the point of sale.

Finally, traditional brick-and-mortar order fulfilment phases are adapted from Mangiaracina et al. (2016) and they include:

- *Store replenishment*: this phase is equal to the one presented for click-and-collect.
- *Post-sale*: as for the click-and-collect case the assumption is that a customer returns its order into the store where she purchased, and the activities remain the same.

Note that the delivery phase for an offline purchase is the customer trip back home with the product (Mangiaracina et al. 2016), thus, the model excludes it.

5.2 Model architecture

The model grounds on four building blocks: input data, context data, model algorithms, and output.

The input data section represents the model interface where the user can set key parameters to build different scenarios; they allow some degree of flexibility to the analysis. Input data are grouped into three classes: merchant features, customer features and behaviours, and last-mile delivery features.

The merchant's turnover can be large, medium, or low and the model automatically dimensions the area and the throughput of the merchant warehouse accordingly. Store size can be either big, medium, or small, and each type of stores has associated the capacity of the workforce and the daily flow of both traditional and click-and-collect customers. The unsold rate is the percentage of garments that remain unsold in the store.

Customer location can either be a metropolitan area, an urban area, or a rural one, based on Boyer et al. (2009). Moreover, the choices of the customer refer to the delivery mode selected when buying online. Finally, the behaviour of a customer can be modelled by setting the online and the offline return rates.

The model acknowledges three possible levels of complexity for the parcel delivery (high, medium, and low), which affect the average time to consign a parcel at home. Moreover, road conditions and traffic are set through the average speed of the van performing the delivery tour, for both home and parcel locker modes. Finally, the rate of home deliveries that fail at their first attempt is the last input (PL and C&C are assumed to have no failed deliveries).

The context data section refers to all the hypotheses that build the logistics flow of the order. They describe the activities within the central warehouse, the hubs, the store, or communication ones. These data include the main hypotheses to compute the time required by some activities such as picking within the warehouse, or the inefficiency coefficients of logistics operators. Others refer to the time required to perform crucial activities, expressed in terms of seconds (e.g., packing, sorting, set-up times, or communication activities), or percentages of the daily shift for store activities. Finally, other hypotheses regard the size of the average packaging for both e-commerce parcels

or bulk freight, the transportation features such as the means involved, their saturations, and the average distances covered.

Input and context data feed the model that combines them through its built-in algorithm to deliver the main output, i.e., the labour time in s/item required by each activity. However, other activity attributes are added to analyse the results from other perspectives, such as the order fulfilment phase, the activity type, the type of worker (e.g. drivers), and the player involved (e.g. 3PL). Indeed, the model automatically computes and present graphs aggregating results by the selected attributes.

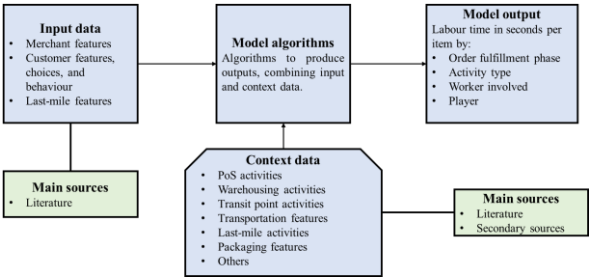

Figure 1: Model architecture

6 Results

6.1 Reference case scenario

The model was applied to a reference case scenario, considered to be representative of the average case of a traditional retailer operating both online and offline. The input data are set based on a literature review and Table 1 collects them (note that the product is returned in-store for click-and-collect and traditional order fulfilment processes).

The results of the model application for the four order-fulfilment processes are shown in Figure 2.

Table 1: Reference case features

Reference case features	
Merchant features	
Turnover	Medium
Store size	Medium
Unsold rate in the store	20%
Customer features and behaviour	
Online return rate	20%
Offline return rate	5%
Online return mode	Home collection (Pick-up point collection)
Location	Urban area (Metropolitan area)
Last-mile features	
Customer delivery complexity	Medium
Average van speed [km/h]	30 (15)
Missed deliveries rate	12% (0%)

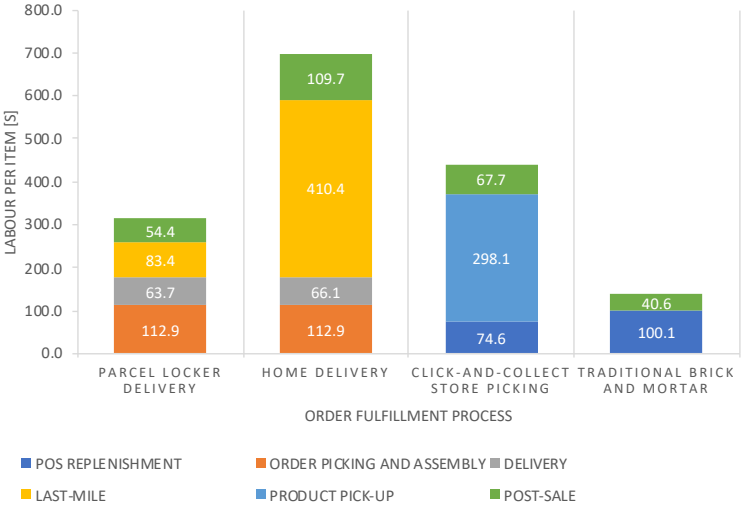

Figure 2: Labour required by order fulfillment process

Results indicate that the e-commerce channel always requires a larger amount of labour time per item with respect to brick-and-mortar retail. However, depending on the delivery type, the needed amount of workforce varies widely.

Home-delivery presents the highest working time (699 s/item), especially because of last-mile delivery, which is the most labour-intensive of all e-commerce phases requiring 410.4 s/item. The second most labour-demanding e-commerce channel is click-and-collect when the product picking is performed in-store (440.4 s/item). Here, the main activity is the delivery of the parcel to the customer (298.1 s/item), which is carried out by shop assistants. Among the e-commerce processes, the most labour-efficient is the order-fulfilment with parcel locker delivery (314.4 s/item), thanks to higher achieved efficiency in both the last-mile and post-sale phases. Finally, the traditional channel results to be the least labour-intensive channel (140.6 s/item), mostly thanks to order-fulfilment phases that are not performed by employees but by the customer (order picking and assembly, delivery, and last-mile). Moreover, additional efficiency derives

from the handling and shipping of bulk quantities throughout the process. While in the other order-fulfilment processes logistics workers manage most of the time small lots, composed by single parcels.

6.1.1 Home delivery

In the home-delivery case, the two most labour-intensive phases are the last-mile and the order picking and assembly (they together represent 75% of the overall time), which are characteristically the additional value that this type of channel offers to the customer. Indeed, they represent "work" or effort that is performed by the shopper in the traditional brick-and-mortar setting. The last-mile phase is the most important in the analysis in terms of time (59% of the overall labour time). Its main components are related to the times spent travelling and consigning the parcel, and they equally contribute to make up 88% of the whole phase time, the missing portion is dedicated to the management of missed deliveries (see Figure 3).

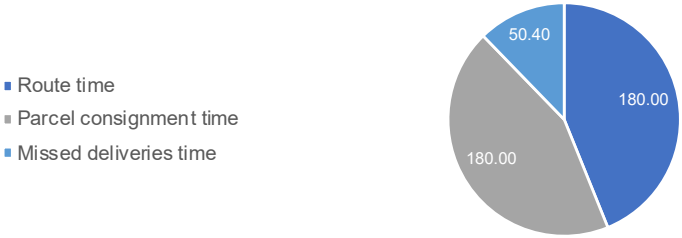

Figure 3: Home delivery - Last- mile [s/item]

On the other hand, the relevant role of the order picking and assembly (16% of the overall process time) is explained by the execution of the activities on small batches or single pieces. The study indicates that this macro-phase is especially impacted by packing activities (40% of the overall phase time), which represents time dedicated to a single product, and picking activities (32%, including the replenishment of the picking forward, of the overall phase labour time), which are performed on small batches of products.

Then, manual labour is determined by van loading, other warehouse activities, and item singularization and order assembly (see Figure 4).

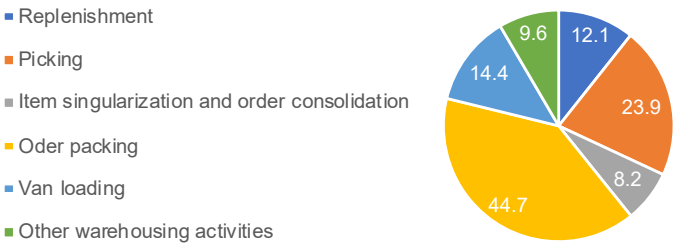

Figure 4: Home delivery - Order picking and assembly [s/item]

Another important share of labour in the home delivery case is represented by the post-sale phase (16% of the overall process time), where the returned products are managed adopting a home collection policy. This is consistent with the typically lenient return policies featured by apparel e-businesses. The high rate of garments working backwards in the supply chain increases the workload and the complexities of this order-fulfilment process. The two most important activities in this phase are the pick-up from the customer's premises (66% of the overall phase time), which replicates the characteristics of last-mile delivery, and the returned product reception and storing (23% of the overall phase time) at the merchant's warehouse. Of course, since not every fulfilled order is returned, such times are weighed upon the return rate.

Finally, the delivery macro-phase (66.1 s/item) is the least labour-intensive one, representing only the 9% of the overall process labour time, since it benefits from the high saturation of vehicles and the high degree of automation in the two transit points.

6.1.2 Click and collect

Click-and-collect order fulfilment process is more efficient compared to home delivery since it exploits the stocks already stored on the shelves of physical shops, avoiding the

order picking and assembly, delivery, and last-mile phases. However, it requires a significant amount of labour during the product pick-up phase (68% of the overall time), because of the direct interaction with customers (85% of the overall phase time). Click-and-collect brings inside stores the labour associated with the consignment, hence, stores are a relevant logistics node for fashion online commerce. The PoS replenishment and post-sale phases represent respectively the 17% and 15% of the overall process time. Most of the labour within PoS replenishment phase (78% of the overall phase time) serves to perform handling activities within the store. Whereas central warehouse and transportation activities are very efficient due to bulk quantities handled. On the other hand, albeit returned products do not go back through the nodes of the network, they need gatekeeping, and they require to be individually screened and rearranged. However, returning items in the store (67.1s/item) reduces by 38% the labour time required adopting a home collection policy, because part of the work is done by the customer.

6.1.3 Parcel locker

Parcel locker delivery is equivalent to home delivery in the order picking and assembly and delivery phases. However, the results show that the contribution of each phase to the total workload varies drastically compared to home delivery, which is less equally distributed. Indeed, order picking and assembly becomes the phase that requires most of the process work (36%), followed by last-mile (27%), delivery (20%), and post-sale (17%). The main reasons are related to the adoption of lockers in both the last-mile (see Figure 5**Fehler! Verweisquelle konnte nicht gefunden werden.**) and the post-sale p hases. The labour time for both of them is observed to be drastically reduced by 80% and 50% respectively compared to the home delivery case. Less work is required due to the absence (as assumed) of missed deliveries, the higher delivery density, and the standardization of the locker replenishment procedure, which makes it far more efficient than attending parcel consignment. All in all, parcel lockers generate large efficiency in the last leg of the logistics chain by drastically reducing driving, consignment, and return collection times.

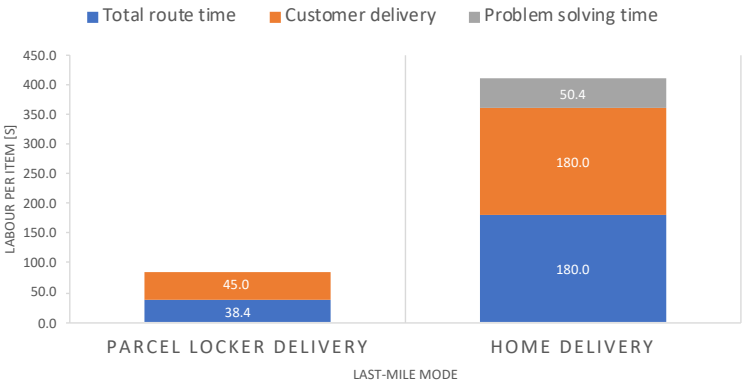

Figure 5: Parcel locker vs. Home-delivery - labour time comparison

6.1.4 Traditional retail

The least working time is required by the traditional channel, the labour is mainly concentrated in the PoS replenishment phase which represents 71% of the process (see Figure 6). Similarly to click-and-collect, handling activities within the store make up to 84% of the overall phase time, since operations in shops are not as efficient as those performed in dedicated logistics facilities (e.g. warehouse or hub). The post-sale macro-phase results to have an important share of working time, nonetheless. The offline channel, additionally to returned products, needs to manage unsold garments, which require the majority (58%) of labour within the phase. Returns are once again mainly affected by the time dedicated to the interaction with customers. While most of the labour for unsold garments lies in the preparation of the shipments to the outlet and in its reception and storing.

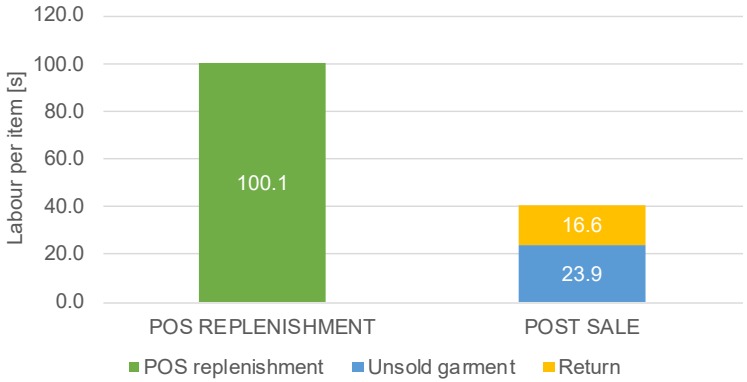

Figure 6: Macro-activities Traditional Retail

6.2 Sensitivity analysis

A sensitivity analysis has been performed to understand how the occupational impact of each order fulfilment process varies compared to the reference case by changing some of the key input data. Several scenarios were developed by changing the input parameters describing the merchant, the customer, and the context of the last-mile delivery.

6.2.1 Merchant type

Three types of merchants were considered, large, medium (reference case) and small, with the following characteristics:

Table 2: Merchants' characteristics

	Merchant type		
	Large	*Medium*	*Small*
Turnover	Large	Medium	Small

Merchant type			
PoS size	Big	Medium	Small
Unsold rate in the store	30%	20%	10%

The impact of the merchant features does not affect the ranking of the four order fulfilment processes, but the effects of the retailer characteristics are different depending on the process examined. Both home delivery and parcel locker delivery do not display any relevant variation in the total labour time required. On the other hand, the two other channels, characterized by the presence of the point of sale, show the tendency to increase their total workload moving from a larger to a smaller merchant. In fact, a large size of the merchant is associated with larger flows, which increase the efficiency of transportation and warehousing activities mainly. Moreover, a larger size of the points of sale is associated with improved productivity of in-store operations. These factors determine a 10% decrease in the total workload for C&C in the case of a large merchant, while the same amount increases by 15% when the retailer is small. Although the same factors influence the labour requirements of the traditional order fulfilment process, their impact is mitigated by the variation in the unsold rate, since larger stores are affected by a higher rate of products unsold. Hence, the model registers almost no variation when the merchant is large and a 9% increase in the total labour time when it is small.

6.2.2 Customer type

Three scenarios were developed based on three types of apparel customer (Cardoso et al. 2010) with the following characteristics:

Table 3: Customers' characteristics

	Customer type		
	Fashion-addicted	*Moderate (reference case)*	*Apathetic*
Online return rate	30%	20%	10%
Offline return rate	8%	5%	3%

The behaviour of a customer is a relevant determinant of the labour required to manage returned products, thus, on the overall occupational impact of each process. However, the analysis reports that the fulfilment processes of the product ordered online are the most affected since the return rates are higher. Moreover, the impact is linearly related to the amount of labour required by the collection policy adopted. Thus, the home delivery process is the most affected, since the home collection policy is the most labour intensive. Click-and-collect with store-picking policy follows, and finally parcel lockers. Obviously, the offline order-fulfilment process is the least affected one, due to the lowest level of return rates, which are driven by the possibility of "feeling and touching" the garment before the purchase, absent possibility in the online shopping.

6.2.3 Customer location

A sensitivity analysis on the location of the customer was performed by considering, besides the so-called urban area, also metropolitan and rural areas. Only parcel locker and home-delivery fulfilment processes are affected by the location of the customer. When home delivery is considered, the location is a crucial factor to determine the workload per item. Indeed, when deliveries are performed in rural areas the total labour time of the process increases by 56% compared to the urban case, because of the lower customer density, which affects not only the last-mile phase but also the post-sale one. Albeit having the highest customer density, the metropolitan area displays similar times (692.7 s/item) to the urban one (699.0 s/item). This is due to the high complexity of the

parcel consignment (e.g., difficulty to find a parking slot, walking *etc.*) and to the lower average van speed, which is forcedly reduced by both traffic and densely populated areas. These two factors partially erode the efficiency derived from a shorter route distance.

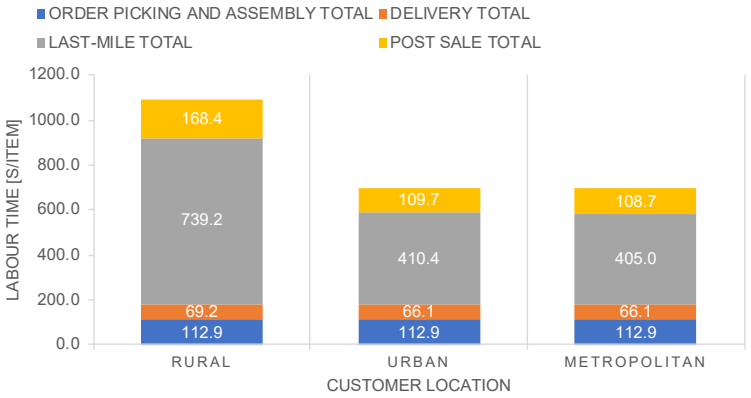

Figure 7: Home-delivery total labour times - comparison

On the other hand, the results show that the effects on locker delivery times are negligible. Because of the absence of any difference in complexities of locker replenishment depending on the area. Differences depend upon van speed and the density of the network of lockers. Ttraffic and congestion can level off the benefits of a higher network density. Indeed, the parcel locker process presents similar times for all three locations.

The observed dynamics underlying home delivery denote that the parcel consignment time (i.e. the time needed to park, unload the van, and collect the customer signature) can be decisive on the total amount of labour generated, especially when the courier is obliged to cover long distances on foot. Nevertheless, parcel consignment time is less impacting when the customer density is low. In fact, rural areas are by far the most

labour-intensive ones, though consigning the parcel to the customer requires the least time (e.g. easy to find a suitable parking lot, no need to walk).

7 Conclusions

The main originality and novelty of the present work lie in the perspective adopted to study the employment impacts of e-commerce. This work provides an analytical and quantitative contribution to the social sustainability literature of logistics. Besides the theoretical implications, this study aims at creating a user-friendly tool to support the decision-making process of practitioners and policymakers. The model helps to make more informed decisions from an employment point-of-view. Retailers within the apparel industry can achieve a higher consciousness of how their businesses and choices affect the social tissue, evaluating their impacts from an occupational perspective.

As the main findings show, often the labour needed to fulfil an order is not concentrated in one actor of the logistics chain (e.g., the retailer), but it is spread among different players such as express couriers or 3PLs. Hence, the model helps a retailer to adopt an enlarged employment perspective, which does not look only inside the business but includes the broader picture of all logistics actors involved. Finally, this work gives policymakers an additional point of view on the effects that electronic commerce has on the employment of our society, which can help them in developing more informed public policies.

The model proposed has some limitations due to its scope and the necessary simplifying assumptions made in certain phases. Such limitations may be taken as insights for future research development. First of all, this analysis is concentrated on one single industry limited to the Italian context, hence it does not guarantee that the same results can be extended to other industries where logistics strategies are typically different. Also, the model does not take into account a global e-commerce perspective. Moreover, only one category of fashion product is analysed: folded clothes. Whereas accessories and hung garments are not modelled in the processes, although they require some differences in their handling and in their packaging. The model does not consider the fast-evolving role of automation and the impact that a broader application of automated processes can

have on the manual labour demand observed across the various phases. Simplifying assumptions have been made to structure the reverse logistics flow that may follow many different paths and combinations from one player to another. Further research may investigate the impact on employment if other less common reverse flow scenarios were adopted. Finally, the last important limitation concerns the less detailed way through which store activity times have been computed, where, instead of examining each single logistics task performed in stores, times were considered as a predefined percentage of the salesmen's daily working hours.

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Appendix

E-commerce channel – Replenishment activities

Phase	Activity name	Activity type	Player	Worker involved
Order picking and assembly	Replenishment order emission	Management	Merchant	Warehouse operator
Order picking and assembly	Order reception and management	Management	Merchant	Warehouse operator
Order picking and assembly	Order fulfilment	Management	Merchant	Warehouse operator
Order picking and assembly	Picking list emission	Management	Merchant	Warehouse operator
Order picking and assembly	Forklift tour to pick the pallet	Warehousing/ Handling	Merchant	Warehouse operator
Order picking and assembly	Pallet retrieval with a man-on-board truck	Warehousing/Handling	Merchant	Warehouse operator
Order picking and assembly	Items storing (shelves replenishment)	Warehousing/Handling	Merchant	Warehouse operator
Order picking and assembly	Auxiliary and support activities to replenishment e-commerce	Warehousing/Handling	Merchant	Warehouse operator

E-commerce channel – Order assembly activities

Phase	Activity name	Activity type	Player	Worker involved
Order picking and assembly	Waybill emission	Warehousing/ Handling	Merchant	Warehouse operator
Order picking and assembly	Scanning parcel and loading trolley rolling container	Warehousing/ Handling	Merchant	Warehouse operator
Order picking and assembly	Moving parcels on a trolley rolling container	Warehousing/ Handling	Merchant	Warehouse operator
Order picking and assembly	Picking up parcels from the container and placing them in the van	Warehousing/ Handling	Express courier	Driver
Order picking and assembly	Van loading	Warehousing/ Handling	Merchant/ Express courier	Warehouse operator/ Driver
Order picking and assembly	Auxiliary and support activities to shipping e-commerce	Warehousing/ Handling	Merchant	Warehouse operator

Home delivery activities				
Phase	**Activity name**	**Activity type**	**Player**	**Worker involved**
Last-mile	Travel activities	Transportation	Express courier	Driver
Last-mile	Customer delivery	Parcel consignment	Express courier	Driver
Last-mile	Problem-solving activities	Parcel consignment	Express courier	Driver

Parcel locker delivery activities				
Phase	**Activity name**	**Activity type**	**Player**	**Worker involved**
Last-mile	Travel activities	Transportation	Express courier	Driver
Last-mile	Customer delivery	Parcel consignment	Express courier	Driver
Last-mile	Problem-solving activities	Parcel consignment	Express courier	Driver