Logistic services in the Industry 4.0 era: identification and analysis of the requirements

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Abstract: The offer of logistic services (e.g. transport, inventory management, customs brokerage, IT solutions and so forth) targeted and personalised to the different customers’ needs is expanding thanks to the benefits foreseen from the implementation and exploitation of the Industry 4.0 technologies. However, this expansion comes at the cost of the increased complexity of the services offered, requiring the identification of the correct infrastructure supporting their provision, and identifying the necessary skills to make them available in the best possible way. Therefore, to avoid situations in which logistics service provision becomes inconvenient, it is necessary to study in depth the characteristics and requirements of each service before offering it to the customers. This paper, adopting the service provider perspective, aims to identify the macro-categories of requirements to provide different logistic services. Starting from a discussion on the differences between different kinds of logistics services providers (from first to fourth party logistics), the paper deals with the analysis of a set of logistics services. The aim is to identify the requirements necessary for the service provision using a combination of case studies, evidence from industry, and the authors’ experience. Eventually, the authors analyse the relationships between the logistic services and their requirements identifying commonalities and clustering them to identify a set of requirements’ macro-categories. The paper concludes with the proposal of future research paths.

Keywords: logistic service provider, logistic services, Industry 4.0, service requirements

1. Introduction
Recent years have been marked by many global trends that directly impact on logistics activities inducing higher degrees of complexity: the relation between globalisation and technology, the development of Information Technology, and e-commerce (Hu and Haddad, 2017) are just a few examples.

Among these trends, the rapid technological evolution – often summarised under the umbrella concept known as Industry 4.0 – is one with the most significant impact on daily logistics operations (Thoben et al., 2017). This rapid evolution is challenging for companies and requires improved technologies, competencies, and models enabling the interconnection of people, products, assets and systems through real-time data exchange (Lee et al., 2016). To cope with these requirements, logistics service providers (LSP) have been investing in technology and ICT optimisation tools (Mena and Bourlakis, 2016). For instance: the installation of On-Board Units allows capturing the fuel consumption for better monitoring and improving the overall fuel efficiency; real-time data on the vehicle location for the feeding of vehicle routing algorithms, which compute and update the most efficient route. Many LSP companies have invested in smart mobile applications for their drivers (e.g. the SmartTruck system by DHL, ORION system by UPS). Without innovation and the development of new services, LSPs will have to cope with the risk of losing the opportunity for long-term profitable growth (Soinio et al., 2012).

Consequently, to achieve the maximum benefits from service provision, companies must compose a service portfolio covering customers’ necessities and, at the same time, in line with the companies’ possibilities in terms of costs, efforts, available technologies and infrastructures, operational capabilities, and consultancy skills. Offering services without the necessary skills or operational capabilities may generate unsatisfactory results for both the provider and the customers (Gebauer et al., 2005). Indeed, (Paiola et al., 2012) affirm that a reorganisation of the initial operational capabilities is required when firms intend to offer new services to customers. Otherwise, the risk of not being able to satisfy the customer needs rapidly and effectively arise. Also, this could result in the loss of the unsatisfied customers, and into an economic loss due to the incorrect exploitation of the resources required to provide the service.

An example of this is provided by Liu and Lyons (2011), which emphasises the higher economic performance achievable, improving the operations in specific services rather than offering a wide range of general services. However, in scientific literature, several authors often neglected the technological aspects and how they could help create a more efficient service portfolio. For example, Hertz and Alfredsson (2002) were among the first to emphasise the importance of collaboration among LSP and other actors in the supply chain in order to “orchestrate” better logistics services. Soinio et al. (2012) highlight the need to extend both knowledge and relationships with customers in order to create new integrated service models delivering smarter logistics services. Finally, Gruchmann and Seuring (2018) state that through the LSP capabilities and the extension of the services portfolio with new and
in innovative logistics services, also the LSP social responsibility could increase creating added value for all the actors of the supply chain. Thus, this paper includes the first results of an extensive analysis concerning the service portfolio offered by Third-Party Logistics (3PL) providers and Fourth-Party Logistics (4PL) providers. In particular, the final aim of this paper is to support LSP in the identification of the technological, human and physical resources needed to provide different possible logistic services to extend their services portfolio.

The paper is structured as follows: Section 2 deals with the explanation of the methodology used in this work. Section 3 focuses on the literature review. Section 4 describes the logistic services classification and the requirements identified from their analysis. Section 5 presents the results of the authors’ analysis and discusses the implications. Eventually, Section 6 concludes the paper and delineates future research streams.

2. Methodology
The research methodology adopted in this paper is based on five sequential steps (Figure 1). Such a methodology has been devised assuming the perspective of the service provider and to support LSPs in the identification of the technological, human and physical requirements needed to provide new services. Given this perspective, the analysis of the customers’ needs does not constitute a central part of the proposed methodology. Customer needs would be the starting point during the design of the service portfolio, thus when the LSP has to select the services to include in its offering.

- Literature review on LSP and service requirements definition
- Identification and classification of services
- Identification of services requirements
- Requirements macro-categorization
- Logistics service requirements definition

Figure 1: Research methodology

The first phase of the research dealt with a literature review performed on two topics: LSP (paragraph 3.1) and service requirements definition (paragraph 3.2) including both scientific and grey literature such as white paper, company reports, company websites and conference presentations. On the one hand, the research on LSP focused on the analysis of the specific LSP companies’ characteristics with the aims of synthesizing commonalities and differences useful to refine service classification. On the other hand, the literature review focused on service requirements definition. In particular, the aim was to comprehend the perspective used to analyse the service offering. Then, the attention moved on the identification of services to be considered in the analysis. The selection procedure was composed of multiple sequential steps. First, a list of services offered by different LSPs was created basing on the result of the analysis on scientific and grey literature concerning specific LSP companies (such as Ferclam, 4PL, Smet, Gefco, Sedisp, DHL, Ceva). Then, the services were classified and selected according to criteria deriving from scientific literature (see paragraph 4 for the detailed explanation of classification and selection processes). In the scope of favouring the requirements and macro-categories’ analyses and the following discussion, the authors selected a different kind of services. One of the aspects that distinguish LSPs is the kind of service that they can offer to customers. Following, the authors analysed each service, listing the requirements necessary for their provision. The authors devoted particular attention to the definition of the requirements necessary to deliver a service, which means exploit all the resources leading to the execution of the activities leading to its provision. In the authors’ intentions, this means approaching the problem from the technological, human and physical point of view. After, the authors clustered the identified requirements into macro-categories. For example, while analysing warehouse management services, the authors identified requirements such as the presence of Warehouse Management System (WMS) software or sensors for the stock management. These requirements were clustered into a single macro-category called monitoring infrastructure. Finally, the authors put in relation service and macro-categories to identify which resources are needed by LSP(s) to offer the specific service to their customers. The discussion around this topic led to the identification of the characteristics belonging to only some of the LSPs and allowed to make distinctions between the different LSPs regarding the way they deliver the same service to customers. The information contained in the table proposed in this work must be later put in relation with the customer needs identified by the company through market analysis. Customer needs analysis is expected to be carried out with the provider in a further extension of this research. The service portfolio composition will emerge from the combined use of this data.

3. Literature review
The selection of the logistic service portfolio offered to customers in a constantly evolving context (especially from a technological point of view) represents a critical decision for LSPs. To better clarify this criticality, a literature review about both LSPs and service requirements definition is provided.

3.1 Logistic service providers
In the scientific literature and common practice, an LSP is defined as “a provider of logistics services that performs the logistics functions on behalf of their client” (Coyle et al., 1988). The main differences among the four types of LSPs reported in Table 1 mainly concern the services offered (e.g., basic services, value-added services, integrated services and advanced services), the supply relations (e.g., single purchase, contract supply, partnerships), and the models of pricing (e.g., payment per transaction, fixed and variable payments depending on the type of contract, depending on the sharing of the risk, based on the value of the added services and the degree of integration of the services) (Win, 2008).

The difference between the four types of party logistics services providers could be ambiguous. In particular, it is possible to define 3PL as “a company that provides multiple logistics services for its customers, whereby the 3PL provider is external
to the customer company and is compensated for its service” (Langley et al., 1999). While 4PL as “an integrator that assembles the resources, capabilities and technology of its organization and other organizations to design, build and run comprehensive supply chain solutions” (Burnshead and Cannels, 2002). According to these consolidated definitions, most 4PL companies have no physical assets (like warehouse facilities or vehicles fleets), they provide services to the customers in the form of responsibility and knowledge of how to fulfill customer requirements while the physical movements of goods are outsourced to other 3PL (Stefansson, 2000). This paper focuses only on 3PL and 4PL services, assuming that 4PL can own or not physical assets.

Table 1: Logistics service providers’ different typologies (Source: Win, 2008)

<table>
<thead>
<tr>
<th>Services</th>
<th>Supply Relations</th>
<th>Pricing Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>1PL Basic Services</td>
<td>Single purchase</td>
<td>Transaction</td>
</tr>
<tr>
<td>2PL Value-Added Services</td>
<td>Contractual</td>
<td>Fixed and Variable</td>
</tr>
<tr>
<td>3PL Integrated Services</td>
<td>Contractual</td>
<td>Risk sharing</td>
</tr>
<tr>
<td>4PL Advanced Services</td>
<td>Partnership</td>
<td>Value based</td>
</tr>
</tbody>
</table>

3.2 Service requirements definition

This subsection deals with the analysis of the literature concerning the definition of the service requirements for the service providers. In particular, the analysis was aimed at understanding the approaches used to define the requirements and understand the convenience of offering or not a specific service. As introduced earlier, the composition of a proper service offering is fundamental for LSPs generating a significant part of their revenues selling services. A service offering not well structured or provided may cause the loss of a customer and the related future revenues. The literature presents several methods to evaluate possible new services, each one focused and tailored on a specific need. On the one hand, many authors focus on methods to support the supplier selection in 2PL, 3PL and 4PL cases focusing thus on the customer perspective. Only few contributions consider the provider perspective discussing the problem of the definition of service requirements (Pezzotta et al., 2016). On the other hand, some papers deal with service offering evaluation only from the purely economic side (Lampe and Hofmann, 2014). Lin et al. (2015) state that many service offerings are not aligned with customers’ real expectations, often being above them and, thus, leading to a mismatch between what is needed and what is provided because of a wrong analysis of the service requirements and customer needs. This may result in the offering of an unnecessarily complicated service, which requires putting in place more resources than the ones needed. To avoid this, it is necessary to follow structured procedures considering also the resource required by each service. Martikainen et al. (2014) propose a case study where three steps have been followed to create the service offering:
- Developing the service concept;
- Developing a basic service package, defining the core service (the one that satisfies the customers’ needs);
- Developing an augmented service offering, defining the facilitating service(s) (the one(s) that increase the usability of the core service) and the supporting service(s) (the one(s) that differentiate the LSP offering).

Eventually, Martikainen et al. (2014) evaluate the service offering the considering the market, the service economic feasibility and the service pricing system, without mentioning the analysis of the service requirements. Other approaches deal with the problem from another point of view, focusing on other aspects, like service quality. For example, the one proposed by (Kilirbada et al., 2012) use the SERVQUAL method (Parasuraman et al., 1988) as a baseline to create a scale to measure service quality (e.g., completeness of service, reliability of service, damage of goods), the Logistic Service Quality (LSQ). LSQ uses the quality of service attributes as a proxy to define the service offering characteristics. The process to develop the service offering proposed by (Kilirbada et al., 2012) is composed of three steps:
- Definition of the logistic requirements, which is achieved through the application of LSQ and allows to evaluate the attributes of the service;
- Linearization and normalisation of the values of the attributes defined in the previous phase to favour the analysis and comparison;
- Service offering composition and selection, which implies the comparison of the service offering created combining different logistic requirements.

The service selection is then performed comparing the differences between the required services and the offered ones, and selecting the ones that satisfy the customers’ requirements from the quality point of view, neglecting other essential requirements such as the technological, human and physical ones. The analysis highlighted that the methodologies presented in the literature are mainly focused on the definition of the service offering but, despite that, only a few of them deal partially with the requirements analysis and definition considering the technological, human and physical resources.

4. Logistic services classification

According to the primary scientific literature (Panousopoulou et al., 2012; Xiaohei Wang et al., 2016) and leading previous cited LSP companies’ services portfolios, it is possible to categorise the offered services as follows:
- Transportation (e.g., lease or chart transportation, intermodality services);
- Warehousing (e.g., picking, packing, inventory planning, storage and management);
- Distribution and freight consolidation (e.g., cross-docking, freight sourcing...
strategies, network analysis and design, control tower);
- Forwarder/Shipper management (e.g., freight forwarding, shipping, customs brokerage, coordination with broad supplier base);
- Financial services (e.g., contract management, consultancy, business planning, projects management);

5. Logistics service requirements

This section deals with the explanation of the macro-categories identified following the analysis of the requirements (sub-section 5.1), with the analysis of the relations between services and macro-categories (sub-section 5.2), and with the discussion of the results emerging from the analysis (sub-section 5.3). For each service, the list of requirements has been built based on scientific literature (Mehmann and Teuteberg, 2016; Mokhtarinejad et al., 2015) and the analysis of the grey literature (e.g., white paper, company reports, company websites). Afterwards, the requirements have been categorised into seven different classes based on the type of resources needed. The final part of the process consisted of clustering macro-categories belonging to 4PLs distinguishing them from macro-categories about 3PL or both 3PLs and 4PLs.

5.1 Macro-category's identification

The macro-category identification phase, performed in the scope of supporting the LSP while searching for possible logistic services to extend their service portfolio, followed an inductive approach centred upon the analysis of the requirements from the technological, human and physical sides.

In particular, the authors focused on the technological perspective arising from the service analysis rather than on a customer-centric perspective. In the authors’ intentions, the customer perspective should be considered when the service portfolio composition is selected. In this case, the result of the analysis is a mean used to identify technological, human and physical requirements necessary for the provider to deliver services. Specifically, the authors clustered the requirements identifying macro-categories useful to represent their characteristics (e.g. monitoring infrastructure to represent all those requirements such as sensors, connections and software necessary to provide IT-related services). The authors conducted the analysis devoting special attention to the operational side of the service provision (what do I need to provide the service correctly? What are the operational tools able to support the service delivery?). The authors identified seven macro-categories:

- **Fleet**, which represents the availability of one or more physical means (e.g., trucks, trains, ships) to transport products for customers;
- **Physical infrastructure**, which represents the availability of physical infrastructures (e.g., warehouses, transit points, distribution centres) to store customer products or to consolidate them;
- **Monitoring infrastructure**, which represents the availability of IT tools and sensors (e.g., RFID, GPS, barcode, sensor temperature) to monitor the position of an item or its status during the transportation or the warehouse management;
- **Data visualisation and management (Software)**, which represents the ability to manage and visualise data using specific software. This macro-category is focused only on data visualisation and management, and not on data analysis;
- **Data analytics**, which represents the ability to analyse data and extract useful information to make a decision and optimise the company strategy;
- **Competencies**, both the abilities of workers to perform specific activities related to the service and their knowledge concerning what should be done;
- **Network**, which represents the set of connections with other actors in the supply chain that the LSP has.

5.2 Services vs macro-categories

Table 2 highlights the links identified between services and macro-categories. Specifically, the authors analysed the relations between services and macro-categories to differentiate between macro-categories about both 3PL and 4PL and macro-categories pertaining only to 3PL or 4PL. In Table 2, the symbol “•” represents the first case, where the macro-categories concern both 3PL and 4PL, while the symbol “⇒” and the symbol “⇒” represents only 3PL and only 4PL, respectively. Moreover, the symbol (“◦”) represents services that could be offered by a 4PL. According to the 4PL definition in subsection 3.1, a 4PL could operate without owning a physical asset. Consequently, if the 4PL owns physical assets could offer the services (“◦”). Otherwise, the service could be offered only by 3PL (“◦”).

5.3 Discussion

Concerning the approaches proposed by the papers mentioned in section 3.2, this work opted for a different level of analysis: instead of focusing on proposing an approach to select services, the analysis is centred on the definition of technological, human and physical requirements needed to provide a specific service. The analysis of Table 2 opens the discussion around different topics. First, it is interesting to notice how some of the requirements identified during the analysis are common to multiple services.
### Table 2: Services vs macro-categories

<table>
<thead>
<tr>
<th>Fleet</th>
<th>Physical Infrastructure</th>
<th>Monitoring infrastructure</th>
<th>Data visualisation and management (SW)</th>
<th>Data analytics (Optimization)</th>
<th>Competencies</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking &amp; Tracing</td>
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<tr>
<td>Own fleet optimisation</td>
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<tr>
<td>Others fleet optimisation</td>
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<td>○</td>
<td>○</td>
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<td>○</td>
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<tr>
<td>Benchmarking &amp; Supplier Selection</td>
<td>○</td>
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<td>Transportation</td>
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<tr>
<td>Temperature controlled facilities</td>
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<tr>
<td>Access to clients' data</td>
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<td>Packaging</td>
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<td>Training</td>
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<td>Warehouse management</td>
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<td>Cloud platform</td>
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<td>Staff at customer</td>
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<td>Re-layout</td>
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<td>Consulting</td>
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<td>Consulting</td>
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<tr>
<td>Transit point, depot, satellites</td>
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<td></td>
<td>■</td>
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<tr>
<td>Warehouse staff</td>
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<tr>
<td>Security sensors</td>
<td>■</td>
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<td>Consolidation facilities</td>
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<td>Quality control</td>
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<td>Distribution and Freight Consolidation</td>
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<td>International teams available 24/7</td>
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<td>Standard processes customised to customer’s specific issues</td>
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<td>Training</td>
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<td>Control tower</td>
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<td>Suppliers' mgmt</td>
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Table Label: • = only 3PL  ○ = only 4PL  ■ = both 3PL and 4PL

In fact, for an LSP, it would be easier to create a new service offering if the new service has many requirements in common with the ones already available in the LSP portfolio. Also, before introducing it, it is necessary to analyse the risks connected to the new offering. Risks can be of various types, and LSPs should consider all the possible scenarios and conditions before making the new offering available. The chance to provide unsuitable or unsatisfactory offerings could result in the loss of customers, as well as in the loss of economic resources invested in building the infrastructure and the competencies to provide the new service. Another interesting aspect can be found in the way data availability can influence service delivery. Something noteworthy is nested in the fact that, despite data availability, only 4PL can exploit it correctly to provide complex services. Data management, visualisation and analysis allows improving the services offered but, at the same time, they increase service complexity. Besides, wrong analyses performed on
data may cause wrong choices in the delivery phase, which may result in a loss for both the customer and the LSP. Specifically, out of the several services identified during the literature and LSPs analyses (Section 4), in this work, the authors considered four services: transportation, warehouse management, distribution and freight consolidation, and control tower. Due to space constraints, authors selected the set of services carefully to include in the analysis to favour the comparison between the characteristics of the services and sub-services offered by 3PL and 4PL. For this reason, some of the services listed in Section 4, such as Forwarder/Shipper management and Financial services were not considered in the analysis but will be included in the future developments. The scope was also to be able to define a list of additional sub-services that 4PL can offer concerning the 3PL offering. For example, considering the distribution and freight consolidation services, only the 4PL can offer quality control sub-service, making the service offering complete. The same can be said for the different sub-services considered in Table 2, which are sub-services that can be added to the core service in the scope of providing the customer with the best possible experience and satisfy his needs. In the transportation category, what emerges is that the tracking & tracing requirement is satisfied by both 3PL and 4PL. Despite this, 3PL are not able to offer also the benchmarking & supplier selection for their customers: in this way, they provide a service that may be satisfactory but limited for the client. The limitation is since the 3PL is more focused on the use and optimisation of the own fleet. This implies that 3PL often neglect the possibility to use other fleets to improve the service provided (for example, in case of a demand peak).

Regarding warehouse management service, both 3PL and 4PL use data to improve some specific aspect of the service but only 4PL satisfy all the requirements for this service. Moreover, what emerges is that despite the exploitation of IT systems by 3PL and 4PL, an only 4PL cover additional aspect of this service like training of employee customers or providing with own workers customers’ facilities. In essence, this can be translated into a more comprehensive set of skills and competencies able to provide the customer with a complete service.

The introduction of additional features to service implies the update of the infrastructure usually used. For example, the management of multiple warehouses located in different places and the coordination of stocks implies the upload of data on the cloud, specific visualisation tools and analysis algorithms able to support the management of the correct stocks. Similarly, the management of customers’ warehouses requires the ability to analyse data with correct instruments and interpret analyses results correctly. Customers’ plants re-layout require being able to compare a considerable amount of information of various type, mixing production politics and space occupation.

This should result in the optimisation of customers’ performance under the aspect of warehouse management. The same thing can be said for the distribution and freight consolidation services. Also, in this case 4PL proved to offer a complete service to customers, including products quality control, which requires both a more sophisticated monitoring infrastructure and additional competencies. Finally, the control tower resulted in being a service provided only by 4PL because of the requirements at the base of its provision. All the requirements identified and the related macro-category resulted in being pertaining only to 4PL. Once again, competency seems to be the most critical macro-category given the fact that the service under analysis is based on the management of a complex system composed of multiple actors, facilities, warehouses and products.

As demonstrated by the requirements, to provide the service also a monitoring infrastructure is required, given the fact that this service needs coordination among LSP company, suppliers and customers, thus, it is necessary to gather data from different sources and compare them. Also, it is necessary to have strong relationships with different actors along the supply chain to be useful in service provision. What emerges from Table 2 is that all the macro-categories but the network, pertain to both 3PL and 4PL. This is consistent with the definition adopted for 4PLs, which are LSPs who works across the entire supply chain and, due to this, necessitate to have strong relationships with the different actors to coordinate their work and the materials flow.

Eventually, the discussion should point out also if the macro-categories are more focused on the tactical or strategical level. Something noteworthy resides in the classification the can be performed on macro-categories. Going from the tactical to the strategical level, what can be said is that it emerges a distinction between the strategic macro-categories (e.g. network), and the tactical ones (e.g. fleet, physical infrastructure). While the latter pertains to both 3PL and 4PL the earlier are related only to 4PL. Specifically, it can be seen from Table 2 that only 4PL are connected to this macro-category.

6. Conclusions

The introduction of new technologies, especially those related to IT, makes it possible to offer a broader range of services. Companies that offer logistic services are faced with finding profitable compromises between the need to standardise services – so that they can serve a more significant number of customers – and the hyper-customisation of services – so to offer increasingly tailor-made solutions for their customers.

This paper aims to support LSP in the identification of the technological, human and physical resources needed to provide different possible logistic services to extend their services portfolio. In particular, several services offered by 3PLs and 4PLs, and the requirements necessary for their offer on the market were analysed. Later, the requirements were categorized according to the type of resource to which they referred (e.g., a fleet of vehicles, physical infrastructure, monitoring infrastructure, data management, expertise, network) in decision macro-categories. Table 2, therefore, allows a second reading: it allows a company to understand which new services can be offered according to the macro-categories characteristics
that the company has or on which macro-categories invest if wanting to offer certain new types of services. The analysis carried out in the paper is however limited, further research is needed to test through case studies the correctness of the macro-categories associated to the relevant services and to extend the analysis to all the services offered by an LSP, without limiting itself to the four taken as an example in this paper.

References


