Benchmarking of Health Technologies distribution models: an investigation of Lombardy's Local Health Authorities

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1. Introduction

The shift of the healthcare focus from the hospital towards the local and domicile levels can be mentioned as one of the most relevant evolutionary trends worldwide (Dirindin and Vineis, 2004; Compagni, Tediosi and Tozzi, 2010). This evolution is to be ascribed on the one hand to the growth of know-how in clinical diagnosis, treatment and rehabilitation and, on the other hand, to the availability of health technologies. These are defined as "the application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives" (WHO, 2007) which allow curing and surviving adverse health events and epidemiological transitions.

As a consequence, over time an increased demand for health and social services has been arising, generated by the steady aging of the population suffering from chronic diseases.

The consequent impact in economic terms has been highlighted by the World Bank and other institutions in the health sector (Gottret, P. and Schieber, 2006): the costs incurred by the National Health Services (NHSs) to provide their services significantly increase for people older than 45 years. NHSs are thus called to adapt and respond to this evolution to secure their economic sustainability, containing costs without affecting the quality of service.

One of the strategies adopted to respond to the mentioned challenges (see Jacobs, 2001; WHO, 2008) is the management at the local level of chronic diseases and of diseases not requiring highly intensive treatments, keeping at the hospital level the acute phase treatment for short time periods. This must be carried out through the supply of on-field assistance services, i.e. curing patients at their domicile or at neighborhood NHS's facilities. To be provided, on-field assistance services require health technologies to be delivered to patients, since they represent essential enabling materials. Moreover, excellent logistics management capabilities, along with optimized logistics networks for distributing health technologies to patients must be developed by NHSs.

To this aim, assessing the performance of the distribution models adopted by NHSs for locally distributing health technologies is the first and foremost move. The measurement of the performance is in fact vital to the improvement of the efficiency and effectiveness of any process of healthcare services (Dey et al., 2008) and benchmarking can represent an essential tool for improvement (Chan et al., 2006).

The performance of healthcare services has been traditionally evaluated by three categories of measures: structure, process and outcome (Donabedian, 1980). These measures have been often condensed in measurement models that, although able to evaluate both objective and subjective elements, fail in analyzing the overall success factors of a whole system (Dey et al., 2008). Moreover, even if sometimes specifically developed for the measurement of the performance of healthcare services (see Dey et al., 2008; Dey et al., 2006), they do not take into account the distribution of health technologies at the local level.

From a managerial perspective, the optimal logistics/distribution management of health technologies at a local level has not been studied in an independent and developed research stream yet. Only a few examples of scientific and technical works generically dealing with the logistics management of on-field assistance services can be mentioned (Harland, 1996; Munoz 2005; Nante, 2006).

Given these gaps, the present paper intends to provide a two-fold contribution: a framework for measuring the performance of distribution models of health technologies at a local level and a roadmap to pave the way towards efficient and effective models for distributing health technologies at a local level, through prescriptions generated by applying the developed measurement framework to a real-life healthcare service.

In details, this study will be carried out with respect to the absorbent devices for incontinence in the Italian NHS within its Local Health Authorities (LHAs).

Absorbent devices for incontinence are a relevant health technology to NHSs for its managerial complexity and economic impact on the NHSs' balance sheet and for the vastness of population suffering from chronic diseases which require these devices (Chapple and Milson, 2012).

The remainder of the paper is organized as follows. In Section 2 we perform a literature review on the frameworks for assessing the performance of healthcare systems with particular focus on the distribution of health technologies at a local level and on the available practices and models for managing the considered processes. In Section 3 we introduce the research questions, while in Section 4 we describe the methodology we adopted for conducting our research. Section 5 presents the application of the framework to the considered healthcare service, i.e. the distribution of incontinence pads, while in Section 6 we discuss the results of our research. Section 7 devises a roadmap towards optimal models for health technologies distribution at a local level. Concluding remarks are presented in Section 8.

2. Literature review

We conducted our literature review adopting the Systematic Literature Review approach. This is an efficient technique for identifying, selecting and evaluating existing contributions (Colicchia and Strozzi, 2012; Denyer and Tranfield, 2009). A number of keywords and search strings were identified to conduct the search on the citation databases. The selected sources of information were: peer reviewed journals and scholarly articles, conference papers. The following criteria have been considered to include papers:

- papers presenting a high relevance to the themes under consideration, i.e. requiring that selected articles contain at least one keyword in their title or abstract;
- papers published in peer-reviewed scientific journals or presented at international conferences.

The search has been extended to non-academic sources, i.e. white papers and regulatory papers from NHSs, which can provide very useful information about the examined issues covering both theory and examples from the practice of Italy.

2.1 Measuring the performances of the distribution of health technologies

Performance measurement is the basis of any benchmarking process. Taking into account the objectives of this research, we start from an analysis of the frameworks available in the literature for the measurement of performance of healthcare services, drilling down to the distribution of the considered health technologies.

Given the typical complexity of healthcare services, the assessment of their performance must take into account a variety of financial, non-financial, subjective and objective factors (Dey et al., 2008). Schneider et al. (1999) have showed that an ideal way for measuring clinical performance should include not only clinical data, but "an integrated health information framework needs to be developed". Dey et al. (2008) have proposed a review on the criteria for measuring performance of healthcare systems, while Galvin and McGlynn (2003) have emphasized the role of performance measurement in the healthcare sector, not limited to provide information on the quality of execution of processes but also devoted to identify solutions for improving performance and to develop prescriptions for improvement. Greatest part of the available researches have presented applications of techniques such as process reengineering, (Kwak and Lee, 2002), benchmarking (Maleyeff, 2003), balanced score card (Inamdar et al., 2002), Analytic Hierarchy Process (AHP) (Dey et al., 2006), and the Fuzzy theory (Nieto and Torres, 2003). Among them, especially AHP has demonstrated to be able to integrate different measures into a single overall score for ranking decision alternatives (Rangone, 1996). This represents a strength of a performance measurement framework in complex contexts such as healthcare services (Dey et al., 2008, Dey et al., 2006), where financial measures need to be integrated with non-financial indices for providing planning, implementation and evaluation guidelines (Dey et al., 2008). Korpela et al. (2001) have shown the potentialities of the adoption of AHP for supply chain development. Moreover, Peng (2012) has shown the use of AHP to enhance the strategic management of logistics, while Chan et al. (2006), So et al. (2006) and Kannan (2010) have offered examples of the application of AHP for measuring the performance of physical distribution processes. Sharma et al. (2008) have exploited AHP for selecting the optimal distribution network design in terms of performance metrics and product characteristics, identifying a set of cost and service factors. Likewise Costantino et al. (2013) have applied the AHP method in order to optimize an Italian regional healthcare drug distribution network.

However no contribution has specifically addressed the measurement of the performance of the distribution of health technologies at a local level. It is only possible to mention Ryu (2009) and Bentur (2000) as works that have respectively addressed the cost-efficiency and the service-effectiveness of the on-field assistance services.

In conclusion, the abovementioned measurement frameworks, although striving towards an adequate performance measurement of healthcare services, are not focused on the analysis of the performance of health technologies distribution at a local level, which, to the best of authors' knowledge, has been completely neglected in the extant body of literature.

2.2 The distribution of health technologies at local level

With respect to the distribution of health technologies, Zinn and Mor (1998) have proposed an overview of the intraorganisational structure's factors (i.e. ownership, organizational size, mission, managerial communication and control structures) affecting the performance of the delivery of services for elderly people in different settings such as ambulatory, hospital, nursing home and home care, highlighting the role of logistics for an improvement of the performance. In support, VanVactor (2011) has identified healthcare logistics as a field of study of fundamental importance which needs deeper investigation, and Gutiérrez and Vidal (2012) have provided a framework of home health care logistics management in order to identify research perspectives in the field.

Other papers (Harland, 1996; Munoz 2005; Nante, 2006) have primarily dealt with the general organisation of logistics of healthcare services but they have not focused on the local distribution of health technologies. Rodriguez Verjan et al. (2013) have compared hospital at home and traditional hospitalization: the authors offer the assessment of the best logistic strategy for delivering medicines in the design of a hospital at home service.

Literature, even if rich of examples of the organisational issues connected to home care (e.g. Chicharro et al., 2009; Gaugler et al., 2007; Randall, 2007; Ryu, 2009), has never dealt with the specific issues related to the distribution of health technologies at the local level. Rather, numerous contributions are focused on the management of the distribution of pharmaceuticals and their traceability within hospitals (Lovis, 2008; Otsubo et al., 2011; Sinha and Kohnke, 2009).

A contribution by Magalhães and Pinho de Sousa (2006) has focused on analytical approaches for the optimization of the secondary distribution, such as the Vehicle Routing Problem to the distribution of health technologies. Damiani et al (2010) have analysed the differences among the Italian regions in the organizational issues of the service for delivering health technologies. With respect to the absorbent devices for incontinence, we found a contribution focused on the degree of satisfaction of Swedish women receiving diapers at home (Kinn and Zaar, 1998).

Sorenson and Kanavos (2011) have analyzed the procurement of medical devices, including incontinence pads, across five European countries (England, France, Germany, Italy, and Spain). They have identified a trend towards centralized procurement, due to the introduction of purchasing groups or consortia.

A contribution related to the focus of our research is presented by Cornago and Garattini (2001): the authors have identified and compared four main models for absorbent devices distribution in five different European countries (i.e. Denmark, France, Germany, Italy, United Kingdom), taking into account national legislations, processes and specific features of the national markets: distribution through territorial pharmacies, home delivery, distribution through neighborhood NHS's facilities and distribution through private shops for medical devices run by health professionals (Table 1). While common patterns across Europe cannot be observed, the authors have found that from an NHS's point of view, the home delivery may lead to savings and a better service for the users, thanks to a more direct distribution channel. However, no other managerial implications or guidelines on the optimal design of distribution models are provided.

Even though the link between logistics and healthcare is becoming tighter, the management of logistics for the healthcare sector seems to be more focused on hospitals, while the study of logistics at a local level seems scarce and literature on the management of distribution at a local level for absorbent devices is remarkably missing.

Table 1. Distribution models for the delivery of absorbent devices for incontinence (Cornago and Garattini, 2001).
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3. Research Questions

The review of the literature has shown on the one hand the growing interest of the scientific community on the issues related to the optimal management of the healthcare services. On the other hand, it has put to the fore an ample gap in the extant body of knowledge with respect to the frameworks for measuring the performance of the distribution of health technologies and to the study, analysis and optimization of models for distributing health technologies to patients at a local level.

Thus, based on our purpose and stated the abovementioned research gaps, we intend to contribute to the extant literature by providing an answer to the following Research Questions:

- RQ1. How is it possible to appropriately measure the performance of the distribution of absorbent devices for incontinence at a local level?

- RQ2. How is it possible to support the development of efficient and effective models for distributing absorbent devices for incontinence at a local level?

We intend to provide an answer to RQ1 through the development of a performance measurement framework able to overcome the limitations and the scope of the frameworks currently available in literature.

We respond to RQ2 through the application of the developed performance measurement framework to the Italian NHS. This, besides being a test-bed for the developed framework, will allow the generation of prescriptions for devising a roadmap towards the design of optimal models for the distribution of health technologies.

4. Research methodology

The research methodology is contingent to the problem to be investigated, to the progress of knowledge on a specific subject (Danese et al., 2006), to the way the research questions are phrased (Yin, 2002; Ellram, 1996) and to the nature of the research itself (Bryman and Bell, 2007).

Taking into account the evidence gathered in the analysis of the literature with respect to the measurement of the performance of healthcare systems (see for example Dey et al., 2006; Dey et al., 2008), we decided to rely on the Analytic Hierarchy Process, developed by Saaty (1980), which has been widely used as a performance measurement framework also for addressing problems concerning logistics and supply chain management, thanks to its strengths, which have been named in the literature review and will be made more explicit in this section. Among these, AHP is a multi-attribute tool that enables to deal with tangible and intangible elements, with financial and nonfinancial quantitative and qualitative measures and it allows to identify levers for continuous improvement (Rangone, 1996; Dey et al., 2008). It ensures also a very high degree of flexibility of application and potential integration with other techniques, such as Linear Programming, Quality Function Deployment, Fuzzy Logic (Vaidya and Kumar, 2006). AHP has furthermore the advantage of permitting a hierarchical structure of the criteria, which provides users with a better focus on specific criteria and sub-criteria when allocating the weights (Ishizaka and Labib, 2009). It is therefore a method for building group interaction and group decision making (Saaty, 1982; Dyer and Forman, 1992; Partovi, 1994) and this is particularly important for studying healthcare systems, where also building groups for matching needs is essential for the development of effective and efficient services.

Besides these well recognized strengths, a series of weaknesses can be highlighted: even though pairwise comparisons are designed to reduce the subjectivity of evaluations, assessments using AHP are based on subjective data and might be affected by the limited capabilities of individuals to provide exhaustive assessments, being its utility theory typically non-axiomatic (Sinuany-Stern et al., 2000). This drawback can be overcome through the mediating role of researchers and through the involvement of different evaluators in the assessment of the same phenomenon (Millet and Saaty, 2000). A more controversial issue regards the “rank reversal”, i.e. the possible variation of the rank order of alternatives when new alternatives are added or existing alternatives are deleted (Belton and Gear, 1983; Saaty and Vargas, 1982). While in many cases this is a perfectly valid phenomenon (Millet and Saaty, 1997), there are also many cases where rank should be preserved (Millet and Saaty, 2000; Belton and Gear, 1983). Authors have provided ways to overcome this potential limitation as well, which however applies only when samples are built as dynamic group of alternatives (Millet and Saaty, 2000; Barzilay and Golani, 1994) – which won’t be the case for the present study.

With respect to our study, we assumed the Italian NHS point of view, narrowing the investigation on the specific NHS local branches (Local Health Authorities - LHAs) in charge of the provision of the on-field assistance services. Within the LHAs, we selected the Pharmaceutical Services department as unit of analysis, since this department is responsible for the distribution of health technologies to patients at a local level.

Given the vastness and the diversity of the LHA system in Italy, we decided to study a specific territory, i.e. Lombardy with its provinces, the most relevant Italian region in terms of healthcare spending (Italian Ministry of Economy and Finance, 2012) and treated population – over 16% of the entire Italian population (EUROSTAT, 2013).

The recommendations proposed by Eisenhardt (1989) constituted the guidelines for striving to theoretical sampling (i.e. including four to ten cases in which the phenomenon of interest is “transparently observable”). Thus, we selected 5 LHAs in Lombardy, which presented a comparable regulation body and included similarities from the epidemiological point of view but also relevant aspects of diversity in the Lombard scenario (in terms of territorial morphology and infrastructures). The features of the selected LHAs are reported in Table 2, where the actual name of each LHA has been secreted for confidentiality reasons.

The number and type of sample cases were deemed as sufficient, given that our principal objective was to capture variations in theory and concepts (Strauss, 1987) and that, as suggested by Pettigrew (1988), given the limited number of cases which can usually be studied, we looked for such cases as "extreme situations and polar types", representing both important similarities and differences for the data analysis.

Moving to the methodology for developing our AHP framework, we based on the theoretical instructions included in the relevant literature (Saaty, 1980). Basing on a relevant example of the application of AHP by Rangone (1996), the AHP includes the following specific four steps:

1. develop a hierarchical structure of the decision problem, from the identification of the overall objective (level 1), to the evaluation criteria (level 2), to the sub-criteria (level 3) and to decision alternatives (level 4);
2. determine, through pairwise comparisons, the relative priorities of criteria and sub-criteria so that it is possible to define their significance with respect to each factor at the higher level;
3. assign, through pairwise comparisons, the ranking of the decision alternatives with respect to each sub-criterion;
4. compute the overall ranking of the decision alternatives, weighting the previously assigned rankings with the relative priorities of criteria and sub-criteria.

The first step was carried out through the methodology of the focus groups (Krueger, 2009; Dey et al., 2009), which allowed confirming the overall objective, criteria and sub-criteria by merging the metrics the researchers derived from the literature (i.e. from Bentur, 2000; Sharma et al, 2008; Ryu, 2009) with the features of the investigated context. In this way it was possible to refine the literature indications, better shaping the structure of the AHP framework. The focus group was conducted involving the Directors of the Pharmaceutical Services, all of them experienced in the studied sector.

The second step was conducted through a further focus group, with the same participants and methodologies as above. Participants were asked to provide a pairwise comparison of the criteria and sub-criteria in each level of the hierarchy, basing on Saaty's scale (1980), and a consensus was reached after discussions among group members – avoiding thus the typical subjectivity of personal evaluations of single individuals.

The third step was carried out asking performance data against each sub-criteria of the AHP (see Table 2) and LHA professionals were required to align the provided data to the precise specifications of each sub-criterion. All numerical and qualitative data had to refer to 2010 (this choice was driven by the fact that 2010 was the last year with complete available data from LHAs, before a reform on the LHA administration process introduced by the Lombardy Region took place in 2011. Full data referring to the changed administration process were not available at the time of this research).

If discrepancies or misalignment were detected, researchers resolved them through a recalling of the participants. Researchers then assessed each LHA with respect to the sub-criteria through pair-wise comparisons, relying again on Saaty's scale (1980). In order to ensure reliability and to avoid the introduction of personal bias in the pairwise comparisons, two researchers separately conducted the comparisons and the outcomes were averaged by a third independent researcher. In this way, we ensured the maximum effectiveness to the mediating role of researches for avoiding subjectivity in evaluations.

For the computational tasks, we relied on the decision support tool Super Decisions™ 2.2.6 (by Creative Decision foundation). This software package, adopting an Eigen value approach to the pair-wise comparisons (Vaidya and Kumar, 2006), performs a series of computations based on matrix calculation and arrays. Calculations get the input from the pairwise comparisons between couples of variables recorded by the user. In this way, it was possible to obtain a numerical outcome for the evaluation of each LHA. Bearing in mind that the results are influenced also by a subjective evaluation of the weights of the criteria and sub-criteria, we performed a sensitivity analysis, aimed at evaluating the impact on the overall outcomes of the variation of the weights of the criteria and the relevant sub-criteria. A series of additional interviews with the professionals involved in the focus groups helped in identifying the factors to be studied in the sensitivity analysis.

Numerical results were shared in a third focus group, with the same participants and methodologies as above, finalized to build a consensus around the outcomes and to discuss the obtained results through the acquisition of further information from participants.

Table 2. Features of the LHAs sample (Year 2010)
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5. Applying the AHP framework to the Lombard LHAs

In the present section we report the application of the devised AHP framework to the sample of Lombard LHAs in particular for what concerns the distribution of absorbent device for incontinence. Through the focus groups we defined the overall objectives, criteria and sub-criteria for determining the structure of the framework (Figure 1):

- the overall objective: the performance of the LHAs' model for distributing the absorbent devices for incontinence at a local level;
- the criteria: Operational Efficiency and Service Quality;
- the sub-criteria.
  For Operational Efficiency:
  - delivery cost;
  - inventory carrying cost;
  - product unit cost;
  - service provision cost.

  For Service Quality:
  - consulting and training;
  - delivery batch size;
  - product range;
  - service accessibility.

  Being the sub-criteria the actual elements for evaluating the performance of the distribution models of the different LHAs, a series of proxies for retrieving data (Dey et al., 2008) for assessing each LHA against each sub-criterion were defined (Table 3).
- the alternatives: the five sample LHAs

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Figure 1. The structure of the developed AHP framework

Table 3. Details of the sub-criteria
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We then determined, through pairwise comparisons, the relative priorities of criteria and sub-criteria. The results of this step are included in Table 4, where we reported the numerical outcomes we obtained through the software (Super Decisions^{TM}). The Consistency Ratio for each group of pairwise comparisons was lower than 0.1 (the threshold validity value indicated by Saaty).

Table 4. Priorities and the weights of criteria and sub-criteria

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The following steps were to assign (through pairwise comparisons) the ranking of the decision alternatives with respect to each sub-criterion and to compute the overall ranking of the decision alternatives. Also in this case, the obtained Consistency Ratio for each group of pairwise comparisons was lower than 0.1. The final outcome of the AHP framework, obtained through the software, is reported in Table 5, along with a graphical representation (Figure 2).

Table 5. Complete pairwise chart with synthesized rankings

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Figure 2. Graphical representation (bar chart) of the results of the application of the AHP framework

The last step of our process was represented by a sensitivity analysis, performed on the variation of the weights of four key dimensions identified by the professionals' panel. These dimensions included the weights of both criteria and sub-criteria and can affect the robustness of results: Service Quality and Operational Efficiency, Product Unit Cost, Service Accessibility, Product range. The single-variate sensitivity analysis showed the following results, which are also graphically reported in Figure 3:

- Service Quality and Operational Efficiency (Figure 3-a): for values of the weight of Service Quality equal or higher than 95% (+29% from the original weight) LHAs A, D and E obtain the same priority. In fact, when Service Quality comes as the unique criterion, the three mentioned LHAs are equally performing with respect to all sub-criteria. *Vice-versa*, when the weight of Operational Efficiency turns equal or higher than 76% (+43% from the original weight) LHA B becomes preferable than LHA C, due to its performance with respect to the Product Unit Cost sub-criterion. For the same reason, for values of the weight equal or higher than 90% (+56% from the original weight) LHA B becomes preferable than LHA A and E and, as an extreme situation, for values of its weight equal or higher than 95% (+61% from the original weight) LHA B becomes the most preferable alternative. This happens when the Operational Efficiency cost becomes the only criterion driving the assessment and, among its sub-criteria, it is deeply influenced by the Product Unit Cost.
- Product Unit Cost (Figure 3-b): negative variations of its weight do not produce any change in the alternatives' ranking. For values of its weight equal or higher than 82% (+33% from the original weight), LHA C becomes preferable than LHA A and E, while for values equal or higher than 83.5% (+34.5% from the original weight) LHA C becomes the most preferable alternative. For values equal or higher than 90% (+41% from the original weight) LHA B becomes the most preferable alternative.
- Product range (Figure 3-c): negative variations of the weight of this sub-criterion do not produce changes in the ranking but tend to equalize the alternatives. Likewise positive variations do not modify the ranking and tend to exacerbate the preferability of LHAs D, A and E.
- Service Accessibility (Figure 3-d): negative variations of its weight do not influence the overall ranking. For values equal or higher than 57.5% (+28.5% from the original weight) LHA C becomes preferable than LHA A and E, while for values equal or higher than 58.5% LHA C becomes the most preferable alternative. For values equal or higher than 88% (+59% from the original weight) LHA B becomes the most preferable alternative.

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Figure 3. Graphical representation (line-markers chart) of the results of the sensitivity analysis

6. Discussion of the results

Prior to the discussion of the results of our analysis, it is worth commenting on the weight assigned to the different criteria and sub-criteria. With respect to the criteria, being the distribution of absorbent devices to patients a critical service for healing chronic diseases, it is necessary to ensure high levels of service quality, but without neglecting the optimization of the operational efficiency and the consequent cost compression. This is compliant with the general guidelines issued by the Regional Government. With respect to the sub-criteria, the highest weights were attributed to Product Unit Cost and Delivery Cost, since they represent, according also to the data provided by the LHAs, the two most relevant cost items in a typical LHA's balance sheet and thus their role should be emphasized. Therefore, the weights of the Service

Quality sub-criteria were more uniformly distributed, with Product range and Service accessibility judged as the most relevant factors.
Besides being realistic, the assigned weights make the outcomes robust, as indicated by our sensitivity analysis. In fact, there needs to introduce major variations in the weight of the criteria and sub-criteria for producing changes in the ranking of the alternatives (i.e. at least +28.5% - with respect to the Service Accessibility). A major variation that could be theoretically taken into account is represented by a shift from a Service Quality orientation towards Operational Efficiency, i.e. reversing the current weight of the criteria. This, however, would mean that the Service Quality issues are almost neglected and for a social utility service such as the one studied in this research, it appears to be unlikely.
Moving now to the discussion of the results, Table 4 leads to the identification of the most preferable alternative (LHA D), of two second-best alternatives (LHA A and LHA E), an alternative ranked as fourth (LHA C) and the least preferable alternative (LHA B).
Besides drawing the ranking of preferences, another immediate highlight clearly emerges from Table 4: the presence of two clusters of LHAs. A first cluster (LHA A, LHA D and LHA E) includes synthesized priorities higher than 0.2, and a second cluster (LHA B and LHA C) which includes synthesized priorities lower than 0.2.
By way of the focus group, we were able to derive some interesting insights on this peculiar result: the first cluster groups all the LHAs delivering the absorbent devices to patients through the distribution channel of the traditional territorial pharmacies. The second cluster instead includes LHA B, which adopted a distribution model based on the home delivery of absorbent devices to patients and LHA C which adopted a "hybrid" approach consisting of home deliveries along with the possibility to deliver also products through the distribution channel of the pharmacies.
In order to appreciate the reasons underlying to the ranking of the alternatives and to the generation of the clusters, it is necessary to analyze the performance of the different LHAs with respect to each sub-criteria.
With respect to the "Product Unit Cost", it emerges that LHA B is characterized by the highest level of preferability. The explanation of this results lies in the fact that in the home delivery of absorbent devices the purchase of products is not mediated by the presence of the pharmacist (as for LHA A, D and E) and thus this represents a sort of "short distribution channel", able to keep as low as possible the cost for purchasing one unit of absorbent devices. LHA C, having adopted the "hybrid" model, is able to compensate the higher unit cost due to the distribution through pharmacies by means of the home delivery (where applicable). The outstanding result for LHA B is even able to make LHA B become the most preferable alternative when the analyzed sub-criterion assumes values equal or higher than 90% (+41% from the original weight).
The "Delivery Cost" presents interesting and apparently controversial results: it appears to be better for those LHAs having adopted a traditional distribution model through pharmacies. Surprisingly, on the one hand, since general literature on distribution systems reports examples of optimized home delivery processes, producing substantial cost savings (see Agatz et al., 2008). This applies for the distribution of generic consumer products, groceries and parcels, where adequate shipment volumes, delivery frequencies and uniform geographical dispersion of customers allow for optimizing the loading capacity of vehicles and the routing activities. However, the distribution of healthcare technologies to patients characterized by specific diseases and which constitute a small sample of the entire population (such as the "customers" of the absorbent devices for incontinence) encompasses different implications (Table 6).

Table 6. Features of the LHAs' operating context and distribution practices.
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By analyzing the data provided by the LHAs, it emerges that the average delivery cost is higher for those LHAs having to reach patients at their domicile. In challenging distribution contexts such as the ones characterized by the prevalence of mountainous morphologies or where the distribution density is low, the cost per delivery can be very high. This is the case of LHA E, which in fact adopted a distribution model based on pharmacies relying on the network or pharmaceuticals wholesalers and distributors. The cost incurred by the patients/caregivers to reach the delivery points is reasonably low due to the capillarity of the pharmacies' retail network. LHA B, even if having a limited territorial surface and good infrastructures, has a low distribution density, so that the impact of operating in a challenging distribution environment made home deliveries costly. On a similar note, LHA C is characterized by a very high distribution density but in a very strongly urbanized territory, traffic congestion and difficulties in parking vehicles as well as the need to deliver products in multi-storey buildings entail a relevant rise of the delivery cost. For this reason, LHA C adopted a hybrid model,

exploiting the distribution through the channel of pharmacies in those areas where the extremely high urbanization and the traffic congestion would excessively increase the delivery cost.
Taking into account the Service Provision Cost, it is possible to highlight the poor performance of LHA B: this is because the need for coordinating and organizing the home delivery service requires LHA B to employ more personnel than the LHAs leaving to the pharmacies the responsibility to make the product available to patients. This kind of coordination and organization costs are often "hidden" for the LHAs, since they can be difficult to be precisely quantified due to the fact that personnel is often internal to the LHAs and not externally hired for that purpose. Interestingly, LHA D, even if adopting a distribution through pharmacies model, is performing worse than the other LHAs adopting the same model. This is due by the fact that LHA D completely outsourced to an external logistics service provider the management of its warehouse and inventory. This requires the need for additional personnel for coordinating the relationship with the outsourcer and for a pharmacist hired by the LHA in charge of certifying the quality of the shipments outgoing from the outsourced warehouse.
On the other hand, the complete logistics outsourcing helped LHA D to enhance the management of its inventory. This is the reason underpinning its outstanding performance with respect to the "Inventory Carrying Cost". However, for values of the weight of the Service Quality criterion equal or higher than 95% (+29% from the original weight) all the LHAs having adopted the distribution through pharmacies model obtain the same priority. In fact, when the Service Quality comes as the unique criterion, the optimization solution for the stock management put into action by LHA D with its logistics provider loses its influence. In general, LHAs having adopted the distribution through pharmacies are able to compress the annual inventory carrying cost and the purchasing cost since the ordered quantities and the stock levels are generally lower. In fact, the reorders of products to be delivered or kept in stock are driven by the actual demand of patients/caregiver reaching pharmacies (a sort of "pull approach") while for the home deliveries the reorders and thus the amount of products purchased and present in the distribution network are dependent on the estimated monthly or quarterly demand of patients (a sort of "push approach") and consequently they are usually overestimated.
This considerably affects also the "Delivery Batch Size". In fact, while the distribution through pharmacies implies that the patient/caregiver withdraws the amount of absorbent devices compliant with the actual needs, the home delivery system implies that the amount of products received at the patient's domicile is based on the estimated consumption between two deliveries (usually monthly or quarterly). Due to this, the patient is forced to build a large stock of a very bulk product at the domicile (with drawbacks especially when storing products at home is critical, as for the urban centres).
"Consulting and Training" is a service quality feature that is rarely offered when home deliveries are organized by LHAs, since a distributor (and not a clinical professional) is in charge of the physical distribution of products to patients, except for cases where special absorbent devices require a particular training for their usage. Diversely, the pharmacist is able to offer an immediate specialized counseling service for patients/caregivers reaching the pharmacy.
Similarly, the possibility to directly deal with the pharmacist and the terms of contract for the service provision usually enable patients to make their choice within a "Product Range". The home delivery model, on the contrary, is generally based on a public tender, which encompasses terms of contract so that patients are restricted to a limited variety of products.
Finally, "Service accessibility" is outstanding for the home delivery models. In fact, even if the capillarity of the network of pharmacies is able to guarantee remarkable levels of accessibility for patients/caregivers, with the home delivery system it is the product that reaches the patients and this, of course, represents a key elements for the convenience of a social utility service.
Summarizing the analysis, it appears that the overall performance of the LHAs having adopted a model for the distribution of incontinence aids based on the traditional pharmacies distribution channel is better than the performance of LHAs basing their distribution practices on the home delivery model. This can be ascribed to the fact that the peculiarities of the distribution context for absorbent devices tends to lower the degree of optimization of the deliveries that usually distributors can attain when they plan the home deliveries of generic products, with a consequent increase of the Delivery Cost. This drawback negatively compensates the advantage that the home delivery model presents with respect to the Product Unit Cost, compared to the distribution though pharmacies, thanks to a non-intermediated channel. On the other hand, the distribution through pharmacies is well performing as per Service Quality issues, thanks to the presence of specialized personnel and to a higher degree of flexibility and consistency with the patients' actual needs.
It is important to consider that, in our research, we didn't take into consideration the possible correlations between poor performances or inefficiencies within the studied sample and poor management or human related factors. This is due to the fact that the LHAs included in the sample refer to the Lombardy Region Healthcare Service and this implies that the regulation governing policies, organizational features and spending allocation rules are consistent across the sample.

Moreover, even though the set of staff members operating in a LHA and involved in the process of the distribution of incontinence devices might be heterogeneous, the professional profile, the expertise and the educational level of the staff members involved in the considered process are very similar among LHAs. For these reasons we have considered the distribution model adopted by each LHA as the main underlying driver that could cause a significant difference in terms of performance. Starting from these considerations our focus has been consistently placed on two main categories of drivers connected to the distribution of incontinence devices (operational efficiency and service quality).

7. Towards enhanced models for the local distribution of health technologies

The developed AHP framework allowed producing a meaningful assessment of the delivery practices adopted by the LHAs included in the sample for distributing the absorbent devices for incontinence to patients. In doing this, it was furthermore possible to depict the peculiar features of the different distribution models implemented by the five LHAs, putting to the fore some major strengths and pitfalls.

The outcomes of the application of the developed AHP framework allow for deriving a series of prescriptions for the design of appropriate distribution models for the health technologies at a local level.

A first comment that can be considered as a prescription is represented by the fact that, to the best of authors' knowledge and according to the obtained results, an ideal "one-size-fits-all" distribution model cannot be proposed. Our analysis allowed for unveiling that approaches explicitly designed for striving towards optimization and cost compression through the standardization of processes (such as the home deliveries) are not always able to provide savings in all contexts. They are more costly compared to other models, and ensure a lower Service Quality especially in terms of compliance to the patients' actual needs. Our analysis showed also that a complete logistics outsourcing must compensate the additional costs arising from the need to manage the relationship with the logistics provider and of the certification of the deliveries by the LHA pharmacist through an increase of the inventory control performance. Thus, a "Total Landed Cost" perspective must be adopted when assessing and designing a distribution model for health technologies, avoiding product unit cost to be the only driving element.

We gained interesting insights from a Service Quality perspective as well. Striving towards Service Quality excellence often means that flexibility and accessibility should be the leading factors in the design process. These drivers should be kept into account without losing the focus on Operational Efficiency and without forgetting the convenience for patients: great accessibility with large delivery batch sizes can make convenience fall and inventory carrying costs rise, as well as the presence of a vast product range must be contemplated only whether respondent to patients' need.

The studied cases, even if focused on the distribution of absorbent devices for incontinence, allowed extracting some insights that clearly have general validity and that, according to the performed analysis, not always are envisaged in the design of distribution models. Driving elements to be kept into account are:

- Geographical morphology: mountainous territories or extremely urbanized areas can generate additional costs for performing home deliveries.
- Quality of infrastructures: the higher the quality level, the greater the probability of attaining excellent levels of efficiency in the distribution process.
- Distribution density: the higher the distribution density, the greater the opportunity for optimizing the loading factor of vehicles and the routing of deliveries.
- Urban and social features: the map of the urban centres, the typologies of buildings as well as the habits and lifestyles of the local population should be kept into account for finding the most proper way of serving patients.
- Epidemiology: the number of patients to be served, their geographical location and their pathologies along with the level of clinical criticality drive the choices regarding the possibility to perform customized or standardized deliveries.
- Central role of the patients in the design of processes: the actual demand of patients, the timing of deliveries, the presence of a caregiver, the possibility of the patient to reach the delivery points must be leading elements in determining the most suitable distribution model.

8. Conclusions and further research

In the present paper we addressed one of the most topical issues on the current evolution of healthcare processes management: the shift of the healthcare focus from the hospital towards the local and domicile levels. This process entails the need for an appropriate logistics system able to support efficient and effective distribution of health technologies to

patients. It is essential that suitable measurement frameworks are available to provide the indispensable information for driving the choices for designing distribution models.
Given the lack of prior research on the considered subject, this paper provides readers with a twofold contribution: first, moving from the literature we developed a benchmarking framework based on AHP for measuring the performance of the models for distributing absorbent devices for incontinence and, second, we applied it to the context of Lombard LHAs within the Italian NHS. In this way we provided an answer to the research questions of our study, i.e. the development of a performance measurement framework and the generation of prescriptions for the design of appropriate and optimal approaches to the distribution of health technologies.
As a first achieved result to be mentioned, our analysis showed that a distribution model with a "general validity" cannot be proposed. On the contrary there is a need to keep into account a series of design factors which can deeply affect the Operational Efficiency/Service Quality performance and to adopt a Total Landed Cost approach for the evaluation/design of distribution models. A second relevant outcome of the performed study is that not always the choice of distribution models intended to strive towards process standardization and operational efficiency through cost saving (e.g. home delivery) is able to grant savings and adequate levels of service. In fact our analysis showed that the home delivery is not able to perform as best distribution model in every potential operating context.
The achieved results have both theoretical and practical implications. From a theoretical viewpoint, this paper fills a significant gap in the current body of literature, since it offers an innovative benchmarking study in healthcare with a particular focus on healthcare logistics, studying a novel and topical aspect of healthcare and thus proposing advancements on theory. Furthermore, the developed AHP framework is based on criteria and sub-criteria that can easily apply to the distribution of other health technologies. From a practical viewpoint, our study offers to managers and decision makers of LHAs an innovative approach to the design of the distribution models for absorbent devices. Moreover, it provides a useful scorecard for performing a benchmarking activity so that LHAs can assess their competitive position and evaluate the consistency and compliance of their current distribution models with the actual requirements of the operating context. Finally, our study provides policy makers of NHSs with a picture for developing regulations able to foster a comprehensive view of the critical success factors for an optimal health technologies distribution at a local level (e.g. Total Landed Cost).
The research presented in this paper has some limitations: even though the developed AHP framework is based on assumptions that, as mentioned, can have a general validity, the outcomes of its application and the generated prescriptions are dependent on the body of norms that regulates the distribution processes and the roles, responsibilities and cost allocation for the parties included in the delivery of health technologies. Another limit is represented by the number of LHAs included in the study: even though they adequately represent the variety of features of the overall context under study, it would be interesting to expand the sample in search for even different approaches to the distribution of health technologies to be assessed, with the aim to further broaden the scope of the generated prescriptions.
Additional directions for further research could be represented by the periodical review of the obtained results over time and by specific analysis of the distribution processes of other health technologies, with particular respect to pharmaceuticals or products having special requirements in terms of storage, transportation and service quality.
Finally, through an appropriate expansion of the sample, a further research development could be represented by the analysis of the impact of management and human related factors on the overall performance of the models for distributing health technologies.

9. References

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