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Applying Lean Management in a Hospital Purchasing Process: A Case Study

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Abstract

Health care systems are generating costs above reasonable limits. Assuring high service levels, especially in remote zones, leads to even higher costs. Based on a lean approach, this research aims at identifying if lean management can be used on more uncertain environments and developing a proposal for a more efficient and effective hospital purchasing process. A case study of a public hospital in a remote European area with high levels of demand uncertainty is used. The most common purchasing process is mapped and analysed, and waste is identified. Conclusions show that it is possible to use lean management in more uncertain environments as long as backup solutions are in place and that it is possible to reduce the purchasing process time by more than 98 per cent. A new overall organizing model for the analysed purchasing option is presented.

Keywords: lean management, process activity mapping, hospital, process, services.

1 Introduction

The public sector is becoming a research focus and hospitals in particular have been the target of much of this effort (see, for instance, Mutter *et al.*, (2010) or Werner *et al.*, (2011)). Although cost reduction has already been analysed (see, for instance, Chandra *et al.*, (2011)), it has been usually approached from the perspective of efficiency of employees or even the management of flows (see, for instance, Hanne *et al.*, (2009)). Not much research has been performed in terms of purchasing processes, and even less in terms of these processes in hospitals with location constraints.

The purpose of this research is to analyse the purchasing process of a public hospital with special characteristics – located in an island the middle of the Atlantic, with a very unpredictable demand level, physically distant from its suppliers, and dependent on unreliable transportation, - and identify how that process may be improved in order to increase speed and reduce cost.

Taking into consideration the purpose of this research, focussed on improving value and waste reduction, a lean approach will be used. Process activity mapping is required as it allows the analysis not only of how the purchasing process is performed, but also where wasted time emerges and may be reduced.

As the scope of the research is the purchasing process in a specific hospital, Hospital do Santo Espírito in the Azores Islands, the methodology adopted is case study research. As the topic is recent, and focussed on an isolated situation, according to Yin (2003), this is the most appropriate research methodology.

Accordingly, this article starts with a brief literature review on lean management and the identification of the research questions, as well as the propositions to be analysed. Then the article continues with a condensed description of how the Portuguese Health System works, the natural singularities of the analysed hospital, the identification of the customers of the process and what they consider value, and the mapping of the process at its present situation. The analysis of the process and of its activities in terms of the time and resources used at each step is the following objective. Lastly, alternative proposals are developed and conclusions on the research questions and the purpose are developed. Also included in the conclusions are the limitations to the results obtained as well as topics for further research.

2 Literature review

Lean Management, as initiated by Ohno (1988), identified by Schonberg (1986), and developed by Womack and Jones (2003), aims at customer value. It is focussed on what is relevant for the customer. From that point forward all efforts are made to reduce what does not contribute to this goal: waste.

Many types of waste can be found (Ohno, 1988). Effectiveness is the measure of the customer, of how his requests are fulfilled. Efficiency only emerges if resources are used in a more rational way as long as effectiveness is fulfilled.

Value is the critical point in lean thinking. Therefore, the provider can enhance value to the customers by adding features to the product or service and/or by removing wasteful activities. As value has to be defined by the customer, it cannot be seen as the opposite of waste.

Activities have to be enhanced if the cost involved is higher than the increase in value they represent, or removed if no value is produced. It means that a cost-value proposition (Hines *et al.*, 2004) should be analysed. The equilibrium represents the cost the customer is available to pay for the offering. Therefore, the higher the cost-value proposition offered the more attractive it will be to the customers.

Although with Ohno (1988), the approach was focussed on lean operations management, contemporary approaches expand the concept of Lean Thinking to several other sectors, including the services area. In fact, it can be found in more obvious areas such as supply chain management (Simonsa and Taylor, 2007), but also in services such as healthcare (Papadopoulos, *et al.*, (2011), universities (Hines and Lethbridge, 2008), logistics (Jones *et al.*, 1997), criminal investigation (Ahluwalia and Srinivasan, 2004), courts of law (Hines *et al.*, 2008), municipalities (Arlbjorn et al, 2011), or government agencies (Radnor, 2010).

Lean cannot be applied the same way in the manufacturing area and in the services area, but service companies can benefit tremendously from it (Allway and Corbett, 2002). Services natural characteristics require an adjusted attitude as referred by Johnston (2005). Nonetheless, the overall approach and goal remain the same. With the current situation of economic crisis and the need to reduce costs, going lean can emerge as an appropriate solution to keep (and even improve) effectiveness while costs are reduced.

Hospitals and health services are an area that has been explored in terms of lean management. Many recent articles (for instance, Papadopoulos, *et al.*, (2011), Stuenkel and Faulkner (2009) or Manos *et al.*, (2006)) can be found in literature on this topic. All of them focus on quite stable processes and conditions. Although a lean approach is more adjusted to stable environments (Womack and Jones, 2003), it is interesting to analyse if it principles can be used to reach more value and less waste in more uncertain healthcare processes. Accordingly, an initial research question (RQ) is as follows:

- RQ1: Is it possible to apply lean management principles in more uncertain healthcare processes?

In order to do so, a case study of a hospital in the Azores islands will be analysed – Hospital do Santo Espírito. The purchasing process will be analysed as this hospital is geographically isolated and distant from its mainland suppliers and supply is dependent on weather conditions.

If RQ1 is true, from a time perspective, and taking into consideration the purchasing process, it is also relevant to analyse the following research question:

- RQ2: Is it possible to reduce time in the purchasing process of Hospital do Santo Espírito?

3 Data and methods

As a case study approach will be used, Yin's (2003) recommendations will be followed. Initial data concerning the national purchasing system was obtained from the Portuguese laws. More detailed information on the details of the Hospital do Santo Espírito was collected from local interviews with both the Head of the Pharmaceutical Department and the Head of the Purchasing Department. Direct observation allowed verifying and adjusting the real process used by the hospital.

This research focuses on reducing time in the purchasing process. Taking this goal into consideration, according to Bicheno (2004), process activity mapping is the most appropriate lean tool to be used.

Hospital consumptions were compared and analysed. Primary data from the hospital was used. Pharmaceutical products were found to be responsible for about 70% of all hospital consumptions.

Several purchasing processes can be used, depending on the product and the specific situation. In the analysed hospital 52% of the purchasing situations were performed according to the "Competition coordinated by the Central Healthcare Administration" option. According to findings it was decided to map pharmaceutical products in a "Competition coordinated by the Central Healthcare Administration" purchasing process.

The pharmaceutical products were analysed using a Pareto Rule. The A products were selected for analysis. A random A product was selected to be the basis for information on the time spent in each activity – Tenecteplase 10000 UI AMP. Latter it was found that several products are purchased at the same time. Therefore, the time frames identified apply to the other products purchased at the same time regardless their classification as A, B, or C.

The sequence mapped starts when the information system is asked for shortages and ends when the bill from the supplier is sent to the Accounting Department.

4 Case study characterization

The analysed hospital, Hospital do Santo Espírito, is located in one of the Azores islands, "Terceira". This hospital serves patients from the island and coordinates demand from four other islands. It is also the international referred location for patients on ships and planes crossing the North Atlantic Ocean.

Demand is unstable as well as supply. Due to weather conditions the island can be isolated both by air or sea for several days during the winter.

Products are usually transported using maritime transportation. There are three companies that assure maritime transportation from the main land to the island, each with a weekly shipment. The trip takes, on average, seven days. If weather conditions are favourable it might require only 6 days.

Although the policy of the hospital is to keep inventory for three months of consumption, the variability of pathologies is such that urgent request are sometimes needed. These are usually transported by air from the main land and require about 1 day to arrive.

There are also local suppliers but these do not have the full range of supplies. Their inventory also supplies local pharmacies and health centres.

This hospital, as all other public hospitals in Portugal, does not negotiate directly with the suppliers. Although it can happen in specific situations it is not the standard procedure. Negotiations are performed by the Central Healthcare Administration and information concerning the products available and their prices is made available to all hospitals through their website. This is the reference all hospitals should follow.

5 Process mapping

5.1 Identifying the customer and value

As each process is (should be) focussed on generating value according to its customer(s), these have to be identified. It is possible to identify customers for the pharmaceutical purchasing process at several different levels. The immediate customers are the hospital departments that will use the product to provide healthcare services. These require product availability.

A second level of customers are the patients of the hospital. Their families could also be included here to some extent. Both the patients and their families require product availability. The cost variable is not included here as the Portuguese healthcare system, at the level of materials consumption during services provided by hospitals, is free of charge for the patients.

At a third and wide-ranging level, the overall population could also be considered a costumer of this process. These not only use the services, and therefore require availability and effectiveness, but also finance the system through their taxes, and therefore want the system to be as efficient as possible.

Accordingly, the purchasing process of the hospital under analysis has to generate value to different levels of customers – internal departments, patients, and the overall population. To these costumers value is not only having products available on time, but also availability in a cost-efficient way.

5.2 The purchasing process

According to the "Competition coordinated by the Central Healthcare Administration" process and the specific product selected, the sequence of mapped activities is shown in Table 1.

The process starts with a request on the information system to identify inventory levels (activity 1). The lists are then printed and manually analysed for shortages (activity 2). As activity 1 lasts for about one week, once it is produced data is no longer valid and has to be manually adjusted considering the consumption level of that week (activity 3).

Once shortages are identified, an employee accesses the Central Administration website to identify the available suppliers, the price of the product and taxes applicable (activity 4). Data collected from the website is then analysed by the head of the Pharmaceutical Department. The most suitable suppliers are chosen and a "purchasing request" produced (activity 5). This document is physically sent to the Purchasing Department (activity 6) and the employee returns with a copy of the document stating that it was delivered. The employee of the Purchasing Department registers the document entry (activity 7).

Some of the suppliers have local representatives. When it happens, that information is added to the "purchasing request" at the Purchasing Department.

When all previous activities are fulfilled, the Purchasing Department employee adjusts the "purchasing request" with additional data on the supplier (activity 8) – location, fax number, unitary dose, etc.. Once these activities are concluded, the document waits for its data to be introduction on the Purchasing Department information system.

The "purchasing request" information is then introduced into the Purchasing Department information system (activity 9). The printed output is now the "purchasing order".

Once printed, the "purchasing order" is sent to the head of the Purchasing Department who confirms it (activity 10) after analysing the available data. Afterwards the head of the department leaves it at the meeting room (activity 11) where it waits for approval by the vice-president of the hospital (activity 14). The vice-president passes by once every two weeks to access these orders. In case of emergency situations, the "purchasing orders" are sent directly to his office for approval.

While the "purchasing orders" wait for approval, the purchasing employee prints copies (activity 12) which are sent to the Pharmaceutical Department (activity 13). These activities are performed so that in case of stock out the pharmacy will send an urgent order directly to the supplier according to the formal order.

Once authorised by the vice-president, the document is left on the purchasing employee desk (activity 15). She will then separate the sheets (activity 16), each to different purposes. Two copies are filed (activity 17), one is delivered to the Pharmaceutical Department employee (activity 19) on one of her visits to the Purchasing Department, and the other one is sent by fax to the supplier (activity 18).

The process was mapped during November. It is policy of the hospital that all orders must be placed no later than the 12th of December. Therefore all orders were announced as very urgent to the suppliers, which means that the quantity ordered should be delivered all at once.

Table 1 - Process Activity Mapping for product Tenecteplase 10000 UI AMP

N.	Activities	Type of activity	Area	Distance	Time	Useful time	Wasted time	N. persons involved	Observation
1	Concult system looking for shortages	VA	Pharm	-	17th Nov. 10:30h/ 24th Nov. 11:00h	7 days	0 min	1	
2	Identify shortages	VA	Pharm	1mt	24th Nov. 11:00h to 13:00	2 hours	0 min	7	
3	Manual adjustment of quantities	NVA	Pharm	2mt	24th Nov. 14:00h to 16:00	2 hours	0 min	1	
4	Consult Central Administration website	NVA	Pharm	-	25th Nov 9:00h to 11:00h	2 hours	1 hour	1	
5	Produce "purchasing request"	VA	Pharm	2mt	25th Nov. 14:00h/ 26th Nov. 13:55h	6 hours and 55 min	0 min	1	
6	Send "purchasing request" to Purchasing Department	NVA	Pharm	229mt	26th Nov. 13:55h (5 min)	5 min	0 min	1	Pharmacy administrative person
7	Reception of "purchasing request"	NVA	Purch	-	26th Nov. 14:00h (5 min)	5 min	0 min	2	
8	Adjust "purchasing request"	NVA	Purch	-	26th Nov. 14:30h (120 min)	2 hours	1 day and 30 min	1	
9	Introduce "purchasing request" into information system	NVA	Purch	-	28th Nov. 09:30 to 16:25h	5 hours and 55 min	1 hour	1	
10	Confirm "purchsing order"	NVA	Purch	11,1mt	02nd Dec 14:30h	2 min	4 hours and 28 min	1	Received purchasing order twice - at 9:00h and at 13:30h
11	Send "purchaing order" to meeting room	NVA	Purch	8mt	02nd Dec 16:00h	2 min	1 hour and 30 min	1	By the Purchasing Director
12	Issue list of "purchasing orders"	NVA	Purch	-	2nd Dec.16:05h (20min)	20 min	5 min	1	
13	Send list of "purchsing orders" to Pharmacy Department	NVA	Purch	229mt	3rd Dec. 10:30h	5 min	2 hours and 30 min	1	Purchasing administrative person
14	Authorize "purchasing orders"	NVA	Purch	9,5mt	09th Dec 15:30h to 16:45h	1 hour and 15 min	4 days and 4 hours	1	By the vice-president Once every 2 weeks
15	Send "purchasing orders" to purchasing area	NVA	Purch	13,2mt	9th Dec. 17:00h (15min)	15 min	15 min	1	By the Purchasing Director
16	Reception, separation and filling of "purchasing orders"	NVA	Purch	-	10th Dec 9:00h (90min.)	1 hour and 30 min	0 min	1	
17	Send copy of "purchasing orders" to archives	NVA	Purch	1mt	10th Dec. 10:30h	2 min	0 min	1	Purchasing administrative person
18	Send fax to supplier with "purchasing order"	VA	Purch	4,9mt	10th Dec 11:10h (34s)	0,5 min	40 min	1	
19	Send "sent purchasing order" to Pharmacy Department	NVA	Purch	229mt	10th Dec 15:00h	5 min	2 hours and 45 min	1	Pharmacy administrative person
20	Receive and register "sent purchasing order"	NVA	Pharm	-	11th Dec 9:30h	5 min	2 hour and 30 min	1	
21	Waiting for product reception	NVA		-	11th Dec (during the morning)	1 day and 4 hours	0 min		
22	Reception of product by the Pharmacy Department	VA	Pharm	5mt	11th Dec 14:30h	10 min	0 min	1	
23	Compare "sent purchasig order" and bill	NVA	Pharm	10mt	11th Dec 14:40h	20 min	0 min	1	
24	Intoduce "sent purchasing order" into information system	NVA	Pharm	-	15th Dec	30 min	1 day and 4 hours	1	
25	Send bill to Purchasing Department	NVA	Pharm	229mt	18th Dec 14:30h	5 min	3 days and 2 hours	1	Pharmacy administrative person
26	Separate bill and duplicates	NVA	Purch	-	4nd Jan	2 min	8 days	1	
27	Introduce bill data into information system	NVA	Purch	-	6th Jan	10 min	2 days	1	
28	Send bill to Accouting Department	NVA	Purch	283mt	7th Jan	5 min	1 day	1	Purchasing administrative person
	Total			1266,7 mt		12 days + 1 hours + 3,5 min	26 days + 7 hours + 53 min	34	
	Legend: VA - value added; NVA - non value added; Pharm - Pharmaceutical; Purch - Purchasing								

At the Pharmaceutical Department, once the “sent purchasing order” is received, it is registered and filed (activity 20). From this moment on the Pharmacy Department waits for product reception (activity 21).

Once the products arrive they are checked in terms of quantity, reference, expiry date, and size of boxes and then stored (activity 22). The bill is checked by the administrative employee in terms of price and taxes, and then stamped (activity 23). Information is also introduced into the Pharmacy Department information system (which is independent from the purchasing information system) (activity 24).

Once information is on the Pharmacy information system the bills are sent to the Purchasing Department (activity 25). Here the bill duplicates are separated (activity 26) and information introduced into the Purchasing Department information system (activity 27). Finally, an employee from the Purchasing Department sends it to the Accounting Department (activity 28).

The mapping analysis allows the identification of several types of waste. Using the waste classification in the services area by Hines and Martins (2005), the identified wastes are as follows:

- Unnecessary movement: employees keep moving between departments, carrying documents;
- Duplication: data is duplicated in independent information systems inside the same hospital; information from the "purchasing request" has to be corrected and adjusted at the Purchasing Department;
- Unclear communication: official information in the Central Administration website has to be confirmed;
- Delay: "purchasing orders" are sent to the vice-president for approval just for formality purposes; documents wait several hours, sometimes days, at desks before they are analysed.

The full process requires over 39 working days to be fulfilled. Of these, only about 12 are in fact useful time. Of these 12 days, most of the time spent involves non-value adding activities. The inventory level of the hospital has to be increased to overcome such a long lead time and space needed is higher, involving higher costs, especially if the products involve short expiry dates. These extra costs from the present process forces the hospital to reduce the value it provides for the customer instead of increasing it.

The initial problem of the pharmacy information system requiring 7 days to produce information so that the shortage list may be computed is but the waste iceberg tip. The software is out-dated and there is no other system to control entry or exit of products but manual control. In fact, although the hospital purchased barcode readers and appropriate software years ago, these are still in their original boxes.

It is also relevant to highlight that for urgent request it is often used parallel processes to speed the system and assure availability as soon as possible. Products are directly ordered by phone and later confirmed by fax. The supplier and immediately sent from the main land to the island. Only then the internal formal process is initiated (a phantom purchasing process) so that the supplier may get paid.

6 The proposals

Taking into consideration a lean approach, the waste levels, and its consequences on the value provided, tentative processes were developed. Information technology is one of the main problems in the hospital process. Its improvement is one of the baseline suggestions the proposals assume. It is also assumed that, in the future, information available in the Central Administration website is correct.

The proposals assume that delegation of decision power exist so that the processes may be faster and lead to a smaller inventory levels, reduced costs for the hospital, and more value to the customer.

It is not possible to overcome the fact that the hospital is located in the middle of the Atlantic Ocean. Products have to be shipped from the main land. Nonetheless, with better forecasts and if more information concerning the demand level is shared with suppliers, those with local representatives may receive preference due to their ability to provide shorter lead times. In fact, it is not only the cost that dictated the choice of the supplier, lead time is also a relevant criteria.

6.1 First proposal

Taking the previous topics into consideration an initial proposal was developed. It is as shown in Table 2.

According to historical data and additional adjustments from the present, a forecast is produced. According to this data and the inventory level at the moment, an information system (for instance an ERP system) would produce the shortage list and suggest the orders (activity 1). Time required for this activity and for the remaining ones results from local simulation.

Table 2 – Mapping of the first proposal to improve the process

N.	Activities	Type of activity	Area	Distance	Time	N. persons involved	Observations
1	Determine shortages and order size	VA	Pharm	-	20 min	1	
2	Consult Central Administration website	NVA	Pharm	2 mt	10 min	1	
3	Produce "purchaing request" on the information system	NVA	Pharm	2 mt	5 min	1	
4	Send "purchasing request" to Purchasing Department	NVA		-	0,5 min	1	Using *E-doclink*
5	Reception of "purchasing request" and issue "purchaing order"	NVA	Purch	-	5 min	1	
6	Send "purchaing order" to Purchaing Director for approval	NVA		-	0,5 min	1	Using *E-doclink*
7	Approval of "purchasing order" and send it to purchasing areas	NVA	Purch	-	5 min	1	Using *E-doclink*
8	Send "purchaing order" to supplier	VA	Purch	-	0,5 min	1	By *e-mail*
9	Wait for product reception	NVA			1 day and 4 hours		
10	Reception of product by the Pharmacy Department	VA	Pharm		10 min	2	
11	Compare "sent purchasig order" and bill	NVA	Pharm		20 min	2	
12	Introduce "sent purchasing order" into information system	NVA	Pharm		10 min	1	
13	System informs purchaing department						Using *E-doclink*
14	Send bill to Accouting Department	NVA	Pharm	412 mt	10 min	1	
Total				416 mt	1 day + 5 hours + 36,5 min	14	
	Legend: VA - value added; NVA - non value added; Pharm - Pharmaceutical; Purch - Purchasing						

The information system should be linked to the Central Administration website and be able to identify the proposed supplier. If several suppliers are available the Purchasing Department would have to check for specific requirements (activity 2).

Once data is reunited, the head of the Pharmaceutical Department should correct/ accept the “purchasing request” on the information system (activity 3). Once concluded, this information should immediately be sent to the Purchasing Department through the information system, even if only the present e-doclink was in use (activity 4). E-doclink is an internal communication system that is already implemented.

At the Purchasing Department the “purchasing order” should then be received and additional information of logistical nature would be added (activity 5). As the information about the suppliers should be already available in the system, this activity would require only a few minutes. A “purchasing order” would be issued and sent to the head of the Purchasing Department (activity 6) through e-doclink for approval.

Assuming that the head of the Purchasing Department would have power to approve orders directly, she would be able to evaluate and confirm it (activity 7). Then it would be sent back to the department by e-doclink and send to the supplier by e-mail (activity 8). Fax could also be used.

From this moment on the hospital would be waiting for the product (activity 9). As no other changes are considered but the ones on the hospital process, it is assumed that the delivery time remains the same.

Once the product is received it has to be checked (activity 10). If bar codes are used the technology already available at the hospital could be used. No additional costs would be required and although the time consumed in the activity could be the same, activity accuracy would improve. From this moment on

the hospital would be waiting for the product (activity 9). As no other changes are considered but the ones on the hospital process, it is assumed that the delivery time remains the same.

Once the product is received it has to be checked (activity 10). If bar codes are used the technology already available at the hospital could be used. No additional costs would be required and although the time consumed in the activity could be the same, activity accuracy would improve.

The "sent purchasing order" would then have to be compared with the bill to check for any discrepancies (activity 11) and information concerning the products received should have to be introduced into the information system (activity 12).

Information concerning the receptions of the product would automatically and immediately be sent to the Purchasing Department through the information system (activity 13). Finally, the bill would have to be physically sent to the Accounting Department (activity 14).

Comparing the present process and this proposal some differences are immediately identified:

- The number of activities is reduced by half (from 28 to 14);
- The number of times employees have to touch the process is reduced from 34 to only 14 (reduction of 59%);
- The total distance to be physically covered is reduced from 1266,7 meters to 416 meters, which represents saving of 67% in terms of distance;
- The total useful time is reduced from more than 12 days to slightly more than a day and a half (reduction of 86%);
- In the period of time waiting for the reception of the product is not considered (which, in fact, does not depend on the hospital), the time reduction is of 98%;
- If only the activities up to waiting for product reception are considered (the ones involved in placing the order), saving are of 99% of the time spent.

It should also be highlighted that of the non-value added activities involved in this proposal, almost all of them are support activities and not pure waste as in the current process described in Table 1.

6.2 Second proposal

This second proposal was developed according to a more radical approach. This proposal assumes a close relationship between the hospital and its several suppliers on a basis of a Vendor Managed Inventory (VMI) system (for further detail on VMI see, for instance, Harrison and van Hoek (2011)). Both entities (hospital and suppliers) would benefit (reduction in costs and improved service levels are the most common benefits of this arrangement) from this information sharing.

The hospital would receive an improved service level from the suppliers (increased number of on-time deliveries) and a reduced number of stock outs. This would reduce uncertainty and require lower investment in inventory. Suppliers would benefit from the fact that they would continuously receive information concerning the level of demand and the inventory level at its customer (the hospital) and would be able to adjust its own purchasing orders accordingly, allowing it to carry less inventory.

In this second scenario urgent orders could be issued according to the first proposal. In fact, there will be requests for special or urgent products as the demand level is unstable.

This second proposal would require a purchasing process as described in Table 3 - Mapping of the second proposal to improve the process

N.	Activities	Type of activity	Area	Distance	Time	N. persons involved	Obs.
1	System alerts for replacement need	VA	Pharm. and supplier	-	-	-	On the supplier
2	Wait for product reception	NVA		-	60 min	-	
3	Product reception and storage	VA	Pharm	-	15 min	1	
4	Send bill to administrative area	NVA	Pharm	412 mt	10 min	1	
Total				412 mt	85 min	2	
Legend: VA - value added; NVA - non value added; Pharm - Pharmaceutical; Purch - Purchasing							

. Estimated time for each activity results from observation at the hospital.

This proposal assumes that once a year there would be procedure according to the first proposal to establish costs, quantities, and service level. From that point forward the process in this second proposal should be in place. In fact, the moment the second proposal process is to begin would be established by the information system, on the supplier, according to a pre-defined the level of inventory.

Table 3 - Mapping of the second proposal to improve the process

N.	Activities	Type of activity	Area	Distance	Time	N. persons involved	Obs.
1	System alerts for replacement need	VA	Pharm. and supplier	-	-	-	On the supplier
2	Wait for product reception	NVA		-	60 min	-	
3	Product reception and storage	VA	Pharm	-	15 min	1	
4	Send bill to administrative area	NVA	Pharm	412 mt	10 min	1	
Total				412 mt	85 min	2	
Legend: VA - value added; NVA - non value added; Pharm - Pharmaceutical; Purch - Purchasing							

Whenever the level of inventory reaches a pre-defined limit it would issue an alert on the supplier. The alert would inform the supplier to send a specific product (or products) to the hospital and the most appropriate quantity (activity 1). After transportation (activity 2) the product is received at the hospital. Reception should be controlled by bar code readers so that the information system would immediately register all entered products (activity 3). The bill would then be sent to the administrative area (activity 4).

It would be possible that no bill was issued and only a transportation document would be sent with the products as an arrangement between the hospital and the supplier could establish, for instance, a monthly payment of the level of consumption or deliveries.

Comparing this second proposal with the present situation, some improvements are to be emphasised:

- Only once a year the purchasing process from the first proposal would take place per product (a process with 14 activities) instead of a continuous process of 28 activities every time the product is required. Replenishment of the inventory level would require a 4 step process for the hospital and almost no effort. This would represent a reduction of 86% in the number of activities;
- The number of times employees would have to interfere in the process is reduced from 34 (in the present process) to 2 (in the second proposal), which represents savings of 94%;
- The distance covered inside the hospital during the process is reduced from 1266.7 meters to 412 meters, which represents savings of 67%;
- The total useful time required was reduced from more than 12 days to only 85 minutes. This represents a reduction of 99% of the total useful time;
- If only the activities up to waiting for product reception are considered, time saving is infinite;

- If the time waiting for the reception of the products is not considered, time savings are from over 10 days to only 25 minutes, which represents a reduction of 99,5%.

7 Conclusion

This research showed that it is possible to apply the main concepts of lean management in more unstable healthcare processes, even though the level of uncertainty in the specific case study is higher than usual in lean processes. This way it is possible to affirmatively answer to RQ1.

The present purchasing process of Hospital do Santo Espírito was mapped. Proposals show a probable reduction in terms of useful time of up to 99%. This way it is possible to affirmatively answer to RQ2.

It was not possible to implement the proposals, but these were based on reasonable assumptions and simulated activity time. This way the purpose of this research is considered as fulfilled.

As this research focuses a single case study findings cannot be generalised (Yin, 2003). Nonetheless, several Portuguese hospitals use similar purchasing processes that might be improved through benchmarking. This way, the development of an overall purchasing model that could be used as a basis for every hospital and then receive minor adjustments to be able to fulfil specific requirements is set here as a topic for further research.

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