INNOVATION IN HOSPITALS: AN E-PROCUREMENT MODEL IN PHARMACY OPERATIONS IN DAY SURGERY

Piera Centobelli[(a)], Giuseppe Converso[(b)], Antonio De Iasi [(c)], Teresa Murino[(d)]

[(a),(b),(c),(d)] D.I.C.Ma.P.I. - Department of Chemical, Materials and Industrial Production Engineering, University of Naples Federico II, P.le Tecchio, 80 – 80125 - Naples - Italy

[(a)]piera.centobelli@unina.it, [(b)]giuseppe.converso@unina.it, [(c)]antonio.deiasi@gmail.com, [(d)]murino@unina.it

ABSTRACT

The relationship between pharmaceutical companies and hospitals is one of the most important key factors in healthcare system. Hospitals are complex organizational structures that can be improved in order to reduce wastes from both the economic point of view and the resources employed. This leads to a progressive modification of their commercial and technological relationships with pharmaceutical companies. This paper analyses the introduction of e-collaboration models for the supply relationship between hospitals and pharmaceutical companies and presents a new and more streamlined materials purchase procedure based on e-commerce. In order to verify the real benefits and analyze the peculiarities of this approach a simulation model using the System Dynamics has been implemented.

Keywords: lean healthcare, e-procurement, e-sourcing, e-supply chain collaboration

1. INTRODUCTION

The main problems of health organizations are bad resources allocation, inefficiency and consequently growing costs. The work presented aims to analyze interconnection between different departments trying to improve information flow through the introduction the of e-procurement innovative technology, a web-based platform used for the regulation of materials and services supply. This technology should ensure the reduction of patients' queues, bad resources allocation and subsequent wastes which inevitably increase the total management cost.

In recent years the trend is to manage hospitals as companies, the organization structure passes from a functional structure to a structure focused on processes.

The new healthcare-company concept is based on the unending search for processes improvement and quality control; recently Lean thinking concepts are being applied to healthcare facilities (Habidin, Shazali, Ali, Khaidir, and Jamaludin 2014; Curatolo, Lamouri, Huet, and Rieutord 2014; Bhat, Gijo, and Jnanesh 2014) focused on flows management to reduce deviations and inefficiencies and finally to improve quality of medical treatments.

In order to improve the Day Surgery (DS) process the innovative technology of e-procurement has been identified. The Day Surgery is considered a solution to the problem of a lack of beds in hospitals, queue management and economic resources waste. Past researches have highlighted the economic benefit to perform some operation in DS than the traditional method (Broekelmann 2006).

As regards the e-procurement, there are many authors who have based their studies on the evolution of web-based systems and e-collaboration solutions with a focus on growth, development and expected trends related to implementing e-procurement. In 2002 Rangone and Balocco classify B2B applications focusing in particular on different tools and interactions provided.

The paper is organized into 2 main sections. The first is an analytical section which has the purpose to analyze the context and the new trends in the field of economic management, i.e. waste reduction, improvement of organizations and introduction of innovative models in healthcare organizations thanks to the development of new information technologies. In the second part a simulation models shows improvements achievable thanks to the introduction of new e-procurement tool. The case study has been provided for central pharmacy at CARDARELLI hospital in Naples.

2. PURCHASING FUNCTION TRANSFORMATION: E-BUSINESS

The introduction of new technological solutions involves both organisational changes and processes reengineering. The B2B tools implementation in companies allows management to pay more attention to activities with higher added value and strategic value. Therefore, the activities of the purchasing function are modified: as a result of increased access to information and the automation of order management, on the one hand greater control, speed and time available for tactical and strategic activities is achieved; on the other hand increases the dissemination of knowledge and purchasing activities carried out independently by other functions within the organization.

One of the consequences is the apparent loss of ' power ' of the Purchasing Department, as it is no longer the only depository of information on contracts, pricing, catalogs and suppliers on the market.

The traditional purchase method changes from centralized to decentralized. This change is a function of the intensity with which the company pursues its buy strategy based on the electronic market.

The production process and effects resulting by the use of certain materials rather than other continues to be important; in this sense the sourcing approach will be strategic in order to manage the most critical direct materials in an appropriate way.

Talking about B2B trading, should be taken into account its application along the logistics chain in two opposite directions: both from customer (downstream, also known as E-commerce) and seller (upstream, where it is known as E-procurement) point of view (Figure 1).

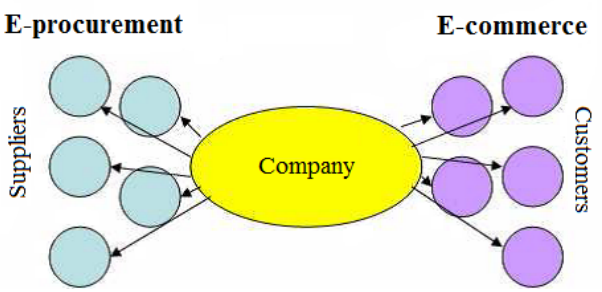

Figure 1: e-business in supply chain

The main aim of e-business, both upstream and downstream in supply chain, is to manage the business transactions in a better way than in the past. This is achieved by exploiting different strategies such as:

- Customized marketing strategy in real time;
- Increase in products and services supply;
- Number of customers reached increased.

The electronic marketplace is the place where online commerce takes place, the so-called e-marketplace is the meeting point between demand and supply on the internet and acts as a connecting point between customers and suppliers.

2.1. Implementation of E-procurement in companies

The buying process is vital for every organization; from this process depends success, customer satisfaction and good cost management. Good management of the supply network and the sales process and customer management are the most important goals compared to only attempt to maximize corporate profit; however it's necessary to understand that an excellent supply chain network and demand process management leads to a growth of corporate profit. The purchase process, such as customer management, has been influenced by new information technologies and in particular by the e-economy.

With the introduction of e-Procurement the procurement process is managed online; for this purpose companies use B2B platforms: this tool allows to reduce costs and time of the procurement process, improves warehouse management, inventory levels and the management of all business processes.

This is a necessary solution both for large companies, since it makes easier manage the entire process of purchasing and supply's growing network, and small companies that, adopting e-procurement solutions, take part of a global system with numerous business opportunities. In order to do this the must invest in two basic elements: an electronic catalogue and online payment procedure.

The e-Procurement process implementation involves several steps:

- the first step is to analyze business processes and understand which should be outsourced ("make or buy" policy). Purchase process and suppliers network management should be managed by qualified e-procurement platforms;
- the second step involves the identification of supplier network through an accurate supplier selection process;
- the third step is the definition of laws to be applied at supplier network, as well as suppliers classification and clustering;
- Finally considerations should be done about purchasing policy.

The whole process of e-Procurement is divided into two phases (Figure 2): the e-Sourcing phase (in which define technical and economical products specifications, send request for quotation to suppliers, collect and select best quotations) and the e-Supply Chain Management (in which the order is issued, supplier sends the merchandise that is checked and payment is processed).

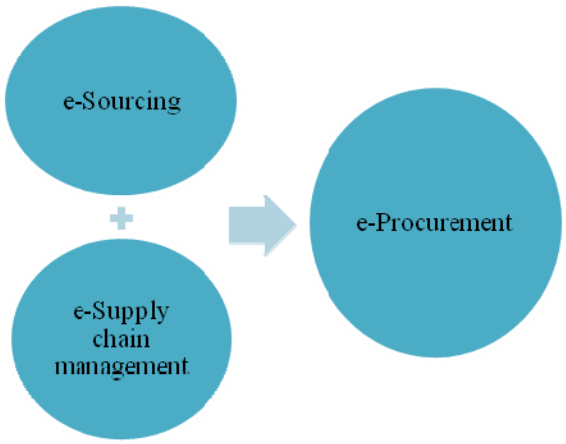

Figure 2: e-Procurement

3. E-SUPPLY CHAIN

The term e-Supply Chain is used to define a logistic chain managed in an integrated way thanks to new technological solutions; the effect is the processes and objectives planning with a view to business ethics in an integrated and sharing information way that involves the entire supply chain.

To understand in detail the features of e-Supply Chain, it's necessary analyze two aspects:

- The analysis of processes involved by new technologies (e-Supply Chain Execution and e-Supply Chain Collaboration);
- Company strategies for new technologies implementation.

As regards the first aspect, we can talk, as mentioned above, two types of processes:

- Operational processes (e-Supply Chain Execution): related to the order-delivery-invoice cycle and pre-sale and post-sale processes with the aim to make automated and integrated interface phases in supply chain logistics;
- Collaborative processes (e-Supply Chain Execution): related to planning processes (demand forecasting, inventory management, monitoring and control) as well as new product development and quality management, with the aim to improve the processes efficiency through the know-how sharing.

As regard the analysis of technological solutions, two choices are available:

- EDI (Electronic Data Interchange) solutions: allow data interchange of data between information systems, through a dedicated channel and in a specific format, they are designed ad hoc for company at issue and for the specific data to be exchanged;
- Internet EDI solutions: are more flexible than the previous one because they use internet for information exchange.

3.1. E-supply chain Execution

The e-Supply Chain Collaboration basic stages are summarized in the figure below (Figure 3).

In each stages considered e-SC Execution considers the use of a specific tool. The benefits of e-solutions SC Execution implementation are:

- the chance to reduce operating costs of all interface activities between customer and supplier;
- the chance to improve the service level due to delivery times reduction and to greater accuracy spent in processes management.

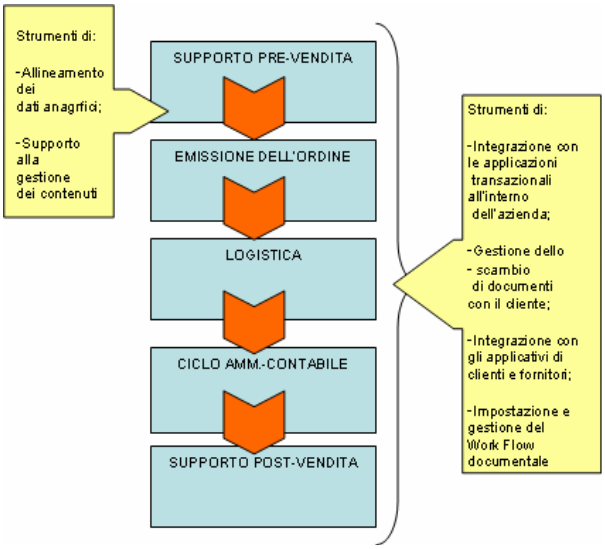

Figure 3: e-Supply chain Execution

3.2. E-supply chain Collaboration

The basic stages of e-Supply Chain Collaboration can be found in the following:

- Supply Chain monitoring and control: involves information sharing (e.g. data sales and availability of production capacity), definition of performance evaluation metrics and the report of critical issues along the supply chain (e.g. stock-out);
- Collaborative management of planning activities: i.e. collaborative demand forecasting, promotions planning and inventory management. It is the application of Collaborative Planning Forecasting and Replenishment (CPFR) model;
- Collaborative management of new product development: provides the sharing of technical documents and project work-flow;
- Collaborative management of marketing communication strategies: involves the collaboration in research and development division as well as the customer relationship management.

An e-Supply Chain Collaboration implementation allows to manage in an integrated way all the phases just highlighted providing significant benefits.

3.3. The benefits and barriers to development

Despite the benefits of collaborative solutions there are numerous barriers that prevent the e-Supply Chain Collaboration. e-Supply Chain Collaboration implementation benefits are longterm effects, arising from difficulties in create, understand and manage the relationship network along the supply chain. Another obstacle is related to the problem of translating the e-collaboration objectives in real company goals that may justify the investment in new technologies.

Furthermore management cultural barriers to change represents an obstacle to innovation.

Benefits are difficult to detect, i.e. is complicated to measures results as the growth of service level. In this paper the main benefits of this solution are highlighted: efficient and effective information management and material flows optimization along the supply chain.

4. THE SIMULATION MODEL

The presented model simulates the evolution of hospital warehouse starting from order emission to the central pharmacy (main warehouse), until required materials arrival. The simulation will follow two phases:

- Definition of time needed for the development of procurement processes and their variability and introduction of events chain in order to obtain a virtual warehouse.
- Quantification of inventory and penalties costs due to a possible stock-out.

Two simulation models have been realized to reproduce the phases descripted above.

In order to reduce inventory costs materials should be available in warehouse exactly when necessary. In general pick orders from warehouse depend on patient treatment; so in case of change of the previously treatment a new order emission to the central pharmacy would be required.

The challenge is to avoid two common situations:

- Materials in stock before required (increasing inventory cost);
- Materials not available in warehouse (increase penalties cost due to stock-out).

The approach used for modeling relies on setting random upper and lower bounded variables to simulate the variability related to orders emission, demand and inventory level. The resulting model is reported below in Figure 4.

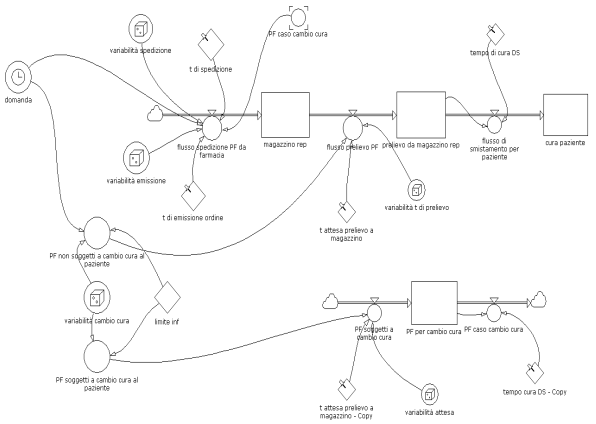

Figure 4: Stock and flow diagram

The second model simulates the total cost, sum of inventory and penalty cost, assessed according to the evolution of virtual warehouse realized in the previous simulation model. The cost diagram is represented in Figure 5.

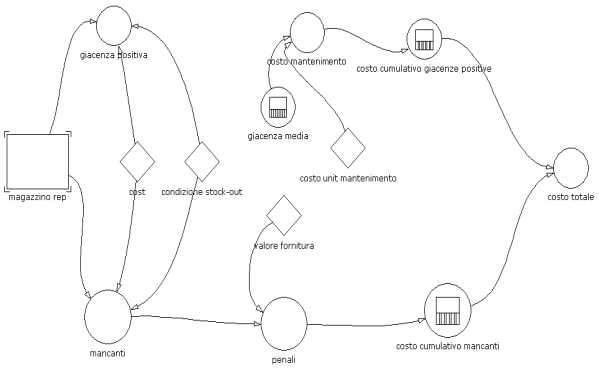

Figure 5: Stock and flow diagram (total cost)

Constants, levels and variables used in system dynamic model development are summarized in the following table (Table 1).

4.1. Case Study: AORN "Antonio Cardarelli" di Napoli.

In order to validate the model a pharmacy department daily demand, derived from the average of Italian hospitals, has been considered and its trend has been represented in Figure 6.

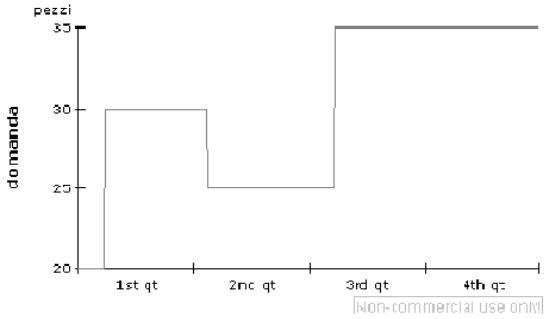

Figure 6: Demand trend

Simulation scenarios, characterized by an observation period of one year, are influenced by the trend of random variables:

- Order variability;
- Shipping time variability;
- Pickup time variability;
- Treatment change.

The warehouse inventory level simulation is based on three scenarios:

- Scenario 1: warehouse evolution and costs analysis without e-procurement;
- Scenario 2: warehouse evolution and costs analysis with e-procurement implementation and orders emitted by the central pharmacy;
- Scenario 3: warehouse evolution and costs analysis with e-procurement implementation and just in time pull strategy.

The following table summarizes parameters used for each simulation scenario (Table 2).

Table 1: Stock and flow diagrams parameters

1ST SIMULATION MODEL		
NAME	**DESCRIPTION**	**TYPE**
Demand	Products required by the warehouse department of the central pharmacy	Variable
Shipping time	Time required to submit the required product to the warehouse department of the central pharmacy	Constant
Shipping variability	Random variable that changes for each simulation time step	Random Variable
Processing time	Time required to send a product enquiry to the main warehouse (including bureaucratic stops)	Constant
Emission variability	Variable that allows to model the variability of orders emission	Random Variable
Inflow	Materials Flow coming from stock /In stock products	Variable
Warehouse	In stock products	Level
Outflow	Withdrawal rate of products from warehouse	Variable
Waiting time	Time constant that takes into account waiting time to withdraw the necessary materials from the warehouse department	Constant
Time of sampling variability	Variable for the modelling of the uncertainty	Random Variable
Withdrawal from warehouse department	Number of pieces taken from the store's department	Level
Flow clearinghouse for patient	Rate of sorted materials for patient care	Variable
Treatment time in DS	Time spent by patient receiving treatment in day surgery	Constant
Patient care	Materials actually used for the treatment of patient at issue	Level
Condition orders that are subject to treatment change	Condition for which occurs the emission of a new order due to a treatment change compared to the previously drawn .	Variable
PF in case of care exchange	Products must be ordered in case there is a treatment change and new order must be added to the input stream to the warehouse department	Variable

2nd SIMULATION MODEL		
NAME	**DESCRIPTION**	**TYPE**
Positive stock	Positive stock level	Variable
Stock out condition	Failure condition of the warehouse inventory	Constant
Missing	Negative stock evaluation	
Maintenance cost	Costs due to a positive inventory level.	Variable
Maintenance unit cost	Maintenance cost for a single product in the warehouse department	Constant
Maintenance cumulative cost	Total maintenance cost in the simulated time horizon	Variable
Penalty	Cost related to stock-out. Quantified according to a percentage of the supply request	Variable
Delivery value	Average value of the supply demand	Constant
Penalties cumulative cost	Total penalties cost in the simulated time horizon	Variable
Total cost	Sum of both maintenance and penalties costs calculated in the simulation horizon	Variable

Table 2: Simulation parameters

Parameter	1st scenario	2nd scenario	3rd scenario
Demand	Step function	Step function	Step function
Total simulation time	1 year	1 year	1 year
Shipping time	24 h	24h	24 ore
Shipping variability	0,99-1,20	0,99-1,20	0,99-1,20
Emission time	3h	1 h	1 h
Emission variability	1,00-1,50	1,00-1,50	1,00-1,50
Waiting time	30 h	29 h	25 h
Variability	0,9-1,20	0,9-1,20	0,9-1,20
Treatment time in DS	24 h	24h	24 ore
Treatment change	0,00-1,00	0,00-1,00	0,00-1,00
Time necessary for treatment change in DS	30 h	29 h	25 h
Treatment change variability	0,15-1,00	0,15-1,00	0,15-1,00

4.1.1. Simulation results

The following figures (Figure 7 and Figure 8) show the trend of both drugs inventory level and costs, obtained from an appropriate number of simulations.

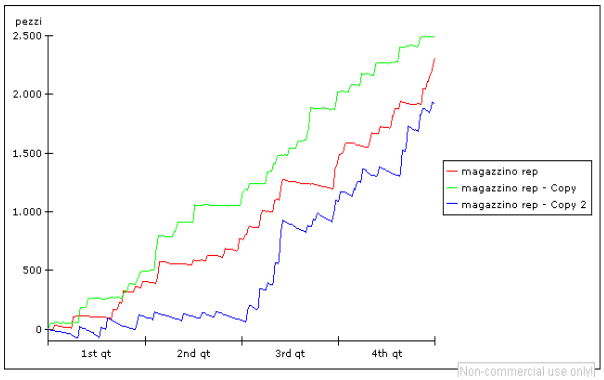

Figure 7: Inventory level trends: 1st scenario (green), 2nd scenario (red) and 3rd scenario (blue)

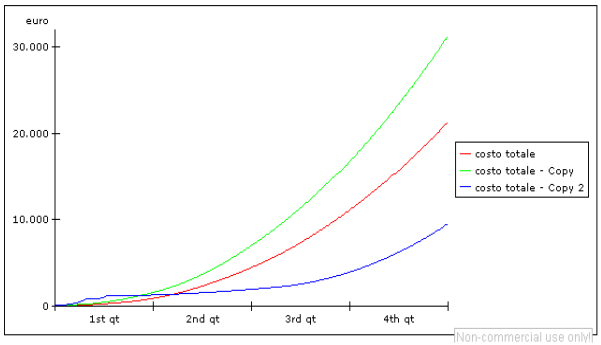

Figure 8: Total cost trend: 1st scenario (green), 2nd scenario (red) and 3rd scenario (blue)

The first and second scenario trends showed an higher inventory level that implies high maintenance costs, while in the third scenario the just in time strategy reduce the inventory level and related costs.

5. CONCLUSIONS AND FUTURE DEVELOPMENTS

The aim of the presented model is to show the benefits achievable in a hospital through the implementation of an innovative management model in order to standardize operations and reduce total costs.

An e-collaboration framework has been implemented in Day Surgery where patients spent approximately 24 hours; it is assumed that web-based platforms decrease orders emission time and improve relationships and interactions with provider at issue.

On these two fundamental issues a simulation model has been realized whose results are acceptable and have highlighted the chances to succeed. In the third scenario, based on just-in-time philosophy reached through a lean healthcare management process, the simulation results show that, the lean emission order process allows to achieve a great reduction of inventory cost.

It's important to highlight that the simulation model developed concerns a single hospital department; the model should be extended to all hospital departments in order to connect them with the central pharmacy as well as connect the pharmacy with its supplier and realize an e-collaboration network.

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