An Innovative Approach To Develop Performance Indicators For Medicines Supply Chain In Moroccan Public Hospitals

Imane Ibn El Farouk, Youness Frichi, Fouad Jawab

Abstract: To accompany the recent changes in Moroccan public health sector in terms of improving patient care, hospitals are required to develop performance management systems. In this context, we present the results of a methodology to build a dashboard for medicines supply chain in public hospitals. The developed methodology, which we have called OPRI (Objectives, Parameters, Risk, and Indicators), is based on process modeling through SCOR, ARIS models, and risk analysis. OPRI's principle is that the supply chain performance can also be achieved by warning risks. The article illustrated the OPRI's architecture, steps and tools, in the first stage, while the second stage provided results obtained through the application of OPRI on a case study of a public hospital in Morocco.

Index Terms: KPI, Dashboard, Supply chain, Hospital, Risk, SCOR Model, Modelling.

1 INTRODUCTION

The recent Moroccan public health sector is characterized by different changes in terms of improving quality of care, enhancing health system performance and the assurance of universal healthcare coverage. These challenges have led health system decision-makers to take several measures, including the generalization of the obligatory medical coverage (AMO) and the medical assistance regime (RAMED). The proper functioning of these measures implies, inter alia, continuous availability of medicines at the hospital level. In that respect, public hospitals are required to develop new tools to manage the performance of the medicines circuit, particularly medicines supply chain performance. In this context, we are particularly interested in the problematic of how to build a dashboard to manage medicines supply chain in hospitals. Indeed, an effective monitoring of performance requires necessarily a measurement engineering [1]. A Dashboard is a management and monitoring tool which requires very high intention; otherwise, the risk of making wrong decisions becomes very probable [2]. In the hospital area, the problem of designing a dashboard is becoming more and more complex and of extreme importance, particularly when it comes to hospital logistics. Researchers' views in this direction are also multiple. Many logistics researchers consider that the exercise of choosing reliable, faithful performance indicators is delicate and this practice must go beyond the simple list of indicators, it should be part of a process of performance management leading to a real feedback from the various actors in the organization [3]. The exercise of designing a performance management system in hospital logistics is complex [4], given the diversity of objectives to be met in the health sector: cost reduction, suppliers efficiency, patient satisfaction [5]. Regarding these challenges, our contribution aims at developing an innovative methodology to build a dashboard for medicines supply chain in public hospitals. The methodology which we have called OPRI (Objectives, Parameters, Risk, and Indicators) is based on process modeling through SCOR and ARIS models, and risk analysis. OPRI's principle is that the supply chain performance can also be achieved by warning risks. The remainder of this article is organized in three parts. First, we review the literature concerning hospital logistics and supply chain. Second, we present the OPRI architecture, steps, and tools. Third, we provide results of the application of the OPRI on a case study of a Moroccan public hospital.

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2 LITERATURE REVIEW

2.1 Hospital Logistics

Before tackling hospital logistics importance and issues, we thought it was necessary to define logistics and supply chain. Wieser [6] argued that logistics today should be defined as the optimal management of flows and resources in a company or organization. There are several and different but interlinked flows to be considered: physical flows (materials, services, etc.), logical flows (information or data), and financial flows, that often act as constraints on optimizing logical or physical flows. A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. It not only includes manufacturers and suppliers, but also transporters, warehouses, retailers, and customers themselves [7]. Logistics and supply chain are two different concepts. In fact, the Supply Chain Council highlighted this difference in the below definition " logistics management is that part of the supply chain management that efficiently plans, implements and controls flows, counter-flows and stocks of goods, as well as related services and information, from their point of origin to their point of consumption, so as to satisfy customer requirements". It can be concluded from these definitions that the principal aim of logistics management is the smoothing of flows across the supply chain like into a pipeline. The main flows are information flow, physical flow and financial flow.

Hospital logistics is a concept that has attracted several researchers who have unanimously confirmed that hospital logistics has long been neglected and reduced to stewardship activities, and emphasized the urgency of internal and external integration of the healthcare supply chain. Logistics

within hospitals is a complex function that manages very different product flows and distribution channels [8]. Hassan [9] has defined hospital logistics as the set of activities of design, planning, management of supply, manufacturing (goods and services), delivery and management of returns, from the provider to the beneficiary (patients), all taking into account the patients' path within the hospital without which there is no flow of (pharmaceutical) products. These activities are orchestrated by the flow of information between the different partners of the chain and lead to financial flows. The goal is to provide optimal service for the quality and safety of the care provided to patient. According to Kritchanchai et al. [10], healthcare logistics can be defined as series of networks or systems performing different activities aiming towards service provision to patients often with severe time constraints. For Landry and Beaulieu [11] hospital logistics is a function located at the interfaces between services. It consists of purchase and supply, reception, management and transfer of patients, hotel and catering services as well as medical-technical function (pharmacy, sterilization, laboratory and medical imaging). The ultimate customer of hospital activities is the patient [12]. To fulfill the patient requirement, two main processes are necessary, medical care process and support process [13]. The support processes involve sourcing and purchasing, order management, transportation management, and inventory management. Based on the literature review, we have modeled hospital flows in Figure 1.

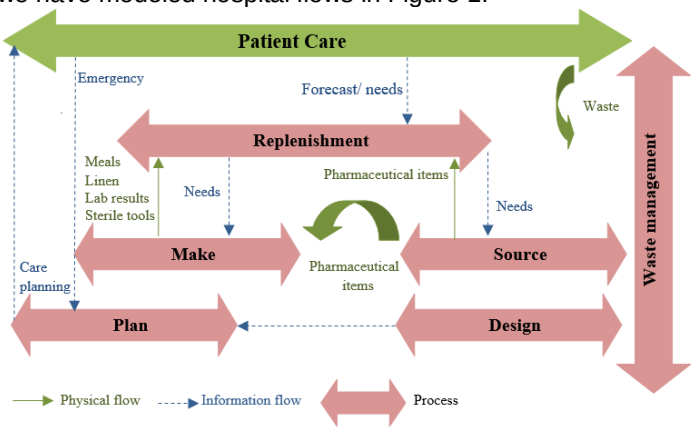

***Fig. 1**. Flows circulation in hospitals*

2.2 Interests of Hospital Logistics

Many authors have highlighted the importance of considering hospital logistics as a performance factor. For Wieser [6], logistics is an essential strategic and operation factor in improving healthcare and cost control. The author added that hospital logistics must be viewed as a major strategic function that serves both patients and medical staff. The fragmented and local logistics view should be replaced by one of supply chain management covering all flows and resources, not only in the hospital itself but also in the entire care network of the region or even the country. Against the complexity of the hospital system, the variability and unpredictability of the patient profile and the high demand for care, logistics is considered as an effective solution for the optimization of working time of healthcare staff by offering them the opportunity to concentrate on their core activities and improve patient care conditions [14], [15]. Another and very important advantage of hospital logistics integration is cost reduction. According to Landry and Philippe [16], about 46% of a hospital's total operating budget is spent on logistics related activities, which translates into 27% being spent on supplies and equipment and 19% on labor. In the same work, the authors have indicated that the EHCR (Efficient Healthcare Consumer Response) study on supply chain integration in healthcare revealed that 48% of supply chain related process costs were avoidable through the implementation of better logistics practices, particularly integration. The conception and design of the hospital logistics function should not be limited to the interfaces between suppliers and traditional logistics activities, but include supplies, costumers and care units since they will ultimately use these supplies for patient care. If the logistics function is conceived as an integral part of each care unit, this relationship between suppliers and customers could be a source of improving inventory management healthcare delivery, and patient satisfaction [17], [18].

2.3 Hospital Medicine Supply Chain

Medicines belong to the family of pharmaceuticals. Their circuit covers two distinct but interdependent components [19]: clinical circuit and logistics circuit. The clinical circuit concerns patient medical management from admission to discharge. It includes prescription, dispensing and administration phases. The logistics circuit concerns the drug as a product, from purchase to delivery at the care unit. However, medicines are a very specific product in the hospital with special management requirements. This complexity can result from the following specificities: price, replenishment frequency, vitality level, actors, and regulation impact. Flows generated by medicines supply chain move in different directions between the pharmacy, care units, and suppliers. The main mission of the medicines supply chain is to guarantee medicines availability in the most efficient possible way, under conditions that guarantee safety and traceability while respecting the numerous regulations surrounding pharmaceutical products and their dispensation [20].

2.4 Medicines Performance Indicators

As mentioned in the introduction, the purpose of this paper is to propose a methodology that helps to build a dashboard to pilot hospital medicines supply chain in the Moroccan context. However, designing a dashboard is problematic. In fact, a dashboard is a tool of measuring the performance for decision-making purposes. It contains a number of indicators that must perfectly reflect the measured reality. Difficulties in making a dashboard arise from the expected implicit requirements. Because a dashboard has to be precise, sensitive, objective, reliable and simple [1]. Any indicator, to fulfill its piloting and assistance roles, should meet three characteristics [2]: (i) measuring performance according to the chosen progress direction; (ii) be adapted to the context and the available means of action; (iii) be in agreement with the specific needs of each decision-maker. According to Voyer [21], several organizations have wasted a lot of time and resources because they embarked on the experiment of developing a dashboard without a rigorous methodology and in-depth reflection on the objectives to be pursued and the results to be achieved. Particularly, in the hospital area, the development of a dashboard becomes more difficult, especially concerning supply chain management, which is complex and involves various stakeholders [5], [4], [3]. For authors in the USAID DELIVER project, the performance of the health system delivery depends heavily on the performance of its supply chain, and to make this chain more

reliable, it is necessary to understand where it is not effective.

3 METHODS

To build our tool, we first reviewed the literature about mains directives and principles in building Key Performance Indicators (KPI). Second, we confronted the requirements with the Moroccan hospital context. Our aim is to determine whether to add or change some criteria. Results from the literature review provided the main principles in developing a dashboard:

1. A dashboard must play a control and steering role,
2. It should also refer to a direction of progress: master objectives must lead to indicators in each level,
3. A division of activities is necessary for the dashboard design: understanding activities, actors, documents is necessary in developing indicators, especially involving stakeholders,
4. There is no ready-to-use dashboard.

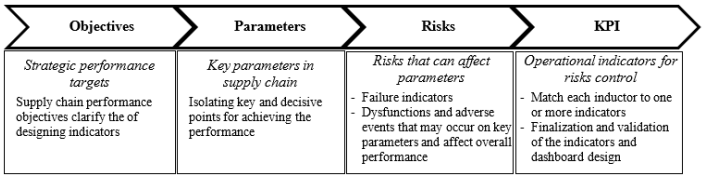

***Fig. 2**. The architecture of OPRI and steps of developing KPI*

However, in a primitive healthcare context like Moroccan hospitals, the second requirement cannot be met because the lack of objectives deployment. To overcome this gap, our proposition is to base performance indicators system on risk management. According to several authors, hospital supply chain is a subject of a lot of risk. Complexity and diversity are the most fact inducing this vulnerability [22]. The idea behind replacing master objectives by risk management is that performance can also be achieved by avoiding risks. The third requirement is obtained by process modeling.

3.1 Medicines Performance Indicators

The principle of our approach called OPRI is that performance can also be monitored via controlling risk and failure situations. The architecture in figure 2 schematizes how strategic indicators are translated into operational indicators through the identification of improvement areas. The approach is organized around four pillars:

1. Objectives: these are the objectives of the expected performance of the medicines supply chain. Here we ask the question what is a successful supply chain?
2. Parameters: Here, we define the key points of the supply chain.
3. Risks: the aim is to identify the inducer of an underperformance situation.
4. Indicators: this final stage consists of linking inducers to a control indicator.

3.2 Implementation Tools

The OPRI approach requires two modeling tools and a risk analysis tool. As a modeling approach, we have chosen the process approach, for different reasons. First, the complexity of hospital systems [23]. Second, the subject which is the supply chain [20]. Third, the high contribution to the performance measure.

The three tools that we have deployed are:

- SCOR Model: Reference Architecture for Supply Chain Modeling. This tool enables modeling the strategic level through processes description (first level) and the determination of performance attributes across the matrix of attributes performance level. The application of SCOR at this level of OPRI provides a set of indicators.
- ARIS: in order to break activities down into tasks, we have used the following functionalities from ARIS: functional view modeling, tree of functions, organizational view modeling, data view flowchart modeling, the model Entity -Relation Modeling, the process view, the process chain.

- FTA (fault tree analysis): Is there any risk? What damage can the risks cause to the links in the supply chain? The chosen tool for this step is the cause tree.

TABLE 1

TOOLS AND STEPS MATRIX

Tools	Level	Element	*O*	*P*			*R*	*I*
				Activities	Actors	Flow diagram		
SCOR	Top level	Process description	Identification of the medicines supply chain					
		Performance attributes and level 1 metrics	Identification of key of performance					
	Configuration level	Process configuration		Processes identification				
	Process element level	Processes breaking down		Activities identification				
ARIS	Function view	Function shaft		Functions identification				
	Organization view	Organigram			Actors identification			
	Data view	Entities relation model			Entities and data schematization			
	Process view	Process chain				Sequence of activities		
FTA							Failure factors identification	
Indicators selection matrix								Indicators validation

This choice was made from a panorama of tools taken from the literature.

To more explain the role of each tool in our approach, we have established a matrix to visualize the output of each tool (Table 1).

4 AN APPLICATION OF THE PROPOSED METHOD: A CASE STUDY OF A PUBLIC HOSPITAL IN CASABLANCA

Our case study is a public hospital in Casablanca - Morocco, which serves 520 000 inhabitants with a litter capacity of 207 beds, 54 specialist doctors, a dozen general practitioners, 60 interns, and 170 nurses. The hospital pharmacy is managed by a chief pharmacist. Its activities are performed by an assistant pharmacist, preparers and a secretary. The hospital pharmacy manages nearly 200 molecules that are distributed to all care units.

4.1 Step1: "O" performance objectives

Using the first level of SCOR Model, we described the process of the studied supply chain and determined the performance requirements. After the analysis, it turned out that the drug supply chain contains the three processes described on the level 1 of the modeling scheme (Figure 3). The Planning process is performed by the procurement division (PD) of the Ministry of Health, while the hospital pharmacy pilots only the execution activities of the medicines supply chain.

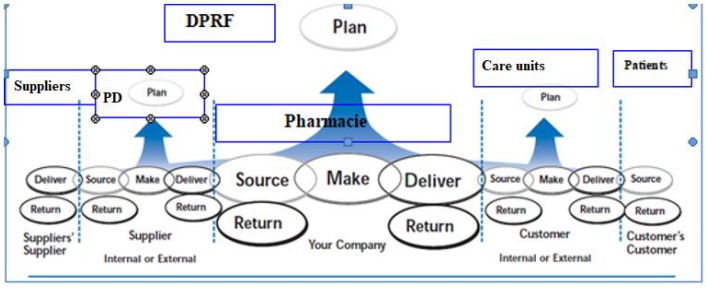

Fig. 3. *Modeling level 1*

The supply chain processes are as follow:

1. Plan: a first strategic planning process is performed by the procurement division and DPRF. It consists of defining the annual budget and allocations to each hospital. A second planning is performed by the hospital pharmacists. It consists of estimating the annual medicine needs according to the allocated budget.
2. Source: it's the process of medicines acquisition from the procurement division and includes reception, checking, storage and inventory management.
3. Make: there is no making operation about medicines.
4. Deliver: distribution of medicines to the point of care.
5. Return: it involves management of all returned items from points of care to the pharmacy.

Using the performance attributes from SCOR level 1, we also obtained the performance requirement for our supply chain (Figure 4). It means that our supply chain will achieve performance objectives if it insures availability, short lead time, low inventory

level and low wasting cost.

4.2 Step2: "P" Key Parameters

There are key points that should be monitored to avoid failure in the supply chain. They include activities, actors, documents and data. To identify these key points, we first modeled the process categories of the supply chain (Figure 5). All categories were broken down using ARIS to obtain all keys parameters as summarized in Table 2.

4.3 Step3: "R" Risks

Using the FTA, we identified several risks that can affect the supply chain performance. We summarized these risks as follow:

1. Unchecked consumption.
2. Varying consumption of medicines.
3. Inaccurate inventory.
4. Lack of verification during reception.
5. Incorrect annual medicines order.
6. Incorrect monthly medicines order from care units.
7. Irregular replenishment of care units.
8. Lack of delivery monitoring.

4.4 Step4: "I" matrix risk - indicators

To make the final dashboard, we joined inducers and indicators. In a matrix, we have linked each risk to an indicator and highlighted some important points:

1. The interest of the indicator, how it can control the risk.
2. Organizational unit responsible to produce the indicator.
3. Actor responsible to produce information for making the indicator.

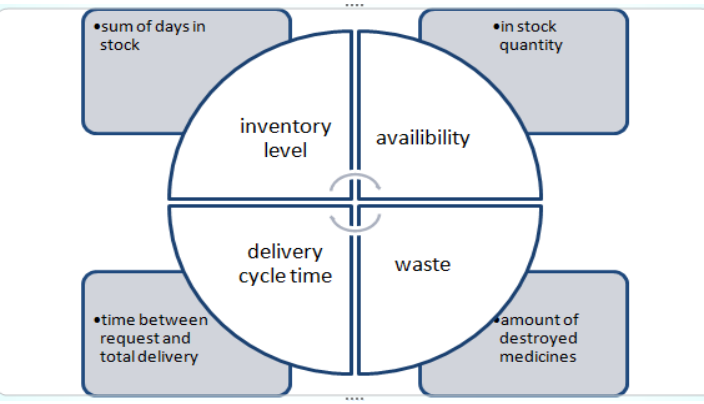

Fig. 4. *Performance attributes*

4.5 Step5: Final KPI

The dashboard resulted from this research contained 7 indicators. For each indicator we indicated the calculation formula, the update frequency and the responsible (Table 3). The dashboard structure combined results and control indicators. For instance: Stock out rate indicator: it measures medicines shortfall inventory and which may generate unsatisfied medicines requests. Regarding the vitality of medicines availability, the target of this rate must tend toward 0%. Expiry date indicator: This ratio is expressed in the value of expired items from the stock total value. Its purpose is to evaluate the part of the lost value. Regarding the nature of medicines as perishable items, we cannot totally avoid the lapsing. However, some efforts are required, for example, the pharmacist has to follow the expiration date and constantly look for ways to use the items with a near expiry date. The best way is to exchange near expiry date items with other hospitals. Items destruction must be the final option. Stock coverage rate indicator: This is a ratio of stock quantities and the daily consumption. It's expressed in number of days and evaluates how many days the stock can cover. The target of this ratio is determined according to the delivery frequency.

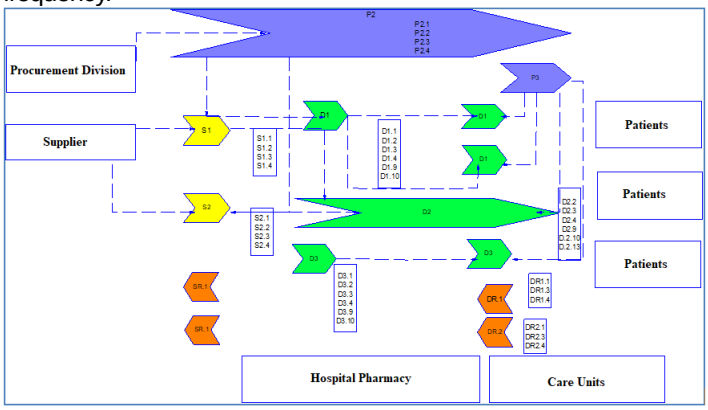

Fig. 5. *Processes categories*

It should be noted that a dashboard is neither an end in itself nor a collection of indicators. It is an effective management tool that helps decision making. In this study, using a cause-effect analysis, we have deduced the main difficulties encountered by the drug supply chain in the Moroccan public hospitals' context. These difficulties can be summarized in two key points:

- Centralization of medicines supply: this centralization provides advantages in optimizing purchasing costs. However, the lack of communication between pharmacists and suppliers as well as the push flow of medicines neutralizes the positive effect of this centralization. In Ibn El Farouk et al. [24], readers can find our propositions to this dysfunction.
- care units' replenishment: the adopted push flow of medicines is ineffective, such system is unsuitable for all kind of molecules because of the consumption variation. Thus, we have proposed a pull flow for items with high consumption [25]

TABLE 2
KEY PARAMETERS

Activities	Actors	Data	Documents
Estimate the annual need of medicines	Supply division	Budget	Order form
Order medicines	Pharmacist	Real inventory	Prescription
Receive medicines	Administrative affairs chief	Average consumption	National list of medicines
Stock medicines	Doctor	Expiration date	Order wad
Distribute medicines	Care unit chief	Consumption level	Delivery sheet
Return medicines	Pharmacy dispenser	Medicines national classification	Order form
	Hade nurse	Address storage	Stock file
	Medicines committee		Narcotic register

5 CONCLUSION

The objective of this paper was to develop an innovative methodology to build drug supply chain performance indicators. The proposed methodology is called OPRI, which consists of modeling processes and activities using SCOR, ARIS and risk analysis. OPRI's principle is that the performance of the drug supply chain can be monitored and reached via warning risks. Through this contribution, we have tried to enrich the performance measurement practices in hospitals with a tool that can be adapted to a particular context such as Moroccan hospitals. As perspective of this research, it is interesting to study how we can implement and conduct a performance monitoring system in hospitals. Such system requires a continuous KPI updating, and essentially an

analyzing process to identify the gap between the target and the realization. Consequently, actions plan will address dysfunctions and improve performance.

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