

## A prospective study on the analysis of risks associated with medicines supply chain in Morocco.

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**Abstract.** The continuous improvement of medicines supply chain for hospitals is a major problem that must take into account all the risks that can disrupt the smooth functioning of the chain. In this paper we present a classification of works that have already treated this problem by risk categories, objectives, approaches, tools used and the action field. Cartography of the concerned supply chain in Morocco is then elaborated as well as a risk analysis related to the different actors in order to define improvements to follow.

**Keywords:** Medicines Supply Chain, Risks Analysis, Medicines Circuits.

### 1 Introduction

The improved performance of hospital systems requires the mastery of many processes that contribute to providing a quality service for patients. Several problems are then to treat; they concern flow optimization of services, staff schedule's management, conception of efficient information systems and many other categories. Medications and medical devices availability is also a primary level problem that can decrease the achievement of care services. Solving these problems exceeds the hospital institutions perimeter, since it isn't only a matter of managing local stocks, but also mastering the flows throughout medicines supply chain which is located in a context of major disruptions despite the efforts made by authorities [1]. Therefore, besides the respect of standards, procedures and good practices references, risks and errors associated to the actors of the supply chain must be considered as well as the implementation of appropriate corrective actions to the organization of each hospital.

Medicines distribution in Morocco reveals many flows classifications. We will make the difference between two types, according to whether flow borrows the clinical circuit or not. The circuit, known as clinical, concern the patient therapy, either he requires ambulatory treatments or hospitalization. The concerned organizations (health ministry, military health, hospital and clinical centers) are supplied by markets, directly from laboratories or through wholesalers. In this work, we will try to model this circuit due to its details significant importance in medicines supply chain. The goal is to identify and analyze the various risks that can disturb the good performance of this chain and deduce improvements to follow.

## **2 Literature review**

### **2.1. Risk and supply chain**

In 1992, Yates and Stone emphasize three elements to define a risk: elements of loss, significance of loss and uncertainty associated of loss. A more scientific definition of risk was provided by the [2]: "the probability of loss and the significance of that loss to the organisation or individual". These first risk definition elements may apply to many areas, including the Supply Chain. Then, there are risks in a supply chain when unexpected events might disrupt the flow of materials on their journey from initial suppliers through to final customers [3]. Concerning medicines supply chain, risk management becomes a critical issue to improve the overall performance of health organizations.

### **2.2. Risk management process**

According to [4], risk management process comprises three parts:

- Risk analysis: seek to identify the risks faced by an institution understand how and when they arise, and estimate the impact of adverse outcomes.
- Risk assessment: is the determination of quantitative or qualitative estimate of risk related to a well-defined situation and a recognized threat.
- Risk control: in this phase the appropriate measures on how to manage risk are chosen including the implementation of risk mitigation plans when needed.

This work focuses on the risk identification and analysis step because without a good knowledge of the risks, it is difficult to implement adequate measures to prevent their occurrence.

### **2.3. Medication supply chain risk**

Several studies propose a risk classification and modelization through medicines supply chain ([5] and [6]). The majority of identified risks are similar to those prevailing in industrial supply chains despite the pharmaceutical products particularities. We synthesized the results into 6 categories and 3 levels as detailed in the Table1. We use three structure approaches of risk management: strategic, tactical and operational.

We classified risks related to the medication supply chain in the literature into 6 categories:

- Process Risks includes 6 risks at operational level related to inventory management, workers skills, information flow, production and acquisition, transport and planning and control. Outsourcing and strategy are associated to the tactical and strategic levels.
- Demand-related Risks include risk of customer demand not matching organization's forecast

- Supply-related Risks: At the strategic level, supply-related risks can be associated with partnership with supplier, contract and agreements and counterfeit. At the operational level, these risks can be associated with raw material, Information systems or timely delivery.
- Environmental Risks: Natural disasters and terrorism, political issues and waste management for suppliers ; can also prevent proper operation of supply chain
- Market risks encompass the risk of financial loss resulting from movements in market prices
- Financial risks generally arise due to instability and losses in the financial market caused by movements in stock prices, currencies, interest rates and more.

A classification of works that have already treated this problem is also proposed. This classification is realized in relation to different categories of proposed risks, objectives, approaches, methods used and action fields (Table 2 and 3).

**Table 1.** The risk categories related to the medication supply chain in the literature.

			Levels		
			Strategic	Tactical	Operational
<b>Risk Categories</b>	<b>Process Risks</b>	R1	1.1	Inventory management	*
			1.2	Workers skills	*
			1.3	Information flow	*
			1.4	Production and acquisition	*
			1.5	Transport	*
			1.6	Planning and Control	*
			1.7	Outsourcing	*
			1.8	Strategy	*
	<b>Demand-related Risks</b>	R2	Customer needs	*	
	<b>Supply-related Risks</b>	R3	3.1	Partnership with supplier	*
			3.2	Supply and supplier issue	*
			3.3	Raw material quality	*
			3.4	Contract & agreements	*
			3.5	Flexibility of supplier	*
			3.6	Delivery reliability	*
			3.7	Information systems	*
			3.8	Flexibility in product variety	*
			3.9	Quality management system	*
			3.10	Timely delivery	*
			3.11	Counterfeit	*
	<b>Environmental Risks</b>	R4	4.1	Natural disasters & terrorism	*
4.2			Political issues	*	
4.3			Waste management for suppliers	*	
<b>Market risks</b>	R5		*		
<b>Financial risks</b>	R6		*		

**Table 2.** The classification of works related to risks.

Authors	RISK																									
	R1								R2	R3								R4				R5	R6			
	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8		3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	3.11	4.1	4.2	4.3			
Alaoui 2007	*		*		*	*																				
Arbouret and al 2008	*																									
Barthélémy et al 2013	*																									
Breen, 2008	*	*	*		*	*					*		*								*					*
COLLOMP and al 2007									*																	
Enyinda and al 2009						*				*											*					
Enyinda and al 2010											*										*					
Jaberidoost and al 2015																										*
Jnandev Kamath and al 2012	*																			*						*
KRISSI, 2010																				*						
LABORIE and al 2006	*								*																	
Martinelly and al 2005	*																									
Mehralian and al 2012	*	*		*	*						*	*	*			*	*	*	*		*	*	*	*	*	*
OUZAYD and al 2011			*		*																					
Reschke 2010								*																		*
Saint-Lorant and al 2013					*													*	*							
Shah 2004	*					*					*															
Smith 2012	*			*							*															

**Table 3.** The classification of works related to objectives, approaches and methods.

Authors	Objective	Approache	Method
Alaoui 2007	Conceptualize, formalize and instrumenting a risk control approach in a health organization.	Modelization	UML
Arbouret and al 2008	Identify the strengths and shortcomings surrounding the drug circuits management.	Descriptive study	
Barthélémy et al 2013	Describe risk management related to disruptions to medications supplies in healthcare institutions.	Descriptive study	
Breen, 2008	Gain a more realistic understanding on the risks' nature and frequency in the pharmaceutical supply chain.	Literature review	
COLLOMP and al 2007	Formalize a performance pilotage model for the medication circuits in the hospital	Modelization	
Enyinda and al 2009	Examines the emerging risks of outsourcing in the pharmaceutical supply chain.	Analytic hierarchy process	
Enyinda and al 2010	Identify and mitigate the risks in the Ghanaian pharmaceutical supply chain.	Analytic hierarchy process	
Jaberidoost and al 2015	The risk assessment in pharmaceutical industry in Iran considering the process priority and the risk probability.	Analytic hierarchy process	Simple Additive Weighting (SAW)
Jnandev Kamath and al 2012	Evaluate the risks in pharmaceutical supply chain and provide solutions.	Analytic hierarchy process	

KRISSI, 2010	Analyze and evaluate the technological strategies effectiveness that could secure the pharmaceutical supply chain.	Quantitative and qualitative study	
LABORIE and al 2006	Optimize drug stocks in pharmacy cabinets	Quantitative and qualitative analysis	Excel
Martinely and al 2005	Optimize the operations of the pharmacy, inventory and the pharmaceutical products distribution	Logic diagram	
Mehralian and al 2012	Formulate basic factors involved in risk analysis of pharmaceutical industry and also determine the effective factors involved in suppliers selection and their priorities.	Logic diagram	TOPSIS Technique
OUZAYD and al 2011	Analyze the performance of the drug logistics system by mainstreaming risk.	Modelization and simulation	ASCI, UML, Petri nets
Reschke 2010	Evaluate the risk sources in a biopharmaceutical industry organization.	Case study	
Saint-Lorant and al 2013	Improving the cold chain of medicines in account held all the risks associated with the quality.	Mapping	
Shah 2004	Identify key issues and strategies related to pharmaceutical supply chain optimization.	Simulation	Probability
Smith 2012	Propose a series of recommendations to mitigate the rupture risk of the medications in the supply chain.	Prospective analysis	

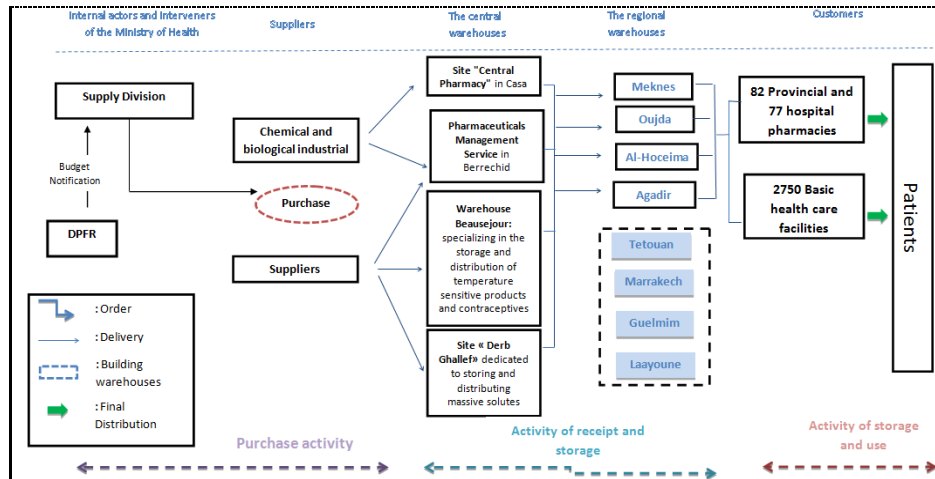
Literature works' classification is conditioned by the study perimeter according as it analyzes and addresses the risks associated with all or part of the supply chain, while answering the objectives and using different approaches and tools (Table 2 ). In [7], the authors evaluate risks of the pharmaceutical industry in Iran by the AHP method. This evaluation considers the process priority and the risks probability. The majority of the risks described in this study were related to the financial and economic class. Same approach and tools were used by [8] and [9] to prevent, reduce and share the risk control in the pharmaceutical supply chain. While [10] proposes measures to manage outsourcing in the pharmaceutical supply chain using the AHP method. At the hospital, [11] presents the process cartography of the cold medications in a CHU Caen. This cartography permits to extract the critical issues involved in this process and also identify the key players involved in the cold medications management, from suppliers to care services.

Then, [12] presents the pharmaceutical logistics' specifics. This approach helps to identify the interactions between the actors and to highlight any problems and errors in the system. To model this process, the authors choose a Logic diagram representation. In another hand, [13] analyzes the system performances of the overall pharmaceutical supply chain (direct and reverse flow) while integrating the risk dimension.

### 3 Risk's identification and analysis related to the actors of the medications supply chain in Morocco

The risk control throughout medicines supply chain contributes to the improvement of the care services provided by health facilities. These risks are such that they can prevent all or part of the effective and efficient movement of the physical and information flows between different actors (Supply Division (SD), suppliers, warehouses, healthcare centers and patients) (Figure 1). In what follows, we will

identify the different risks associated with each actor in the chain in order to present a detailed analysis of all risks in the Moroccan medicines chain. This task is done through the identification of physical and information flows involved.



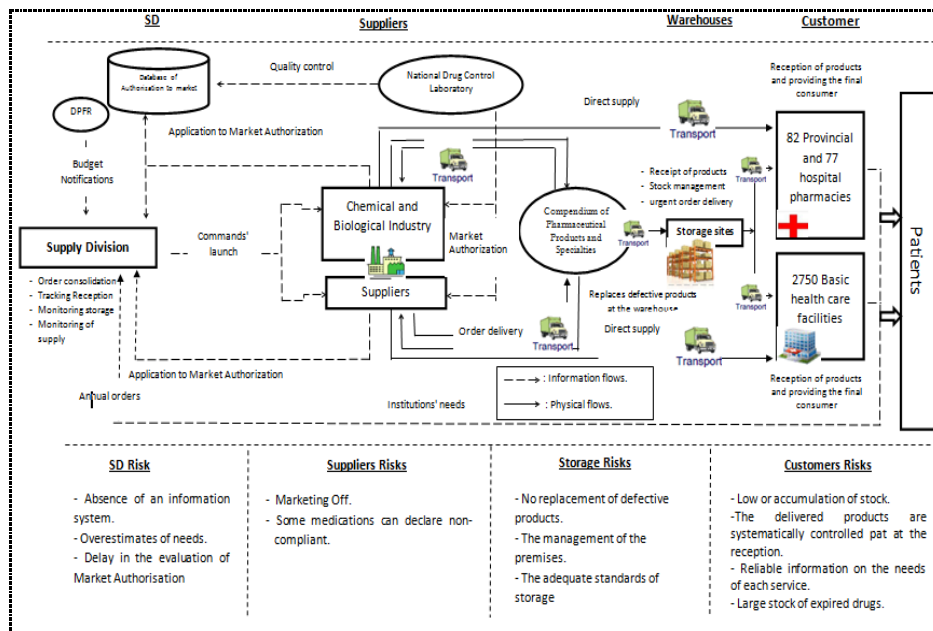
**Figure 1.** Medicines supply chain's cartography in Morocco.

The needs are then recapitulated and treated at the hospital pharmacy and transferred to Regional Delegations and Provincial Directorates who develop annual orders in pharmaceutical products on the basis of the budget notified by the Department of Planning and Financial Resources (DPFR) and submit all to the Supply Division (SD). This last one deals with needs consolidation, launching of tenders, receiving, storage and distribution of pharmaceuticals, administrative management and monitoring of supply. These operations are performed in the absence of an information system which allows traceability at the level of the whole process as well as the registration of various products. The Directorate of Medicines and Pharmacy (DMP) is responsible for granting the Market Authorization (MA) through the controls performed by the National Drug Control Laboratory (LDCL). It's also responsible for quality control process of products delivered to warehouses.

The Ministry has four depots for products' storage located in the region of Casablanca. The concentration of these areas within a radius of 40 KM compromises the performance of the chain. In [14], the author states that these warehouses don't meet the suitable standards for storage and present, for some of them, defects related to the security system, to the location right in the urban center and to the wholesomeness of infrastructures.

The distribution to the basic health care and the hospitals attached to the regional and provincial hospitals (Out CHU) is done by the means of each delegation or hospital. Deliveries are planned 4 times a year. These schedules are established without consulting the recipients who can receive the drugs they already hold in stock in large quantities. This situation explains in part the existence of large stocks of expired drugs [15].

These findings are synthesized in Figure 2 which summarizes some risks involved in the medicine supply chain in Morocco. The main actor of the chain, the SD, is exposed to multiple vulnerabilities. The grouping of orders and their assignment to budget restrictions presents several risks regarding references and delivered quantities. The various tasks assigned to this direction are realized in the absence of an information system that can support the operational efficiency of the chain. The deliveries in fixed dates are a finding that confirms the repercussions of this failure. In terms of storage infrastructure, insalubrity and unsuitability of locals in an urban concentrated perimeter are problems with a very high impact on the chain.



**Figure 2.** The risks associated with each actor in the global medicaments supply chain in Morocco.

## 4 Conclusion

The purpose of this work is to analyze the risks in the drug supply chain in Morocco. A classification of the works that have already addressed this problem is made in relation to categories, objectives, approaches, tools and action fields. This classification has guided us to describe the system of supply, storage and distribution for the pharmaceutical products. By determining the different actors involved in the medicine supply chain in Morocco, we have defined various risks associated with each actor. It would be relevant to analyze and evaluate the actors opinions in the chain through an interview guide in order to better understand how responsible are organized to face the risks associated with the medicine supply chain in Morocco. The aim is also to be able eventually to highlight the contribution that we believe significant which is the design of an information system adapted to the management of such a chain.

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