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# Building a pharmaceutical supply chain risk map as a management control instrument in professional organizations: the results of a research-intervention in a Moroccan public healthcare establishment

# Élaboration d'une cartographie des risques de la chaîne d'approvisionnement pharmaceutique comme un instrument de contrôle de gestion dans les organisations professionnelles : résultats d'une recherche-intervention au sein d'un établissement public de santé marocain

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**Abstract**

Public-sector healthcare establishments are called upon to optimize hospital logistics processes, which can make a major contribution to improving operational efficiency and reducing costs, with a view to improving the quality of care offered to users. As a result, risk management of the logistics chain has become a premise for them, in order to minimize the impact of internal and external risks on hospital performance. The Central Pharmacy department is an essential intermediary between patients, suppliers and professionals, with a mission to manage pharmaceutical products. In order to strengthen the internal control system, the design of a risk map will enable us to identify the areas of potential risk faced by this department, and facilitate the concentration of efforts on the most sensitive areas. We have opted for a research-intervention at the level of the Central Pharmacy Department of CHU Mohammed VI Oujda, which accounts for a significant proportion of expenditure. Ultimately, this risk mapping will not only help to identify and prioritize risks, but also to raise the awareness of those involved through a more proactive and enlightened risk management culture.

**Keywords :** Risk management ; intervention research ; supply chain ; central pharmacy.

**Résumé**

Les établissements de santé du secteur public sont appelés à optimiser les processus logistiques hospitaliers, lesquels peuvent contribuer de manière significative à l'amélioration de l'efficacité opérationnelle et à la réduction des coûts, dans le but d'améliorer la qualité des soins offerts aux usagers. Dans cette optique, la gestion des risques de la chaîne logistique est devenue pour eux une nécessité, afin de minimiser l'impact des risques internes et externes sur la performance hospitalière. Le service de la Pharmacie Centrale constitue un intermédiaire essentiel entre les patients, les fournisseurs et les professionnels, avec pour mission la gestion des produits pharmaceutiques. Afin de renforcer le dispositif de contrôle interne, la conception d'une cartographie des risques permettra d'identifier les zones de risques potentiels auxquelles ce service est exposé, et de concentrer les efforts sur les domaines les plus sensibles. Nous avons ainsi opté pour une recherche-intervention au niveau du service de la Pharmacie Centrale du CHU Mohammed VI d'Oujda, qui représente une part importante des dépenses. En définitive, cette cartographie des risques contribuera non seulement à identifier et à hiérarchiser les risques, mais aussi à sensibiliser les acteurs impliqués en faveur d'une culture de gestion des risques plus proactive et éclairée.

**Mots clés :** Gestion des risques ; recherche-intervention ; chaîne d'approvisionnement ; pharmacie centrale.

**Subject contextualization**

In the public hospital sector, optimizing the supply chain remains essential to satisfying user needs, especially in terms of pharmaceutical products. With this in mind, risk management is emerging as a means of providing information on potential risks, with a view to making informed decisions in a constantly changing environment. In this respect, risk mapping is considered to be one of the risk management tools providing the most detailed identification of potential risks impacting all processes in the pharmaceutical supply chain. It is worth mentioning that there is no consensus on the definition of supply chain risk management, despite the fact that it is one of the current topics of both academic and practical interest to everyone, aiming at a collaborative effort between supply chain partners to identify and manage risks in order to reduce the supply chain's vulnerability to risk and ensure its profitability and continuity" (Deshpande et al., 2017).

In our research, we will opt for the process of risk management in line with international standards, in order to develop a risk map adapted to the pharmaceutical supply chain of a Moroccan public healthcare establishment, the CHU Mohammed VI Oujda. In the same vein, and in order to strengthen the internal control system, the design of a risk map is an essential step. This process makes it possible to identify and prioritize the risks with which the central pharmacy department may be confronted, by highlighting areas of potential risk. In this respect, risk mapping will make it easier to focus the organization's efforts on the most sensitive areas requiring particular attention. Preventive and/or corrective action can then be taken to mitigate these risks. Public healthcare establishments are called upon to reason about and optimize hospital logistics, which can make a major contribution to a hospital's performance in a context of improving the quality of care offered to patients.

As a result, risk management of the supply chain through appropriate measures has become a premise for them to minimize the impact of risks on hospital performance. The Central Pharmacy Department is at the heart of CHU Mohammed VI Oujda, and is an essential intermediary between the patient, suppliers and healthcare professionals, dedicated to managing pharmaceutical products for the safety and well-being of patients. Due to changes in the environment, the pharmaceutical supply chain faces internal and external risks that affect its performance. The central pharmacy department is not directly involved in the act of care, but it is involved in a number of activities that contribute to the proper performance of this act, with an intersection of pharmaceutical product flows.

**Problematization of questioning**

From this point of view, it is necessary to optimize costs through risk management mapping, as the central pharmacy service represents a significant proportion of the expenses of the CHU Mohammed VI Oujda. Our research problem is the result of in-depth reflection adapted to the needs of our chosen field of intervention namely: ***"Which risk mapping is best suited to the pharmaceutical supply chain of CHU Mohammed VI Oujda ?".*** We have chosen intervention research as a strategy for gaining access to the field in a complex organization, in order to evaluate pharmaceutical logistics at the CHU Mohammed VI Oujda. To clarify our problem, our research will follow the following plan. The first part will be devoted to a literature review to clarify our problematic and clarify the concept of the logistics chain with its various definitions, specifying this concept in the hospital sector and also dealing with risk management. Next, we will present the methodology adopted and the chosen field of intervention. And finally, the last part will be dedicated to the presentation of the results and its discussion and proposed recommendations for the improvement of the pharmaceutical supply chain. With regard to the methodology applied to design a supply chain risk map for the central pharmacy department, we familiarized ourselves with the organization of the central pharmacy department by means of a documentary study and by observing the operation of the said department in order to carry out an initial inventory with the aim of detecting significant risks linked to the activity. We also conducted interviews with key members of the central pharmacy department to gain a more detailed understanding of the pharmaceutical supply chain's purchasing, receiving, storage and distribution processes. In the same vein, we felt it necessary to co-construct and implement a risk map at the level of the central pharmacy department, which could contribute to controlling the risks associated with pharmaceutical logistics through actions to mitigate or eliminate disruptions, including the loss and opportunity aspect.

## 1. Conceptualization

### 1.1. The hospital pharmaceutical supply chain

The pharmaceutical supply chain must ensure that pharmaceutical products are made available to patients in an optimal way, while guaranteeing strict conditions of safety and traceability. It must also meet the complex regulatory requirements governing product management, distribution and dispensing. In the same vein, hospital pharmacy accounts for a significant proportion of a healthcare establishment's expenditure. It is an essential component of hospital logistics, supporting patient care activities. It is important not to perceive the pharmacy as an

isolated department within the hospital, but rather as a central element in the pharmaceutical logistics chain, whose mission is to supply pharmaceutical products to patients.

Supply chains have also been widely studied in the field of industrial management. Literature reviews such as Thomas' (Thomas DJ et al. 1996) on integrated supply chain management, and Slats' (Slats et al. 1995) on chain modeling, illustrate this abundance of research. In addition, numerous articles have been published on inventory management and models integrating inventory and distribution management, such as the work of Muckstadt (Muckstadt et al., 2001) and Qu (Qu et al. ., 1999). However, relatively few articles address these issues in the hospital environment, which may be explained by the legal constraints specific to the drug supply chain, as well as by the importance of the human factor (Beretz, 2002).

In fact, the hospital logistics chain, known as the pharmaceutical logistics chain, is a circuit for drugs and medical devices in hospitals, made up of a series of successive stages carried out by different professionals. This circuit is also connected to the hospital information system and logistics. The pharmaceutical supply chain encompasses two main areas: - The pharmaceutical supply chain, which includes administrative, procurement, logistics, inventory management, distribution, global dispensing and production, control and sterilization functions;

Together, they form the clinical circuit for pharmaceutical products, encompassing the functions of nominative dispensing, analysis and pharmaceutical information. Managing a hospitalized patient's drug therapy is a multidisciplinary and interdependent process, beginning with the medical prescription, the initial decision-making act. This prescription triggers the pharmaceutical activity and the act of care performed by the nursing staff, which organizes the work of all those involved in the drug and medical device circuit. The quality of the prescription has a direct influence on the quality of the following stages: dispensing (pharmaceutical process) and administration (nursing process). These stages are structured according to the general objectives of securing the medication circuit and the proper use of pharmaceutical products. The logistics circuit concerns drugs and medical devices (MDs) as material products. This circuit extends from acquisition from the supplier or manufacturer to delivery/dispensing in the care unit, and connects with the clinical circuit at the final stage, when the drug is administered to the patient or other pharmaceutical products are used. This process is complex and varied, involving numerous players such as healthcare professionals and other stakeholders. As it is mainly based on human elements, the circuit presents considerable risks of errors and malfunctions that could compromise the overall quality of patient care. The pharmaceutical product logistics circuit requires specific skills, both for selecting the most suitable products

and for controlling, managing and organizing supplies according to the facility's needs. This physical management of products is inseparable from their clinical management.

Furthermore, in Morocco, the Ministry of Health has accorded interest to medicines in its two plans "Plan 2025" and "Politique Pharmaceutique Nationale", which aim to establish a high-quality, equitable and local healthcare system for all citizens and are based on good governance of the healthcare sector as well as the rational use of resources (Ministry of Health, 2012; Ministry of Health 2018). These plans also place great emphasis on organizing the 5 availability of medicines in health facilities with affordable prices to facilitate universal access to medicines and health products for Moroccan consumers. Accordingly, the Ministry of Health publishes a list of essential medicines and allocates an annual budget to ensure their availability in public hospitals and basic health care facilities (Ministry of Health, 2012). The 2025 plan also claims to extend the list of reimbursable medicines, support the fight against diseases such as hepatitis C and combat communicable diseases. The 2025 plan also focuses on maternal and child health, and aims to improve the drug supply and distribution system.

### 1.2. Pharmaceutical supply chain risk management for operational efficiency

Zur Muehlen and Rosemann (2005) argue that the relationship between risk management and process management is complementary. On the one hand, risk management is characterized as a correlated and interrelated process that needs to be optimized. On the other hand, process management can draw on risk management for continuous improvement. Moreover, according to Wibo (2000), risk is generally defined as a random event that deprives a system of its resources and delays the achievement of its objectives (Barthélémy, 2000). ISO 31000 version 2009 offers a clear, official definition of the concept of "environmental risk", designating it as "the possibility of an event occurring whose consequences (or effects of uncertainty) are likely to affect people, corporate assets, the environment, corporate objectives or reputation". This concept has always been a component of business (Knight, 1921) and is intrinsic to all entrepreneurial action (Schumpeter, 1926). It accompanies every decision, implying risk-taking in the hope of a favorable outcome (Persais, 2003). Thus, action is closely linked to risk, which is both its driving force and its consequence (Beck, 1986). In the private sector, the notion of risk is often linked to the quest for growth, higher profitability and organizational evolution. Beck (1986) stresses that risk and its cost are inherent elements of economic activities, constituting potential induced effects. The cost of risk is assessed on the basis of the expected benefits in relation to the risks incurred in the event of realization. However, from the work of

Knight (1921) until the 1990s, the distinction between risk, hazard and uncertainty was blurred. Despite this confusion, risk has become a central element of organizational thinking.

Risk management involves detecting, analyzing and assessing potential risks associated with a company's activities, with the aim of eradicating them or minimizing their impact. It also involves anticipating crisis situations and assessing potential risks associated with profound transformation or change management (new commercial positioning, digital transformation, internationalization project, etc.). In this way, risk management makes it possible to avoid or reduce situations likely to compromise the achievement of objectives or the sustainability of organizations. For his part, Courtot (1998) defines risk management as a continuous process that takes place throughout a program, including the identification, assessment and management of risks, based on an organized study of risks, sorted according to their nature, causes, origins, consequences on functionality and impact on organizational and human aspects. At this level, we can distinguish between minor, major, critical and catastrophic risks, hence the importance of moving on to a control phase to implement a set of actions planned and carried out to reduce and maintain risks at a tolerable level. In the same vein, risk mapping is a risk management tool defined by ISO 31000 as a fundamental tool for risk managers, offering the advantage of illustrating, at a given point in time, the results of analyses carried out as a visual tool that facilitates the comparison of risks by presenting them in the form of a matrix. Generally speaking, each of the risks analyzed is positioned according to its likelihood (or probability) - impact (or severity), and the risk matrix can be divided into different colored zones, also known as "temperature zones", representing the level of criticality of the risks: - red (A) for critical risks; - orange (B) for risks requiring vigilance; - green (C) for controlled risks; - black (D) for rare but exceptionally serious risks. It is a tool for discussion with governance on the level of risk acceptance and the treatment strategies to be implemented, and requires regular updating.

In addition, risk mapping is an effective way of structuring the risk management process, and must be integrated into the decision-making process not as a result, but as an end in itself, following a structured, dynamic and iterative logic, in line with the principles set out in the standard. In this respect, a policy of communication and consultation must be put in place, in line with the design of the organizational framework within which this policy can also be developed with the aim of raising awareness and fostering understanding of risk. However, once risks have been identified and analyzed, organizations can have different levels of severity (/impact): scale from 1 to 4 (low, medium/moderate, high, very high/catastrophic) or from 1 to 9, for example. The levels are related to financial losses caused or operating losses. Probability,

also known as occurrence, corresponds to the possibility of the risk occurring. Organizations have different levels of probability: a scale of 1 to 4 (rare, unlikely, possible, almost certain) or 1 to 9, for example. The combination of impact and probability provides the weight of the risk and therefore its cost. In practice, risks are represented in the form of an impact/probability matrix (risk mapping). It presents a summary of risks and their respective importance in order to focus on the major risks and on the appropriate internal control systems, thanks to this prioritization of analyzed risks as a tool for good management in a dynamic environment prone to disruption (Knemeyer, Zinn, and Eroglu 2009).

## 2. Methodology adopted

As the backbone of a university hospital, there are at least three main reasons for choosing the Central Pharmacy department in this paper. The first relates to the transversal relationships with all the other departments in the center. The second is the department's central, strategic role within the hospital. As the nerve center for the supply, receipt and distribution of drugs and medical devices, the central pharmacy is directly involved in all logistical processes. Any failure or risk in this department can have major repercussions on the quality of care, availability of pharmaceutical products and patient safety. Risk assessment in this area is therefore crucial to ensuring the continuity and efficiency of hospital operations. The third reason is that the department consumes a large part of the facility's budget.

Penetrating the field, in order to understand the context (the services), requires a stay within the framework of a research-intervention, which was easy for us to negotiate, given that the authors of this paper are practitioner-researchers within the CHU. The aim of intervention research is to encourage the researcher to maintain an interactive relationship with the field of choice, in order to experience the situation first-hand and come face to face with its problems, so that the actors in the field also become involved in the research (Perez, 2008). This confrontation enables us to fully understand the research object and contribute to its transformation through a process of co-creation of knowledge alongside actors from both services. In short, intervention research aims to produce theoretical knowledge based on rigorous observation of the facts, with a view to contributing to change (Cappelletti et al. 2018).

To this end, we have recourse to cognitive interactivity, generic contingency and contradictory intersubjectivity, three epistemological principles developed by Savall and Zardet (2004) and conditioning the scientificity of a research project. The first principle is embodied in successive iterations between researchers (ourselves) and actors (CHU staff). This principle increases the significance of the information processed in scientific work (Savall and Zardet 2005). As for

the second principle, it develops the idea that knowledge production obeys the principle of complementarity between universal (generic) and specific (contingent) variables (Voyant 2005). With regard to the third principle, it results from the confrontation of several intersubjectivities (which may be contradictory) relating to actors of different profiles and hierarchical levels, to produce a meaning that can be shared.

The mode of investigation of our study is based on a qualitative approach through observations and semi-structured interviews with central pharmacy staff (Savall and Zardet, 2004).

In doing so, we first carried out observations to identify the procurement, storage and dispensing processes within the central pharmacy reporting to the CHU.

We then carried out a qualitative study through semi-structured interviews, based on the ISO 30001 standard, with a total of 27 employees of the central pharmacy, distributed as follows:

**Table 1 : Personnel interviewed**

| Profile of interviewees | Number of interviewees | Estimated time per service |
|---|---|---|
| Department Manager | 1 | 3H |
| Major/Vice Major | 2 | 2H |
| Pharmacists | 4 | 3H |
| Pharmacy assistants | 11 | 4H |
| Hospital ward nurses | 10 | 5H |
| **Total** | 28 | 17H |

**Source : Authors.**

As our research is transformative in nature, it consists of two stages. The first stage is descriptive, in that it describes the processes of the central pharmacy in question. The second stage is intended as a blueprint for change, through the prescription of a risk map of the central pharmacy's processes.

## 3. Analysis of results

After familiarizing ourselves with each stage of the pharmaceutical logistics circuit within the central pharmacy department of CHU Oujda, we will identify the risks associated with each stage, then analyze these risks to understand their main causes. It's worth mentioning that the risk management process includes a situation analysis phase to identify the risks to which the pharmaceutical supply chain processes within CHU Mohammed VI Oujda are exposed, as well as a risk assessment and classification phase based on their severity, to reveal the most critical and highest-priority risks, which we will present in the following phases.

- ✓ ***Identification and analysis of risks by process***

Based on the results of the semi-structured interviews carried out during the risk diagnosis, we have identified and analyzed the risks that may arise within the pharmaceutical supply chain

circuit at CHU Mohammed VI Oujda, using a process-based approach. The risks identified will be analyzed in terms of their causes and consequences.

✓ ***Risk assessment and classification***

Assessing and classifying risks is an essential step in drawing up a risk map, and in implementing appropriate measures to improve the flow of the pharmaceutical supply chain. In order to assess the probability and severity of identified risks, we have opted for evaluation grids which the persons in charge must complete.

✓ ***Design of a supply chain risk map for the central pharmacy department***

The risk identification stage is a key step in the design of risk mapping. Based on participant observation, we will present the following risk assessment criteria:

**Table 2 : Risk likelihood scale**

| Likelihood level | Quotation | Description |
|---|---|---|
| **Highly unlikely** | 1 | that the risk occurs |
| **Improbable** | 2 | unlikely to occur |
| **Probable** | 3 | possibility of the risk occurring |
| **Very likely** | 4 | virtual certainty that the risk will occur |

**Source : Authors (based on ISO31000 Version 2018).**

With a view to contributing to improving the availability of medicines and medical devices required for patient care at the CHU Mohammed VI Oujda, we have sought through this research, to analyze the pharmaceutical supply chain circuit within the chosen intervention site, in order to identify the management problems linked to each stage of this circuit which negatively influence the availability of pharmaceutical products, and to achieve operational efficiency, using the scale for measuring the probability and likelihood of risks presented in the table above, as well as the scale for measuring the severity of risks, which is as follows:

**Table 3 : Risk severity scale**

| Severity level | Quotation | Description |
|---|---|---|
| **Very low** | 1 | It doesn't seem possible that risk can realize threats |
| **Low** | 2 | It seems difficult for risk to realize threats |
| **Strong** | 3 | It seems possible for the risk to realize threats |
| **Very strong** | 4 | It seems extremely easy for the risk to carry out threats |

**Source : Authors (based on ISO31000 Version 2018).**

The combination of the two scales for measuring the likelihood and severity of risks gives rise to a scale for measuring criticality, which is detailed in the table below:

**Table 4 : Risk criticality scale.**

| Criticality scale | Criticality level | | Description |
|---|---|---|---|
| **Minor risk** | Green | $1 \leq Cr \leq 3$ | Controlled risk |
| **Moderate risk** | Yellow | $3 < Cr \leq 8$ | Risk to watch out for |
| **High risk** | Orange | $8 < Cr \leq 12$ | Risk to be reduced |
| **Critical risk** | Red | $Cr > 12$ | Priority risk |

**Source : Authors (based on ISO31000 Version 2018).**

It should be noted that the general aim of our study was to take a look at the pharmaceutical supply chain from January 2024 to September 2024. The data for this study were based on a documentary study of the various management supports, in particular order forms, delivery slips, stock sheets and others. Semi-structured interviews with the pharmacist in charge and the team helped to refine the data. In the following, we shall present the risks identified by process:

***The purchasing management process :***

Using a semi-structured interview guide, we conducted interviews with members of the central pharmacy department at CHU Mohammed VI, in order to gain a better understanding of the purchasing management circuit and identify the associated risks, which are presented below.

**Table 5: Extract of risks related to the purchasing management process**

| Process | Global risks | Sub-risks | Causes | Consequences |
|---|---|---|---|---|
| Purchase | Risks associated with determining requirements | Overestimated needs | - Estimated needs not well studied | - Overstock<br>- Expiry date<br>-Extended lead time (>12 months) |
| | | Underestimating needs | - Estimated needs not well studied | - Out of stock |
| | Risks associated with placing an order | An unsuccessful lot/AO | - No submission.<br>- Global disruption.<br>-Disqualification of suppliers due to non-compliance with bidding criteria.<br>- Supplier's financial offer is excessive or abnormally low. | - Out of stock<br>- Unmet needs of care units |
| | | Failure to comply with the time limits of the public procurement procedure | - No supplier commitment<br>- Lack of contract follow-up | - Delivery delay<br>- Out of stock |
| | | Wrong choice of supplier | - Absence of supplier evaluation lists | - Delayed deliveries<br>- Supplier non-commitment<br>- Out of stock |
| | | Refusal of delivery | - Supplier payment delays | - Out of stock |

**Source : Authors.**

Once you've identified the risks associated with the purchasing process, it's time to move on to the incoming goods management process, to better understand qualitative and quantitative delivery controls.

***The incoming goods management process***

Pharmacists and dispensing staff check the quality and quantity of pharmaceutical products received, under the supervision of the major, to ensure compliance with the required criteria. With regard to the qualitative verification of medicines, pharmacists check the conformity of the BL (hidden and signed by the supplier) and the name of the medicine (international non-proprietary name), the dosage, the form (monogram and name of the recipient with the expression "forbidden for sale"), the expiry date (greater than or equal to 18 months), and the reservation temperature.

**Table 6: Extract of risks related to the receiving process**

| Process | Global risks | Sub-risks | Causes | Consequences |
|---|---|---|---|---|
| Reception | Risks associated with verifying the order received | Receive damaged products (in terms of quality) | -Packaging defect<br>- Transport error | - Out of stock<br>- Unmet needs of care units |
| | | Qualitative non-conformity of the order received | -Non-commitment of suppliers<br>-Regulatory changes (customs and changes to product labels) | - Out of stock<br>- Unmet needs of care units |
| | | Quantitative non-conformity of the order received | -Non-commitment of suppliers | |
| | Risks related to the delivery of pharmaceutical products | Late delivery | -Non-commitment of suppliers | |

**Source : Authors.**

With regard to the quantitative verification of medical devices, pharmacists check the conformity of products received on the basis of the technical document validated by the prof (head of a care unit department) and the registration file.

***The storage management process :***

Storage robots are most often implemented in hospital pharmacies, and offer intelligent solutions for drug storage. They enable full or partial automation of inventory management processes.

**Table 7 : Extract of risks related to the inventory management process**

| Process | Global risks | Sub-risks | Causes | Consequences |
|---|---|---|---|---|
| Stock management | Inventory management risks | Out-of-stock situations | - Late delivery<br>-Anticipated internal order<br>-Non-compliance with public procurement procedure deadlines<br>- Refusal of delivery<br>- Refusal to accept non-conforming products | - Delay or cancellation of internal orders<br>- Failure to meet care unit needs |
| | | Overstock | -Overestimated needs<br>-Lack of storage space<br>-Consolidation of the quantity of 2 or more deliveries into a single delivery if the 1st delivery is delayed. | - Financial loss<br>- Product shelf life |
| | | Expiry date | - Overestimation of needs<br>- Overstocking.<br>- Consolidation of the quantity of 2 or more deliveries into a single delivery if the 1st delivery is delayed. | - Financial loss<br>- Out of stock |
| | Premises and storage safety risks | Loss or detour of pharmaceutical products | - Superficial control of products received by care units from the central pharmacy<br>- Lack of cameras at Med Stations and DM stocks at care units<br>- Lack of traceability of medical device stocks in care units linked to IS | - Financial loss<br>-Advance order<br>- Out of stock |
| | | Product deterioration | - Inadequate storage conditions | - Financial loss<br>-Failure to meet care unit needs |
| | Information system risks | Goodwill | - Input error | - Expiry date<br>- Financial loss |

**Source : Authors.**

In the central pharmacy department, a storage robot called "ROWA" has been implemented, reducing the error rate when preparing orders for care units. And let's not forget the intelligent cabinets for storing medical devices.

***The distribution management process :***

When care unit departments require medicines and/or medical devices, they send an internal order to the central pharmacy for distribution of pharmaceutical products. Pharmacists verify and validate this order, both qualitatively and quantitatively. Verification is carried out using the PYXIS system (an information system used to track the traceability of drugs stored in the Med Stations) and the HOSIX system (enabling pharmacists to track the movements of medical devices stored in the care units).

**Table 8: Extract of risks related to the distribution process**

| Process | Global risks | Sub-risks | Causes | Conséquences |
|---|---|---|---|---|
| Distribution | Risks related to internal control | An anticipated internal order | - Poor definition of needs by care units<br>- Increasing patient frequency | - Out of stock<br>- Internal conflicts |
| | | Risk of excessive returns of distributed products | - Pharmacovigilance<br>- Overstock on care units | - Expiry date<br>- Overstock at the central pharmacy |

**Source : Authors.**

After positive validation, the pharmacists forward the validated internal order to the order pickers. The pickers then remove the validated quantity of drugs and medical devices from stock, in line with the validated internal order. At this stage, the order pickers are divided into two groups : the first is responsible for preparation, and the second for verification. The pickers then communicate the validated internal order to the technicians, who evacuate the quantity of pharmaceutical products from the HOSIX information system and print out the release slip. The pickers then check that the quantity prepared corresponds to the quantity discharged from the HOSIX system.

In addition, there are other external risks that need to be taken into consideration, such as environmental risks linked to fire, leaks and sometimes spills of certain products, in particular medical gases, which can have very harmful impacts on the environment, and which need to be managed effectively and operationally in order to maintain a sustainable development approach. Not forgetting problems sometimes linked to regulations, information system failures and unexpected fluctuations in demand, as well as external risks due to the uncertain

environment which require the use of risk management strategies for operational efficiency. In what follows, we shall attempt to present an extract from the table used to calculate the criticality of risks associated with the receiving process.

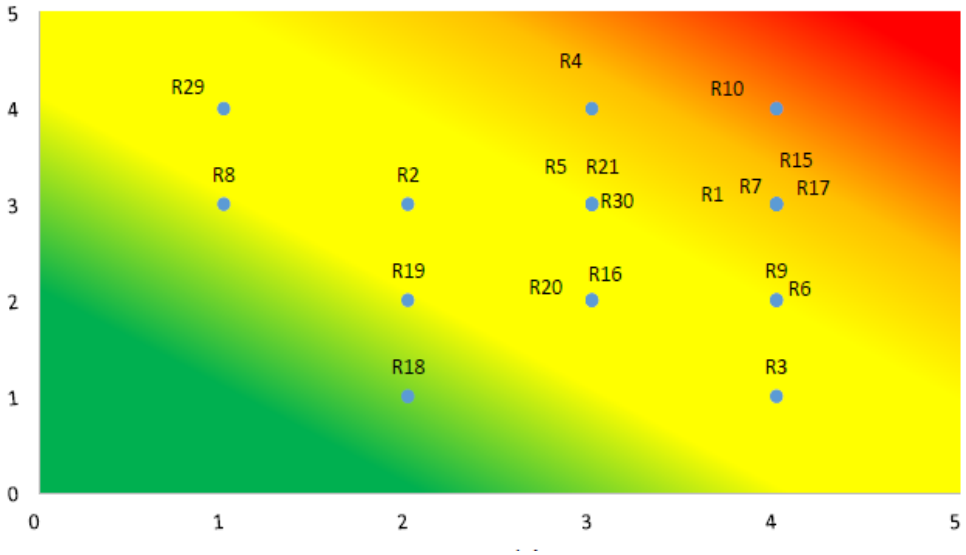
**Table 9: Extract from the table calculating the criticality of risks related to the reception process**

| Process | Overall risk | Under risk | | Likelihood (P) | Gravity (G) | Criticality (C=PxG) |
|---|---|---|---|---|---|---|
| **Reception** | Risks related to the verification of drugs received from suppliers | Receive damaged products (in terms of quality) | R7 | 3 | 4 | 12 |
| | | Quantitative non-conformity of the order received | R8 | 3 | 1 | 3 |
| | | Qualitative non-conformity of the order received | R8 | 2 | 4 | 8 |
| | Risks associated with drug delivery | Late delivery | R10 | 4 | 4 | 16 |

**Source : Authors.**

At this point, we will present two risk maps: one for the drug logistics circuit and the other for the medical device logistics circuit.

**Figure 1: Presentation of risk mapping for the drug logistics circuit**

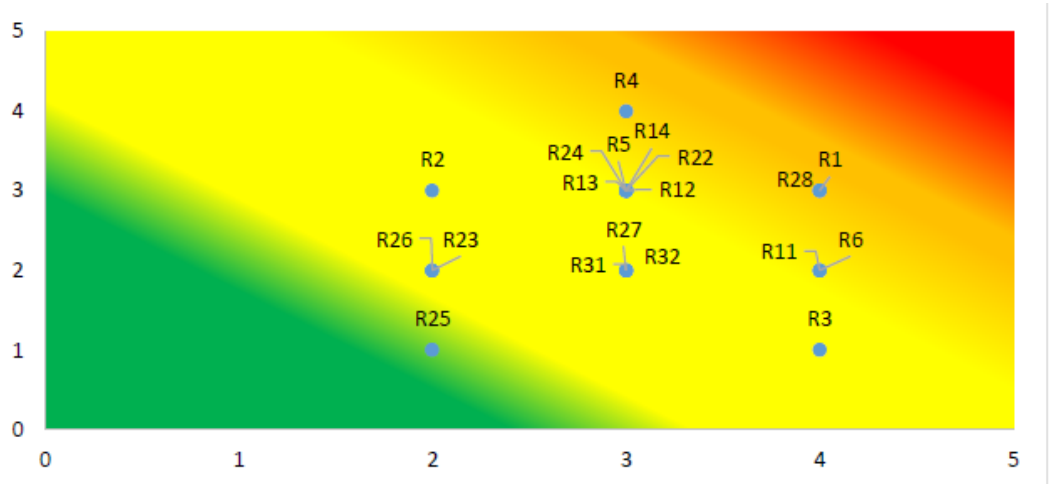



**Source : Authors.**

Risks associated with drug delivery and refusals to deliver must be given priority in risk management. Careful monitoring of qualitative and quantitative non-conformities in the medicines received is also crucial to guaranteeing the safety and effectiveness of the care

provided. Specific mitigation plans should be drawn up for these risks, especially those of high criticality, such as late delivery (R10). The figure below illustrates the risk mapping of the medical device logistics circuit.

**Figure 2 : Presentation of risk mapping for the medical device logistics circuit**




**Source : Authors.**

By way of consolidation, the pharmaceutical supply chain is subject to numerous disruptions in the purchasing, receiving, storage and distribution processes, which have a detrimental impact on the continuity of care offered to users. This being the case, risk management of the latter through appropriate measures has become a premise for public hospital organizations to minimize the impact of risks on their performance for greater operational performance across the entire supply chain.

**Discussion of results**

Supply chain risk management is an essential process that can be broken down into four phases: risk identification, risk assessment, risk management decision-making and risk control (Wu and Blackhurst, 2009). This framework enables risks to be prioritized, helping organizations to focus their decisions on the most critical threats. This is particularly relevant for public hospital organizations, where supply chains are subject to numerous internal and external risks. These risks include those associated with transport, procurement, information flows, delivery reliability, raw material mislabeling, production cost management issues, planning, drug temperature control and inventory management.

These potential breaks in the supply chain do more than just cause damage to hospital pharmacy. They also have a direct impact on patient access to medicines, jeopardizing continuity of service and patient health. Faced with these challenges, we have co-constructed a risk map specific to central pharmacy processes, in order to systematically identify and visualize

all potential risks. This collaborative approach enables us to better anticipate critical risks and implement appropriate preventive measures, thereby guaranteeing continuity of care and patient safety.

**Conclusion**

Risk mapping within the pharmaceutical supply chain is an essential approach to improving supply chain management and safety in the hospital sector. Our study, carried out in the central pharmacy of CHU Mohammed VI, enabled us to draw up a detailed inventory of pharmaceutical logistics processes, identifying major risks and proposing corrective actions to control them.

Throughout the assessment, we followed a phased approach: an initial phase of preliminary analysis using interviews to gain a better understanding of internal processes, followed by a final assessment phase using analysis grids to identify priority risks according to their probability and impact. These steps led us to a clear diagnosis of critical points, notably in the purchasing, receiving, inventory management and distribution processes for pharmaceutical products and medical devices.

Moreover, the implementation of such a tool illustrates the expanded role of management control, which now goes beyond its traditional financial dimension to serve as a strategic lever for organizational performance and risk management. The integration of risk mapping with management control enables optimal resource allocation, strengthens coordination among stakeholders, and helps mitigate the impact of both internal and external disruptions on the supply chain.

From a managerial point of view, we have demonstrated the importance of proactive risk management through improved communication with suppliers, the use of IT tools to ensure traceability and stock integrity, and ongoing staff training in good logistics practices. These recommendations are aimed at improving efficiency, reducing losses, and preventing stock-outs or product expiry risks.

From a theoretical point of view, this study represents an original contribution to the field of risk management in the pharmaceutical supply chain, particularly in the context of public hospitals, a subject that is still little explored in Morocco. It provides a solid basis for better management of logistics flows in healthcare establishments, based on a rigorous risk mapping methodology.

Finally, the limitations of our research, notably linked to the specificity of the study context, open up avenues for future research. These could include comparative studies in other hospitals,

or the integration of new technologies to further automate and secure the pharmaceutical supply chain. These prospects will further enhance risk management and optimize the performance of hospital logistics departments.

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