# Prioritizing the Risk in Customs Supply Chain Using AHP-Based Approach: Application to the Moroccan Customs

Lamia. Hammadi

National Institute of Applied Sciences INSA, Lofims, Rouen, France, National School of Applied Sciences, Oscars, Cadi Ayyad University, Marrakech, Morocco Email: hammadi.lamia@gmail.com, lamia.hammadi@insa-rouen.fr

> Jos éEduardo. Souza De Cursi National Institute of Applied Sciences Insa, Lofims, Rouen, France Email: eduardo.souza@insa-rouen.fr

Abdellah. Ait Ouahman National School of Applied Sciences, OSCARS, Cadi Ayyad University , Marrakech, Morocco. Email: aitouahman@yahoo.fr

Aomar. Ibourk

Faculty of Juridical Sciences, Economic and Social, GRESS, Cadi Ayyad University , Marrakech, Morocco. Email: aomaribourk@gmail.com

Abstract-Customs is concerned with managing the risk in various stages of the customs supply chain. effective deployment of this key objective could not only fulfill the safety requirements, but also provide a competitive advantage in the commercial world. Risk assessment in Customs context is a multi-criterion decision problem which includes both qualitative and quantitative factors. The purpose of this paper is to develop a risk prioritization model enabling a structured analysis and an effective assessment of the risk. An Analytic Hierarchy Process (AHP) based methodology will be a useful tool not only to tackle the different decision criteria for prioritizing risks, but also to handle the multivariate qualitative nature of data involved in the decision-making process. A case study is presented to demonstrate the structure and organization of the model. The paper concludes by identifying the critical risks in Moroccan customs supply chain, and establishing consensual data input for a risk management strategy.

*Index Terms*—risk, risk prioritization, Analytic Hierarchy Process (AHP), customs supply chain, moroccan customs.

# I. INTRODUCTION

Customs Supply Chain is widely classified as a complex system, due to not only the large number of actors (customs, businesses, companies categorized, freight forwarders, individuals,...), but also their complex structural links, and the interactions between these actors. in fact, this system is subject to various types of Risks as smuggling of drugs, weapons or commercial fraud. The

Manuscript received March 5, 2015; revised August 1, 2015.

economic, political and social impacts of those risks are highly detrimental to the countries, businesses and to the public. For this reason, risk management in the Customs Supply Chain context is becoming a crucial issue to ensure the sustainability, safety and performance. Risk management based approach as systematic identification and implementation of all measures necessary to limit exposure to customs risk, determines which persons, goods, and means of transport should be examined and to what extent. Therefore, it is clear that just any safety policy, implementation of risk management principles, consists of an effective risk prioritization. Accordingly, it is important to use an risk assessment approach and an effective analyze of the risk faced in customs context, thus enabling decision makers to understand the capabilities and resources that need to be deployed so as to successfully implement risk management in the Customs Supply Chain. Making such judgment, however, is never an easy task as there are many qualitative factors concerned with the Risk assessment decision-making process. In the literature, analytic hierarchy process AHP is a widely employed methodology to handle the kind of this process [1]. It used qualitative variables to establish an integrated Risk assessment model so as to effectively analyze, quantify and assess the associated risk in different stages of the Moroccan customs supply chain. A numerical analysis is included in this paper to prove the effectiveness and demonstrate how of the proposed model it works. Our proposed model is aimed to not only to support the decision-making process while developing safety strategy, but also to provide a framework helps to define the various elements of a structured risk analysis approach focuses on an indicator measuring the risk.

The remaining section of this paper are organized as follows: section 2, presents the customs supply chain as a context for Risk assessment and discuses the concept and identifies the major risks. Section 3, the proposed AHP model for Risk prioritization and a numerical analysis are presented. Finally, Section 4 concludes this paper.

# II. CUSTOMS SUPPLY CHAIN

The customs logistics specialists have already dealt with the customs supply chain with great interest. Nevertheless, its practical usage has always been full of ambiguity. Consequently, it's necessary to clearly spot its conceptual, structural and functional sides.

### A. Definition of Customs Supply Chain

Customs supply chain incorporates all aspects of

moving cargo from the exporter through the transport process, the logistics operations and customs crossing to the final importer. The customs crossing refers to declaration processing, custom clearance, data analysis, risk assessment, document checking,

scanning, physical inspection, etc. The customs supply chain is no longer contained within countries borders, but encompasses all nations, whether they are exporters, importers or manufacturers [2].

### B. Customs Supply Chain Actors

Any organization takes part in the routing of flows from the starting point to its destination in the best conditions is called link or actor in the supply chain [3]. During the research internship carried at the Casablanca port, we determined the actors and their roles in the Customs Supply Chain and the major actors are divided into the main building blocks of our system, the results are summarized in Table I.

TABLE I. ROLE OF ACTORS IN THE CUSTOMS SUPPLY CHAIN (CASE OF MOROCCO).

| Basic Blocks | Actors   | Role in the supply chain  |
|--------------|--|---|
| Customs      | Importers  | Importers, in international trade, bring in (goods, merchandise, commodities, ect) from a foreign country into a domestic country (Morocco) for use, sale, processing, reexport, or services.   |
| operators    | Exporters  | In International Trade, "Exporter" refers to selling goods and services produced in the home country to other markets   |
| Transport    | Air/rail/sea carriers  | Carriers transport cargo via air, rail, or sea  |
| process      | Border highway<br>carriers   | Highway carriers transport cargo for scheduled and unscheduled operations via road across the Algerian or Mauritanian borders.  |
| Customs      | Customs officer  | Officers clear goods through customs. The responsibilities of a customs agent include documentary control, the preparation of the registration form and deposit, the determination of duties and taxes to pay, and arranging for delivery to the importer.  |
| crossing     | Freight forwarder  | Is a person or company that organizes shipments for individuals or corporations to get goods from the manufacturer or<br>producer to a market, customer or final point of distribution. A forwarder does not move the goods but acts as an expert<br>in Supply chain management.  |
| Logistic     | Freight consolidators/<br>ocean transportation<br>intermediaries and<br>nonvessel-operating<br>common carriers | <ul> <li>A freight consolidator is a firm that accepts partial container shipments from individual shippers and combines the shipments into a single container for delivery to the carrier.</li> <li>A transportation intermediary facilitates transactions by bringing buyers and sellers together.</li> <li>A nonvessel-operating common carrier is a company that buys shipping space through a special arrangement with an ocean carrier and resells the space to individual shippers.</li> </ul>   |
| process      | Port authorities<br>/terminal operators  | <ul> <li>A port authority (in Morocco: National Ports Agency, ANP) is an entity of state or local government that owns, operates, or otherwise provides wharf, dock, and other marine terminal investments at ports.</li> <li>Terminal operator (in Morocco: Marsa Maroc) responsibilities include the overseeing and unloading of cargo from ship to dock, checking the actual cargo against the ship's manifest (list of goods), checking documents authorizing a truck to pick up cargo, overseeing the loading and unloading of railroad cars, and so forth.</li> </ul> |

Source: Authors.

C. Functional Analysis

Most of specialists consider customs supply chain as a complex system, due to not only the large number of components (customs, businesses, companies, freight forwarders, individuals,...), but also their Structural links, and the interactions between these components [4]. Indeed, to establish links between actors in the customs supply chain, we opted to Functional Diagram for positioning the system in its environment (Fig. 1).



Figure 1. Functional diagram of the customs supply chain.

System Functions: Basic Functions (BF) and Complementary Function (CF):

- **BF1**: Reduce clearance delay; Simplify customs clearance procedures; Covering the customs duties and other taxes.
- **BF2**: Achieving an appropriate balance between trade facilitation and regulatory control.
- **BF3**: Fight against fraud; Comply with customs regulations (sanitary, phytosanitary, technological, etc...); Comply with customs laws.
- CF1: Achieving compliance between Customs procedures and international regulations and standards
- CF2: Facilitate commercial exchange.
- **CF3**: Achieving Customs supply chain safety and security; Monitor and manage the supply chain.
- CF4: Managing risks to ensure that the customs objectives are achieved as effectively as possible.

- **CF5**: Control cargo by the use of risk-based selectivity.
- **CF6**: Identifying high risk operators (the WCO's SAFE Framework of standard).

### D. Specification of Moroccan Customs Context

The process of Risk prioritization in Moroccan Customs Supply Chain starts with defining the Moroccan customs context in which this prioritization will take place. For this reason, It is essential to know the Strengths, Weakness, Opportunities and Threats of Moroccan customs (SWOT Analysis as depicted in figure 2) [4] to analyze the internal and external environment of Moroccan customs in order to set the criteria and parameters for the prioritization process.

| 6   | 3 | o                               | *** 1  |  |  |  |
|-----|---|---------------------------------|--|--|--|--|
|     |   | Strength                        | Weakness                                     |  |  |  |
| ÷   |   | -Implementing contemporary      | -The quality of service                      |  |  |  |
| - 6 | 7 | improvement and                 | provided to external                         |  |  |  |
| - 1 |   | development in                  | customers is still insufficient;             |  |  |  |
|     |   | standardization and             | -The articulation between                    |  |  |  |
|     |   | harmonization of customs        | central and external services is             |  |  |  |
|     |   | procedures and management       | lacking to efficiency and                    |  |  |  |
|     |   | system;                         | reactivity                                   |  |  |  |
|     |   | -Moving from control to         | <ul> <li>Lack of cooperation with</li> </ul> |  |  |  |
|     |   | facilitation;                   | other institutional actors                   |  |  |  |
|     |   | -Increasing Moroccan            | (WCO, WTO, and                               |  |  |  |
|     |   | companies competitiveness;      | INTERPOL)                                    |  |  |  |
|     |   | -Keducing both time and         | -Customs human capital                       |  |  |  |
| _   |   | procedures of clearance.        | could be better valorized                    |  |  |  |
| ÷   |   |                                 | (training, working condition.).              |  |  |  |
| Ē   |   | Opportunities                   | Threats                                      |  |  |  |
| 9   |   | -Implementing Risk              | Picks in Managan sustams                     |  |  |  |
|     |   | Management in various stages    | - Risks in Moroccan customs                  |  |  |  |
|     |   | of Moroccan customs supply      | selectivity do not cover all                 |  |  |  |
|     |   | chain,                          | types of risks in the Moroccan               |  |  |  |
|     |   | -Strategic Plan (2011-2015)     | customs:                                     |  |  |  |
|     |   | aimed to stimulate the services | - Integrity and the lack of                  |  |  |  |
|     |   | efficiency and capacity         | congruence between the                       |  |  |  |
|     |   | building.                       | written policy of Risk                       |  |  |  |
|     |   | -Reinforcing the                | management and what                          |  |  |  |
|     |   | competitiveness                 | happens in practice,                         |  |  |  |
|     |   | of Morocco and promote          | - Criminals, smugglers and                   |  |  |  |
|     |   | investment (National Pact for   | traffickers are always in                    |  |  |  |
| 9   |   | development of logistics        | search of other entry routes;                |  |  |  |
| 5   | , | competitiveness.)               |  |  |  |  |
| Ť   |   | competitiveness ).              |  |  |  |  |
| Ē   |   | Holpful                         | Hannefel                                     |  |  |  |
|     |   | Fact                            | tor Harmiul                                  |  |  |  |
|     |   | 140                             |  |  |  |  |

Figure 2. SWOT matrix of moroccan customs

The top left quadrant of the matrix Strengths (internal origin, helpful factors) represent positive internal factors in which Moroccan customs achieve an improvement and development in trade facilitation, simplification and harmonization of its procedures and management systems, and in social security and safety. The top right quadrant Weakness (internal origin, harmful factors) represents negative organizational factors and events occurring that prevent Moroccan customs from achieving its objectives,--provide international trading community with an appropriate level of facilitation, and ensure compliance with customs laws. The bottom left quadrant **Opportunities** (external origin, helpful factors) depicts the possibilities of development, technological changes, general economic trends, and political and regulatory changes expected that Moroccan customs must consider so as to involve in all international modernization process. Finally, the bottom right quadrant **Threats** (external origin, harmful factors) represents elements in the customs supply chain environment that could cause trouble for Managing supply chain, trade security, compliance with customs laws and regulatory requirements and community protection.

The important consideration from our SWOT analysis perspective is that the vulnerability of the customs supply chain is related to Risks facing in customs, to avoid and/or to limit the possibility to expose to these menaces, Customs Administrations in all over the world must implement an efficient and effective Risk Management Approach (RMA).

# E. Risk Typology in Customs Context

Whenever, we are asked to provide a consideration on risks in the customs context, there are many questions to be answered, "What are the risks? How will be identified, recognized and assessed? Where, When and How the risk is likely occurred? Who does it affect? and Why are there possibilities of fraud?". Determining the answers of these questions are not always as simple as it sounds, due to not only the relative difficulty of the actors to understand the true nature of risks, but also the large number of partners involved in customs supply chain and the economic and financial environment changing. The concept of risk in customs context refers to the possibility of events and activities occurring that may prevent the customs from achieving their objectives [5]. And it is a commonly held belief that risk is a strategic prevention and response to potential threats [6]. The important consideration from a risk perspective is to ensure that the potential risk has been correctly identified, assessed and treated, so as to achieve three primary objectives- secure the customs supply chain, ensure compliance with regulatory requirements and guarantee balance between the needs for trade facilitation and the level of regulatory control and intervention. Risks facing customs are related to the potential for noncompliance with customs laws, regulatory requirements and international standards such as restricted and prohibited goods, rules of origin, duty exemption regimes, security and safety regulation, sanitary, environmental and technical standards, intellectual property, transnational crime, commercial fraud, and illicit traffics, as well as the organizational risks. Customs supply chain, like any other supply chain, needs to manage its risks. This requires the systematic implementation of Risk management principles to limit exposure to those risks in a way to achieve a high level of both performance and safety. The underlying elements of such a strategy are identifying, analyzing, evaluating and treating risks.

Three main risk areas are defined in the documents on selectivity controls in customs operations adopted by the Moroccan Customs Administration. They are customs frauds, threats on social safety and security and organizational risks. Customs frauds, as evading payment of tariffs and other duties, are treated through: declaring and accepting improper customs value; declaring and accepting misclassification; declaring and accepting improper origin of goods; discharging of import for processing; discharging of outward processing; illicit removal of goods from customs supervision; and undeclared import goods for customs clearance, are one of the most important and highly recognized risks in Customs management strategies worldwide. Threats on social safety and security in terms of public health, and consumers, including environment proper implementation of measures related to import and export of goods to and from Morocco, as a risk area is regarded to: smuggling of weapons; smuggling of drugs and precursors; money laundering and terrorist financing; smuggling endangered animal and plant species; smuggling of nuclear and radioactive material; smuggling of high technology and weapons; illicit trade in dual-use goods; smuggling of cultural heritage; trafficking in counterfeit / pirated goods; ecological crime, and human traffics. And organizational threats are the events and activities occurring that may prevent Moroccan customs from achieving its objectives, as a risk area is regarded to: lack of staff competence, integrity, ineffective procedures, lack of coordination with other agencies, limited human and material resources, and IT failure. Determined risk areas, along with the information from different sources (IT system for processing declaration; internal detailed records from different related units within Customs Administration; information from external governmental institutions; international customs cooperation), are the main basis for identification of risks. Based on the obtained information, each identified risk is analyzed in terms of probability of risk occurrence and consequences of the risk occurrence. The level of risk is determined as intolerable, substantial or moderate.

It often assumed that, as the level of vulnerability increases, the severity of impacts increases also, this is an extremely simplistic views, as it assumes that risks in customs context have economic, political, environmental and social impacts cause serious harm to the countries, businesses and the public. Its deleterious consequences occur every day when governments cannot afford to provide vital public services because revenues are siphoned away by smugglers, criminals and corrupt officials, risks are also reckoned negatively affect industrial and commercial development due to the huge loss of turnover for some domestic companies and the transfer of economic power from the market, government and citizens to criminals which leads to the increase of crime rate (terrorism, illicit trade), The proliferation of hazardous and noxious products, which do not meet the standards of quality and consumer's health or environmental deterioration or death cases due to the drugs or counterfeit medicines consumption. In conclusion, the Customs risks affect negatively a country's economic growth, grind down its social development programs and erode investor confidence.

# III. RISK PRIORITAZATION APPROACH

Customs Supply Chain, like any other System, needs to manage its Risks. This requires a systematic approach of Risk prioritization to determine classes of risks in Customs context. Such an approach is the key to not only implement an appropriate action plan so as to limit exposure to risk, but also enable Customs to better understand the risks. The process consists of deciding whether the risk is tolerable (acceptable), and assists in determining how imminently the risk event may occur. This paper focuses on establishing a risk indicator measuring the risk in Customs Supply Chain. In this section, a Risk evaluation model is presented using Analytic Hierarchy Process AHP. It aims to prioritize as effectively as possible risks in Moroccan customs context. The following steps have been considered to form the Risk prioritization approach are:

- Structuring the problem and building the AHP model.
- Determining the normalized priority weights of individual factors and sub factors.
- Synthesis-finding solution to problem.

# A. Research Methodology

In this study to prioritize strategic Risk areas and Risks in Customs Supply Chain, Analytic Hierarchy Process (AHP) approach is used. It provides a framework to cope with multiple criteria situations involving intuitive, rational, quantitative and qualitative aspects. AHP [7] was developed in 1972 as a practical approach in solving relatively complex problems. AHP helps the analysts to organize theoretical aspects of a problem into a hierarchical structure similar to a family tree. By reducing complex decisions to a series of simple comparisons and rankings, then synthesizing the results, the AHP not only helps the analysts to arrive at the best decision, but also provides them with a clear rationale for the choices made [8]. Due to its mathematical simplicity and flexibility, AHP has been a favorite decision tool for research in many fields, such as engineering, food, business, ecology, health, and government. In addition to AHP, the Analytic Network Process (ANP) technique, also developed by Thomas L. Saaty, is a generic form of AHP that allows for more complex, interdependent, relationships, and feedback among elements in the hierarchy [9]. Ho [10] reviewed integrated AHP articles and observed that mathematical programming, Quality Function Deployment (QFD), meta-heuristics, SWOT analysis, TOPSIS and Data Envelopment Analysis (DEA), decision tools were commonly combined with AHP.

# B. Structuring A Hierarchy Model for Prioritization of Risks

This step involves formulating an appropriate hierarchy of AHP model. consisting of the goal, strategic areas, sub-factors and results. The goal of our problem is to prioritize Risks in Customs Supply Chain to implement an appropriate action plan so as to prevent or respond the criticality of risks. This goal is placed on the first level of the hierarchy as illustrated in Fig. 3. Five strategic risk areas are identified to achieve this goal, which form the second level of hierarchy. The third level of hierarchy consists of 28 risks of five strategic risk areas. The strategic areas and their sub factors used in these two levels of AHP hierarchy can be assessed using the basic AHP approach of pair wise comparison of elements in each level with respect to every parent element located

one level above [11], [12]. The lowest or the fourth level of hierarchy consists of the results.



Figure 3. Hierarchical structure of integrated risk assessment model for Moroccan customs

### C. Normalized Weights Evaluation

In order to determine the relative importance of the strategic Risk areas and Risks, the pair-wise comparison judgment matrices are formed by guidance of experts and senior officials from Moroccan customs administration who had been tasked with implementing the risk management in Moroccan customs. For evaluating normalized weight, following steps above .

### 1) Establishment of pair-wise comparison matrices

To assess risk in customs context, it is essential to hierarchize the criteria used, i.e., how important one criterion or sub-criterion is when compared to another one. Using AHP method, it means that the pair-wise comparisons are established using a nine-point scale that converts human preferences into available alternatives such as equally, moderately, strongly, very strongly or extremely preferred. For example, if two elements are assumed equally important, the comparison will have a scale of 1. If one element is moderately more important than the other, the analysis will have a scale of 3. Subsequently, scales 5, 7 and 9 are used to describe strongly more important, very strongly more important and extremely more important, respectively. The corresponding reciprocals 1, 1/2, 1/3,..., 1/9 are used for the reverse comparison. The pair-wise comparisons of the attributes at each level in the hierarchy are arranged into a reciprocal matrix [1]. In general, the comparison matrix are defined as =  $(a_{ii})$ , where A = reciprocal matrix with the elements  $a_{ii} = 1/a_{ii}$ . The relative weights of the elements at each level with respect to a given element are computed as the components of the normalized eigenvector associated with the largest eigen-value of the comparison matrix A. Table II to Table VII shows the pair-wise comparison matrix for different level of hierarchy.

TABLE II. PAIR-WISE COMPARISONS OF RISK AREAS.

| Criteria | TF | PNH   | EECR  | PNR  | CPS  | Weights<br>(PV) |
|----------|----|-------|-------|------|------|-----------------|
| TF       | 1  | 1/3   | 1/5   | 1/7  | 1/9  | 0,033           |
| PNH      | 3  | 1     | 1/2   | 1/6  | 1/8  | 0,064           |
| EECR     | 5  | 2     | 1     | 1/4  | 1/7  | 0,103           |
| PNR      | 7  | 6     | 4     | 1    | 1/7  | 0,230           |
| CPS      | 9  | 8     | 7     | 7    | 1    | 0,570           |
| Σ        | 25 | 17,33 | 12,70 | 8,56 | 1,52 | CR=0.085        |

TABLE III. PAIR-WISE COMPARISON JUDGMENT MATRICES: OF TRADE FACILITATION (TF).

| Criteria | ITF   | IP   | LCA  | Weights<br>(PV) |
|----------|-------|------|------|-----------------|
| ITF      | 1     | 1/5  | 1/7  | 0,074           |
| IP       | 5     | 1    | 1/3  | 0,283           |
| LCA      | 7     | 3    | 1    | 0,643           |
| Σ        | 13,00 | 4,20 | 1,47 | CR=0.054        |

TABLE IV. PAIR-WISE COMPARISON JUDGMENT MATRICES: OF PROTECTION OF THE NATIONAL HERITAGE (PNH).

| Criteria | SACH  | SAH   | SCH   | Weights<br>(PV) |
|----------|-------|-------|-------|-----------------|
| SACH     | 1     | 1/2   | 1/3   | 0,170           |
| SAH      | 2     | 1     | 1     | 0,387           |
| SCH      | 3     | 1     | 1     | 0,443           |
| Σ        | 6,000 | 2,500 | 2,333 | CR=0.016        |

| Cri | iteria | LSC   | IG    | LMR   | LHR   | ML       | CF   | Weights<br>(PV) |
|-----|--------|-------|-------|-------|-------|----------|------|-----------------|
| ]   | LSC    | 1     | 1/2   | 1/3   | 1/4   | 1/7      | 1/9  | 0,033           |
|     | IG     | 2     | 1     | 1/2   | 1/3   | 1/5      | 1/8  | 0,050           |
| Ι   | LMR    | 3     | 2     | 1     | 1/2   | 1/5      | 1/7  | 0,075           |
| I   | LHR    | 4     | 3     | 2     | 1     | 1/4      | 1/5  | 0,114           |
|     | ML     | 7     | 5     | 5     | 4     | 1        | 1/2  | 0,284           |
|     | CF     | 9     | 8     | 7     | 5     | 2        | 1    | 0,443           |
|     | Σ      | 26,00 | 19,50 | 15,83 | 11,08 | 3,7<br>9 | 2,08 | RC=<br>0,03     |

| TABLE VI. PAIR-WISE COMPARISON JUDGMENT MATRICES: OF      |
|---|
| PROTECTION OF PRESERVATION OF THE NATURAL RESOURCES (PNR) |

| Criteria  | SNR    | SSIOL  | STW    | ITPPH | ITPSA | SEAP  | Weights<br>(PV) |
|-----------|--------|--------|--------|-------|-------|-------|-----------------|
| SNR       | 1      | 1/2    | 1/3    | 1/5   | 1/5   | 1/7   | 0,038           |
| SSIOL     | 2      | 1      | 1/2    | 1/3   | 1/3   | 1/7   | 0,059           |
| STW       | 3      | 2      | 1      | 1/2   | 1/3   | 1/6   | 0,089           |
| ITPP<br>H | 5      | 3      | 2      | 1     | 1     | 1/5   | 0,158           |
| ITPSA     | 5      | 3      | 3      | 1     | 1     | 1/3   | 0,183           |
| SEAP      | 7      | 7      | 6      | 5     | 3     | 1     | 0,472           |
| Σ         | 23,000 | 16,500 | 12,833 | 8,033 | 5,867 | 1,986 | RC=<br>0,03     |

TABLE V. PAIR-WISE COMPARISON JUDGMENT MATRICES: OF PROTECTION OF COLLECTION OF REVENUE (EECR).

TABLE VII. PAIR-WISE COMPARISON JUDGMENT MATRICES: OF PROTECTION OF COMMUNITY PROTECTION AND SECURITY (CPS)

| Criteria | SE    | ITD   | IPT   | SP    | SW    | SG   | тс   | SC   | SD   | SN   | Weights<br>(PV) |
|----------|-------|-------|-------|-------|-------|------|------|------|------|------|-----------------|
| SE       | 1     | 1/2   | 1/3   | 1/4   | 1/5   | 1/7  | 1/7  | 1/7  | 1/7  | 1/7  | 0,018           |
| ITD      | 2     | 1     | 1/2   | 1/3   | 1/5   | 1/7  | 1/7  | 1/7  | 1/7  | 1/7  | 0,021           |
| IPT      | 3     | 2     | 1     | 1/3   | 1/4   | 1/7  | 1/7  | 1/7  | 1/7  | 1/7  | 0,027           |
| SP       | 4     | 3     | 3     | 1     | 1/2   | 1/7  | 1/7  | 1/7  | 1/7  | 1/7  | 0,038           |
| SW       | 5     | 5     | 4     | 2     | 1     | 1/5  | 1/5  | 1/5  | 1/5  | 1/5  | 0,056           |
| SG       | 7     | 7     | 7     | 7     | 5     | 1    | 1    | 1    | 1    | 1    | 0,168           |
| тс       | 7     | 7     | 7     | 7     | 5     | 1    | 1    | 1    | 1    | 1    | 0,168           |
| SC       | 7     | 7     | 7     | 7     | 5     | 1    | 1    | 1    | 1    | 1    | 0,168           |
| SD       | 7     | 7     | 7     | 7     | 5     | 1    | 1    | 1    | 1    | 1    | 0,168           |
| SN       | 7     | 7     | 7     | 7     | 5     | 1    | 1    | 1    | 1    | 1    | 0,168           |
| Σ        | 50,00 | 46,50 | 43,83 | 38,92 | 27,15 | 5,77 | 5,77 | 5,77 | 5,77 | 5,77 | RC= 0.048       |

# 2) Calculation of the Degree of Consistency at Different Level of the Hierarchy

It is known that people are often inconsistent in answering questions, and thus one of the important tasks of AHP is to calculate the consistency level of the estimated vector. Consistency ratio (CR) is used to measure the consistency in the pair-wise comparison. Saaty [13] has set the acceptable CR value for different matrices sizes; the CR value is 0.05 for a 3-by-3 matrix 0.08 for a 4-by-4 matrix; and 0.1 for large matrices. If consistency level falls into the acceptable range, the weight results are valid. Having done all the pair-wise comparisons and entered the data, the consistency is determined using the Eigen value. To do so, normalize the column of numbers by dividing each entry by the sum of all entries. Then sum each row of the normalized values and take the average. This provides priority vector (PV). To check the consistency of judgments following steps are followed:

- Let the pair-wise comparison matrix be denoted C<sub>1</sub> and principal matrix be denoted C<sub>2</sub>.
- Then define :

$$C_3 = C_1 \times C_2 \text{ and } C_4 = \frac{C_3}{C_2}$$
 (1)

- $\lambda_{max}$  = average of the elements of C<sub>4</sub>
- Consistency index :

$$(\mathbf{CI}) = \frac{(\lambda_{\max} - \mathbf{N})}{(\mathbf{N} - \mathbf{1})}$$
(2)

Consistency ratio

(CI) = 
$$\frac{(CI)}{(RCI)}$$
 corresponding to N (3)

where **RCI** = random **CI** and **N** = numbers of elements (refer Table VIII). If **CR** is less than 10 percent, judgments are considered consistent, if CR is greater than 10 percent, the quality of judgments should be improved so that **CR**  $\leq$  **0.01** [1].

TABLE VIII. AVERAGE RANDOM INDEX VALUES

| 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|------|------|------|------|------|------|------|------|------|------|
| 0.00 | 0.00 | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

# 3) Results and discussion

After computing the normalized priority weights for each pair-wise comparison judgment matrices of the AHP hierarchy, the next step is to discuss the result as depicted in the Fig. 4.



Figure 4. Final weights of each risk areas

According to the final score the community protection and security is the most critical risk areas because it has a highest priority weight, and Smuggling of Narcotics, Smuggling of cigarettes, Smuggling of drugs, Trafficking in counterfeit /pirated goods, Smuggling of goods, Smuggling of weapons, Smuggling of precursors of drugs, Illicit traffic of Product not corresponding to the required technical standards, Illicit trade in dual-use goods and Smuggling of explosives are the most critical risks within Moroccan Customs Supply Chain which required a specific treatment. Such treatment is impacted by many different issues, including: internal capability; internal capacity; risk rating/level/ nature return of treatment, and financial, human and material resources allocated to addressing risk. And preservation of the natural resources and effective and efficient collection of revenue are the next recommended risk areas to give more importance in order to secure Moroccan Customs Supply Chain. All other risks under protection of the national heritage and trade facilitation must be dealt with by scrutiny, in order to keep precious time and efforts for potentially higher risks.

One main purpose of this research is to establish the Risk prioritization using priority weight as an indicator measuring the risks in Customs Supply chain. Such a quantified risk indicator will be useful to compare the risk level between the various stages of supply chain under different approach of Risk management and derive classification of Risks. A higher risk indicator corresponds to a more critical risk in the customs context, which requires a specific treatment and control process. Through the numerical analysis presented, the effectiveness of the proposed model is established.

The development of such a prioritization model assists in the determination of procedures and main points where efforts and resources have to be concentrated. It helps to answer questions such as, where future compliance resources should be directed? which goods and means of transport should be examined? to what extend?. In addition, it provides a way to ensure that the relevant risk has been effectively quantified, to avoid the introduction of extraneous variables into the decision making process.

#### IV. CONCLUSION

Facing increase in pressure to secure the Customs Supply Chain, obliges decision makers to react accordingly in order to effectively assess the risks in different stages of the customs supply chain. It is important to be aware of the tools that can help them to make associated decisions. The purpose of this study was to develop a risk prioritization model enabling a structured analysis and an effective assessment of the risk in customs context. A hierarchical structure model using AHP approach was developed addressing diverse vulnerability aspects associated in Moroccan customs supply chain.

The relative weight of each risk gives an indicator to measuring the risk and helps to identify key critical risks that highlight the vulnerability of Moroccan customs supply chain so as to implement an efficient and effective actions to treat these risks. The Results could not only be helpful to support the decision-making process while developing safety strategy, but also be used to better understand the true nature of the risk customs supply chain [14].

Although methodology adopted in this study has been quite useful in prioritizing different Risk areas and Risks under them but not without some limitations. Major limitation is that the rating scale used in the AHP analysis is conceptual, uses a discrete scale of one to nine which cannot handle the uncertainty and ambiguity present in deciding the priorities of different attributes as well as the different decision criteria in risk assessment in customs supply chain involves a high degree of subjective judgment. This prioritization approach does not provide guidance on an appropriate action plan to address deficiencies. There are also chances of biasing while making pair wise comparisons to different factors. Therefore due care should be taken while deciding relative score to different factors. This study can be further extended by considering Fuzzy AHP approach or ANP so as to revise this model after considering some other factors responsible for securing Customs supply chain.

# APPENDIX A CALCULATION OF THE GLOBAL WEIGHTS OF RISK AREAS

Following steps are followed for calculation to make normalized table of Risk areas of community protection and security, preservation of the natural resources, effective and efficient collection of revenue, protection of the national heritage and trade facilitation:

Let C1= Pair wise comparison matrix From Table II. (pair wise comparison of Risk areas)

|             | /1 | 1/3 | 1/5 | 1/7 | 1/9\ |
|-------------|----|-----|-----|-----|------|
|             | 3  | 1   | 1/2 | 1/6 | 1/8  |
| <b>C1</b> = | 5  | 2   | 1   | 1/4 | 1/7  |
|             | 7  | 6   | 4   | 1   | 1/7  |
|             | \9 | 8   | 7   | 7   | 1 /  |

Normalized table is achieved by dividing each value of column by the sum of respective column.

T= the total sum of the values of the same row.

Priority vector (P.V.) = T/N

N= Number of elements

Example for TF normalized value =  $1/_{25} = 0.04$ 

$$T = 0.04 + 0.02 + 0.02 + 0.02 + 0.07 = 0.16$$

$$P.V = \frac{0.16}{5} = 0.033$$

C2= Principle matrix

Criteria pair wise comparison matrix normalized (from Table II)

|      | TF   | PNH  | EECR | PNR  | CPR  | SU<br>M | PV    |
|------|------|------|------|------|------|---------|-------|
| TF   | 0,04 | 0,02 | 0,02 | 0,02 | 0,07 | 0,16    | 0,033 |
| PNH  | 0,12 | 0,06 | 0,04 | 0,02 | 0,08 | 0,32    | 0,064 |
| EECR | 0,20 | 0,12 | 0,08 | 0,03 | 0,09 | 0,52    | 0,103 |
| PNR  | 0,28 | 0,35 | 0,31 | 0,12 | 0,09 | 1,15    | 0,230 |
| CPS  | 0,36 | 0,46 | 0,55 | 0,82 | 0,66 | 2,85    | 0,570 |

$$C2 = \begin{pmatrix} 0.033\\ 0.064\\ 0.103\\ 0.230\\ 0.570 \end{pmatrix}$$

$$C3 = C1 \times C2$$

$$C3 = \begin{pmatrix} 0.171\\ 0.310\\ 0.509\\ 1.281\\ 3.630 \end{pmatrix}$$

$$C4 = \frac{C3}{C2}$$

$$C4 = \frac{C3}{C2}$$

$$C4 = \frac{5.1818}{4.8437}$$

$$4.9417\\ 5.5695\\ 6.3684 \end{pmatrix}$$

Check the constancy:

 $\lambda_{max}$  = average of the elements of C<sub>4</sub> Consistency index :

$$(\mathbf{CI}) = \frac{(\lambda_{\max} - \mathbf{N})}{(\mathbf{N} - 1)}$$
$$(\mathbf{CI}) = \frac{(5.381 - 5)}{(5 - 1)} = 0.0952$$

And Consistency ratio:

$$(\mathbf{CI}) = \frac{(\mathbf{CI})}{(\mathbf{RCI})}$$

where RCI = random consistency index corresponding to N from Table IV

$$CR = \frac{0.0952}{1.12} = 0.085$$
  
i.e.  $CR < 0.1$ 

Global weightage of the main Risk areas = P.V. value from the respective normalized Table III.

Similarly, global weightage for the Risk areas and Sub risk areas can be calculated.

### ACKNOWLEDGMENT

F. L. Hammadi thanks the Staff of Moroccan Customs Administration for their cooperation and directives were exceptional assistance in the design, progress and completion of this research.

### REFRENCES

- [1] T. L. Saaty, *The Analytic Hierarchy Process*, New York: Mc Graw-Hill, 1980.
- [2] C. S. Tang, "Perspectives in supply chain risk management," *International Journal of Production Economics*, vol. 2, pp. 451-488, 2006.
- [3] H. Hugos Michael, Essentials of Supply Chain Management, John Hoboken, New Jersey: Wiley & Sons Inc, 2003. pp. 23.
- [4] H. L. Ait Ouahman and A. Ibourk, "Risk management and security practice in customs supply chain: Application of cross ABC method to the Moroccan customs," *International Journal of Social, Management, Economics and Business Engineering*, vol. 8, pp. 1563-1573, May 2014.
- [5] D. Widdoson, "Managing risk in the customs context," in *Customs Modernization Handbook*, L. D. Wolf and J. B. Sokol, Eds., Washington DC: World Bank, 2004, pp. 91-99.
- [6] C. W. Autry and Bobbitt "Supply chain security orientation: conceptual development and a proposed framework," *The International Journal of Logistics Management*, vol. 19, 2008.
- [7] T. L. Saaty, "How to make a decision: The analytic decision process," *European Journal of Operational Research*, vol. 48, pp. 9-26, 1990.
- [8] K. S. Chin, S. Chiu, and V. M. R. Tummala, "An evaluation of success factors using the AHP to implement ISO 14001-based ESM," *International Journal of Quality & Reliability Management*, vol. 16, no. 4, pp. 341-361, 1999.
- [9] T. L. Saaty, *The Analytic Network Process*, Pittsburgh, PA.: RWS Publications, 2001.
- [10] W. Ho, "Integrated analytic hierarchy process and its applications: A literature review," *European Journal of Operational Research*, vol. 186, no. 1, pp. 211-228, 2008.
- [11] R. K. Singh, "Prioritizing the factors for coordinated supply chain using analytic hierarchy process (AHP)," *Measuring Business Excellence*, vol. 17, no. 1, pp. 80–97, 2013.
  [12] J. Gilleard and P. W. Yat-Lung, "Benchmarking facility
- [12] J. Gilleard and P. W. Yat-Lung, "Benchmarking facility management: Applying analytic hierarchy process," *Facilities*, vol. 22, no. 1-2, pp. 19-25, 2004.
- [13] T. L. Saaty, "How to make a decision: The analytic hierarchy process," *Interface*, vol. 24, no. 6, pp. 19-43, 1994.
- [14] Report of World Customs Organization WCO, Risk Management in Customs Context, 2003, vol. 1, pp. 3-54.



Lamia. Hammadi, is a PhD Student in in the second year of logistics engineering under the theme "Customs supply chain Engineering: modeling and risk management: application to Moroccan Customs" at the National School of Applied Sciences, University Cadi Ayyad, Marrakech, Morocco. Lamia graduated as an Industrial Engineer from National School of Applied Sciences-Fes Morocco, in July 2011. Her research areas include Customs

Supply chain

Management, Modeling, Risk Management and Supply Chain Security. During her study period and previous professional training experiences in some well-known Moroccan companies, she was given an effective contact to all the considered fields: Reliability Engineering, Process and Method Engineering, Lean Manufacturing Systems, Quality Management, Supply Chain Management, and Maintenance. Through those experiences, she enhanced her leadership skills, communication and teamwork capabilities, and also she acquired how to manage a team, develop HR processes of organizations and to set clear and measurable goals.



Jos é Eduardo. Souza de Cursi graduated in Physics from the University of São Paulo, master's degree in physics from the Brazilian Center for Physics Research and Docteur en Sciences - Universit é des Sciences et Techniques du Languedoc. It is a full professor at the Institute National des Sciences Appliqu és of Rouen, France. He is currently Director of the Laboratoire de M écanique de Rouen, Director of European

Affairs and International of INSA Rouen and responsible for the Franco-Dominican training program Dominicans engineers in France. He has experience in Applied Mathematics and Theoretical Mechanics area, with emphasis on Numerical Analysis, Stochastic Methods and Convex Analysis.



**Prof. Ait Ouahman** WON the 3rd cycle doctorate in 1981 at the INPG Grenoble, France in the field of Signal Processing applied to climatology and Renewable Energy. In 1981 he joined the higher education a s Assistant Professor in the Department of Physics at the Faculty of Sciences Semilaia Marrakech. In 1992 he supported the state doctorate in Physical Sciences. He was

appointed to the rank of PES since 1993.. In the field of Scientific and Technical Research island framed several national doctoral theses, condition PhD and Habilitation. He has participated in the publication a hundred articles in international scientific journals and more than a hundred papers in international conferences and congresses. Currently, he is in the field of signal processing applied to telecommunications networks, transportation, renewable energy, energy efficiency. Member of the working group: Sustainability Model Moroccan development option of the green economy, this topic belongs to the curriculum: "Global competitiveness and positioning of Morocco in globalization,"



**Prof. Ibourk** is a professor of quantitative methods and social economics at the Cadi Ayyad University in Marrakech and an economist. He is also the director of GRES (Economic and Social Research Group) at the same university. His research focuses on econometric methodologies applied to social sciences (labor economics, economics of education and economy of philanthropy). His doctoral thesis looks into the "Contribution to

Econometrics through the Labor Market Matching Process: Macro and Micro econometric Approaches to the Moroccan Labor Market." He has recently published in *Empirical, Prospects: Quarterly Review of Comparative Education.*