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## Conference Paper

# Interrelationships Among Airports And The Hinterland Players. A Value Network Analysis Approach

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# INTERRELATIONSHIPS AMONG THE AIRPORTS AND THE HINTERLAND PLAYERS. A VALUE NETWORK ANALYSIS APPROACH.

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## ABSTRACT

The measured of airport performance and its efficiency is generally made using operational and financial data, thus, providing a position rank in respect to a set of airports. But this methodology, by itself, cannot provide the relationships between a certain position in the rank of an airport and the generated value associated with that position, either within the entire business system of the airport or within the inter-relationships that it establishes with the surrounding community.

To understand the role that airport infrastructure plays within the regional development, not only a variety of relationships must be recognized, but also how they create or may create value. For better understanding of how processes and people create value in an airport network ecosystem, it is possible to use Value Network Analysis (VNA). VNA is a methodology that provides a

capability to understand, visualize and optimize internal and external value networks of complex economic ecosystems, thus capturing dynamics of the entire system

This paper presents a map of the interrelationships between the airport's players and the hinterland's players in four different scenarios: the air traveler; the cargo, the supply chain; and infrastructure development, considering the related impacts in the form of the tertiary effects and perpetual effects. The first scenario, results, from the existence of the air transport services for the use of individuals, the second for when companies need a high speed and quality transport services. The third and fourth scenario considers perpetual effects associated with the regional economy considering that an infrastructure investment will raise the level of activity and stimulates productivity.

These scenarios are comprised in a adapted model with four interconnected interface domains that we assume reinforce the sustainability of airport business activities within a territory in the long-term: Economic Development, Land Use, Infrastructures and Governance.

This model is essentially an organizing tool that identifies key policy areas to improve integrated decision-making processes and is a conceptual framework for future research. The application of VNA methodology allows the recognition and assessment of impacts and relationships between multiple systems, thus avoiding an ad-hoc analysis and compartmentalized of issues. In the context of the present study not only a variety of relationships are recognized, but also how they create or may create value, allowing a better understanding of the role that airport infrastructure plays within the regional development.

**Keywords:** Airports Infrastructure, Regional Development, Scenarios, Value Network Analysis

**JEL-CODES:** L93, O18 and R41

## INTRODUCTION

Accordingly to the expected results of one of the Airdev<sup>1</sup> Project's tasks, related with the hinterland effects, two main outcomes will be delivered: 1) A system dynamics model; and 2) a model for the evolution of an airport into a city airport, which derives from the first outcome.

The first outcome will show the mechanisms responsible for the generation of economic and social benefits. It identifies the key variables and their relationships that allow evaluating the impacts resultant from the existence of an airport. The second outcome will provide the framework for evolution from airport into city airport, being sufficient flexible to handle with different sizes of

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<sup>1</sup> AIRDEV- Business Models for Airport Development and Management, a project in partnership with MIT-Portugal Program and financed by FCT (Fundação para a Ciência e Tecnologia) with the reference MIT-Pt/TS-AAS/0046/2008.

airports. The model will include all the relevant activities that may be located in an airport city and also the relevant vectors of development: economic, financial, strategic, marketing and processes.

The concept of system is transversal to the both outcomes, which relies on networks and dynamic interrelations. For better understanding of how processes and people create value in an airport network ecosystem, it is possible to use Value Network Analysis (VNA). VNA is a methodology that provides a capability to understand, visualize and optimize internal and external value networks of complex economic ecosystems, thus capturing dynamics of the entire system.

Our study, maps the players and their interrelationships in four different scenarios: the air traveler experience, the air cargo, the infrastructure development and the supply chain.

## **THEORETICAL FRAMEWORK**

A number of limitations in the practice of airport economic impact studies were identified (TRB, 2008), which raise the question if the metric of the impacts is the more adequate and even if this metric is more important than majoring the opportunities associated with airport.

The adequacy of any method (traditional or not) to measure net benefits, impacts or even to identify relevant vectors of development depends on the understanding of the complex roles and spatial interactions actually associated with a given system. The same is true when the goal is not the metric of the impacts but instead majoring the opportunities associated with that system. These facts call for refreshed conceptual frameworks for better understanding the regional opportunities and constrains associated to airports and, at the same time, for integrative models that allow recognizing and understanding the nature and importance of international, national, regional and local airports' sustainable growth.

In this context, quantification alone is not enough for the understanding of such complex systems. Matters of pattern, structure and value conversion must be considered along with several levels of analysis.

Network approach is viewed as one strategy for cross-level analysis and has been used to understand the conversion of the value of financial and non-financial assets in other forms of value.

### **Networks and Social Network Analysis (SNA)**

The concept of network is being used in scientific literature in two directions (Romeiro, 2007), particularly relevant in the context of this paper. As a 1) fundamental architecture for the economic, social and institutional organization: in this context a network represents an organizational structure comprised of independent elements that establish relations between them for medium-long term, based on the will of the elements to work together around common

objectives, which could not be achieved in the same way through individual work (Vernon, 2005); and as an 2) explanatory principle of complex realities structure: in this sense the concept of network refers to a set of actors (individuals, institutions or organizations) bound by a set of social relations of a certain type (friendship, business or other), (Gulati, 1998). Therefore, the social network can be viewed as a series of links that are established between a defined set of social actors (Requena, 1989; Powell and Smith-Doer, 1994).

Both perspectives of analysis are important for this research. While organizational structure the concept of network is understood as a structure between the market and the hierarchy, formed by more than two organizations (corporate, public organization, association, university, airports among others) who decide, formally or informally, initiate cooperation in the medium term involving the exchange of resources (material or immaterial). The network is established under the premise that all organizations within a network are interdependent, meaning that the behavior of one organization affects and is affected by the behavior of the others organizations. This design points out explicitly the components of a network - a set of actors and a set of relations, whose structure can be systematized and analyzed through the Social Networks Analysis (SNA).

### **Value Network Analysis (VNA)**

To overcome the SNA limitations Allee (2008a) proposed a network methodology that allows measuring the value creation of networks. According to this author (op.cit., 2008a:2) (...) *because the network is the primary economic mechanism for value conversion, network analysis can be used to describe the value creation dynamics of work groups, organizations, business webs, and purposeful networks engaging in both tangible and intangible value exchanges to support the achievement of specific outcomes and to generate economic and social good.*

According to Allee (2008) value network is any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social value. This definition allows application of the value network perspective to the a) internal value networks focused on the sets of relationships between individuals, within and among work groups and between and among the various work groups that make up the organization; and to the b) external-facing value networks, which comprise those between the organization and its suppliers, its investors, its strategic business partners, and its customers.

Another related concept is value conversion, which refers to the act of converting or transforming financial to non-financial value or transforming an intangible input or asset into a financial value or asset. When considering value conversion, it is necessary to assess the inputs and outputs for each role in the network to determine whether value conversion opportunities are being overlooked. Also the network is a value conversion mechanism that achieves not only positive

goods and outcomes, but nefarious and negatives ones as well, according to the values and intent of those who serve the network.

Based on these concepts, Allee (2008b) proposed a methodology called Value Network Analysis (VNA) which provides a network ecosystem perspective into how processes and people create value.

This methodology presents several advantages in comparison with the traditional SNA (Allee, 2008b):

- It shows both structured relationships and the informal yet essential flow paths of knowledge sharing and support;
- Provides a perspective for understanding value creating roles and relationships, both internal and external, upon which an organization depends;
- Offers dynamic views of how both financial and non-financial assets can be converted into negotiable forms of value that have a positive impact on those relationships;
- Explains how to more effectively realize value for each role and how to utilize tangible and intangible assets for value creation;
- Provides a systematic analysis of how one type of value is converted into another.

The ability of VNA to better describe effective work networks has been demonstrated at many organizations addressing a wide range of business issues. The number of published case studies and academic articles referencing and applying Value Network Analysis is multiplying rapidly with more than 50 relevant academic articles published in 2007, more than double those published in 2006. Company adoption of VNA, especially the Allee method, has been growing rapidly in global companies, government agencies, and civil society organizations and networks (Verna, 2009).

## **DYNAMIC PROCESSES OF AN AIRPORTS SYSTEM. AN EMPIRICAL STUDY**

Most executives, managers and operations professionals use production line thinking in a networked world; this production line includes Value Stream Map and Business processes, and this is the traditional way to access the characteristics of the network. This is a process that is much time consumer and slow, and in real business you don't follow the rules all the times: if a little extra help is necessary, probably you will talk to someone who will help you, rather than follow some procedure... time is money. Value Network Analysis, VNA, is a methodology that provides a capability to understand, visualize and optimize internal and external value networks of complex economic ecosystems, thus capturing dynamics of the entire system.

According to Allee (2008) value network is any set of roles and interactions in which people engage in both tangible and intangible exchanges to achieve economic or social value. This definition allows application of the value network perspective to the a) internal value networks focused on the sets of relationships between individuals, within and among work groups and between and among the various work groups that make up the organization; and to the b) external-facing value networks, which comprise those among the organization and its suppliers, its investors, its strategic business partners, and its customers.

To establish the VNA Scenarios it was necessary to understand the airport network with all of its partnering relationships and transform the business itself as set of networks (scenarios). The airport as several business networks, the first scenario, business network, results from the existence of the air transport services for the use of individuals; the second for when companies need a high speed and quality transport services; in the third scenario the infrastructure itself is a network of services offered to the airlines and clients and its supply chain; and the fourth scenario considers perpetual effects associated with the regional economy considering that an infrastructure investment and development will raise the level of activity and stimulates productivity. Thus it was created 4 different scenarios, the Traveler Scenario, Cargo Scenario, Supply Chain Scenario and the Infrastructure Development Scenario. Applying the Value Network Analysis to the scenarios provides an approach to network ecosystem perspective, how processes and people create value within the Network. These scenarios are comprised in an adapted model with four interconnected interface domains that we assume reinforce the sustainability of airport business activities within a territory in the long-term (Figure 1):

The **Economic Development** of the territory, as a result of airport activities. For all stakeholders in the different scenarios it is important to be acquainted to the roles and interactions and to understand all financial and social economic impacts of their activities to ensure that opportunities to achieve regional, national and international benefits are maximized.

**Land Use** is related with geographical/geophysical resources of the region, and has both social and biophysical environmental impacts. These impacts can be best managed if planning schemes and strategies incorporate: development trends; existing land use patterns; land characteristics; identified human and physical characteristics of land; and desired and possible future uses. The compatibility between individual intentions of land use and collective land use planning beyond is fundamental; these roles and interactions are primarily with/in the Infrastructure Development Scenario but can also be in the Services and Supply Chain Scenario.

**Infrastructures** include large-scale installations that connect and serve commercial, industrial, residential and cultural nodes within the region. Typical elements are roads, railways, utilities, ports, other airports, freight and service interchanges, and information and communication

technology. They are fundamental for airport systems efficiency and for the development of its capacity, but must be well balanced ensuring that regional connections are not achieved by the damage of local connectivity; these roles and interactions are primarily with/in the Infrastructure Development Scenario.

**Governance** refers to the legislative arrangements and institutionalized processes that have been designed or have evolved to guide the social structures and behaviors of individuals and organizations. Governance may also be recognized as the administering of policy and actions of all kinds, often relating to decisions taken; these roles and interactions are transversals to all Scenarios.



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For the analysis made in the business networks, scenarios, it was used the Value Network Indicators of Figure 2.

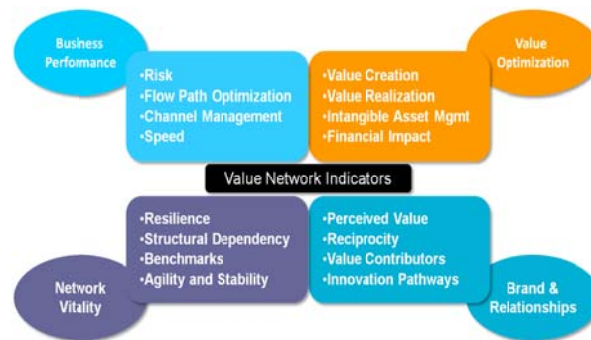


Figure 2: Value Network Indicators

- **Resilience** indicators are useful for asking about whether flows need to be more or less formally structured and appropriate ratios of formal vs informal exchanges;
- **Value Creation** indicators help understand which Roles are playing key informational Roles that are often overlooked in process improvement;
- **Asset Management** indicators also help identify low-value Transactions and Deliverables and show which value flows accelerate value creation and which are drains on assets;
- **Risk** indicators show where too much dependency on a Role puts a value flow under risk.



Thus for a better understanding of how processes and people create value in an airport network ecosystem, the Value Network Analysis (VNA), a methodology proposed by Allee and colleagues (Allee ,1998, 2000, 2002, 2008; Allee and Taug 2006; Venezia *et al.*, 2007; Allee and Schwabe, 2009), has been used for this research.

## **Methodology**

The analysis begins with a **visual map** or diagram that shows the essential contractual, **tangible** revenue or business funding-related transactions and exchanges that occur between each node of the network.

The **nodes** represent individuals or groups of individuals, as a business unit, or aggregate groups as a type of business in a network of industry and each node is analyzed from a perspective of the **role** it plays within the system.

People generate **value** by assuming or creating **roles** to **convert** tangible and intangible assets into **deliverables** that can be conveyed to other roles through the execution of a **transaction**. In turn, companies realize value when they convert inputs into gains.

Furthermore the critical **intangible** exchanges (informal knowledge exchanges and benefits or supports that build relationships) are also made visible with a value network analysis. These intangible exchanges, traditionally ignored by the business practices, are a fundamental key for creating trust and opening ways for innovation.

The several visualizations and diagrams link to a variety of **assessments** (usually using Excel spreadsheets) allowing to increase value outputs, to leverage knowledge and intangibles for improving financial and organizational performance, and to detect new value opportunities. Through this analysis it is possible to gain insights into what is happening into the ecosystem, where more value can be realized, and what is required to achieve maximum value benefit across the entire business activity or ecosystem that is the focus of the analysis.

Our study maps are related to the interrelationships among the airport's players and the hinterland's players in four different scenarios, considering the related impacts in the form of the tertiary effects and perpetual effects:

1. Air Traveler Experience Scenario;
2. Cargo Scenario;
3. Supply Chain Scenario;
4. Infrastructure Development Scenario.

The first scenario results from the existence of the air transport services for the use of individuals. The second is related with those companies that need a high speed and quality transport service. The third scenario considers the supply of goods and services that contribute to

the operations of an airport. The fourth scenario considers perpetual effects associated with the regional economy considering that an infrastructure investment will raise the level of activity and stimulates productivity, setting in progress a bigger and longer lasting cross regional economic development leading to profitable scale economies.

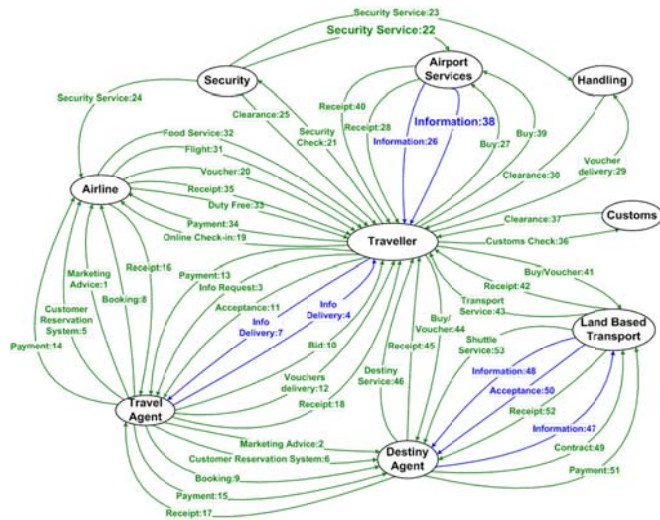
For the validation of each scenario, several interviews were done with several experts.

**Air Traveler Experience Scenario**

This scenario tries to explore all the steps that a traveler needs to undertake before and during the travel, and how the "bubble" around the traveler works at the airports.

The Agent list is as follows:

- Travel Agent
- Airline
- Traveler
- Destiny Agent
- Airport Security
- Handling
- Customs
- Airport Services
- Land Based Transport



1st Step: Marketing advertisement and Customer reservation

First, there are some marketing advices by airlines and travel agents that need to be implemented in order to capture the attention of the customers (in this case, travelers). The travelers will then contact the travel agents in order to set up a reservation, which provides vouchers and payment transfers among the elements of the chain.

2nd Step: Travelers go to the origin airport

Once this is done, the travelers go to the airport, where they are subject to the check-in and security processes common in all airports. Many airport services provide information about flights, food services, duty free shops, and so on. If the Schengen treaty does not cover the flight, the passengers will have their luggage checked and cleared by the customs.

3rd Step: Flight to the destination airport

During the flights, the airlines usually provide food service and duty free shopping.

4th Step: Landing and Destiny agents

Once the airplane lands on the destination airport, travelers will look for the land based transportation system to lead them towards the destiny agents. They can gather information while at the airport through airport services. Those destiny agents need to have contractual agreements with the transport agents in order to lead potential customers to them. Destiny agents include (but are not limited to) most of the airport hinterland agents: Hotels; Restaurants; Congress and conference rooms; Tourist attractions; Real State Developers and Industries.

### Cargo Scenario

For this Scenario, we will consider some conditionals related with the contractual nature of the relationships among roles. Furthermore, there is symmetry when we draw a simplified sequence of the cargo transport, as we can take the inverse path. The symmetry is verifiable if we draw a line where the Airline role is considered.

Thus, the Agents of this scenario and the overall sequence is as follows:

**Export Firm → Insurance → Freight Forwarder A → Handling → Customs → Airline → Handling → Freight Forwarder B → Import Firm**

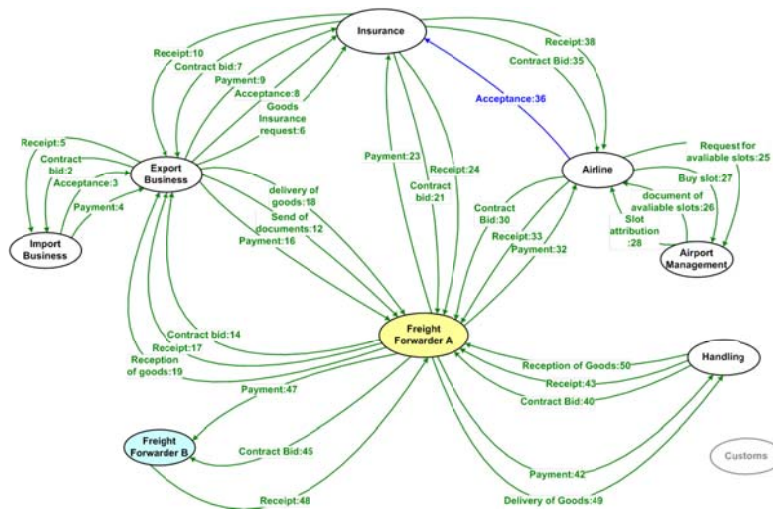


Figure 4: Cargo Contracting Scenario Map

**Import Firm → Insurance → Freight Forwarder B → Handling → Customs → Airline → Handling → Freight Forwarder A → Export Firm**

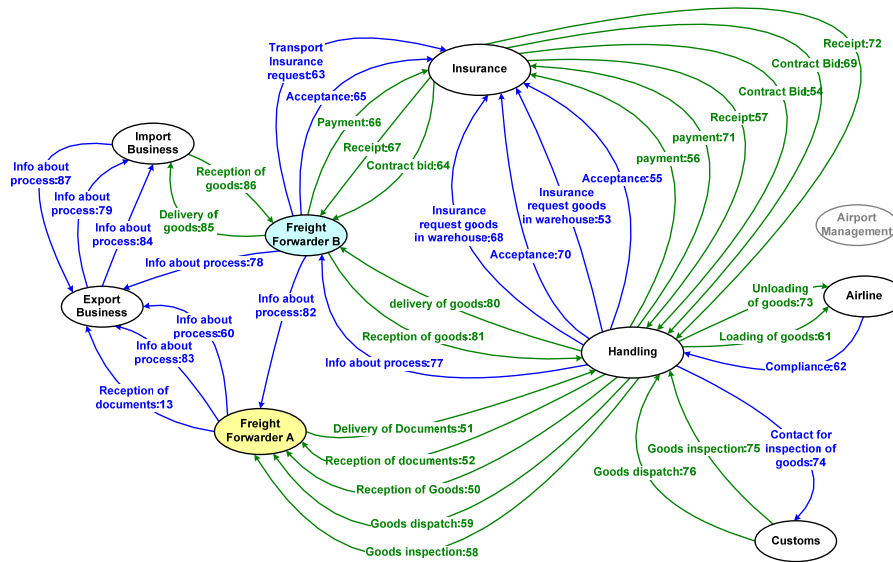


Figure 5: Cargo Transporting Scenario Map

We consider “Role A” as a participant in the origin country or land of the airport, and “Role B” as a participant in the country or land of the destination airport, for example, “Freight Forwarder A” as the one present in the area of Lisbon, working with the corresponding airport, and “Freight Forwarder B” as the one present in the island of Madeira, which works with Madeira's airport.

1st Step: Contact between businesses

The *sine qua none* condition of the realization of the whole cargo scenario is the existence of a contract deal between a local business and a foreign business. Several informal contacts normally occur before the closure of the deal. According to the contract, the cost of the merchandise transported can be shared in several ways, involving more or less participants in the process. For example, if the first firm only supports the cost of the transport until the ground handling unloads a cargo aircraft, the second firm will have contractual relationships with the Freight Forwarder present in the second country, or eventually will go directly to the airport to get the goods. Outnumbering scenarios could be made, depending on how the firms try to minimize the costs of transport. Since there is so much flexibility in the contracts, we consider that the local business will endorse the costs of the transport, and the import firm will receive the goods in its warehouse. This allows us to consider the most roles that can be involved in this scenario. The local business will then make a contract with an insurer, which will provide insurance for the goods during the transport. Now again, the Freight Forwarder could also provide an integrated package of insurance, and architect the whole procedure, freeing the local business of any constraint, but this would exclude the insurer of the scenario. At this time, the Freight Forwarders (local and foreign) and Ground Handling Operators would need to have an insurance contract as well, unrelated with the goods. That contract would provide safety for the whole transport process. We assume that those insurance processes are at an initial state (as well as the network itself), that is, the insurances

are made during the process as they become required for the operations made by the several participants. The freight forwarder contacts the Airline to proceed to the flight booking and space reservation inside the aircraft. The Airline establishes contracts with the airport managers to buy slots, normally for a reasonable period of time.

2nd Step: transporting the goods from the local business to the origin airport

For this procedure and after the whole path for the goods have been traced, the local freight forwarder goes to the local business to pick up the merchandise. Next, a first verification of the documents needed ensues, and the freight forwarder checks if the packages are correctly packed and correspond to the initial description. The freight forwarder transports the goods to the ground-handling operator, where the good is stored at the warehouse. The ground-handling agent will, at his turn, verify the whole package, seal it and treat it according with its content, and emit carry documentation. These, along with the transaction bill, are the necessary documents to pass the frontier when the transaction is made inside the EU. Informal contacts are made along the path of the merchandise, in order to ensure both business agents are kept informed about the process. Those contacts are critical, as they permit to contour several abnormalities, such as delays and possible shortcuts, damage of the goods, and so on.

3rd Step: Flight and reception of goods

After the loading of the airplane, the flight goes to its destination. The foreign ground-handling operator unloads the aircraft and proceeds to the storage of the good in a warehouse. The customs are contacted to supervise the merchandise, label it, and emit a bill note to the ground-handling operator. The merchandise will only be dispatched after the payment and conformity of the package. The Foreign Freight Forwarder goes to the airport and takes the merchandise from the warehouse to the foreign business. Informal contacts are kept along the way.

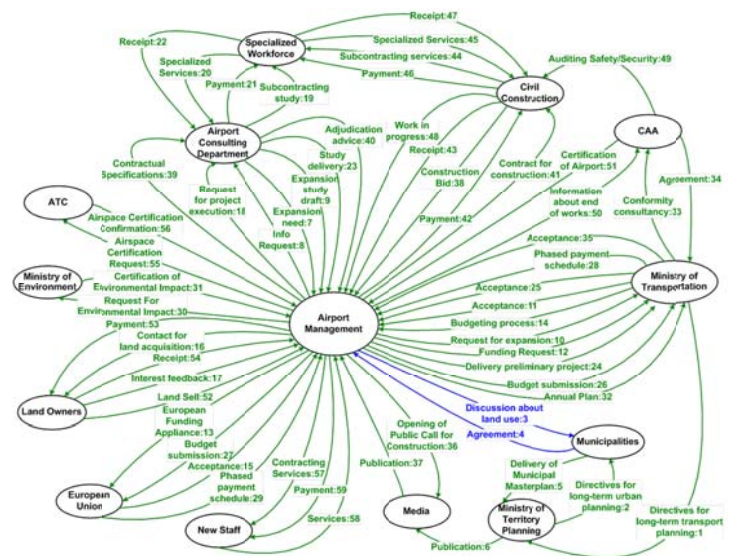
**Infrastructure Expansion Scenario (Public Ownership)**

This scenario attempts to explain the planning and construction processes of an airport's expansion, the whole set of political and budget constraints, and the overall set of relationships which have to be established among agents.

The agent list is as follows:

- Ministry of transportation
- Ministry of territory planning
- Municipalities
- Airport Management
- Media

- Airport Consulting Department
- European Union
- Land Owners
- Specialized Workforce
- Civil Aviation Authority (CAA)
- Civil Construction
- Air Traffic Control (ATC)
- New Staff



1st Step: Land use

Land use is a critical element of public planning, notably at the level of the municipality. An airport, for example, should have a surrounding safe area, notably in terms of environmental impact and for possible expansions of the runways, terminal areas, and so on. The planning process is a long-term phase, which begins with informal talks among airport owners, municipalities, and ministries of planning and transportation. These informal talks provide a key role in the definition of an eventual expansion scenario in the planning of the municipality.

2nd Step: Preliminary draft

First of all, to draw this expansion scenario, we must consider that a need exists. That need is normally identified by the airport operator, which has a consulting department. After the determination of the nature of the need, a preliminary project study will start to be conceived, taking in consideration 3 important aspects:

- the extent of land that will be used in the future;
- the environmental impact, and, to a lesser importance (at least in this preliminary phase);
- the economic viability of this project.

Once this work is done, there is an informal contact between the airport management and the ministry responsible for the transportation policy, which will provide a pre-acceptance that will support the furthering of the expansion study. At the same time, municipalities have an important role, since any expansion that involves environmental and political impact needs to be articulated with the municipality master plan, as well as the use (and purchase) of land. Normally, those plans are long-term, and structure the use of adjacent land and impacts on other infrastructures.

3rd Step: Preliminary project

Next, a more detailed study begins to be made. The idea of what has to be done is clearer, and a rigorous costing is outlined. The initial sequence involves more or less the same roles as with the preliminary draft: the airport operator elaborates the study through its consulting department, establishing contacts with municipalities and land owners, and send the study to the ministry tutoring the transportation policy. The ministry of transportation then contacts the Civil Aviation

Authority to ask for a sight on the project. The project starts to get media exposure. The airport operator contacts also the Air Navigation Authority (NAV) and the CAA to ask for a sight as well, in order to see if the expansion involves any type of disturbance to air links and trajectories. The airport operator also gets in contact with the ministry of environment, to get a certification of environmental impact. Pressure groups also start to influence the public opinion and the policymakers, as they can expose weaknesses of the project, but can also act as facilitators of the decision, if there is such interest. A formal request for funding is made to the ministry of transportation, and eventually to structural funds of the European Union. The pressure can eventually raise or lower the price of land, making the negotiation with the land owners and the municipalities more difficult. There is a special article in the Portuguese law stating that the land can be used for construction before the buy/sell/expropriation of land is done, as long as the process is in its course.

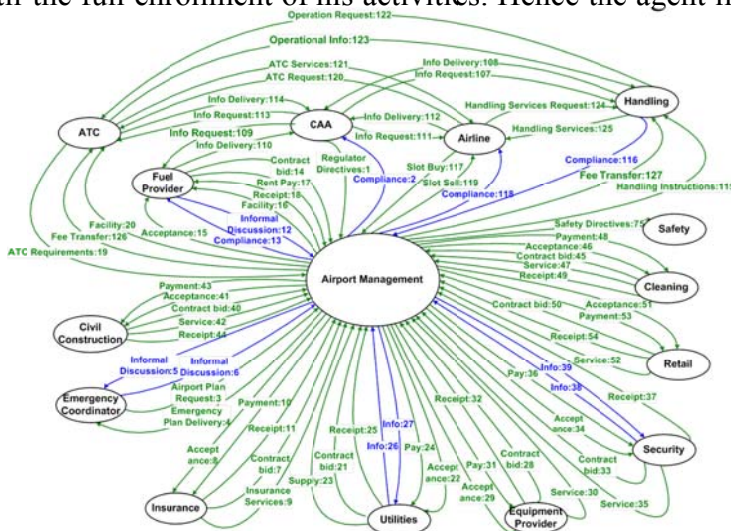
4th Step: Final project and construction

The main focus of this phase is the budgeting. Stakeholders normally budget the funding and the payment in several tranches delayed in time. Once the funding is made and the land owners and municipalities get paid, the CAA analyses and supervises the regulation and standards applicable. A public concourse is open for the construction itself by the airport operator. Media disclose the information to civil constructors, which make construction bids to the operator. Civil constructor may resort on specialized workforce, creating laces and economic value through the sub-contracting process. After the construction is done, the airport operator gets the airspace and the infrastructure certified by NAV and CAA, respectively. The airport operator can then hire staff if necessary.

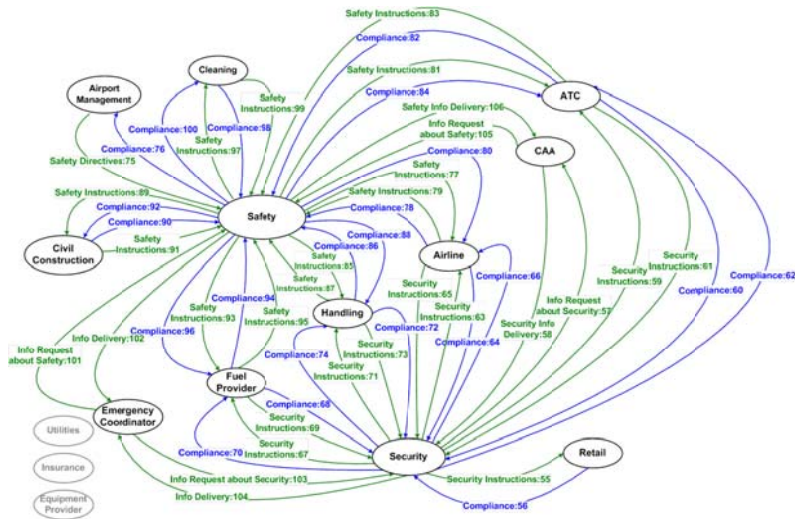
**Supply Chain Scenario**

The supply chain scenario is focused in exploring what is necessary for the airport to work every day, before it starts his activity until the full enrollment of his activities. Hence the agent list is as follows:

- Civil Aviation Authority (CAA)
- Airport Management
- Emergency coordinator
- Insurance
- Fuel Provider
- Air Traffic Control (ATC)
- Utilities
- Equipment provider



- Security
- Civil Construction
- Cleaning
- Retail
- Airline
- Handling
- Safety



1st Step: Airport regulation and eme.

The CAA gives to the Airport management the regulation, which it has to follow. Since these regulations are compulsory, the airport management gives his compliance in order to fill all the requirements from CAA. Also, in an airport is necessary to have an emergency plan. The emergency coordinator is responsible to develop this plan. To do it, he requires the airport plan from the airport management, and during this process, both participants keep informal discussions.

2nd Step: Contractual relationships

Furthermore, insurance is necessary for the airport's operation. Thus, there is a contract bid from possible insurances to the airport management. After the acceptance from the airport management, a normal contracting process for the insurance of the airport takes place. Relating the fuel provider with the airport management, both intervenes establish an informal discussion before advancing to the contract bid. After the acceptance, the airport management gives a place, according with a rent, to the fuel provider inside the airport so he can explore his activity. Regarding the ATC, they require a facility from the airport management, which is granted to develop their activities. The utilities are necessary on the airport to have the tools and materials before and during the airport activity. Hence, there is a contract bid from the utilities to the airport management. After the contract bid we have an acceptance for the contract and a regular contract takes place. Here the utilities supply the airport with the necessary tools and materials, taking place the payment and the receipt from the utilities to the airport management. Both intervenes keep a relationship between them to give information's if something needs to be replaced, to order new tools and materials. There is a contract bid in order to select the most proper equipment provider among equipment providers. So, after the contract bid, there is an acceptance from the airport management, hence, the equipment provider supplies the airport and also gives a service of maintenance of that equipment which is paid by the airport management. The same happens with the security, where we have a contract bid and an acceptance from the airport to the security's bid. Then a normal contract takes place and both entities keep sharing information to have a right



procedure for the security inside the airport. Civil construction and cleaning have the same roles, both have a contract bid and an acceptance from the airport management. These two agents give their services depending on a payment, paid by the airport management. The same happens with the retail, but additionally the *security gives security* instructions, which they must follow.

### 3rd Step: Security and Safety issues

The security also requires information's about the security directives from the CAA. Furthermore, the security gives to the ATC, Airline, Fuel Provider, and handling, security proceedings that were compiled for those agents. In the same way, the airport gives to the Safety Agent the safety directives they have to follow. Thus, having these directives, the safety gives information's about safety to the ATC, Handling, Civil Construction, Airline, Fuel Provider, and Cleaning. Shared information by these Agents with the Safety Agent occurs for the good development of safety on the airport. The emergency coordinator requires information's about security and safety directives and proceedings, which are delivered. On the next step, CAA requires information from the Safety, Airline, Handling, ATC and Fuel Provider. The agents deliver that information's. This step has the objective to identify if everything is in order, as the CAA requires for the good function of the airport.

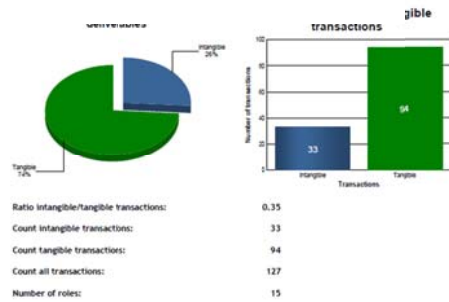
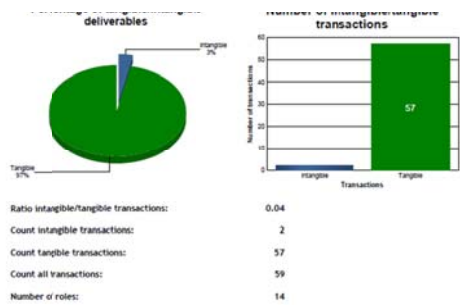
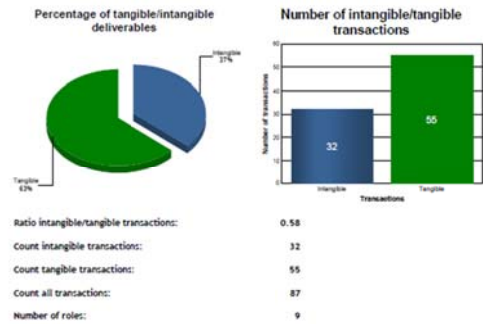
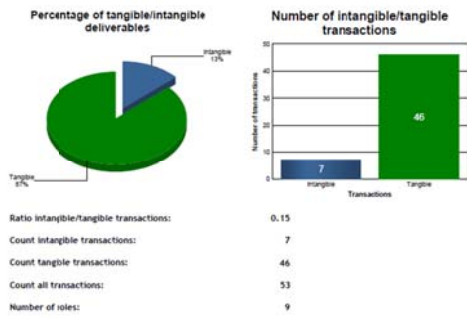
### 4th Step: Airport operation

The airport management gives instructions to the Handling agent, receiving compliance from the Handling agent. Next, the airline agent buys slots of the airport so he can land his aircrafts. This is accompanied by a compliance of the airport management and the sale of the chosen slots. During the flight and when reaching the airport, the Airline agent requires ATC services. Then the handling communicates with the ATC to have information's about the operation. Still on air, the airline agent requires handling services in order to have them when landing. At last, the airport management pays a fee to the ATC and the Handling agent for their services.

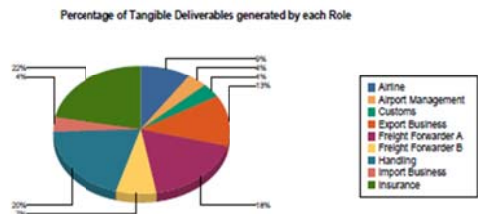
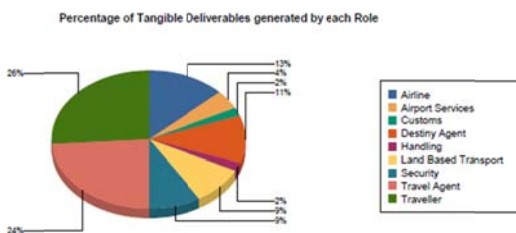
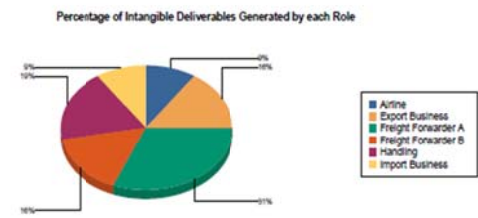
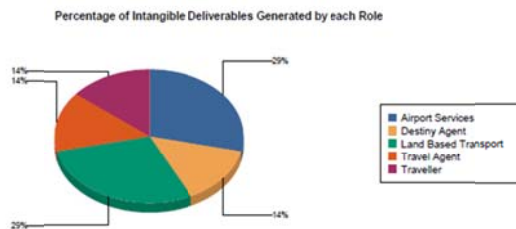
## **MAIN FINDINGS FOR THE FOUR SCENARIOS**

### **Resilience of the networks**

According to VNA, is normal to have a higher level of tangible transactions than intangible in process-focused operational networks. In this context we can state that Air Traveler Experience, Cargo, Infrastructure Development and Supply Chain Networks are a formal structure with systematized processes and established routines (see Figures 9 to 12). In this way it's possible to see that the most formal is the Infrastructure Development Network with intangible/tangible transactions ratio of 0.04 and the most flexible is the Cargo Network with an intangible/tangible transactions ratio of 0.54.



## Value Creation

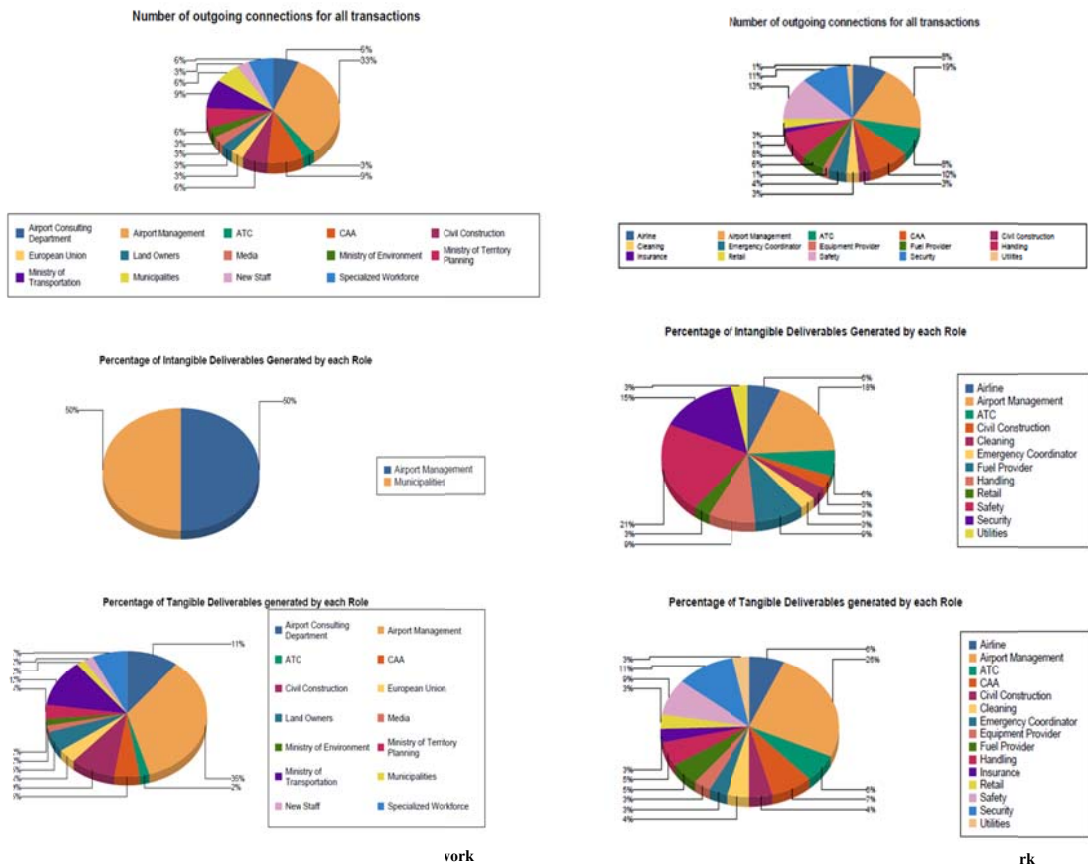


The active agents for Value Creation are the Roles in the network. The value creation depends on the capacity for each Role to generate both tangible and intangible value. A decrease over time in value outputs can be an indicator that resource availability or productivity has declined. An increase in value outputs with minimal additional resource demands is an indicator that value

productivity is improving. The capacity of a network to generate value depends on good asset utilization - in both financial and non-financial terms.

As the above Figures 13 and 14 illustrates the Traveler Role is the one that generates more value (tangible and intangible) in the Air Traveler Experience Network, followed by the Airport Services and Land Based Transport (intangible) and Travel Agent role (tangible); in the Cargo Network the one that generates more value is the Freight Forward’s Role, followed by the Handling (intangible) and the Insurance roles (tangible).

For the other two scenarios, Infrastructure Development Network and Supply Chain Network (Figures 15 e 16, respectively), it is possible to see that the Airport Management Role is the one that generates more value (tangible and intangible) in the Infrastructure Development Network, followed by the Municipalities Role (intangible) and the Ministry of Transportation Role (tangible); in the Supply Chain Network the one that generates more value is again the Airport Management Role (tangible and intangible), followed by the Safety Role (intangible) and the Security Role (tangible).



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## Structure and Value

Centrality Indicators help to see value from a structural standpoint and explains how do roles gain or contribute to the value. The Centrality is a classic network indicator that shows which roles have the most ties. Roles with more ties hold important structural positions; they may have access to more of the resources of the network as a whole. Nevertheless a Role with a strong structural position does not mean it is providing the most value to the network. It is possible to examine incoming and outgoing ties separately, using another Centrality Indicators as the Centrality In Degree (related with the value a Role gains from the network) and the Centrality Out Degree related with the value a Role provides to the network).

The number of incoming Deliverables by Role in the four scenarios is that of Figures 17 to 20).

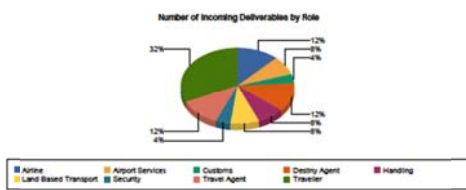


Figure 17: Centrality In Degree of Air Traveler Experience Network

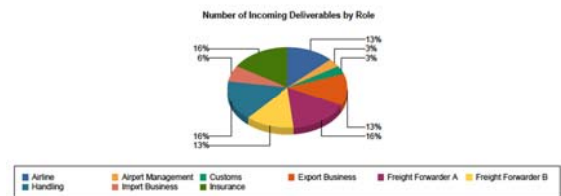


Figure 18: Centrality In Degree of Cargo Network

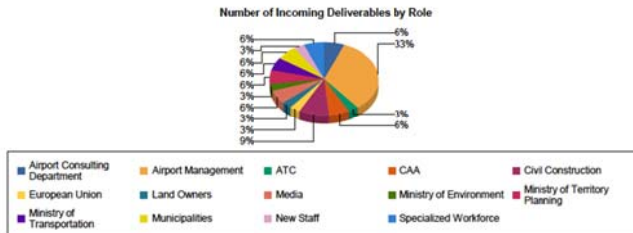


Figure 19: Centrality In Degree of Infrastructure Development Network

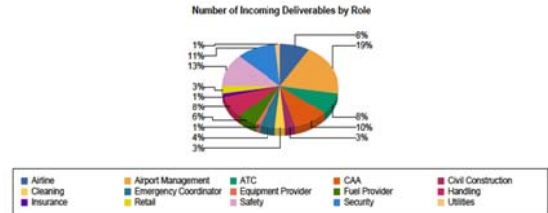


Figure 20: Centrality In Degree of Supply Chain Network

In the Centrality In Degree of the Air Traveler Experience Network, the Role that gains more from the network is the Traveler Role thus having the strong structural position (presents more ties), for the Cargo Network the strong structural position is shared by the Handling, Freight Forwarder and Insurance Roles, within the Infrastructure Development Network is clearly the Airport Management Role that leads the gains as in the Supply Chain Network.

In the Centrality Out Degree of the Air Traveler Experience Network, the Role that provides more from the network is the Traveler Role thus having the strong structural position (presents more ties), for the Cargo Network the strong structural position is the Freight Forwarder Role, within the Infrastructure Development Network and Supply Chain Network it is shown that the Airport Management Role is the role that provides more value to the network.

The number of outgoing connections for all transactions in the four scenarios is that of Figures 21 to 24.

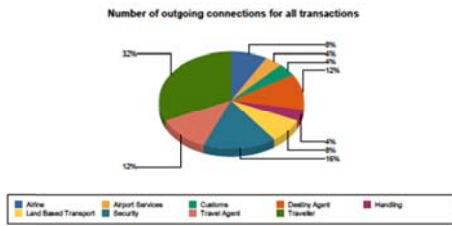


Figure 21: Centrality Out Degree of the Air Traveler Experience Network

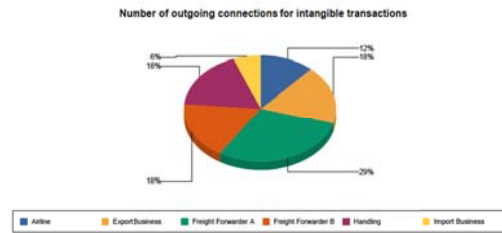


Figure 22: Centrality Out Degree of the Cargo Network

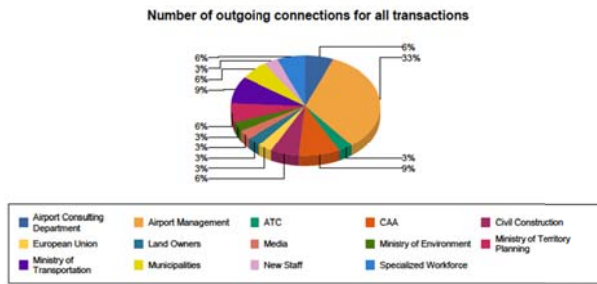


Figure 23: Centrality Out Degree of the Infrastructure Development Network

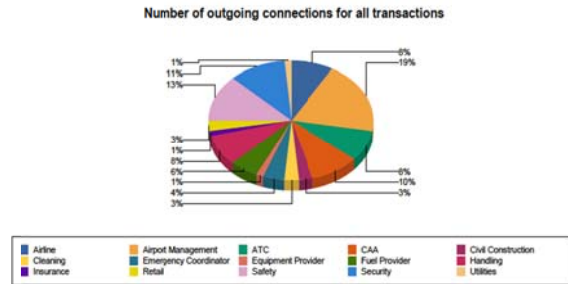


Figure 24: Centrality Out Degree of the Supply Chain Network

## Risk

One kind of risk to the network shows up in Role dependency. The risk is that the Role could be a bottleneck. If the Role is not adequately resourced then flow paths can be negatively impacted with time delays. If a Role cannot keep the value flow paths moving then it affects the speed of value creation and conversion in the network. The second risk factor is that if there is too much Structural Dependency on a Role then it can affect the entire network if something goes wrong.

Structural Dependency is based on centrality, one of the most common structural indicators in network analysis. Centrality is about which Roles or Participants have the most ties or connections. In classic network analysis, high centrality is generally viewed positively as an indicator of prominence or high prestige. However, in value network analysis, extremely high centrality for any one Role or Participant may actually be a risk factor for the network. Structural Dependency correlates to variance between the connections of all the Roles. We can assume that the higher the variance the more we are likely to find some Roles with many connections and others that have almost none. This means that power in the network is not well distributed (the wider the variance the higher the risk to the network). The network might be unduly influenced or controlled by one or two Roles. In such cases the network might break down or disintegrate if those Roles for some reason disappear or are unable to perform. Thus the Infrastructure Development and Supply Chain Networks are not very centralized networks because of a strong dependency on the

Airport Management Role; in the other two networks there is a good balance between the roles and it's fare to say that these networks are centralized.

### Asset Impact

Asset Impact measures the impact of a transaction to the network as a whole. Therefore, it is necessary to identify which assets are impacted by the transaction activity in the network and also which assets are most affected by the network behaviour as a whole and by the actions of specific Roles. On these networks were identified three main assets: financial, competence and business relationships. The following charts (Figures 25 to 32) show which assets are impacted by the transaction activity in the network. These figures are compiled from how individual transactions impact assets. These indicators can be used to consider which assets are most affected by the network behavior as a whole and by the actions of specific Roles.

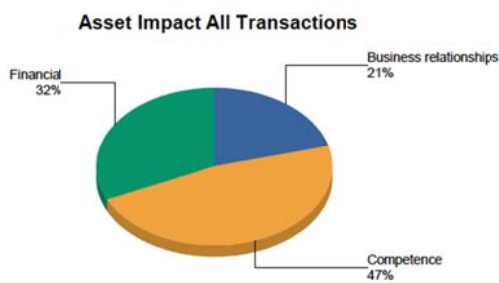


Figure 25: Air Traveler Experience Network Asset Impact

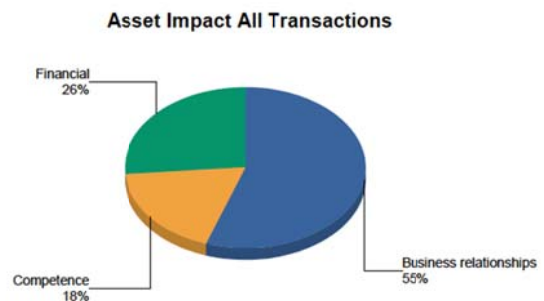


Figure 26: Cargo Network Asset Impact

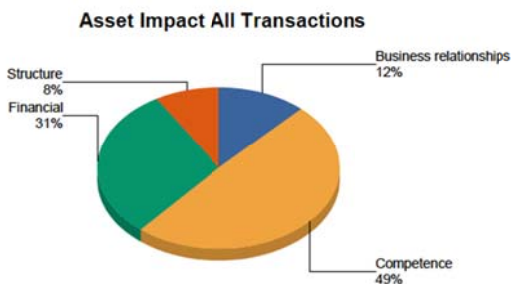


Figure 27: Infrastructure Development Network Asset Impact

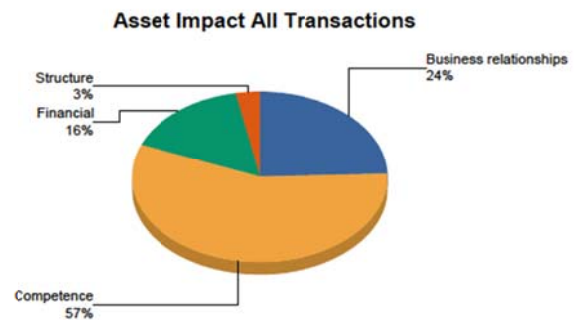


Figure 28: Supply Chain Network Asset Impact

On the Cargo Network the “business relationship” asset is the most impacted by the transaction activity of the network as a whole either for intangible or tangible transactions; for the other three scenarios the “competence” asset is the most impacted by the transaction activity of the network.

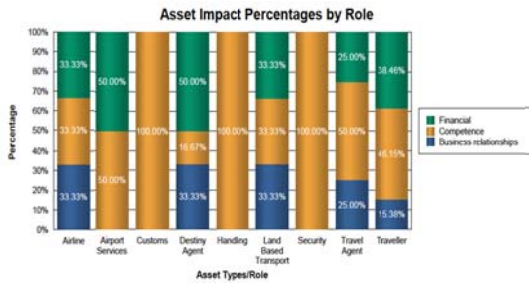


Figure 29: Air Traveler Experience Network Role Distribution for Asset Impact

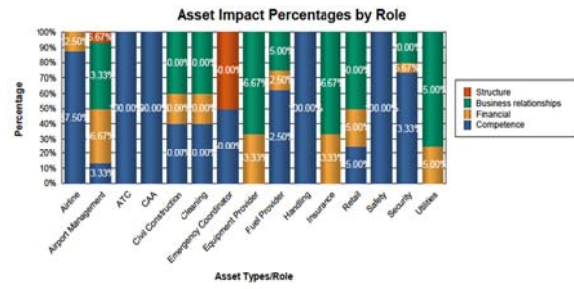


Figure 30: Cargo Network Role Distribution for Asset Impact

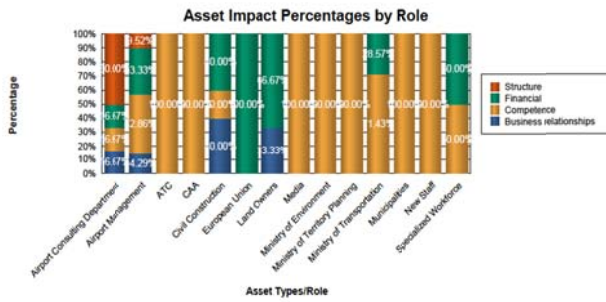


Figure 31: Infrastructure Development Network Role Distribution for Asset Impact

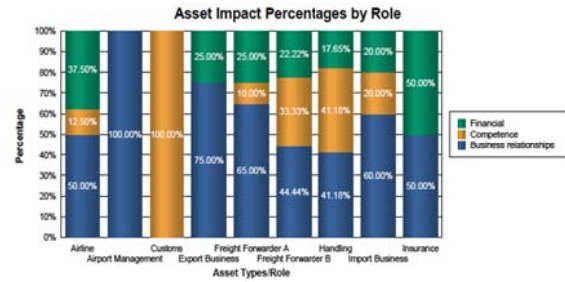


Figure 32: Supply Chain Network Role Distribution for Asset Impact

## SYNTHESIS AND CONCLUSIONS

Value Networks are sets of roles, interactions, resources and relationships that generate economic or social value. In this context any purposeful organization or activity can then be understood as a value network. Applying the VNA methodology to the four Scenarios we concluded that the Airport Network presents a formal structure with systematized processes and established routines, where density of tangible connections is dominant.

Having in mind that the active agents for Value Creation are the Roles in the network, the Traveler Role is the one that generates more value (tangible and intangible) in the Air Traveler Experience Network, and the Freight Forwarder's Role is generating more value within the Cargo network; for the Infrastructure Development Network and the Supply Chain Network, Airport Management Role is the one that generates more value.

For The Centrality In Degree the Traveler Role in the Air Traveler Experience Network is the one having the strong structural position (presents more ties), in the Cargo Network this position is shared by the Handling, Freight Forwarder and Insurance Roles, and in the Infrastructure Development Network - as in the Supply Chain Network - the Airport Management Role has the strong structural position. For The Centrality Out Degree the role that provide more value to the network are the same as in the Centrality In Degree, except for the Cargo Network in which the strong structural position in providing value is the Freight Forwarder Role. Infrastructure Development and Supply Chain Networks are not very centralize networks because of a strong

dependency on the Airport Management Role; in the other two networks there is a good balance between the roles and these networks are centralized.

“Business relationship” asset on the Cargo Network is the most impacted by the transaction activity of the network; “competence” asset for the other three scenarios is the most impacted in the transaction activity of the network

We argued that networks are fundamental instruments for the development of business system of the airport. The ability of VNA to better describe effective network of the Airport System justified the option for this methodology. We conclude that the application of the VNA provided a network ecosystem perspective into how processes and people create value within the Cargo Network.

The next research steps will allow extending the analysis using more indicators.

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