

DYNAMIC PROCESSES OF AN AIRPORT'S SYSTEM. APPLYING VALUE NETWORK ANALYSIS (VNA) TO THE AIR TRAVELLER EXPERIENCE

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ABSTRACT

In this paper, we argue that networks are fundamental instruments for the development of the business system of airports' landside area. We propose value network analysis (VNA) to gain a better understanding of how processes and people create value in airports' network ecosystem. This methodology makes it possible to understand and visualise the internal and external value networks, mapping the players and their interrelationships and thus capturing the dynamics of the airports' entire system. Applying value network analysis (VNA) to the air traveller experience, we conclude that this approach provides a network ecosystem perspective on how processes and people create value within the air traveller experience network. For the validation of this scenario, several interviews were conducted with experts.

Keywords: Airports' Landside Areas, Air Traveller Experience, Social Network Analysis, Value Network Analysis

JEL Classification: R42, Y10

1. INTRODUCTION

In accordance with the results of the fifth task of the Airdev Project¹ related to hinterland effects, **two main outcomes** were expected: 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 clarify the mechanisms responsible for the generation of economic and social benefits. It must identify the key variables and their relationships that allow the evaluation of the impacts resulting from the existence of an airport. The second outcome will provide the framework for evolution from an airport into a city airport, being sufficiently flexible to handle different sizes of airports. The model will include all the relevant activities that may be located in an airport city as well as the relevant vectors of development: economic, financial, strategic, marketing and processes.

Common to both outcomes is the concept of a system, which relies on networks and dynamic interrelations.

Jimenez *et al.* (2012, p. 24) argued that the studies applying network analysis to airport or airline systems can be divided into two broad categories, which "either take a strict network theory point of view or have an air transportation field perspective". The first group of studies is normally "interested in analysing the topology of the networks and their performance according to graph statistics". The "second group uses some network-related

¹ R&D Project "AIRDEV – Business Models for Airport Development and Management" financed by the FCT/MIT Programme (MIT-Pt/TS-AAS/0046/2008) (rating of "very good").

parameters to classify business strategies of airports and airlines, to perform economic analysis or to evaluate technical features of the systems”.

In line with both perspectives of analysis, we propose to use value network analysis (VNA) to gain a better understanding of how processes and people create value in airports' network ecosystem. This methodology makes it possible to understand and visualise the internal and external value networks, mapping the players and their interrelationships and thus capturing the dynamics of the airports' entire system.

Our study maps the players and their interrelationships in **four different scenarios**: the air traveller experience, the supply chain, the infrastructure development and the air cargo experience. For the validation of each scenario, several interviews were conducted with experts.

In the context of this paper, only the air traveller scenario will be presented.

2. THEORETICAL FRAMEWORK

Much of the relevant literature refers to the huge economic impact of airports on local, national and international economies. Indeed, some airports contribute to national and/or international economies, but the mechanisms by which the regions benefit from the existence of an airport remain fairly unknown.

A number of limitations in the practice of airport economic impact studies have been identified (TRB, 2008), which raise the question of whether the metrics of the impacts are adequate and even whether the focus on metrics is more important than increasing the opportunities associated with airports.

The adequacy of any method (traditional or otherwise) to measure net benefits or 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 increasing the opportunities associated with that system. These facts call for refreshed conceptual frameworks to provide a better understanding of the regional opportunities and constraints associated with airports and, at the same time, for integrative models that allow the recognition and understanding of the nature and importance of international, national, regional and local airports' sustainable growth.

In this context, quantification alone is not enough to understand such complex systems. Matters of pattern, structure and value conversion must be considered along with several levels of analysis. The 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 into other forms of value.

2.1 Networks and social network analysis (SNA)

The concept of a network is used in the scientific literature in two directions (Romeiro, 2007), which are particularly relevant in the context of this paper: 1) a fundamental architecture for the economic, social and institutional organisation: in this context, a network represents an organisational structure comprised of independent elements that establish relations between them for the medium-long term, based on the will of the elements to work together towards common objectives, which could not be achieved in the same way through individual work (Vernon, 2005); and 2) an explanatory principle of the structure of complex realities: in this sense, the concept of a network refers to a set of actors (individuals, institutions or organisations) bound by a set of social relations of a certain type (friendship, business or other) (Gulati, 1998). Therefore, a 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. Unlike the organisational structure, the concept of a network is understood as a structure between the market and the hierarchy, formed by more than two organisations (corporate, public organisation, association, university and airport, among others) that decide, formally or informally, to initiate cooperation in the medium term involving the exchange of resources (material or immaterial). The network is established under the premise that all the organisations within a network are interdependent, meaning that the behaviour of one organisation affects and is affected by the behaviour of the other organisations. This design points out explicitly the components of a network – a set of actors and a set of relations – the structure of which can be systematised and analysed through social network analysis (SNA).

Applications of social network analysis (SNA) have increasingly been expanding to the business world, at the level of organisational performance and/or strategic alliances (Cross and Parker, 2003; Dawson, 2003; Iansiti and Levien, 2004; Anklam, 2007; Basol and Rouse, 2008; all cited by Allee, 2009, p. 2). However, some inherent limitations of SNA have limited that progress (Allee, 2009):

- Although SNA provides a structural analysis of the network linkages, it does not directly address economic or social value creation and outputs;
- The empirical link between the organisational structure and the performance of companies remains to be demonstrated adequately;
- The links defined in a social network are of the same nature and only one link is represented among actors. When there are multiple variables and unique features, it becomes necessary to build separate networks for each different type of social or economic exchange between players, which turns the analysis very weighty;
- Due to the high level of technical expertise needed to analyse and interpret the patterns of the network, the use of SNA as a management tool is limited.

2.2 Value network analysis (VNA)

To overcome these limitations, Allee (2008)² proposed a network methodology that allows the measurement of networks' value creation. According to this author (op. cit., 2008, p. 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), a **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 the application of the value network perspective a) to the **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 organisation; and b) to the **external-facing** value networks, which comprise those between the organisation 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 into 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. In addition, the network is a value conversion mechanism

² This section is largely based on Allee's work since it was that author who developed the VNA methodology.

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.

The emergent purpose and value dynamics of the network are revealed through the particular pattern of **roles** (contributing individuals or organisations) and their unique negotiated **value exchanges** in service fulfilling an economic or social goal or output. Shared purposes and values may be either tacit or explicit but can be deduced from the network patterns and the nature of the exchanges. Value is continually being negotiated in this context of both individual and overall purposes and values.

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

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

- It shows both the structured relationships and the informal yet essential flow paths of knowledge sharing and support;
- It provides a perspective for understanding the value-creating roles and relationships, both internal and external, upon which an organisation depends;
- It 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;
- It explains how to realise value more effectively for each role and how to utilise tangible and intangible assets for value creation;
- It provides a systematic analysis of how one type of value is converted into another.

The ability of VNA to describe effective work networks better has been demonstrated in many organisations 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. Companies' adoption of VNA, especially the Allee method, has been growing rapidly in global companies, government agencies and civil society organisations and networks (Verna, 2009).

This is the case, for example, of Cisco's Global Call Center. Value networks and VNA were fundamental and highly instrumental in achieving advancements in Cisco's Global Call Center strategy. According to LaVeta Gibbs, former Director of Global Contact Center Strategies for Cisco, "Value Network Mapping of an organization, or even better, multiple organizations is the most unbiased and necessary view into what really goes on in business interactions. If done successfully, it changes the way job roles and the value of interactions are perceived and measured."

Mayo Clinic, one of the largest medical clinics in the US, adopted VNA to solve problems related to the time that patients had to wait (six months) to receive a confirmed appointment for a critical medical procedure. ValueNet Works analysts identified a key bottleneck that other management tools, including Lean analysis, could not identify and reduced the waiting time to four weeks.

AgResearch, New Zealand's largest crown research institute, identified through the VNA method how a twelve-year innovation process was being disadvantaged by differences between scientific research and commercialisation networks. The time to market was reduced and employee morale improved by creating new roles, enabling the scientists to focus on research. Furthermore, value network evaluation was performed in the Skåne region in Sweden to explore the regional innovation system.

The Boeing Company is another example of the successful implementation of VNA. It launched a complex new product that significantly expanded the daily product testing without a corresponding increase in resources. The flight test team completely changed the

business unit model and increased the number of tests that could be performed through the use of VNA in combination with process engineering. VNA is now being used to achieve similar gains in productivity for other business units within the company.

3. DYNAMIC PROCESSES OF AN AIRPORT'S SYSTEM. AN EMPIRICAL STUDY

According to Macário and Reis (2012, p. 7), airports have traditionally viewed airlines as their primary customers and airlines, in turn, have considered passengers as their primary clients. However, “today, in a more commercial and private environment, with an increased pressure on the awareness of the relevance of a business model for airports, these complex infrastructures are increasingly dependent on non-aeronautical revenues (business centres, health care, etc.), and thus perceiving passengers as another segment of their primary customers”.

As mentioned in the previous section, several studies have applied value network analysis to different business and organisational areas, but no research concerning the application of this methodology to the business system of airports' landside areas has been undertaken as far as we know. Since we argue that networks are fundamental instruments for the development of this domain of activity, in this section, we explore how this methodology can be adopted to achieve “more economically efficient, aesthetically pleasing and socially and environmentally sustainable” (Kasarda, 2010, p. 31) development. Considering that business systems for airport landside areas have to be considered on a global base, we agree with Stevens *et al.* (2007) that the list of system impacts beyond the system boundaries has grown through time, but treatments have remained highly specialised and contained within disciplinary paradigms. Even the empirical analysis has been generally limited to the evaluation of the isolated components of a complex system.

These facts call for refreshed conceptual frameworks to enable a better understanding of the business opportunities and constraints related to airports' landside and at the same time for integrative models that allow the recognition and understanding of the nature and importance of international, national, regional and local airport industry growth and the need for sustainable balanced development.

To gain a better understanding of how processes and people create value in an airport network ecosystem, 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), was used for this research.

3.1 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, such as a business unit, or aggregate groups as a type of business in an industry network and each node is analysed from the perspective of the **role that** 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, value is **realised** by companies 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 by a value network analysis. These intangible exchanges, traditionally ignored by business practices, are a fundamental key to creating trust and opening ways for innovation.

The various visualisations and diagrams link to a variety of **assessments** (usually using Excel spreadsheets) enabling an increase in value outputs, the leveraging of knowledge and intangibles for improving financial and organisational performance and the detection of new value opportunities. Through this analysis, it is possible to gain insights into what is happening in the ecosystem, where more value can be realised and what is required to achieve the maximum value benefit across the entire business activity or ecosystem that is the focus of the analysis.

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

- The air traveller experience scenario;
- The cargo experience scenario;
- The supply chain scenario;
- The infrastructure development scenario.

The first scenario results from the existence of air transport services for the use of individuals. The second is related to those companies that need a high-speed and high-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 the perpetual effects associated with the regional economy considering that an infrastructure investment will raise the level of activity and stimulate 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 conducted with experts**.

The air traveller experience scenario is the only subject of analysis in the context of this paper.

3.2 A Value network analysis of air traveller experience. Research approach and main findings

3.2.1 Research approach

People travel for many reasons. However, regardless of the reason, there is a set of procedures that is more or less common to travellers. Particularly those who travel by plane need to make the necessary travel arrangements (e.g. air travel, ground travel, accommodation), directly or through a travel agency (virtual or real), and follow specific air travel rules and regulations (eg. security, handling, customs).

To apply the VNA methodology, the air traveller scenario needs to identify the main steps that an air traveller needs to undertake before and during the journey and to understand how the “bubble” around the traveller works at the airports. This procedure will allow easy identification of the different roles involved in the process.

First step: Marketing advertisement and customer reservation

First, there is some marketing advice from **airlines** and **travel agents** that needs to be disseminated to capture the attention of the customers (in this case, **air travellers**). The travellers will then contact the travel agents to set up a reservation, which provides vouchers and payment transfers among the elements of the chain.

Second step: Travellers go to the origin airport

Once this has been completed, the travellers go to the **airport**, where they are subject to the check-in and security processes common to all airports. Many **airport services** provide information about flights, food services, duty free shops and so on. If the flight is not

covered by the Schengen treaty, the passengers will have their luggage checked and cleared by customs (**security services**).

Third step: Flight to the destination airport

During the flight, the airlines may provide food services and duty free shopping.

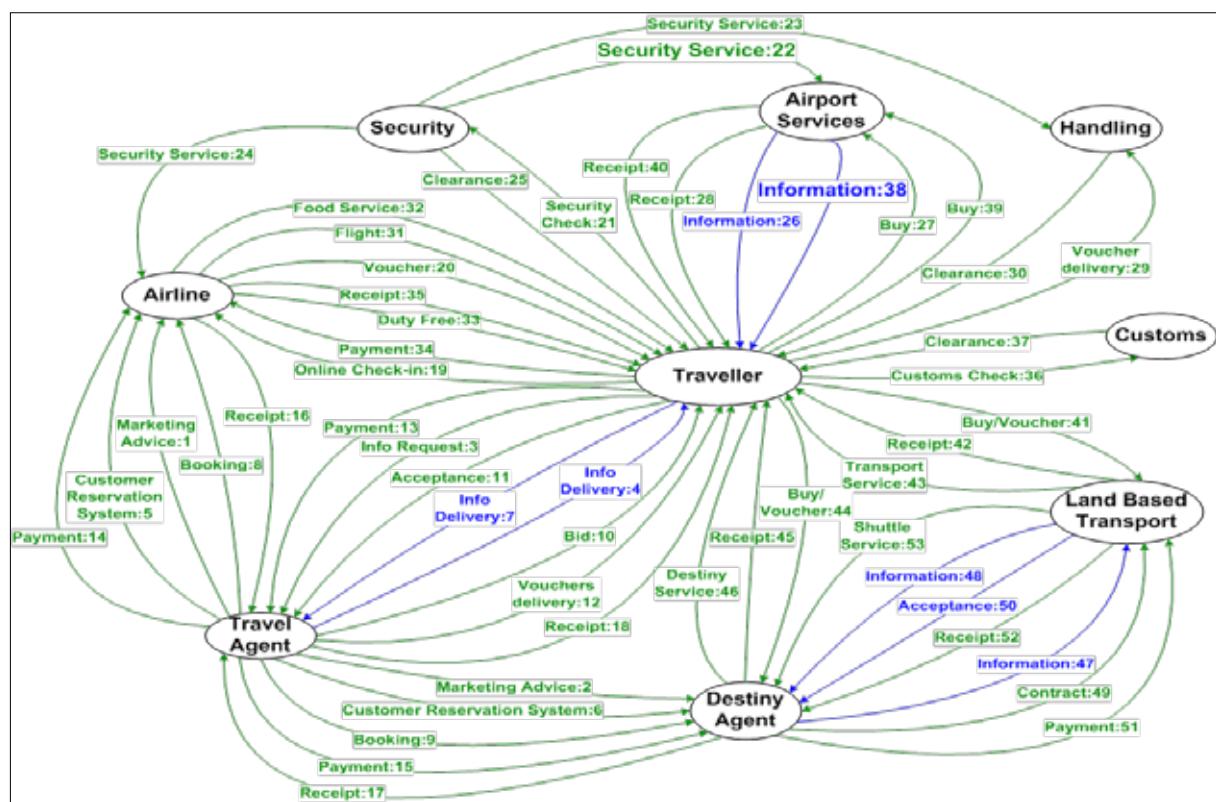
Fourth step: Landing and destination agents

Once the aeroplane has landed at the destination airport, and after reclaiming their luggage (**handling service**), travellers will look for the **land-based transportation** system to lead them towards the **destination agents** (e.g. hotels, restaurants, congress and conference rooms, tourist attractions, real estate developers, industries, etc.). They can gather information at the airport through airport services. Those destination agents may have contractual agreements with the transport agents to lead potential customers to them.

3.2.2 Main findings of the air traveller scenario

Following the steps mentioned above, it was possible to identify the **key roles** – traveller, travel agent, destination agents, airline, land-based transport, customs, security, handling and airport services – related to the air traveller scenario **and map the main tangible and intangible transactions** among them, as shown in Figure 1.

Figure 1. Value Network Modelling of Air Traveler Scenario. All Transactions and Deliverables



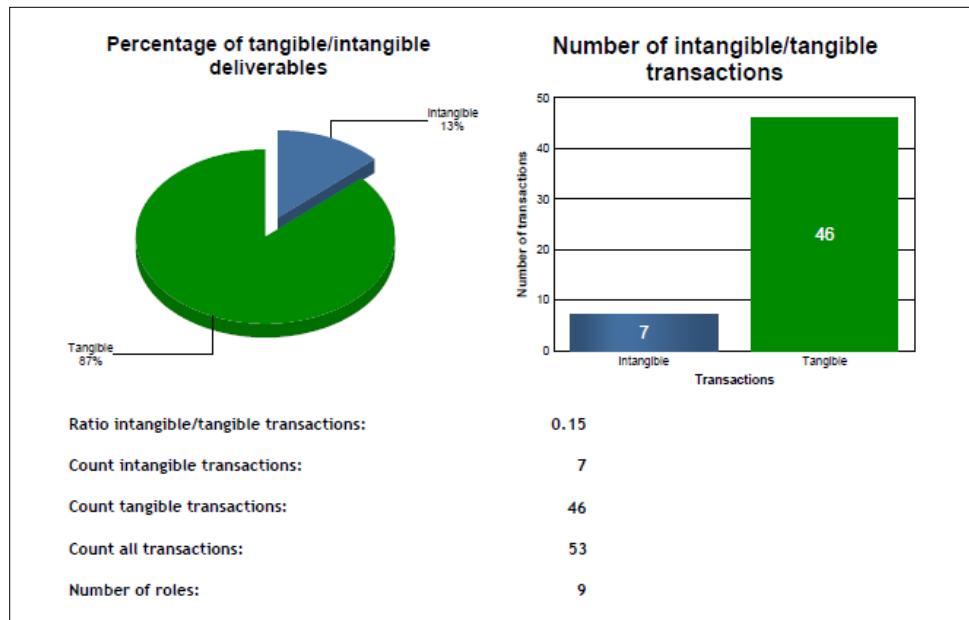
Source: Own elaboration

Resilience of the air traveller experience/network

The predominance of tangible transactions over intangible transactions is reflected in the resilience ratio of 0.15 (see Figure 2). The information (intangibles) about the destination, transport, lodging and so on is crucial to the traveller's decision about his/her

trip. Nevertheless, all the roles engaged in contributing to his/her (good) experience while travelling have to work efficiently. This fact may explain why the scenario of the air traveller experience presents a higher level of tangible than intangible transactions, meaning that it is a **process-focused operational network characterised by a formal structure**.

Figure 2. Resilience of the Air Traveler Network

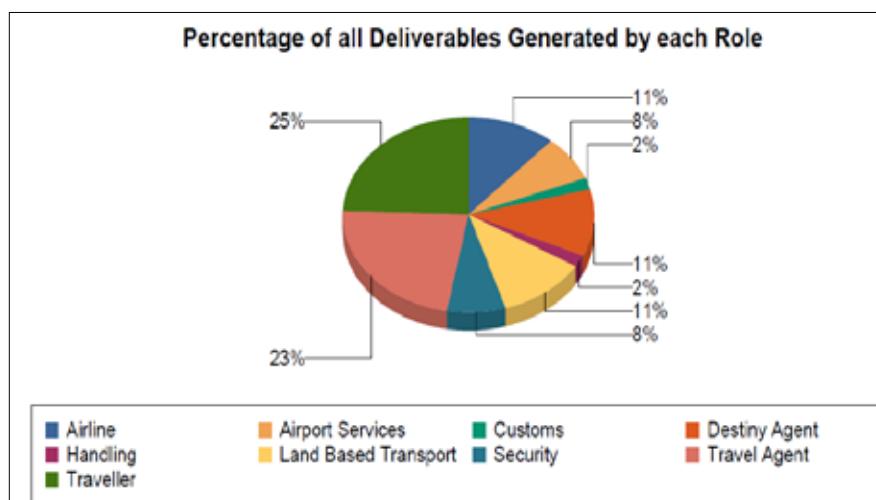


Source: Own elaboration

Value creation

The active agents for value creation are the roles in the network. The capacity of each role to generate both tangible and intangible value determines the ability of the network to generate value. The **traveller** and the **travel agent** roles are the ones that **create more value** within the traveller experience network, followed by the roles of **land-based transport**, **airlines** and **destination agents** (see Figure 3). They are indeed the key roles for the materialisation of travel.

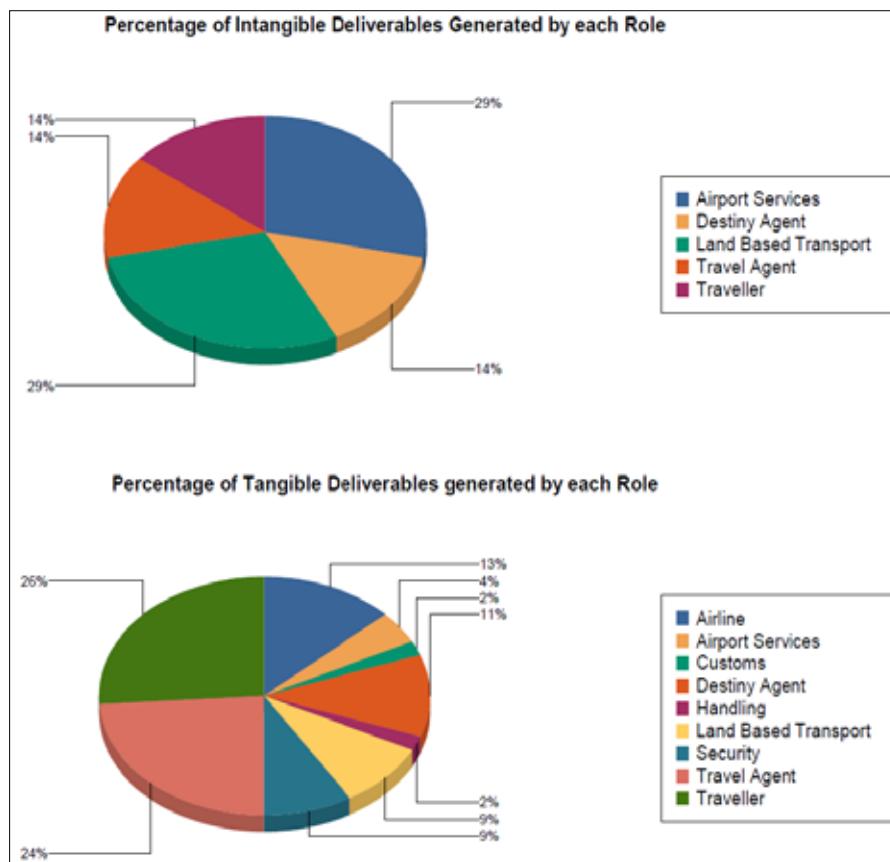
Figure 3. Value Creation by Air Traveler Network's Roles



Source: Own elaboration

Either on the demand side or on the supply side, tourism demands large amounts of information (intangibles) (Benabdallah and Ben Soltane, 1996). The airport services and the **land-based transport** are the roles that generate more intangible deliverables (Figure 4). Notably, the **traveller** is the role that generates more tangible value, followed by the **travel agent** (see Figure 4). Indeed, the traveller is the one for whom all the other roles converge.

Figure 4. Percentage of Tangible and Intangible Deliverables by each role

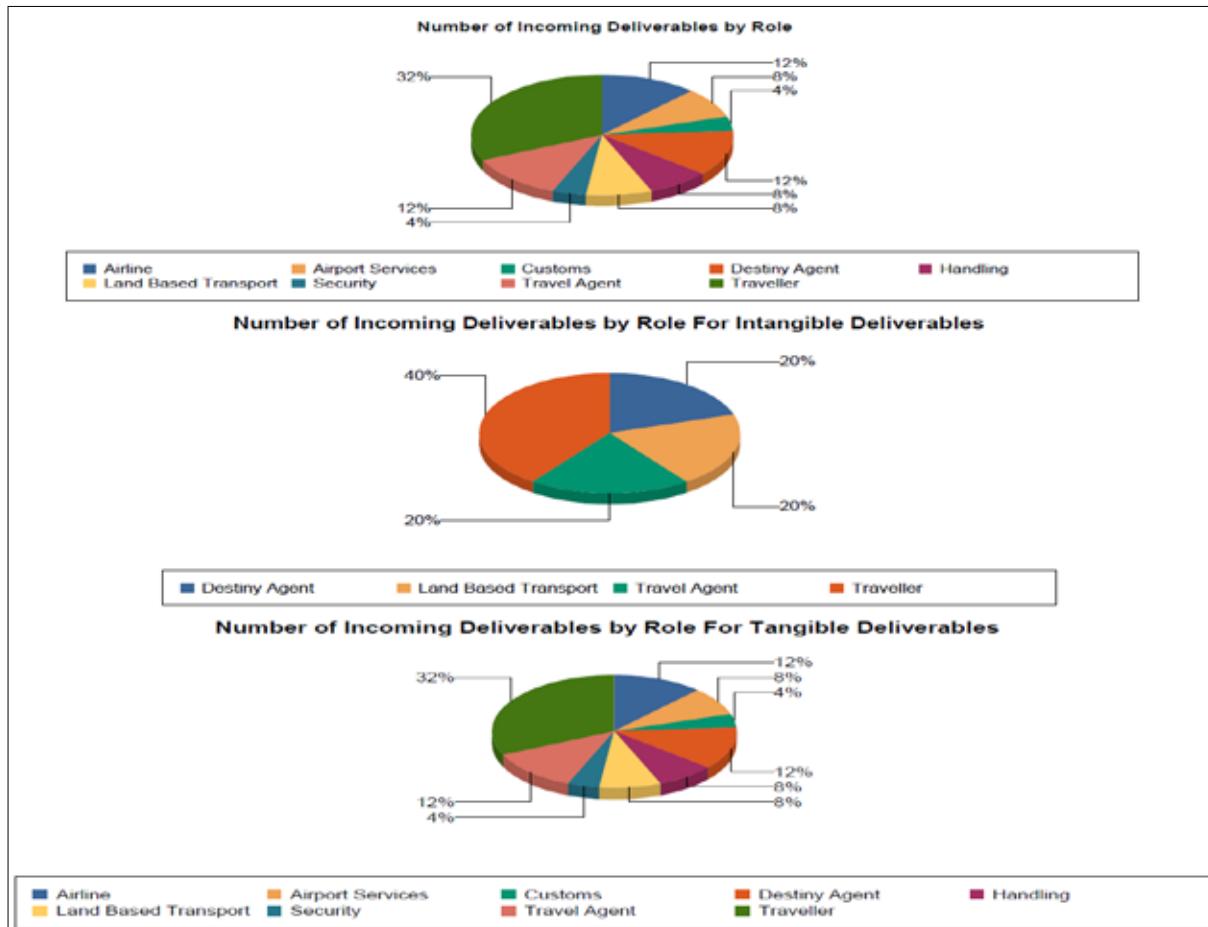


Source: Own elaboration

Structure and value

Centrality indicators help to show **value from a structural standpoint** and explain how roles gain (or contribute to) value. **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 necessarily provide the most value to the network**. It is possible to examine incoming and outgoing ties separately, using other centrality indicators such as the **centrality in degree** (related to the value that a role gains from the network) and the **centrality out degree** (related to the value that a role provides to the network). The **traveller's role is, by far, the one that gains more (tangible and intangible) value from the air traveller network** (see Figure 5).

Figure 5. Centrality In Degree of Air Traveler Network



Source: Own elaboration

In addition, the traveller's role is, by far, the one that provides more value to the network (see Figure 6).

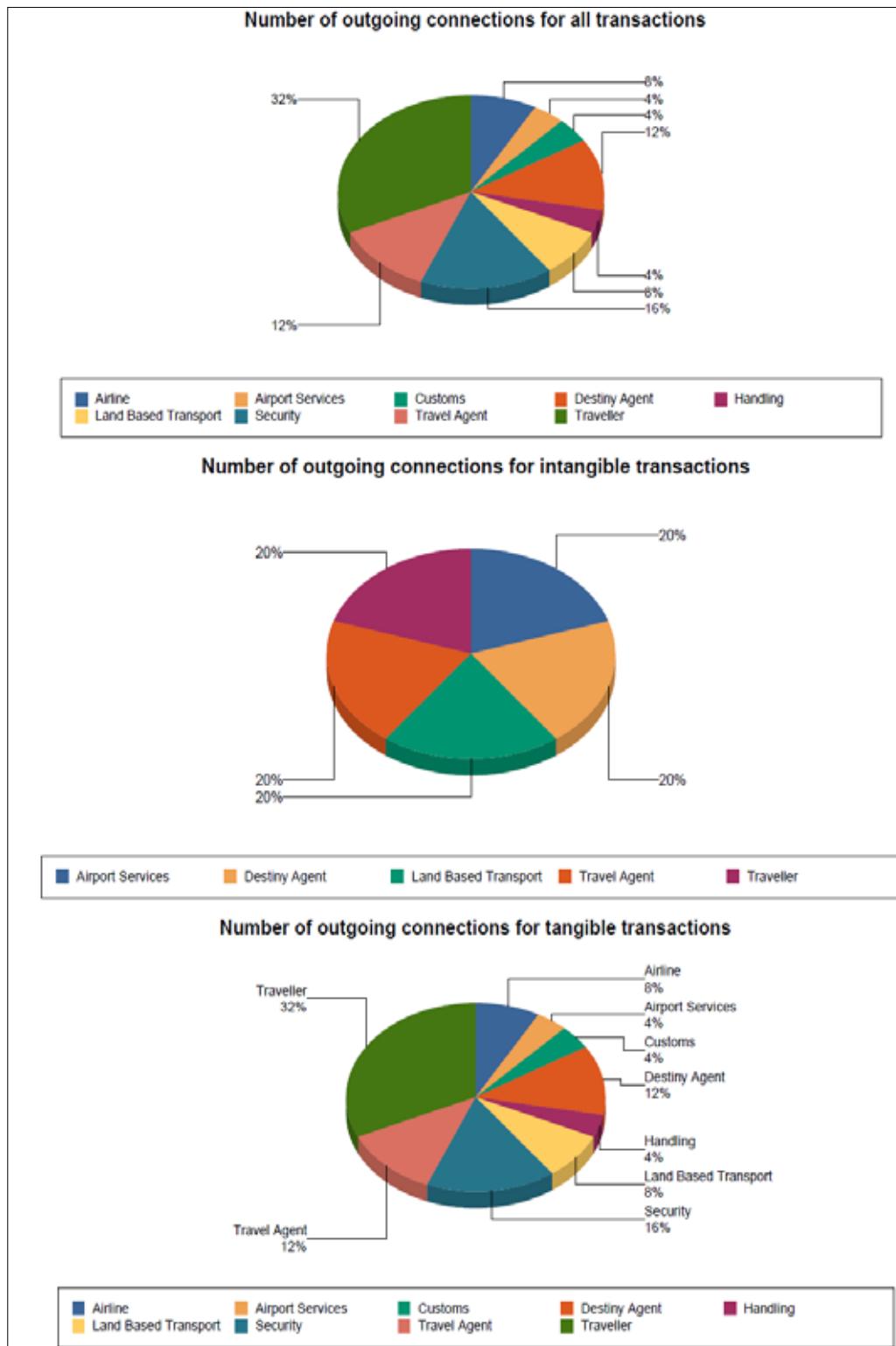
It is possible to say that the traveller's role has a strong structural position within the air traveller network, receiving and sending more value (see Figures 5 and 6).

Risk

One kind of risk to the network appears in role dependency. The risk is that the role could represent a bottleneck. If the role is not adequately resourced, then the flow paths could be negatively affected by time delays. If a role cannot keep the value flow paths moving, it affects the speed of value creation and conversion in the network. A good cross-check for whether a role is a bottleneck is to look at the speed indicators to see whether a potential bottleneck role is slowing down the value flow paths.

The second risk factor is that if there is too much structural dependency on a role, it can affect the entire network if a problem occurs.

Figure 6. Centrality Out Degree of Air Traveler Network



Source: Own elaboration

Structural dependency is based on centrality, one of the most common structural indicators in network analysis. Centrality concerns which roles or participants have the most ties or connections. In value network analysis, extremely high centrality for any one role or participant may actually be a risk factor for the network.

Structural dependency is correlated with 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 the 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 disappear or are unable to perform for some reason.

Structural Dependency	All	Intangible	Tangible
a) Highest Number of connections per Role for Transactions	33	4	29
b) Lowest Number of connections per Role for Transactions	2	2	2
c) Variance Transactions	82.84	1.17	64.62
d) Average number of connections per Role for Transactions	11.78	1.56	10.22

In spite of the strong structural position of the traveller's role, the predominance of the highest number of connections per role for transactions and the relatively low level of variance transactions allows us to state that the **power in the air traveller network is distributed across almost all the roles**. This means that if the traveller is the main focus of several roles, it is also true that the experience of the traveller is dependent on those roles.

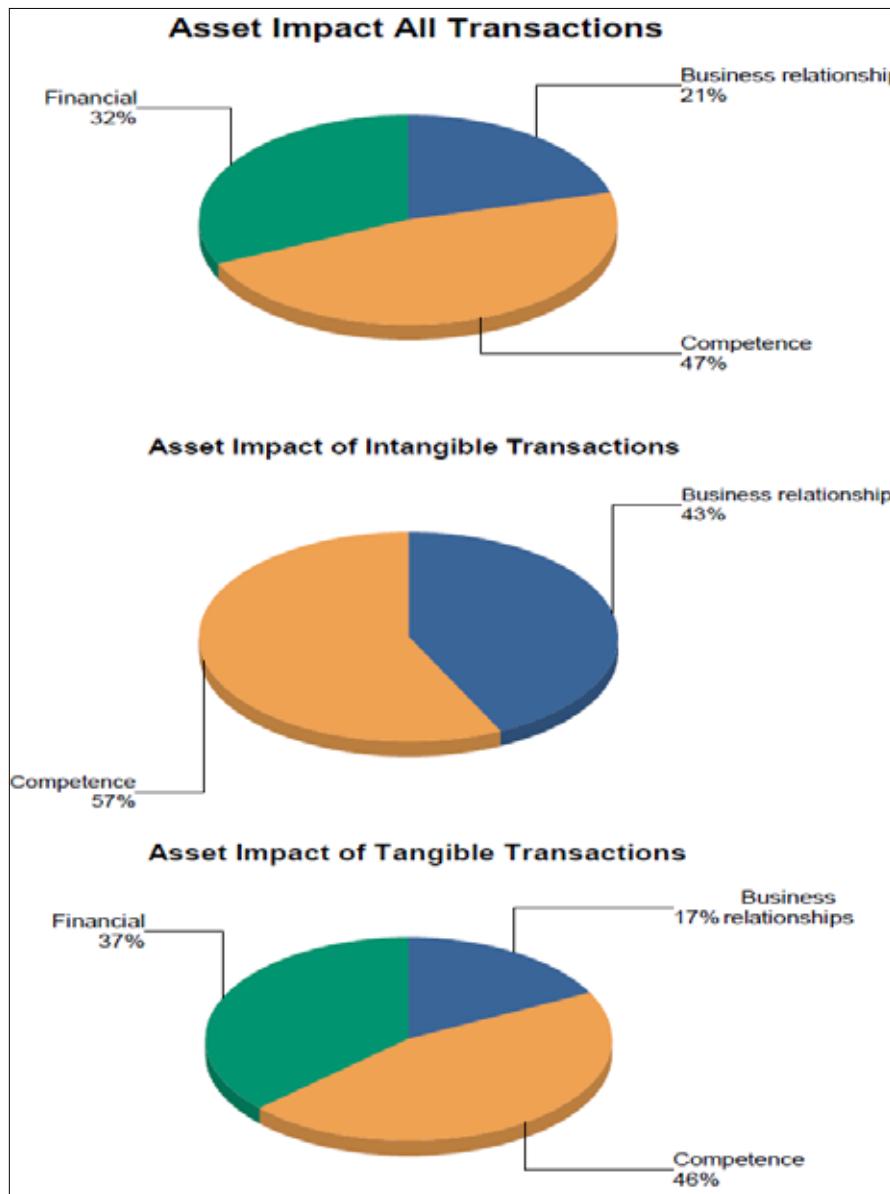
Asset impact

Asset impact measures the impact of a transaction on the network as a whole. Therefore, it is necessary to **identify the assets that are influenced by the transaction activity in the network and the assets that are most affected by the network behaviour as a whole and by the actions of specific roles**.

In the air traveller network, we identified **three main assets**: financial, competence and business relationships. The following charts show which assets are affected by the transaction activity in the network. These figures are compiled from **the way in which individual transactions exert an impact on assets**. These indicators can be used to consider which assets are most affected by the network behaviour as a whole and by the actions of specific roles.

Within the air traveller network, "**competence**" and "**financial**" assets are the most influenced by the transaction activity of the network as a whole, the "**Competence**" asset receiving a greater impact either from tangible or from intangible transactions (see Figure 7).

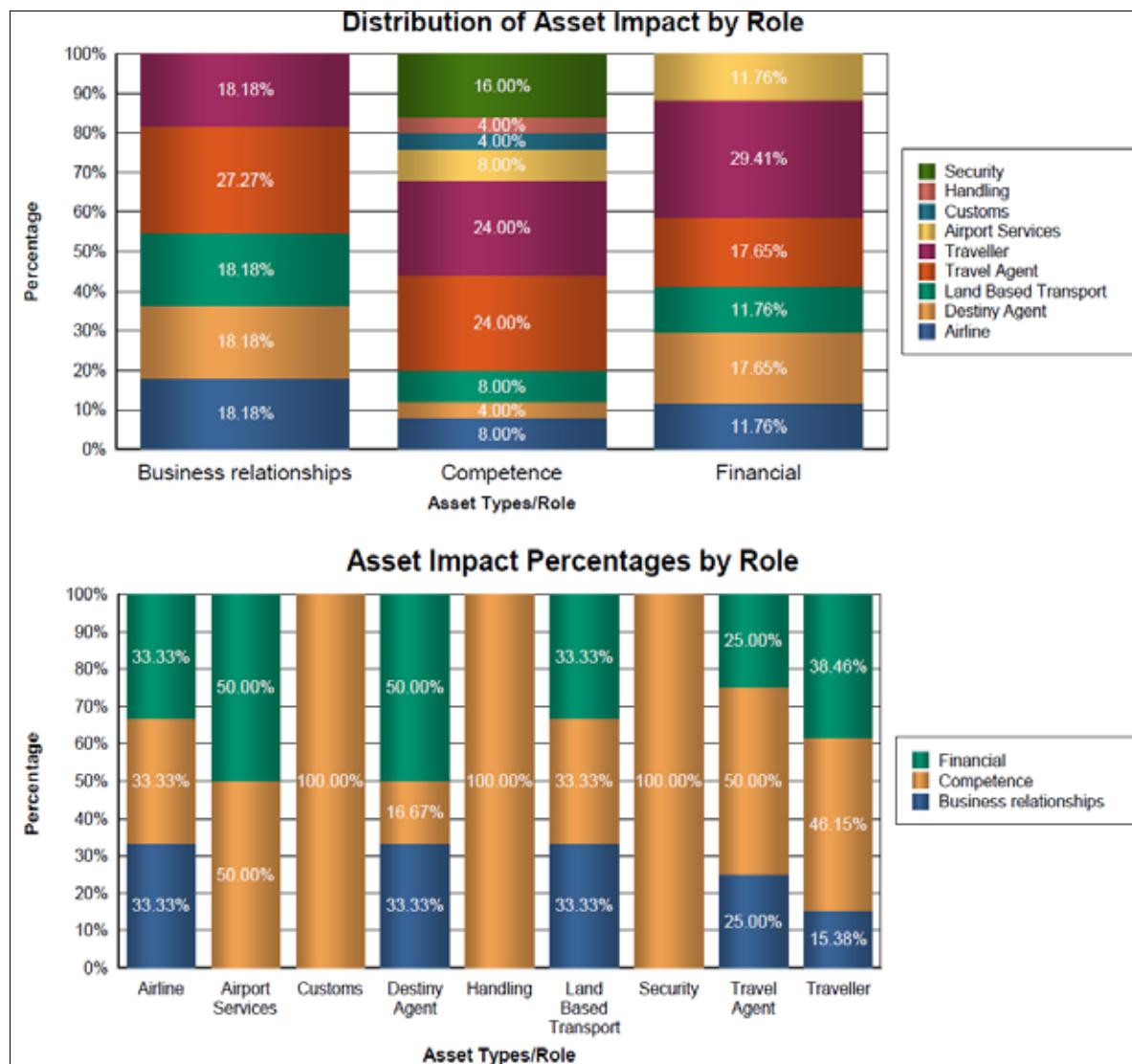
Figure 7. Asset Impacts of Air Traveler Network



Source: Own elaboration

The following charts (Figure 8) show the role distributions for the asset impact. We can conclude that the **role of travel agent** has great impact on the business relationship asset as well as on the competence asset. Furthermore, the traveller role has a significant impact on the competence and financial assets.

Figure 8. Role distributions for Asset Impact



Source: Own elaboration

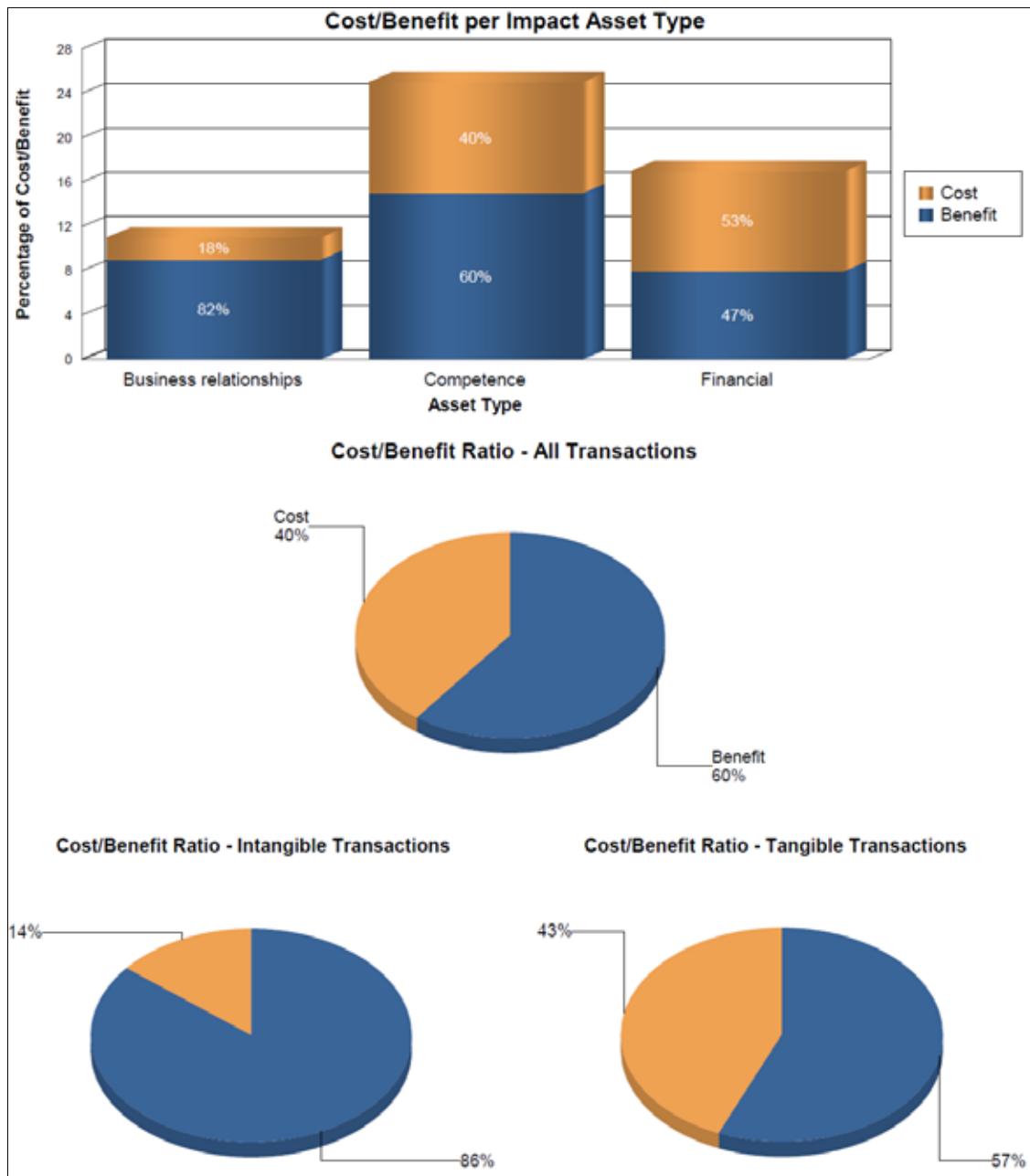
Analysing the asset impact percentages by role (Figure 8), we can conclude that the asset competence is transversal to all the roles, notably being important to the roles of customs, handling, security, airport services, travel agent and traveller. It is interesting to observe that the financial asset, present in almost all the roles, has great importance for the roles of airport services and destination agent, for which the competence asset has a lower relative weight.

Asset impact-cost/benefit

Once the influenced asset has been identified, the next questions are “Does the transaction have a positive or negative impact on the asset? When the deliverable is received, how is it going to affect the overall asset picture?”

The next figure (Figure 9) shows the cost/benefit ratio from all the transactions then from intangible transactions only and finally from tangible transactions. All the transactions have more positive (benefits) than negative (costs) impacts on the different assets within the air traveller network, either for tangible transactions or for intangible ones.

Figure 9. Cost/Benefit Ratio from Transactions (tangible, intangible and all) of Air Traveler Network

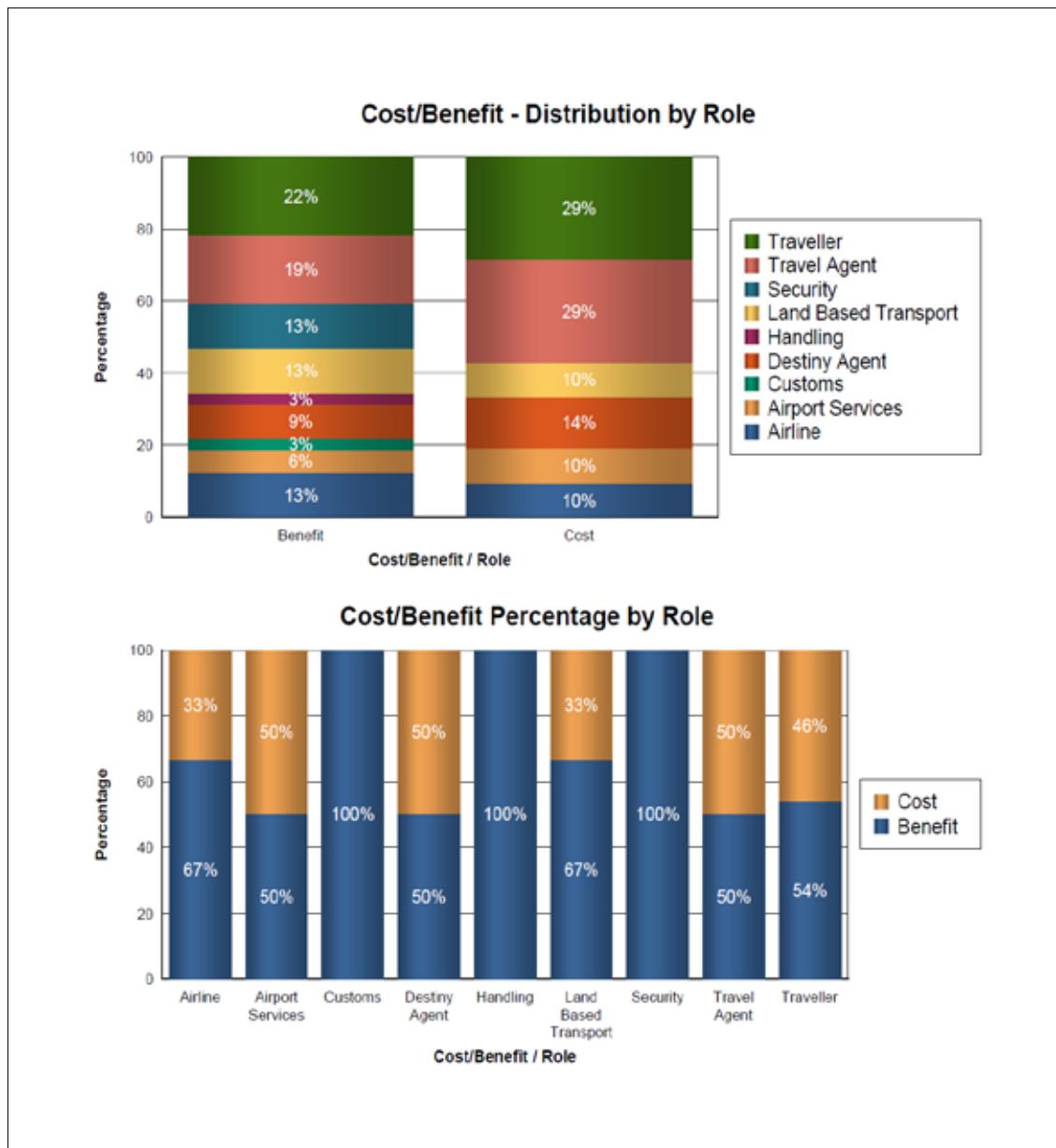


Source: Own elaboration

The following figure (Figure 10) examines the cost/benefit distribution and percentage by role.

The roles of traveller and travel agent are the roles that contribute more to the positive (benefits) and to the negative (cost) impacts on the assets. For the roles of customs, handling and security, the transactions have a 100% positive impact (benefit) on the assets. For the other roles, the transactions have both a positive and a negative impact on the assets (see Figure 10).

Figure 10. Cost/Benefit Distribution and Percentage by Role of Air Traveler Network



Source: Own elaboration

Transaction speed

The transaction speed indicator is helpful in spotting network bottlenecks. Transaction speed can refer to the actual transit time of the deliverable. Used in this way, it is useful for comparing the speed with the transport channel profile.

The transaction speed can also refer to how slowly or quickly the deliverable is executed and released by the role. Used in this way, it represents the “waiting time” for a role to complete and send the deliverable. This approach is useful for identifying any roles that could be better supported with resources or improved processes for faster execution.

The average speed is calculated by giving the following rating: fast = 1, medium = 2 and slow = 3.

Average Speed of All Transactions:

Total Number of Transactions: 53

Average Speed: 1.17

Average Speed of Intangible Transactions:

Total Number of Transactions: 7

Average Speed: 1.71

Average Speed of Tangible Transactions:

Total Number of Transactions: 46

Average Speed: 1.09

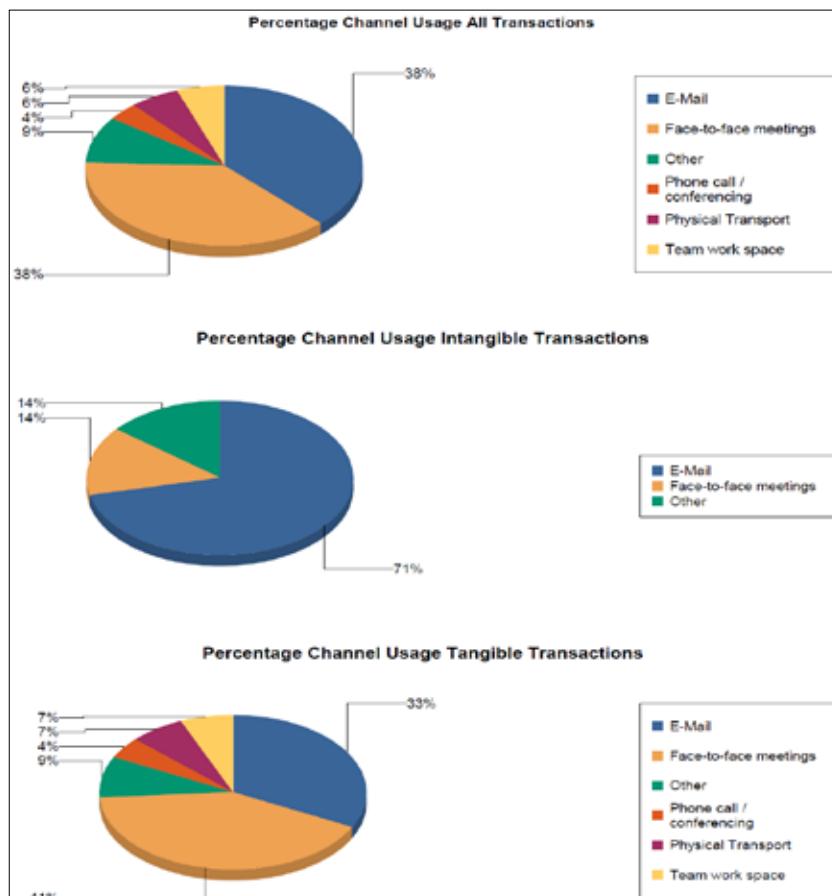
The obtained results allow us to state that, within the air traveller network, all the transactions (tangible and intangible) are executed quickly and released by the roles.

Channel

The channel profile provides a way to consider the effectiveness of different delivery mechanisms for specific deliverables. For example, some companies rely heavily on face-to-face meetings, but video conferencing might be a more effective way to work. Other companies rely on technology and systems for delivering information or automating provisioning.

The next figure (Figure 11) shows the distribution of different channels used within the air traveller network for all the transactions, intangible transactions only and, finally, tangible transactions.

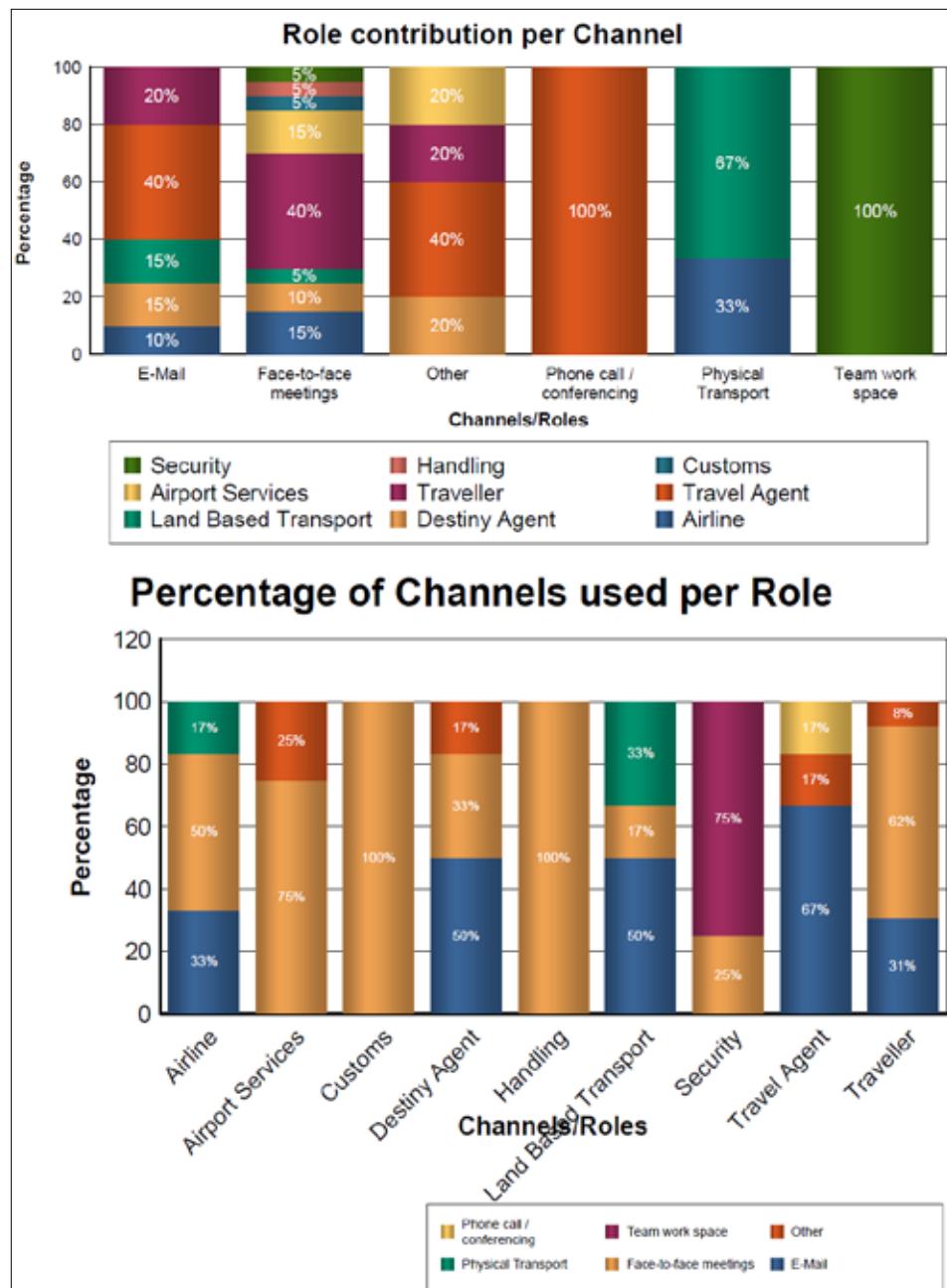
Figure 11. Channel profile of Air Traveler Network's Transactions



Source: Own elaboration

Email is the most-used channel in all the transactions of the air traveller network, but for the tangible transactions, face-to-face meetings are the dominant channel. However, the preferred type of channel varies depending on the role, as shown by the next figure (Figure 12).

Figure 12. Channels used per Air Traveler Network's Roles



Source: Own elaboration

Agility

One indicator of network agility is the speed with which information can move around the network. The “degrees of separation”, technically referred to as “distance” in a network, are a measure of how quickly information can spread out across the network to reach all its members. It is an important indicator of a network’s agility in being able to make sense of and adapt to internal and external changes. It is also an indicator of the ease with which

any individual can reach the person who might be able to solve a specific problem. A high average distance between roles can be an indication that there are not enough hubs or connectors in the network.

Average Degrees of Separation for all Transactions	:	1.61
Average Degrees of Separation for all Intangible Transactions	:	0.14
Average Degrees of Separation for all Tangible Transactions	:	1.61

Within the air traveller network, the tangible transactions present greater agility than the intangible ones.

Stability

Stability is revealed by measures of network density. Density is calculated as the number of actual connections between roles divided by the number of potential connections between roles. The most significant density indicator is weak tie stability, which helps us to understand the extent to which the loss of connections in the network will affect the performance of the network as a whole.

Weak tie stability is the ratio between intangible and tangible transaction density: the higher the ratio, the more dominant the density of intangible connections; the lower the ratio, the more dominant the density of tangible connections. A resilience score of 1 shows a perfect balance between the densities of tangible and intangible connections.

Weak Tie Stability: (intangible/tangible)	0.15
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Within the Air Traveler Network the density of tangible connections are dominant.

Density All transactions: In your network 147.22 % of all possible ties are present.
Density Intangible transactions: In your network 19.44 % of all possible <i>intangible</i> ties are present.
Density Tangible transactions: In your network 127.78 % of all possible <i>tangible</i> ties are present.

4. SYNTHESIS AND CONCLUSIONS

People travel for many reasons, and as Denys and Mendes (2014, p. 4) argued, “(...) to comprehend what factors drive tourists and determine their choices requires a thorough analysis of various complicated variables of internal and external environments that embrace the tourist behavior”.

Applying the VNA methodology to tourists as air travellers, we identified the key roles related to the air traveller experience: traveller, travel agent, destination agent, airline, land-based transport, customs, security, handling and airport services.

The information (intangibles) about destination, transport, lodgings and so on is crucial to the traveller’s decision about his/her trip. Nevertheless, all the roles engaged in contributing to his/her (good) experience while travelling have to work efficiently. This fact may explain why the scenario of the air traveller experience presents a higher level

of tangible than intangible transactions, meaning that it is a process-focused operational network characterised by a formal structure.

The traveller and travel agent roles are the ones that create more value within the traveller experience network, followed by the roles of land-based transport and airlines. They are indeed the key roles for the realisation of travel.

Either on the demand side or on the supply side, tourism demands large amounts of information (intangibles) (Benabdallah and Ben Soltane, 1996). Airport services and land-based transport are the roles that generate more intangible deliverables; also important in this context are the roles of travel agent, destination agent and traveller. Notably, the traveller is the role that generates more tangible value, followed by the travel agent. Indeed, the traveller is the one for whom all the other roles converge.

The traveller's role is, by far, the one that gains more (tangible and intangible) value from the air traveller network. In addition, the traveller's role provides more value to the network. Accordingly, we can say that the traveller's role has a strong structural position within the air traveller network, receiving and sending more value.

In spite of the strong structural position of the traveller's role, the predominance of the highest number of connections per role for transactions and the relatively low level of variance transactions allows us to state that the power in the air traveller network is distributed across almost all the roles. This means that if the traveller is the main focus of several roles, it is also true that the experience of the traveller is dependent on those roles.

Three main assets were identified in the air travel network: financial, competence and business relationships. The "competence" and "financial" assets are the most influenced by the transaction activity of the network as a whole, the "Competence" asset being more affected by either tangible or intangible transactions. The role of travel agent has a great impact on the business relationship asset as well as on the competence asset. Furthermore, the traveller role has a significant impact on the competence and financial assets. The asset "competence" is transversal to all the roles and notably important to the roles of customs, handling, security, airport services, travel agent and traveller. It is interesting to observe that the "financial" asset, present in almost all the roles, has great importance for the roles of airport services and destination agent, for which the competence asset has lower relative weight.

All the transactions have more positive (benefits) than negative (costs) impacts on the different assets within the air traveller network, either for tangible transactions or for intangible ones. The roles of traveller and travel agent are the ones that contribute more to the positive (benefits) as well as the negative (cost) impacts on the assets. Within the air traveller network, all the transactions (tangible and intangible) are executed quickly and released by the roles. Email is the most-used channel in all the transactions of the air traveller network, but for the tangible transactions, face-to-face meetings are the dominant channel. However, the preferred type of channels varies depending on the role. Within the air traveller network, the tangible transactions present greater agility than the intangible ones. In this regard, we recall Belo *et al.*'s (2014, p. 218) statement that "the key features of business and innovation, which in past decades were tangible, are now replaced by intangible assets such as connections, knowledge, and integration". Although, in our opinion, not all tangible assets are replaceable by intangible ones, it is necessary to take into account the growing importance of the latter in the business and innovation strategies.

As mentioned by Fattah *et al.* (2009), airports need to adopt a customer-centric approach focused on enhancing the passenger experience and, in this context, "the airport's role must evolve from passive landlord to active participant, enriching the passenger journey as a key ecosystem partner". For this goal, consistency, control and manageability, customised experiences and the right level of service intensity are needed as passengers increasingly

expect their travel experience to be seamless, stress-free and comfortable (Fitzpatrick and Bluell, 2015). The ability of VNA to describe better the effective network of the airport system justifies the choice of this methodology. We conclude that the application of VNA provided a network ecosystem perspective on how processes and people create value within the air traveller network.

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