INTELLIGENT TRANSPORTATION SYSTEM TO ENHANCE THE SUSTAINABILITY OF THE AIR FREIGHT TRANSPORT

Miquel Angel Piera[(a)], Xavier Leal [(b)], Lorenzo Castelli [(c)] , Dace Aizstrauta [(c)]

[(a,b)] Logistics and Transport Unit, Universitat Autònoma de Barcelona, Spain
[(c)] DIA. University of Trieste, Italy
[(d)]Sociotechnical Systems Engineering Institute of Vidzeme University of Applied Sciences, Latvia

[(a)]miquelangel.piera@uab.cat, [(b)]xavier.leal@uab.cat, [(c)]castelli@units.it, [(d)]dace.aizstrauta@va.lv

ABSTRACT
When addressing the transport problem in isolation from production, the object is to obtain the lowest total cost of transport. Thinking the production and the distribution as a linked system, the optimisation goal should balance between production and transport costs, considering the minimization of the total distribution cost (TDC) instead of considering only the minimization of the transport costs.
In this paper it is presented the commercialization of passenger airline bellies for freight transport purposes under a business model approach.

Keywords: freight transport booking, turnaround, business model, air transport logistics.

1. INTRODUCTION

From the logistic point of view, Industry is trying to devise a goods creation and distribution system that creates greater value than its costs. Improvements in the efficiency of the global supply chain are essential to increase the overall levels of demand for Just-In Time (JIT) logistics services. Costs related to inventory (ie. depreciation, spoilage, obsolescence, good insurances, bay hiring cost, etc) plays an important role when designing the supply chain architecture.

Air cargo is an important sector of the airline industry. Cargo can be carried in cargo holds of passenger airlines or on aircraft designed exclusively to carry freight. Cargo carriers in this industry do not provide door-to-door service. Instead, they provide only air transport from an airport near the cargo's origin to an airport near the cargo's destination. Companies that provide door-to-door delivery of parcels either across town or across the continent are classified in the couriers and messengers industry, and are known as integrators.

Cargo airlines can provide a critical link in any supply chain consortium to reduce stocks while reducing transport times, supporting different type operations "hub and spoke" or providing ad hoc transportation of freight from point to point.

Cost of transport usually is split into two parts:

- Direct Operating Cost: Fuel, crew, vehicle depreciation, maintenance, etc.
- Indirect Operating Cost: sales, cargo handling, administration, profit, etc.

With regards to direct operating cost, it is easy to see that ship transport is much less expensive than airplane transport, however for the indirect operating cost, there are several aspects related to cargo handling, such as ship mechanized loading and large containers versus some manual air load and balancing operations that nowadays increases the air cargo transport cost and time, but that in a near future "low cost cargo airline" could tackle in a more efficient way without affecting safety aspects.

Traditional air cargo business must deal with strategic, tactical and operational changes in order to give a proper answer to the growing air cargo expectations. Too many trouble spots should be re-designed not considering only logistic at operational level but also the proper planning of infrastructures in which the non-added-value operations could be removed or minimized.

Since a structural change is inevitable for a competitive, reliable and low cost air cargo it is important to evaluate the different emerging scenarios from a sustainability perspective instead of only considering economical or operational aspects.

Based on a deep analysis of Intelligent Transportation Systems (ITS) tools in the air cargo sector, developed in the European FP7 T-Trans project, in this paper it is presented the development of a technology commercialization model for the use of passenger aircraft bellies to satisfy cargo industrial purposes, considering the sustainability aspects of the ITS applications.

Due to the huge number of resources and operators that should be properly coordinated, a system engineering approach would help to design a methodology focussed on process simplification, verification and audit, while

also meeting increasing security demands. This new methodology should tackle air cargo agility, flexibility & adaptability, plus visibility from an integrated perspective considering always the cost and yield aspects of any decision.

Section 2 presents the main components to be considered in the FTB system, while section 3 summarizes the identifier enablers of the business model.

2. SYSTEM DESCRIPTION

One of the main difficulties to deal with a competitive and cost effective air transport system rely ion the proper coordination of the different actors, considering the available transport and handling capacities together with the different technologies and procedures through which goods should flow. In this section it is described the main components to be considered.

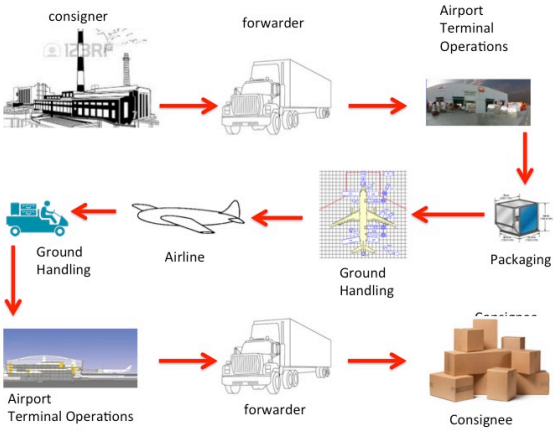

Figure 1: Aircargo supply chain

In Figure 1 it is summarized the main actors through which the cargo flows, while in Figure 2 the technologies required for seat booking are highlighted, most of which should be adapted for freight belly booking.

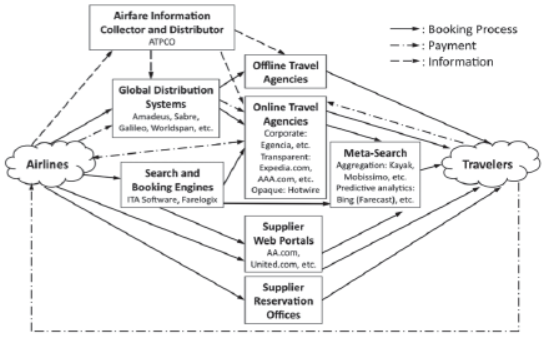

Figure 2: Travel Distribution value (Granados et al., 2011)

2.1. Actors

To deal with a sustainable approach to the use of passenger aircraft bellies it is essential to understand the role and functionalities of the different actors handling the freight in order to remove the non-added-value operations and understanding the value change.

Consigner is the person or company that is physically and administratively responsible for shipping the goods. Consigners can either directly contact the Air Cargo Carrier either can pass through a third party provider, e.g. the Freight Forwarder. The Air Cargo Carrier who is providing to both the service plays the central role.

Passenger/Cargo Airlines have contracts with passenger airlines that allow them to ship items via passenger service. Passenger flights have such high frequencies they can offer shipping rates that are competitive to the cargo only airlines. Many may be surprised to find out that even if everyone on board their airplane checked a bag, there would still be a large amount of space in the baggage compartment left unused. That's where cargo makes the airline some extra money. Standard aircraft almost always carry some cargo in the baggage hold - in the aircraft belly. These companies operate passenger services and cargo services simultaneously. These airlines can combine the advantages of destinations and frequencies supplied by passenger services with the benefits of power and specialization of cargo network.

Freight Forwarders are persons or companies that organizes shipments for individuals or to get goods from the producer to a market, customer or final point of distribution acting therefore as an expert in supply chain management. Freight forwarders arrange the best means of transport, taking into account the type of goods and the customers' delivery requirements. They use the services of shipping lines, airlines and road and rail freight operators. In some cases, the freight forwarding company itself provides the service. A distinction can be made between Forwarder out (expeditor) and forwarder in. The expeditor operates by buying space at the airline's sales or customer service department, or in case of a foreign airline, to the General Sales Agent. The Forwarder in manages the shipment from its arrival at the airport up to the delivery to the final customer or consignee.

Airport Terminal Operator: it provides the required infrastructure to receive the freight form the land side, inspect and pack in ULD's and send to the air side, and also receive freight from the air side, unpack and forward to the land side after the required administrative processes.

Ground Handling: It is a company, which provides all the services required by the aircraft while it is in the ground for the next fly. Speed, efficiency, and accuracy are important in ground handling services in order to

minimize the turnaround time (the time during which the aircraft must remain parked at the gate).

Consignee: is the person or company that is physically and administratively responsible for receiving the goods.

2.2. Technologies

In order to evaluate the sustainability of a Freight Transport Booking (FTB) system, it is of outmost importance to understand how the booking is performed within the air passenger segment and to establish similarities and differences between air passenger and air cargo segment. It is worthwhile to note that the core technologies in which FTB applications rely on are at a maturity level.

ISP: Internet Service Providers, referring to the companies that provide internet services to large companies, providing a direct connection from the company's networks to the Internet.

IBE: Internet booking engines are applications that help travel and tourism industry support reservation through the Internet. By installing them in the home page of an airline, they enable easy access for customers. Once customers enter their travel preferences, the IBE contacts the GDS or CRS to receive the relevant information but displaying it in an appropriate and user friendly interface. With the growing online travel booking, companies developing and integrating online booking engines have multiplied.

Data management platforms are the back-bone of data-driven marketing, serving as unifying platforms to collect, organize, and activate first and third party audience data from any source, including online, offline and mobile. A Data Management platform should collect unstructured data from any source, including mobile web and app, web analytic tools, CRM, and points of sale.

PSP: E-commerce and payment service providers are companies specialized in offering webshops online services for accepting electronic payments by a variety of payment methods. A PSP manages the technical connections to multiple acquiring banks, card and payment networks, offering also risk management services.

GDSs: Global Distribution Systems are the link between travel agents and airlines in the passenger sector. In particular, in the cargo context, capacity exchanges are implemented in the form of an electronic cargo-booking system, allowing a forwarder to see the schedules, available capacities, and prices of all airlines serving a particular route, and to make the best selection for its customers (Schwarz, 2006). There are a set of available tools owned by different providers of e-freight business solutions for air cargo, which implement separately the steps for booking (see for example (www.calogi.com).

GSSA: General Sales and Service Agency provides a valuable role in assisting Airline to achieve a cost-effective presence in a market where it may be uneconomical for an airline to maintain its own sales force and premises. The GSSA works on behalf of their Airline Principals providing the freight forwarding community with the full range of cargo services within the specified territory .

2.3. Processes

Among the different process that could affect drastically the implementation of the FTB there 2 processes which requires a deep understanding of the FTB dynamics to avoid over costs and poor competitivity:

Fast turnaround times. A crucial issue for the successful exploitation of such a large unused belly capacities is the possibility for airlines to maintain their current turnaround times, and then the high aircraft utilization rate. This is mostly true for low cost airlines that show very fast turnaround times (25 minutes for Ryanair) and then cannot afford disruptions due to the cargo operations, such as the processing of the appropriate cargo papers. Hence the capability of handling paperless documentation is a key enabler for the actual implementation of transporting cargo in passenger flight bellies, in particular e-Air Waybill (e-AWB). The Air Waybill (AWB) is a critical air cargo document that constitutes the contract of carriage between the "shipper" (forwarder) and the "carrier" (airline). e-AWB removes the requirement for a paper AWB, significantly simplifying the air freight supply chain process. IATA's target is 100% penetration for e-AWB shipments by 2015.

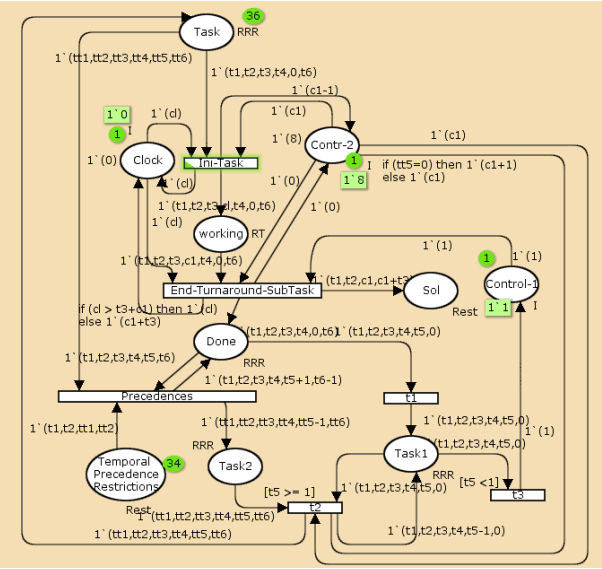

Figure 3 Turnaround CPN model

Clearly, optimised ground holding operations (such as cargo loading/unloading to/from the aircraft belly) are

also mandatory to maintain fast turnaround times. In (Fernandez, 2014) it is presented the use of a CPN model (see Figure 3) to analyse the different interdependencies which affects the turnaround process, with special attention to introduce ULD palletized freight tasks designing also mitigation mechanisms to the propagation of disturbances between freight, passenger and aircraft tasks.

In Figure 4 it is represented the critical path of a turnaround obtained with the CPN developed, in which some delays appeared in de-boarding and in the catering tasks

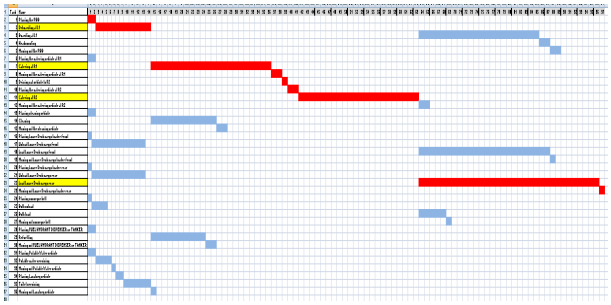

Figure 4: Critical path of the turnaround process considering delays

Revenue Management: to increase an airline's profitability based on customer insight. The RM techniques applied to the commercialization of the bellies should consider:

- *Capacity Forecasting (CF)* – evaluation of the space available on future flights
- *Demand Forecasting (DF)* - aims at estimating how much cargo will tender for a particular flight
- *Overbooking* - the practice of selling more cargo space than what is physically available, in order to compensate for no-shows, cancellations or variable tendering
- *Capacity Management (CM)* - deals with how to optimally allocate the booking requests in the forecasted cargo capacity for a particular flight
- *Allotment Management (long-term sale)* – deals with a long-term agreements (typically 6-12 months) between a freight forwarder and an airline
- *Free Sale Space Management (short-term sale)* – deals with decision of selling the capacity when a request comes in, or to save it for a potential later sale at a higher price
- *Routing Optimisation* – supports the decision about delivery route of the cargo from origin to destination
- *Freight Transport Booking* – reservation of space by customer and payment of transportation fee
- *Freight Tracking* - allows a customer (and the airline) to know in real time the (approximate) location of a shipment

2.4. Present Shortages

Despite most technologies for FTB are at a mature stage, there are some aspects which should be properly considered for the sustainability of the freight transport in the passenger airline bellies:

- Product capacity definition: In passenger each entity is well-defined: a passenger. In cargo, each item is more complex: length, width, and weight define each entity, and the most constrained resource between volume and weight should be considered to predict the "rest capacity".
- Booking time-frame: short term booking is highly dependent on medium-term allocations. Allocations in pure cargo airlines are sold usually twice per year in which customer agreements are issued to guarantee capacity on specific flight/weekday. The cargo delivered by customers every week usually fluctuates with respect to the agreement signed.
- Booking process is subject to considerable volatility: The kilograms and cubic metres of cargo demand often depend on extraneous factors that make demand more difficult to anticipate. As example, consider industrial freight forwarders do not know what shipments they will consolidate until the last minute, usually shippers may only know the approximate size of their shipments at time of booking since the task of accurately estimating weight, volume and density is not always feasible.
- Forecast Demand Models for short term booking are unviable since the time efficiency inherent to air cargo transport usually is required by manufacturers to overcome unpredicted inventory shortages or demand fluctuations (ie. stochastic events).
- It is very difficult to compare fares among different carriers. Most airlines allow registered users only to check on the internet prices and associated service conditions. And, to the best of our knowledge, there are not websites, such as Expedia or Travelocity for passengers, simultaneously showing several options from different airlines for a given shipment.
- Business models incompatibilities: Air cargo carriers are subordinated to the passenger marketing requirements, which unable cargo requirements to influence on schedules, frequency, destinations and equipment. Cargo capacity at departure is often the leftover space in aircraft bellies after passenger baggage loading.
- Hidden Logistic Costs: The cost of the full cargo chain cannot be easily modelled due to the diversity of intermediate agents and operations that must be coordinated from the shipper location until the destination customer, which usually can require different van-truck transport agents, more than four warehouse operations and different cargo packing and consolidation tasks.
- Aeronautical taxes: The major part of aerial cargo within Europe is transported by feeding surface

service (RFS or also known as the aerial truck). The truck shipments are done with the code IATA (International Air Transport Association) reflected on the air waybill including the company and flight number detailing the operation was carried out by RFS. Airlines usually opt for this service to connect major European airports, used as hub airports, with secondary airports to power and operate the first flight with a greater load factor.

- Bureaucracy: According to IATA, every air cargo shipment carries up to 30 paper documents. With this volume of documents could fill eight Boeing 747 aircraft each year. This entails an increase administrative burden of waiting time and therefore a higher total transportation time. This extra time results in additional costs to the actors as they must maintain a safety stock in the supplier chain.
- Lack of operational flexibility due to an undesirable interaction between documentation flow and physical flow: The documentary portfolio (ie. documentation required by the destination airport, customs, transportation companies, etc.) is prepared in the airport cargo terminal once one knows exactly the goods that can be transported on a particular flight. During the belly loading operation it is not possible manage the cargo containers by removing a small part of the weight due mainly that the full documentation should be prepared again in the cargo terminal.

3. BUSINESS MODEL

A business model is a formal description of an opportunity that incorporates four elements: the product or service being offered, the customer definition, the value proposition (the benefits to the customer), and the means by which the benefits will be delivered to the customer (the distribution channel).

Among the main difficulties in the past to enhance the use of belly cargo of short and medium range passenger aircraft against dedicated freighter was mainly because freight operations use to be secondary to the passenger business in some airlines with potential penalties slowing turnaround times for example and because on some routes, demand for air cargo transportation far exceeds belly capacity: for example belly space alone is far from being able to cope with the demand.

Once at this point in which aircraft companies are introducing extra capacity for passenger bellies, airlines are looking for new incomes to compete with the increment of fuel prices and other taxes, and production industries and wholesalers are always trying to reduce stocks through faster and cheaper transport means for replacement, it seems obvious that a new website platform that could fit the cargo transport demand from one side into the passenger bellies, would provide a challenging and competitive solution to present transportation market.

Regarding the extra cost of flying with freight, it has been estimated by means of BADA model and also from empirical data that the extra fuel per each Tone of cargo use to affect in an increment of 4% of kerosene for a short/medium range route. Thus, the transport of 2 Tones would affect only on 80 Kg of kerosene. It can be assumed no extra cost regarding Airport fees and ATC fees meanwhile the aircraft do not exceed the MTOW (maximum take off weight) declared, which is independent of the freight transported in each particular flight. Handling costs are not considered since some companies have a flat rate independently of the amount of ULD to be managed.

A macro approach to the cost of freight transport by trucks is estimated by:

Total Cost Truck= distance* road price (0.69 €/Km) * ULD
Total Time = International transport (3 days aprox)

The freight transport cost considering the use of passenger airline bellies is estimated by:

Total Cost = (distance to airport (0.69 €/Km) * ULD) + Belly Cost + (distance from airport to destiny (0.69 €/Km) * ULD)
Total Time = maximum 1 day

Despite different scenarios could be considered, just a rough comparative considering the shipper and the consignee close to the origin and destination airport would provide a difference of transportation costs for a 1000 km distance around 600 € per ton.

By considering that all key technologies for develop a FTB in the air sector are nowadays in a mature stage, and the competitive trade-off between time and cost estimated,, the main break-even risk is the critical mass of commercial passenger airline bellies that could satisfy not only the predicted demand to each particular destination, but also an extra capacity at zero cost to support problems related to late shipments and off-loads.

In order to enhance the use of passenger airline bellies and increase the frequency of flights to the freight destination, a strategic model analysing the hinterland characteristics of the airports is proposed. An analysis at macro level of the different routes to satisfy the freight demand will provide a picture of those airports which tends to run short of bellies for freight, those airports which tends to offer more bellies than, together with its relationship with the hinterland characteristics, with special emphasis about the different airports from which freight could be send or received. Note that freight forwarders arrange the best means of transport, taking into account the type of goods and the customers' delivery requirements. Thus, they can collect the freight

from a warehouse and transport to the more convenient airport by surface transport.

In Figure 5 it has been represented the different combination to transport freight from a consigner to a consignee. A circle is used to represent the hinterland of the different airports, each one with a surface leg with several airports. The blue circle denotes a hinterland with a clear consigner capacity while the green circle denotes a hinterland with a clear consignee capacity, while red and yellow describes hinterland with consigner and consignees. The specific airline, and departure and destination airports are in principle irrelevant to the customer provided that the freight is picked up in O and delivered in D within the agreed time windows.

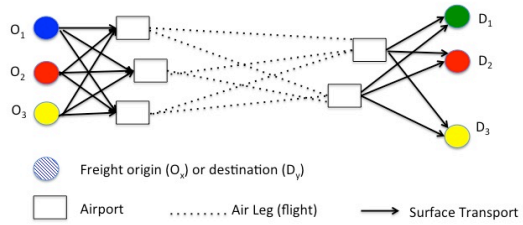

Figure 5: Surface and air leg combinations

The commercialization of a critical mass of passenger airline bellies is one of the main enablers to support air cargo routing optimisation at leg level, segment level, or origin and destination (O/D) level, depending on the structure of the network. Furthermore, an excess of bellies with respect to predicted demand should be the right target of a business model to support over sale (ie. overbooking) which somehow is a mandatory approach to implement revenue management tools and pricing algorithms that could compete with better established transport means such a road surface transport in which freight forwarders are few and they are strongly positioned in the value chain. Note, that an excess of empty bellies do not repercute at all in a negative impact on the sustainability of the business, since bellies are inherent to the commercial passenger airlines.

In the airline industry (e.g., Bell, 2009). there are empirical studies in which it can be observed a trend of convergence of strategies and structures ("business models"), in which a best-practice initiative developed by one airline, is implemented by the rest of airlines in the same sector as a booming effect. Trend convergences have positive effects if it reflects the diffusion of efficient processes and practices among firms. Thus, it can be expected that the right integration of the different DSS used by the FTB actors, and a minimum amount of bellies that could be achieved by the combination of surface and air legs would provide the seed for a sustainable air freight transport system.

CONCLUSIONS

This paper focuses on the advantages of commercializing the passenger airline bellies considering the use of ULD palletized cargo to avoid any extra time in aircraft turnaround process and the airport KPI's.

A review of actors, technologies and procedures to be considered for the FTB has been described, in which it has been identified the critical process, and the technologies which are at mature stage. A business model has been also considered to deal with the critical mass required to overcame present air freight transportation shortages, such as the well known off-load problem.

ACKNOWLEDGEMENTS

The research described in this paper was conducted in the context of the EU-funded FP7-project T-TRANS under contract N° 314263.

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