IS YOUR BELLY EMPTY?: THE ANALYSIS OF THE TRANSITION FROM FULL FREIGHTERS TO BELLY CARGO OF KLM

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ABSTRACT
KLM has revealed the plan to downsize the full-freight cargo fleet in Schiphol Airport, for that reason the company requires to explore the consequences of moving the cargo transported by the Full freighters into the bellies of the passenger flights. In the current study, the authors analyse the implications of that decision by using public information of KLM cargo. We analysed four different scenarios taking into consideration the future cargo fleet, the load factors and how the transition towards the Belly operation should impact the current operation of KLM at Schiphol. Our study show that the first impact will be in the increase of traffic of commercial flights, the traffic of KLM should match the destinations and frequency of flights in order to absorb the cargo from The Netherlands to the rest of the world. The results rises the discussion on future problems to be faced and how to make a smooth transition from full freighter to belly operation in addition to the key question if KLM fleet is able to absorb the increase in cargo or requires to subcontract companies for specific destinations.

Keywords: Air freight operations, optimum capacity, air-freight performance, Full Freighters, Belly capacity, scenario, multi-modal transport

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1 INTRODUCTION

On a worldwide level, the transport of commercial cargo is a key economic indicator of international trade as well as a thermometer for the state of the global economy. The logic is simple: as people become more productive, they become richer and they demand more consumer goods. The supply chain and logistics industry exists to connect manufacturers with suppliers and middlemen shippers with the end customer (Feng, 2015).

In terms of the business model between cargo operations and passenger operations, there exist many similarities as well as differences. Air cargo transport is more complex than passenger transport because the former involves more players, more sophisticated processes, a combination of weight and volume, varied priority services, integration and consolidation strategies, and multiple itineraries of a network than the latter.

Key similarities include:

- Similar revenue management tools and concepts such as demand forecasting, overbooking, capacity forecasting, route generation, bid prices (opportunity cost).
- A growing movement towards network capacity as opposed to leg capacity, in a similar fashion for passenger airlines. However, cargo shipments do not care about the quality of the service (nonstop vs. connecting) as much as passengers, disregarding time.

Major differences include:

- A focus on building customer, supplier, and retailer relationships because of a limited number of customers.
- Focus on profitability rather than load factor. Average load factors for passengers flights hovered around 80% in 2015 while cargo load factors in the passenger flights are around 40% and 70% in full freighters.
- Medium to long term allotment management - optimal assignment of space to customers. This is in contrast to the passenger airline business where a majority of passenger’s book in the short term for business trips and/or leisure travel.
- New optimization factors such as freight mix based on density of payload and revenue.
- Schedule optimization based on alternate constraints on noise and airport utilization (night-time flying).
- Cargo ground transport in Europe is at least approximately 700 km radius from airport. For passengers is mostly less than 3 hrs. travel.

The key differences between cargo and passenger operations are uncertainty, complexity and flexibility (e.g., Bartodziej et al., 2009; Leung et al., 2009; Li et al., 2009; Wang and Kao, 2008).

(1) Uncertainty: Air cargo transport has higher uncertainty than passenger transport in terms of capacity availability. In passenger transport, passengers may cancel reservations, and a small number of passengers may not show up. However, in capacity booking for air cargo, freight forwarders have to pledge the use of the cargo capacity on specific flights ahead of twelve (or six) months (Amaruchkul et al., 2011). Because freight forwarders do not need to pay for unused capacity, they may book more than the actual needed capacity to cut risks or to compete with others forwarders. Many bookings in air cargo can be cancelled and/or rebooked because airlines typically do not charge for changing reservations. Therefore, the booking process is subject to considerable volatility (Petersen, 2007).
(2) Complexity: forecasting cargo capacity is more complex than forecasting passenger capacity. While the capacity of a passenger aircraft is fixed by its number of seats, cargo capacity depends on the type and dimensions of container used (called unit load devices, ULDs), and specified according to pivot weight, pivot volume, type, and centre of gravity (Leung et al., 2009). For instance, the capacity may be enough in terms of volume but not in terms of weight in case of heavy cargo. Multiple dimensions are a key feature of freight, which render both complexity and uncertainty to air cargo capacity management.
(3) Flexibility: Transhipment itineraries between an origin and destination (OD) pair for cargo transport benefit the airline more than they benefit passenger transport. In general, all major airlines operate within so-called hub-and-spoke networks. Both passengers and cargo are transported from many different origins to a small number of hubs, where passengers and cargo are consolidated and then transported further to other hubs by wide-body aircrafts. The total number of transits are limited for passenger transport, and much larger for air cargo transport i.e. air cargo can be transhipped via several intermediate airports from the origin to the destination to meet the delivery time (Amaruchkul et al., 2011). The airline only needs to declare the origin, stopover (transit) airports, and destination to the forwarders and can decide on the optimal use of transhipment itineraries of air networks.

Air freight is the fastest form of transportation in terms of distance divided by time travelled. However, given extra costs related to delivery time such as customs processing, security considerations, consolidation of loads at a hub, warehousing, etc. air freight is less suitable for short distances transport (less than 700 km is transport by rail more efficient and less costly than transport by the air). Since the key value added by air transport is time, the quick delivery of goods results in a demand and high willingness to pay for specific types of items. Common items shipped by air include perishables,

pharmaceutical products, high-tech and electronics, clothing, animals and high-value products such as diamond, art cars among others.
Because of these differences, air freight accounts for less than 1% of total freight carried by all transport modalities (air, sea, water, and road) in terms of both volume and weight. However, air freight accounts for about 40% of its value (Damme et al, 2014) and almost 1% of global GDP is spent on air transport (IATA 2016).

1.1 The development of World Cargo and its impact in Schiphol

The global full-freighter fleet increased during 2015, with the entry into revenue service of 25 new freighters and the return to service of 10 B747-400s which had been parked for several years. This growth was partially offset by the progressive retirement of the B747-classic and the MD11. According to BOEING (BOEING 2016) the growth trend estimates that cargo will be doubled the next 20 years (in Revenue Tons Kilometres) as Figure 1 illustrates.

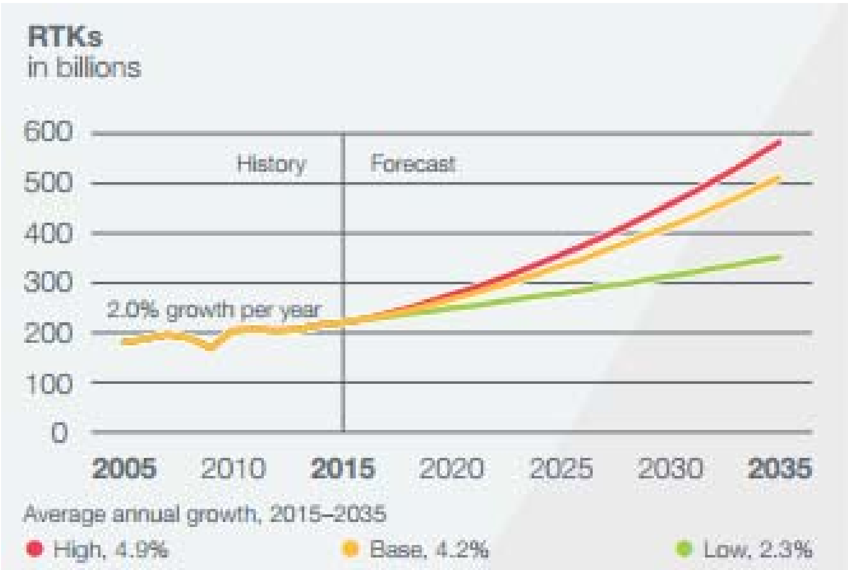

Figure 1. Cargo Trend Worldwide

Purchases of new high-capacity cargo aircraft saw a gradual slow-down between 2012 and 2015, moving from 42 to 25 annual deliveries. This steady downward trend looks set to continue for the next two years with 19 deliveries expected in 2017.
Belly capacity in the passenger aircraft fleet continued to see strong growth thanks to the expansion in the fleet, the latter expected to see annual growth of 5% between 2011 and 2019. For the years to come, around 400 new aircraft (for the most part B777s, B787s and A350s) will be introduced each year with the phasing out of only some 100 to 200 aircraft per year (mostly B747s, B767s and A340s). The introduction of new aircraft will have an important impact since the bellies of new aircrafts have more capacity than the older aircrafts. As a result, cargo capacity increased by 6.1% in 2015 for global air freight demand up by only 2.2%. For the European market, air cargo traffic was virtually stable, whereas capacity was up by 4.3%. In view of this dynamic, several air freight carriers are following the Air France – KLM Group's example in gradually decreasing their full freighter fleets in favour of bellies. Within Europe, the most noteworthy example is Lufthansa which mobilized two MD-11s.

1.2 Schiphol as important node in air-cargo networks

The cargo operations at Schiphol faces major challenges from macro- developments (such as rapid changes in aviation sector and cargo market, technology/ICT revolution, transitions to green and circular economy, e-commerce and 3D-printing, etc.), increasing volumes and volatility and uncertainty of airfreight and logistics, and last but not least changes in freight strategy of the hub carrier KLM cargo. The last one consists in reducing its full-freighter and increase cargo transport in the bellies of the passenger's aircrafts.
Schiphol is important for the logistics sector and economic growth of the Amsterdam metropolitan region economy. Airfreight operations are fully concentrated at Schiphol airport, with minimal cargo activities in other regional airports such as Maastricht and Eindhoven airports.
Schiphol is ranked third in Europe in term of airfreight aggregated volumes (2 million tons in 2015), behind Charles-de-Gaulle and Frankfurt airports. There exists strong competition between the three European airports, which all of them function as gateway to the European market. Also, there is increase in the number of European regional airports that focus on airfreight activities/operations, which attract mainly full-freighters (and almost no belly aircrafts). The top four regional airports have home carrier as the main airfreight carrier, such as Cargolux/Panalpina in Luxemburg, UPS in Köln, DHL and TNT in Liège/Belgium.

The main carrier in Schiphol is KLM whose passenger operation accounts for more than 80% of the revenues of KLM-Air-France group, however, an important part of airfreight volumes are transported in combined (belly) aircrafts. In this way, revenues generated from airfreight operations are complementary to passenger operations, especially on intercontinental networks that are difficult to maintain financially. Maintaining and strengthening the intercontinental and continental networks is strongly dependent on accessibility of the airport (compared to the competitors) and the existence of high quality and efficient multimodal transport system (air, sea, road and water transport system) (Bronsing 2013).

During the financial year, the Group transported nine billion Revenue Ton-Kilometres of which 75% in the bellies of passenger aircraft and 25% in the dedicated full-freighter fleet, to a network of 316 destinations in 115 countries.
In 2010, confronted with the crisis in the sector, the Group adopted a new "priority to bellies and combis" strategy aimed at optimizing the economics of passenger aircraft bellies. The full- freighter fleet is used as a complement to cover the routes not served with passenger flights, products that cannot be carried in bellies and markets in which belly capacity is not adapted to demand.

Over the next four years, Air France – KLM Cargo then implemented a transformation and adaptation program focused on revenues, costs, hub productivity and the quality of bellies and combis, to optimize the payload on its full-freighter fleet.
This "Transform 2015" program enabled a maintained contribution of some €940 million from the cargo business to the Group's operating result, despite the significant reduction in capacity (-4.5% in 2015, of which -23% for the full-freighter operations) and a deterioration in unit revenues (-5.6%). Thanks to full freighter fleet rationalization, strict cost management and adaptation to customer requirements, Air France – KLM's cargo business has engaged in a successful restructuring to contend with a highly competitive market where capacity is steadily increasing.

Roughly speaking, 30% of the total cargo capacity of Schiphol is handled by KLM and Martinair (a cargo subsidiary of KLM). At December 31, 2015, the KLM fleet comprised 113 aircraft (111 at December 31, 2014), of which 65 long-haul aircraft and 48 medium-haul aircraft.

KLM reduced Martinair cargo fleet from 10 Full Freighters (FF) to only 4 (KLM 2016). Also, airlines such as British Airways and Delta Airlines planned reduction in total number of full freighters in favour of more bellies aircrafts. The reason for this is that cargo transported in the Bellies is less costly and improve the profit margin of airlines. Especially the popular destinations such as New York and Shanghai, where more passengers are flying to, bellies offer new possibilities to improve operational costs and improve competitiveness of airlines. However, the transition from full freighters to more bellies has tremendous implications on the organization of airport operations (time slots, schedule and punctuality). As a result, cargo operations have to be alienated with the passenger's operations, where both processes should be combined in a limited and common airports areas.

The current study is the first approximation of the consequence for KLM fleet at Schiphol and the knock on effects that this decision might have. As it has been mentioned, the downsize of the fleet will continue due to the characteristics above mentioned. For KLM and Schiphol group the understanding of the consequences of the fading out of the remaining full freighters is key for improving the operational management of the airport systems which besides all the limitations its growth is still on with the consequences in congestion, delays and capacity.

2 METHODOLOGY: APPROXIMATION OF CARGO MODELLING AT SCHIPHOL

For the evaluation of the transition from Full freighter to the transport of cargo in the bellies of the aircraft (A/C) we took the public information from KLM and Martinair together with the traffic numbers from OAG database for developing and analysing four different scenarios. We performed some assumptions based on different studies and reports and we came up with the numbers and the initial implications of the transition.

2.1 Mass Balance of the Cargo Goods in Schiphol

The overall model of the transition can be conceptualized as different elements interacting with each other such as traffic, infrastructure, vehicles, passengers and cargo. As it has been reported Schiphol Group in 2016 (Schiphol 2016) the amount of tons transported to and from Schiphol are approximately 823 tons per year. The conceptualization of movement of goods can be represented by a mass balance in which the outbound flux – the inbound flux represents the accumulation of goods or in other words the amount of cargo that is either non-reported (not found in the consulted reports) or stays in the warehouses in the surroundings of Schiphol. The inbound flux is a combination of aircraft with cargo that arrive at Schiphol and ground cargo transported by trucks. The outbound flux is the combination of cargo that goes as export products and the ones that arrived to Schiphol and goes to a final destination, thus the airport is just a stopover for the products (Wederuitv concept). This concept is presented in Figure 2 where the inbound is based on the 2016 report as well as the output.

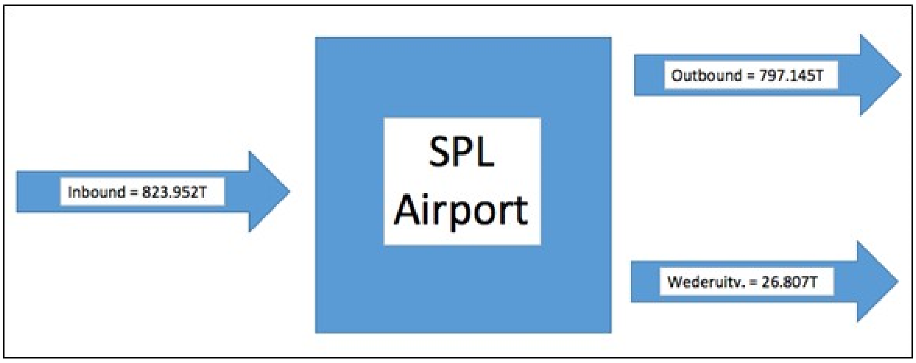

Figure 2. Flow model of Cargo at Schiphol

Based on this approach the Inbound corresponds to 824 tons while the outbound is 797 tons. The difference between those numbers is then the amount that is stored in the warehouses for later distribution and other quantities that are moved via road transport.

In order to understand not only the impact of the downsize of FF fleets and the knock on effects of this decision it is necessary to perform a multi-level analysis of the situation. The different levels to be addressed are tactical and operative, the first one which is performed in this study reveals the high-level impact of the decisions taken, the outcomes of this analysis will be the initial estimation of requirements for absorbing the changes such as frequencies, sizes of fleet and capacity limitations. The operative analysis (which is out of the scope of the current study) will allow to understand what the effect at operational level will be. The following are the initial results of the tactical analysis based on public information, however, the authors highlight the importance of obtaining particular internal information so that the analysis becomes more accurate and relevant for the stakeholders.

2.2 Analysis of Air Traffic at Schiphol

For the analysis of the impact of the transition phase we performed the analysis taking as the main input the inbound traffic to Schiphol, this is because we could obtain only the arrivals information of the operation at Schiphol. For the sake of simplicity, we considered one day as the representative of the operation, in particular the information from March 16th of 2015. In addition, due to data limitations we put focus on the operation of KLM and Martinair.

In order to calculate the amount of cargo carried by the different aircraft and FF we used the reported load factors. Figure 3 presents the evolution of load factors of passenger traffic and cargo from the year 2000 until 2013 (CAPA, 2014)

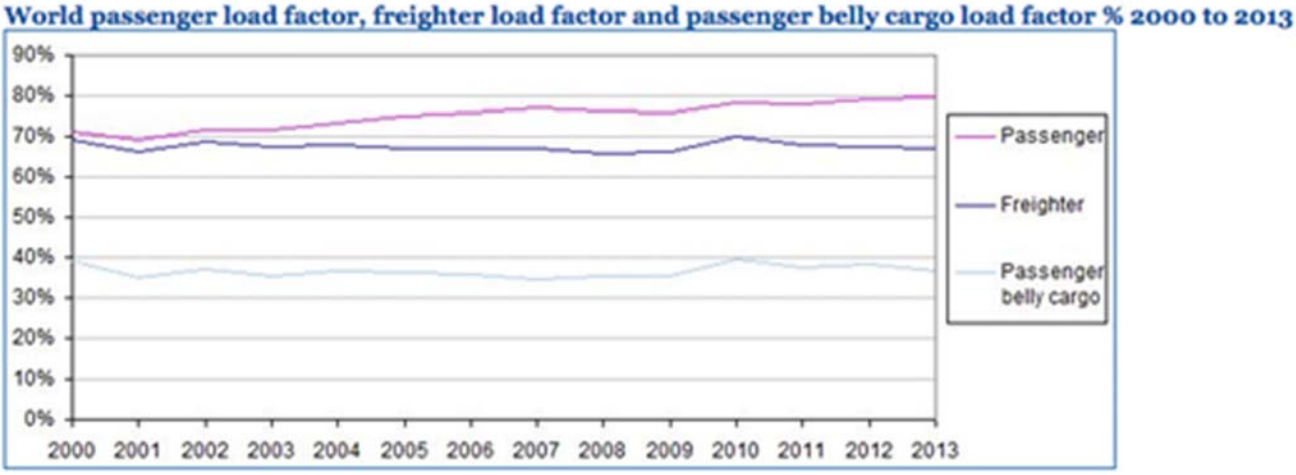

Figure 3. Evolution of load factors

It can be noticed that for the FF the load factor has been kept stable throughout these years around the 0.7 of the total capacity of the freighters. On the other hand the cargo bellies in passengers' flight have also kept the 0.4 value which means that there is still spare capacity for the passenger traffic. As it is mentioned, the belly capacity will be increased in the coming years once the fleet is renewed with the new B-787s, B-777s and A350s aircraft. For this reason, in the approach we assumed constant values of 0.7 and 0.4 for the load factors for FF and passenger flights respectively.

2.3 Scenario Analysis

As it has been mentioned, we used an OAG flight schedule of March 16th of 2015 as a representative day of operation. Since the focus was put on Martinair and KLM operation, we first filtered the flights which corresponded to Martinair and KLM. Martinair as a subsidiary of KLM holds the main FF operation of the company. As mentioned, the load factors of 0.4 for passenger flights and 0.7 were used for all the scenarios. With the use of load factors we multiplied the capacity of each type of aircraft for the load factors to get the estimation of the amount of cargo transported by the flights. Using those numbers we could estimate the amount of cargo in and out of Schiphol. Table 1 provides the cargo capacities of the different types of aircraft within the fleet under study.

Table 1. Cargo Capacities of different Aircraft

A/C Type	Cargo Capacity (Kg)
B744	12500
B772	12700
B738	2000
A332	10900
E190	1000
B773	23700
B737	2000
A333	17400
F70	1000
B739	2000
RJ85	1000

Making the previous assumptions we were able to construct different scenarios where the full freighter fleet is progressively downsized and with that action we can identify what the impact will be. Once we identified the impact we can assess how to rebalance the input flow with the tools at hand which in this case is the increase in frequency.

Operational Fleet Composition

From the analysis of the daily traffic we could define the operational fleet composition of the arrivals and departures of the day, we assumed also that this fleet is constant. The following figure presents the composition of arrivals of KLM at Schiphol:

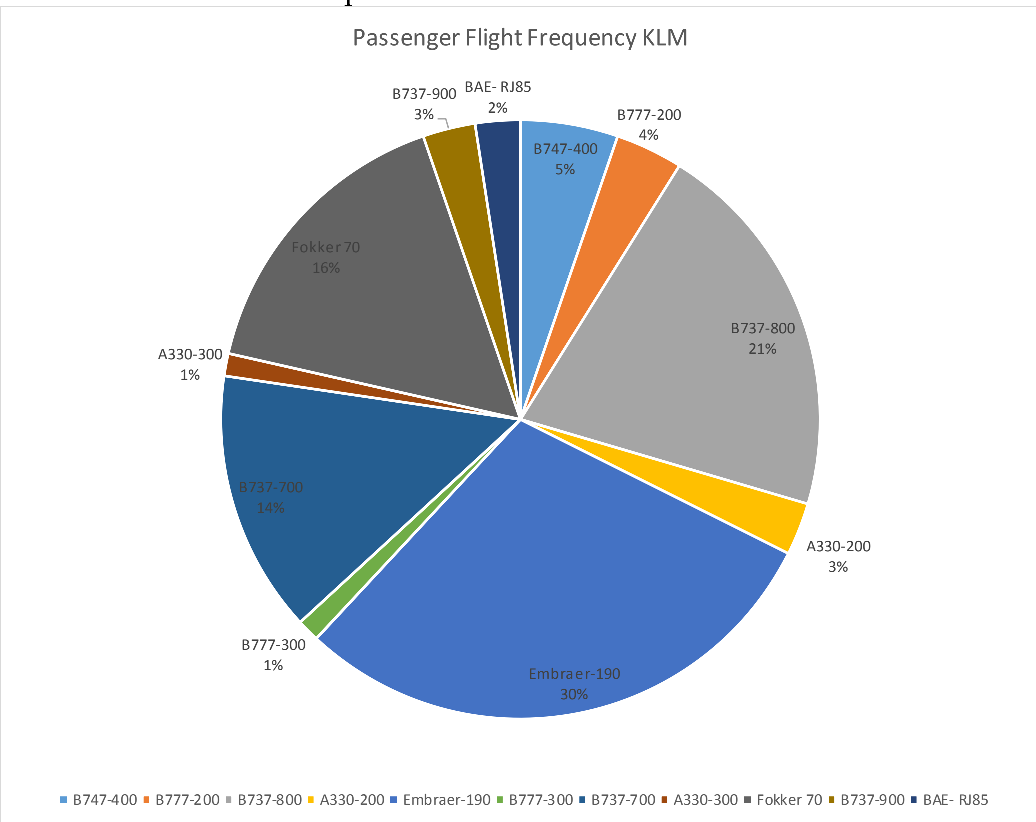

Figure 4. KLM departure traffic composition of March 16th of 2015

As it can be noticed the Embraer+B737s account for more than 60% of the fleet however the capacity of the FF accounts for almost 50% of the total of the fleet.
Martinair currently have only 4 aircraft in operation. The scenarios will evaluate the situation that Martinair will fade out progressively the fleet from 4 to 0. The analysis of the situation will also assume that the cargo from Martinair will be absorbed in the bellies of KLM passenger fleet.
Since information is not available regarding the destination or composition of cargo we will assume that the composition of the traffic will be kept constant in the different scenarios, which means that for instance the percentage of 737-800s will be always 21%. In addition, the resulting numbers of required flights or 'bellies' for absorbing the reduction do not make a distinction of the type of aircraft so in order to get the number of aircraft of one type that will be required is just a matter of multiplying the percentage by the final number.

This analysis is important for further studies since in this one we present the initial and most visible consequence of the decision of downsizing the fleet (increase of frequencies) but the knock on effect on the complete logistic chain must be addressed in order to understand the logistic impact of the decision (ground handler requirements, facilities, congestion levels etc.).

Base Scenario

The scenario taken as the base case is the current one of the selected day. We calculate for the current scenario the amount of cargo transported by KLM and Martinair. Table 2 illustrates the estimated amount for what is the current situation or base scenario.

Table 2. Year Capacity Situation in the Current Operation of KLM+Martinair

CURRENT SITUATION	ARRIVALS	DEPARTURES
Cargo Load Factor bellies	0.4	0.4
Cargo Load Factor Full Freighters	0.7	0.7
Cargo Capacity Annually bellies	114,084,400	101,075,800
Cargo Capacity Full Freighters	101,433,500	101,433,500
Total Capacity	**215,517,900**	**202,509,300**

These numbers represent the amount of input cargo for a year, giving as a total amount of 215 k tons of cargo arrived and 202 k tons of cargo departing. The difference might be due to the cargo that stays in the Netherlands and also some error of flights not taken into consideration in the OAG database.

From Table 2 we can see that the total capacity for FF is approximately 101 k tons. For obtaining this number we assumed the following fleet flies every day:

- 3 McDonnell Douglas MD11F with capacity of 95 tons of cargo
- 1 Boeing 747 ERF with capacity of 112 tons of cargo

For the calculation of the capacity of arrivals we took into consideration the types and amount of flights for the day under study, this gives a capacity for the passenger bellies as 114 k tons for arrivals and 101 k tons for departures. These numbers were calculated based on the traffic information from OAG database. Since these numbers do not differ much between arrivals and departures we will continue the analysis putting focus only in the departures information.

Scenario 1: Reduction of 1 Full Freighter

For the initial scenario we assumed that the Boeing 747 was removed from the fleet. This aircraft was chosen for no particular reasons. If we calculate the implication of that action we end up with a deficit of 28 k tons annually. Table 3 presents the new numbers once the fleet is reduced to 3 full freighters.

Table 3. Capacity numbers for reduction of 25% FF Capacity

Scenario 1 (DEP) 25% Less FF	
Cargo Capacity Annually bellies	101,075,800
Cargo Capacity Full Freighters	72,817,500
Total Capacity (Annually)	173,893,300
Missing Capacity (Daily)	-78,400
Missing Capacity (Annually)	-28,616,000
Extra Bellies Req. (Daily)	**64**

Under the assumptions of constant load factors and fleet composition, for balancing the demand it is necessary to add either more frequency or increase the size of the fleet. Since for the moment the plan of KLM for replacing the old fleet with new aircraft is not public, we assume the only solution would be to increase the frequency which in the presented case the number is 64. Again under the assumptions taken, this number is not a particular type of aircraft but a proportional mix of the current composition. For example, for determining what is the amount of a particular type of aircraft it is necessary to multiply 64 times the proportion of the interested aircraft found in Figure 4.

Scenario 2: Reduction of 2 Full Freighters

The scenario 2 analyses the impact of reducing in 50% the full freighter fleet, in this case one of the remaining McDonnell Douglas was removed from the fleet. Again the initial consequence would be to increase the frequency assuming the same load factors and composition of KLM fleet. Table 4 presents the results of this decision.

Table 4. Capacity numbers for reduction of 50% FF Capacity

Scenario 2 (DEP) 50% Less FF	
Cargo Capacity Annually bellies	101,075,800
Cargo Capacity Full Freighters	48,545,000
Total Capacity (Annually)	149,620,800
Missing Capacity (Daily)	**-144,900**
Missing Capacity (Annually)	-52,888,500
Extra Bellies Req. (Daily)	**119**

For this scenario the deficit would be approximately 53 k tons of cargo. Which translated in the same way to Bellies or flights for this scenario we require roughly 119 flights daily.

Scenario 3 and 4: Reduction of 75% and 100% Full Freighters

For the remaining scenarios we removed another McDonnell Douglas and the remaining one for the last scenario. A similar calculation as the previous ones were performed and the results are presented in Table 5.

Table 5. Capacity numbers for reduction of 75% and 100% FF Capacity

Scenario 3 (DEP) 75% Less FF		**Scenario 4 (DEP) 100% Less FF**	
Cargo Capacity Annually bellies	101,075,800	Cargo Capacity Annually bellies	101,075,800
Cargo Capacity Full Freighters	24,272,500	Cargo Capacity Full Freighters	0
Total Capacity (Annually)	125,348,300	Total Capacity (Annually)	101,075,800
Missing Capacity (Daily)	**-211,400**	Missing Capacity (Daily)	**-277,900**
Missing Capacity (Annually)	-77,161,000	Missing Capacity (Annually)	-101,433,500
Extra Bellies Req. (Daily)	**170**	**Extra Bellies Req. (Daily)**	**225**

As it can be noticed from the table, in the worst case scenario or the one without full freighters we have a deficit of 101 k tons annually. This number translated into flights mean that we require 225 more flights daily or 82125 bellies during the year.

2.4 Discussion

In the current study we identified that however few FF are in the fleet, its impact once it is translated as demand of volume in the commercial passenger traffic is very high. In the worst case scenario the amount of bellies required would put Schiphol above the limitations in ATM movements (which currently is 500,000 ATMs/ year). Just by considering absolute numbers we see that we need to increase the traffic by adding more flights for absorbing the cargo demand. In the first scenario for instance, assuming the load factor of 0.4 for every flight, we required 63 new flights departing from Schiphol on a daily basis. These new flights can be new aircraft or just the increase of frequency. We need to emphasize that this results are based on the assumptions that we have daily flights of full freighters which might not be the case, the load factors are kept constant as well as the composition of departure traffic. In addition, the FF most of the time operate in a tour basis which means that they visit several destinations before flying back to Amsterdam, this imply that they do not depart daily from Schiphol. However the elimination of FF means also that if we assume that the tours consists of at least three stops before flying back, this destinations should be considered for the cargo assignment. Meaning that probably 3 more flights need to be scheduled every week to different destinations under this scenario with the extra restriction that the destinations of cargo should match the passenger flights to the same destinations. This situation wil be a challenge for the handlers.

Regarding the load factors of the operation, it will be interesting to discuss with the handlers if these factors are a hard number due to the operative limitations of the passenger flights (e.g. turnaround time and on time performance), if this is the case, it means that the frequency solution is the only one while if they are able to increase for instance to 0.6 the load factor of the bellies the required number of flights might be reduced approximately to the half. In addition if this is not possible then a solution to the cargo problem would be to increase the capacity of the warehouses and increase the lead time of delivery to the final destinations. These are situations that require further investigation and also need to be discussed with the handlers in order to get a better idea of the capacities of the handlers and the real frequencies of FF cargo flights.

3 CONCLUSIONS AND FUTURE WORK

In the paper we made the initial analysis of the impact that the switching from full freighter cargo fleet to Belly Fleet might have. The results indicate that under the assumptions of daily flights of the 4 FF in the traffic, constant load factors and constant fleet, the numbers of ATM will importantly increase and might become a problem for Schiphol in terms of capacity. Furthermore, the results indicate that the initial effect of the decision will be the increase in traffic, however the frequency itself can be buffered if the airline is able to make the operation more efficient putting more cargo in the bellies of the aircraft or storing more cargo in the warehouses. Particular scheduling problems might arise since different cargo loads have to flight to different destinations and with different aircraft, this means that the original tour-based operation of some freighters now have to be accommodated in the commercial flights making the operation more demanding for the operators and handlers since they need to be able to match cargo demand with passenger demand in a timely basis. In addition, the operators need to perform the operation under restricted conditions keeping the same or even improving operative indicators such as on-time performance or turnaround times. Another important consequence of the downsize decision will be the knock-on effect in the logistic chain within the airport such as emerging congestion problems, emerging delays due to more frequent operations, and even the change in technology for making the load and unload operation more efficient. The authors will investigate further the ability of handlers at Schiphol to increase the load factors and a more accurate impact regarding the frequency of the FF. Furthermore, some of the consequences discussed here cannot be studied with analytical techniques such as the ones presented but require more advanced techniques such as simulation. The authors are working on a joint project with Schiphol group to get insight of the tactical impact and the knock on effects of these decisions by using simulation techniques. Using these techniques will allow the stakeholders to evaluate the emergent dynamics of the new operation which is a characteristic that in most of the cases is not perceived until the operation is in place. Furthermore, the operational model will allow the understanding of the limitations of the cargo capacity of the handlers once the downsize takes place.

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