Application of System Dynamics to assess competitive rivalry in the airline industry - A Case Study

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Abstract

The present study applied system dynamics modelling to assess the competitiveness between airlines from Germany to Asia. Legacy airlines like Lufthansa, Singapore Airlines or Cathay Pacific who traditionally served a majority of travellers between Europe and Asia have come under pressure through airlines from the Gulf region, but also other European airlines, like Turkish Airlines or Finnair who position themselves as gateway. Some of these airlines offer lower airfare than their competitors, but a similar or even better product and according to their financial statements are in a sound condition. Therefore tools and processes were necessary to assess the internal resources of the airlines in scope, namely Cathay Pacific, Emirates, Lufthansa and Singapore Airlines and later model the competition. Consequently, an exploratory-descriptive case study approach was chosen to set the scene and take this data into the system dynamics modelling. Due to the identification of key resources, changes to them were modelled to evaluate the dynamics of the system. It was found that system dynamics guides the researcher through the different tasks and forces to rethink and reapply certain steps to get to the notion, which resources contribute to the success of the airline.

Keywords: System dynamics, resource-based-view, airlines, case study, Germany, Asia

Word count: 5,129

1. Introduction

Over the last decade airline competition has grown fierce between Germany and Asia. Besides a number of new non-stop connections (especially to China), the carriers from the Gulf – Qatar, Emirates and Etihad – have continuously developed their position as hub between these two regions. These airlines have not only increased their number of destinations / frequencies, but frequently also offer lower airfares than their competitors.

The growth of RPK from airlines of the Middle East was more than four times the global average (in 2010) and is strongly supported by the growing Gulf based airlines that utilise the geographical location to attract traffic share between European and Asian major and secondary airports (O'Connell, 2011). According to Hoppe et al. (2011) the Middle East can potentially account for up to 16% of the world's traffic". In other words the Middle East hubs are located to reach 4.5 billion people within an 8-hour flight (O'Connell, 2011), and through this connect even more people through a single stop-over.

Hence, the airlines from the Middle East offer their actual and potential customers a convenient travel through not only from one major airport to another with only one stop, but also from one secondary airport to another (Vespermann et al., 2008). E.g., Newcastle via Dubai to Melbourne (25:55/24:10h travel time) vs. Newcastle via London via Singapore to Melbourne (26:25/26:50h travel time).

At the moment Middle East airlines are mainly seen as competition on routes between Europe and southern parts of Asia and Australia (Vespermann et al., 2008), which might change with improving travel times and frequencies to destinations in Northern Asia. Especially the growth regions like China, India and Southeast Asia will continue to create demand for intercontinental traffic (Franke & John, 2011). And as witnessed by O'Connell (2011), Emirates, Qatar and Etihad had increased their seat capacities by four times to Europe, Asia and Australia between 2002 and 2008, and are forecasted to continuously grow by 15% p.a. until 2016. Even so Franke & John (2011) see European hubs in a favourable position to capture traffic between the US, Europe and Asia, they acknowledge that Middle East airlines are in a similar geographic position to attract passenger flows.

The latest crisis has shown that business travel managed to return to it's pre-crisis pattern, but there is also a trend towards more price cautious travel, at least on short haul routes (Morrell, 2011). The Middle East airlines base their strategy on offering high-quality, in-flight product and stimulate passengers to travel with them through extensive brand awareness campaigns (O'Connell, 2011), their lower fares might be an additional argument to cope with slightly longer travel time.

Based on the above, the overall aim of this research is to understand through the application of system dynamics modelling, how airlines can offer lower airfares than their competitors, while having a comparable product and staying profitable. Therefore, this study has a number of inter-related objectives set within the context of airline competition (Figure 1).

2. Literature review

2.1. Resource-based view and competitive advantage

The firm's challenge is to either create "products with irresistible functionality or, better yet, creating products that customers need but have not yet even imagine" (Prahalad and Hamel, 1990). Chandler (1997): „strategic growth resulted from an awareness of the opportunities and needs – created by changing population, income, and technology – to employ existing or expanding resources more profitable" emphasises the statement of Prahalad and Hamel. In terms of resources, Wernerfelt (1997) found that a firm could specify its resource profile and through this to find its ideal product-market activities. This is supported by the finding of Kunc et. al (2009) about two beneficial factors: "first the creative conceptualisation of strategically relevant resources and then the implementation of operating policies to build those resources." The term "resource" used in this paper refers to Grant (2010), which means tangible, intangible or human resources.

RBV focuses on the internal resources of a firm and how to utilise these resources for superior performance. Barney (1991), Grant (1991), Peteraf and Barney (2003) and Wernerfelt (1984) argue that performance differences between firms are mainly based on results of Ricardian rents.

This means, if the firm succeeds to deliver greater net benefits through superior differentiation and / or lower costs than its competitors, it achieves competitive advantage (Peteraf and Barney 2003). The notion behind the competitive advantage and achieving above-normal returns is summarised in Figure 2 (Peteraf, 1993).

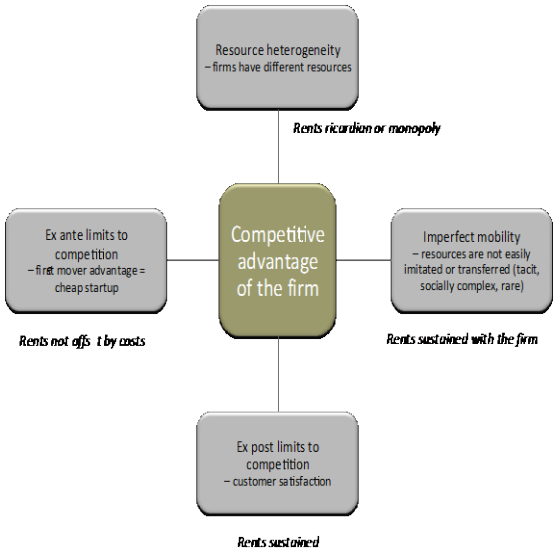


Figure 2: Competitive advantage and above-normal returns (Peteraf, 1993)**Figure 1:** Inter-related objectives based on overall research aim

The approach of looking within the firm for sustained competitive advantage and diversification are demonstrated to be both influential and useful for the analysis of many strategic issues (Foss and Knudsen, 2003). However, it needs to be differentiated between the short run advantages, which mainly arises from price and performance aspects, and the long run one that stems from the ability to create products at lower cost and faster than the competition (Prahalad and Hamel, 1990).

2.1.1. RBV in the airline industry

Couvret (1996) found that airline's main assets are the airline's routes and their organisational capabilities. Besides the airline route network, Holloway (1997), as well as Oum and Yu (1998) found airport slots could be a highly critical resource. Especially, if the airline successfully manages to combine its route structure, history and culture, it realises competitive advantage (Couvret, 1996).

Further studies on RBV within the context of LCCs found that the path of resource accumulation was a critical success factor (Salge and Milling, 2007), or Minkova (2009) who noticed corporate culture to be a very important resource, besides route structure. Shaw (2007) also identified that long established airlines possess some valuable resources in terms of their Grandfather Rights and hub systems to collect traffic.

2.1.2. Limitations of the resource-based view

According to Gary et al. (2008), several important issues are left unanswered by resource-based. Some researchers argue that complex organisations make it difficult to identify in regard to whether the particular resource is responsible on its own for the success of a firm, or in combination with other resources (Foss et. al, 1995; Lockett et al., 2009). On the other side, Priem and Butler (2001) argue that 'only valuable and rare resources can be a source of competitive advantage' and these two factors are depending on the corresponding usage of the resources. In addition, Lockett et al. (2009) found that easily identifiable resources are unlikely the source of success. And much RBV research has "ignored the interdependencies and complementarities of a firm's system of resources that typically make them valuable" (Gary et al., 2008).

2.1.3. Resource-based view and system dynamics

With the information gained through RBV, stocks and flows can be created (Kunc et al., 2009). Through understanding the causal linkages between the management of resources and the performance outcomes, the development of dynamic capabilities is tackled at its core (Zollo and Winter, 2002). These dynamic capabilities will allow the firm to incorporate, shape, and reconfigure its core competencies. Disregarding whether they are internal and external, the firm can therefore adapt fast to the changing environments (Teece et al., 1997). Hence, a combination of RBV and system dynamics supports the notion of identifying resources and helps understanding the competitive advantage through visualising their interactions. As Gary

et al. (2008) points out: “system dynamics research in the area of industry rivalry has leveraged the strengths of the system dynamics approach to develop explanations about the dynamics of firm resource profiles and performance”.

2.2. Choices and needs of air passengers

Consumer choices are influenced by different factors and how these factors interact with their preferences (Steverink and van Daalen, 2010). The different types of travel length, purpose of travel, as well as class of travel, all have impact on the choices and needs of the consumers (Liehr et al., 2001; Vesperman et al., 2008; Shaw, 2007). The most important factors for air travel are identified by studies of Sultan and Simpson (2000) and Gilbert and Wong (2003) and are shown in Table 1.

Rank	Sultan & Simpson (2000)	Gilbert & Wong (2003)
1	Reliability	Assurance
2	Responsiveness	Reliability
3	Assurance	Responsiveness
4		Flight patterns
5		Employees
6		Facilities
7		Customization

Table 1: Important factors for air travel

However, the leisure and business travel market have to be considered separately. Business travellers are known to have higher budget than leisure travellers, because they normally need more flexibility with their tickets in terms of time of booking, length of trip, as well as, re-booking and cancellation charges. These fare are usually offered at a premium price in comparison to their low fare counterparts. According to Liehr et al. (2010), airlines try to attract these consumers, as they promise higher yields. On the other hand, business travellers whose expenses are paid by the company and those who are self-employed business travellers can be different (Shaw, 2007). In general, business travellers value flights schedules (frequency, flights times) higher than price (Liehr et al., 2010). Table 2 outlines the most important factor for business travellers as found in studies of Shaw (2007) and Versperman et al. (2008).

Rank	Shaw (2007)	Vesperman et al. (2008)
1	Frequency and timing	Connection times
2	Punctuality	Travel convenience
3	Airport Location and Access	Frequent flyer programmes
4	Seat Accessibility/Ticket Flexibility	Broad network
5	Frequent Flyer Benefits	
6	Airport Service	
7	In-Flight Service	

Table 2: Important factors for business/corporate travellers

2.3. Airline Industry

2.3.1. Business Models of scheduled passenger services

In order to cope with industry cycles, the highly competitive environment and major incidents, airlines have to find suitable business strategies and organisational ways to manage them (Agusdinata and de Klein, 2002). According to Hamel (2000) the business model configuration needs the incorporation of strategy, structure and processes. Therefore it is essential for any firm to build on the chosen strategy “to sustain cost leadership, product differentiation, or focus (Holloway, 2002).” The two business models adopted by most airlines are shown in Table 3.

Airline business model	Characteristics
Product differentiation business model	• Looking for customers who perceive their product as unique or better than others and therefore willing to spend a higher airfare. • Understanding customers' perceptions • Building on understanding unique service-price offers that differentiates themselves from others • Managing trade-off between costs and offered services
Cost leadership business model	• Outperforming their competition at a lower cost base • Charging lower airfares than the competition, while achieving same profit or offering the same airfares but manage a higher profit • Assuming certain product features will be sacrificed by their customers in order to access lower airfares

Table 3: Airline business models

2.3.2. Revenue and cost characteristics of the airline industry

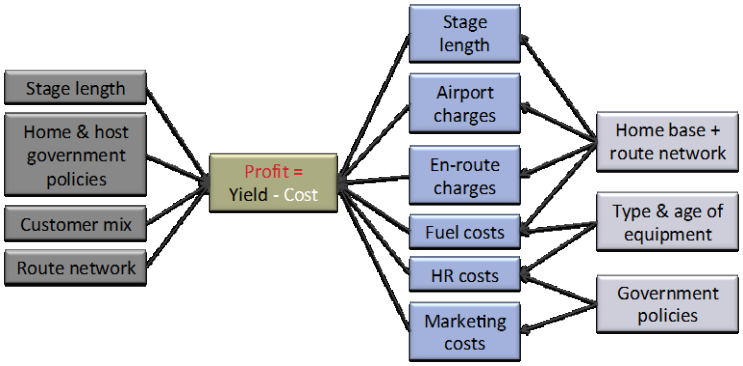


Figure 3: Determinants of airline profitability (Heracleous, 2009)

"The airline industry is atypical in the sense that, to a greater extent than most other industries, it is impacted by several factors beyond its control" (Heracleous et al., 2009). Based on their findings, they summarised the determinants of air profitability (Figure 3).

In addition, limited capacities at airports in desired markets create barriers to entry. Hence, growth can be reached by taking market share from competitors, or by identifying undeserved markets with potential for expansion. Airlines will need to effectively utilise capacity and price elasticity as determinants of success (Riley et al., 2003; Homburg et al., 2005). According to Merkert (2010) the top operational cost drivers of airlines are shown in Table 4.

Cost drivers	% of total airline costs
Flying expenses (incl. wages, fuel, airport & en-route charges)	~40%
Maintenance and overhaul	~10%
Aircraft depreciation	~6%
Station and ground costs	~16%
Passenger services (catering, in-flight entertainment)	~8%
Ticketing, sales and promotion	~8%
General administration	~6%

Table 4: Typical airline cost drivers

3. Methodology

The research strategy follows a dual approach in terms of combining system dynamics modelling (Sterman, 2000) with case study research. The case study provides the overall setting, while system dynamics delivers the tools to build and analyse the case. According to Andersen et al. (1997) the combination of system dynamics and case study research is useful for:

- Describing what is happening
- Assessing whether a certain method or approach is really feasible, and
- Generating valuable and pertinent hypotheses that allows for testing.

In this study, an exploratory-descriptive case study – as defined by Yin (2003) is used, as it clearly illustrates the past and current state of airline competition between Germany and destinations in Asia, while hypotheses are made using system dynamics based on the given context. This allows focusing on airline competitive positioning and how customers choose their airlines, as well as perceiving the airlines in scope for travelling in the future. The dual focus is critical for obtaining a balanced view between the airlines' aspirations on the value of their business models and customer perception.

3.1. The Modelling process

The five step approach by Sterman (2000) is applied as a frame to this research, as outline in Table 5.

Sterman's Five steps to the modelling process	Addressed within this study by
I. Problem articulation	*Describing the problem based on different sources of data – primary (like company reports of the airlines in scope, conference presentations, computer reservation system) and secondary (like journals, books and online databases) ones*
II. Dynamic hypothesis	*Exploring airline resources and conceptualising resource maps, as well as identifying key variables, and findings from the survey, literature and airline data*
III. Formulation	*Putting together findings from airline research and survey to establish the base passengers, market share and assumed load factor for each airline, as well as an equation to calculate the dynamics of changes in airfare, travel time and appealingness, and all cost variables are put together, like fuel, wages, airport charges*
IV. Testing	*Building the model with the Vensim software and incorporating all four airlines into one model, and so testing the dynamics between the different resources and how they alter if one airline change their appealingness*
V. Policy Formulation & Evaluation	*Discussing the results and making recommendations for future research on this topic, as this study is primarily of exploratory-descriptive nature*

Table 5: How Sterman's five steps of the modelling process are applied to this study

3.2. Research Limitations

One of the major limitations of this study is the access to data. Some airlines are very restrictive to the publication of their data, while others provide more detailed information (e.g. passenger numbers between Asia and Europe, revenue and costs per airline within their group). Although there are organisations that hold detailed information about airlines, route developments and passenger flows, it is costly to obtain these data. Since this study is not funded, data from such organisations were not accessible. Furthermore, access to surveying passengers was denied at Frankfurt airport, which would have provided a larger population of travellers flying non-stop. On the other side, the face-to-face traveller survey provided the chance to meet travellers who need to transfer for most of their long-distance flights, as Dusseldorf has less non-stop flights than Frankfurt or Munich.

While Cooper and Schindler (2011) argue that case studies usually involve a reliance on quality data, which in turn makes support or rejection of hypothesis more challenging, this research focus on multiple methods (Tashakkori and Teddlie, 2003). Hence, the data collection and analysis is less reluctant on mainly qualitative data. Brymann and Bell (2011) support the notion of combining quantitative and qualitative research in order to overcome the prejudice with case studies being of qualitative nature.

Furthermore, system dynamics provides various tools to support the aim of this study to identify the factors of competitive advantage and overcome limitations of being lost in a sea of data. Such tools are resources maps, as they 'are better suited to competitive strategy and firm performance because they explicitly depict asset stock accumulations and are compatible with ideas about competitive advantage from the strategy field' (Kunc and Morecroft, 2009). In addition, Kunc and Morecroft (2009) found that resource maps support the visualisation of a company's strategy and through the system dynamics model it is possible to study the effects of the resources and therefore the company's performance over time. Furthermore, system dynamics has been widely used to investigate and focus on the competitive interactions between a firm and its rivals (Lenox et al., 2007; Sterman et al., 2007).

4. Model Development

4.1. Problem Articulation

The overall aim of this research is to understand through the application of system dynamics modelling, how airlines can offer lower airfares than their competitors, while having a comparable product and staying profitable.

4.1.1. Research on airlines

In order to research this phenomenon , the number of airlines and routes to be investigated were reduced. Hence, the study focussed on Germany's flag ship airline Lufthansa, Emirates to represent the Gulf region and currently operating from four German airports, and the traditional Asian hub airlines Cathay Pacific and Singapore Airlines. In terms of airports, Frankfurt as largest airport and Dusseldorf (as most passengers would need to transfer) in Germany, and the three top financial centres in Asia – Hong Kong, Singapore and Tokyo – were chosen (Z/Yen, 2012, 2013). As Tokyo is one of the destinations, All Nippon Airways and Japan Airlines were included for an initial analysis, but excluded from a more detailed one, as Tokyo's geographic position results in less frequent used as gateway to Asia for European travellers.

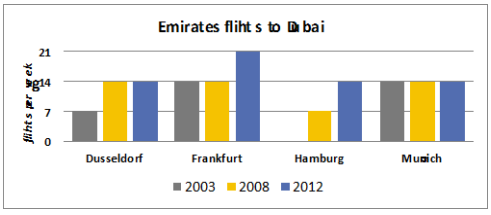


Figure 4: Development of Emirates flights from Germany to Dubai

Source: Dubai Airports (2012), Emirates (2013)

Based on these players, an initial research confirmed the changes within the market, i.e., Emirates continued to grow its number of

destinations, as well as frequencies and therefore growing its market share, while the traditional airlines mainly kept their frequencies (as shown in figure 4 to 6).

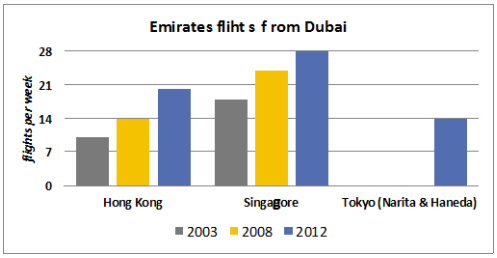


Figure 5: Development of Emirates flights from Dubai to selected Asian destinations

Source: Dubai Airports (2012), Emirates (2013)

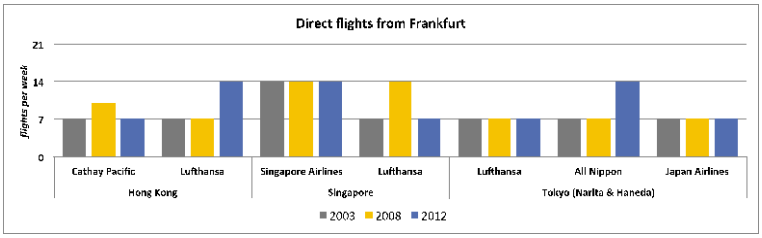


Figure 6: Development of direct flights from Frankfurt to selected Asian cities

Source: Fraport (2012)

Emirates also increase their capacity into the markets, as currently published by replacing a Boeing 777 service with a second Airbus A380 service from Munich to Dubai and therefore increasing their weekly capacity by 1,800 seats (Emirates, 2013). Through their aggregated number of seats e.g. out of Germany and from their hub to the cities in scope (see Appendix 1), Emirates is in a position to collect a vast amount passengers at their hub and distribute them to their final destinations.

In addition with offering lower air fares than their competitors, as shown in figure 7 and 8 on a spot check to Tokyo (and the other cities in scope in Appendix 2), Emirates continuously also offered lower fares than Lufthansa over a time span of 23 months (Appendix 3). One key difference of Emirates airfares is the much lower proportion of taxes & surcharges in comparison to all other airlines. However, the figures also show that the economy class net fares of Emirates are in general higher than the net airfares of the other carriers. Hence, it can be assumed that Emirates absorb part or all of the petrol surcharges levied by other airlines into their net fares.

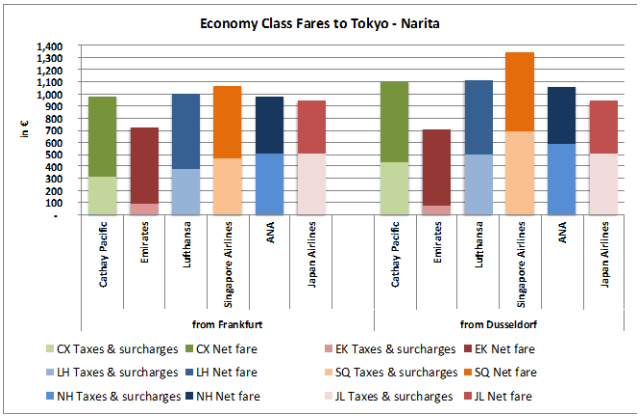


Figure 7: Comparison of economy class fares to Tokyo

Source: Amadeus (2013)

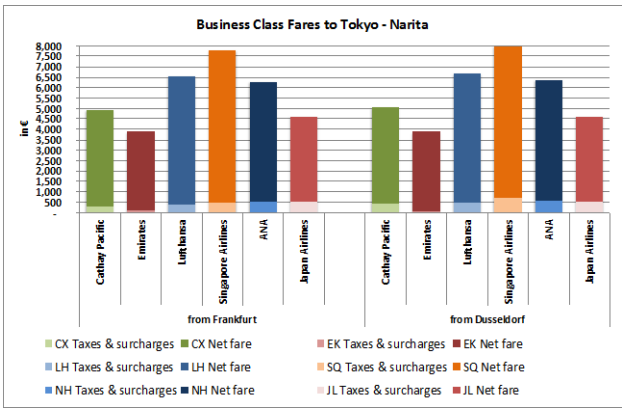


Figure 8: Comparison of business class fares to Tokyo

Source: Amadeus (2013)

The substantial differences between some airfares of the four airlines leads to a comparison of the airlines general financial and operational performance of their passenger business. Findings of some major ratios are shown in Appendix 4, with the result of Emirates performing above industry specific quota despite their low airfares.

A comparison of airline operating expenses provide an indication of the individual dependency on the separate cost items by relating the operating expenses to available seat kilometres (ASK) and transferring them into one currency, (Figure 9).

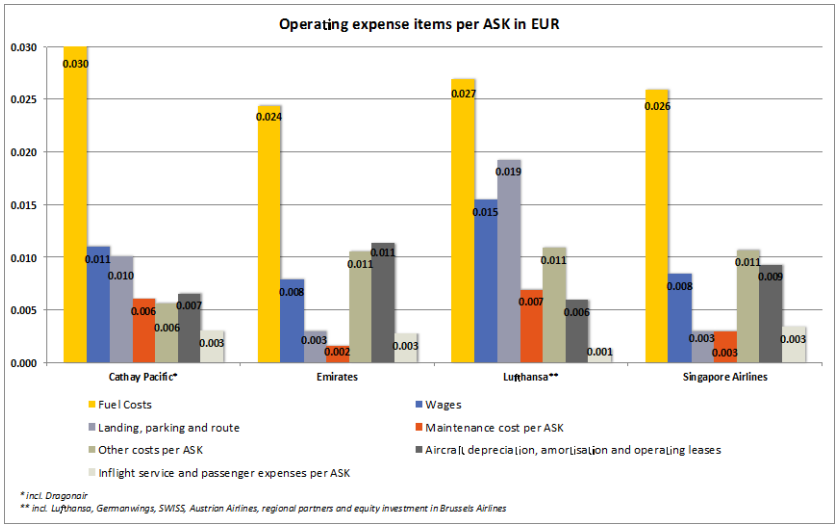


Figure 9: Operating expenses per ASK in EUR

Source: Cathay Pacific, Emirates, Lufthansa, Singapore Airlines (2013)

Regarding differences of the two largest costs items, fuel costs are rather similar, while wages per ASK have differences. Lufthansa operates from Germany, which have strong workers unions and therefore it will not be possible to gain benefits in terms of labour costs like Emirates or Singapore Airlines. Therefore the other airlines are not operating at a lower wage base per employee. Landing, parking and route expenses are by over four times higher than Emirates and Singapore Airlines, which can be attributed to higher charges that have to be paid within Germany and Europe, which witness most of Lufthansa's traffic. Emirates with the lowest expenses in this category might benefit from their strategy in connecting mainly European secondary airports with Dubai and therefore resulting in lower charges.

A final comparison of the airlines yields and unit costs reveals that all four airlines have a similar margin between yield and cost, as Figure 10 shows. This implies that in theory they are all positioned in a similar way to cover their costs. However, as Figure 11 shows, Lufthansa's load factor is below the breakeven load factor, i.e. the breakeven point at which the passenger load factor covers the expenses. This implies that different ratios provide different results and the problem has to be viewed under different scenarios and the key variables for model has to be carefully selected.

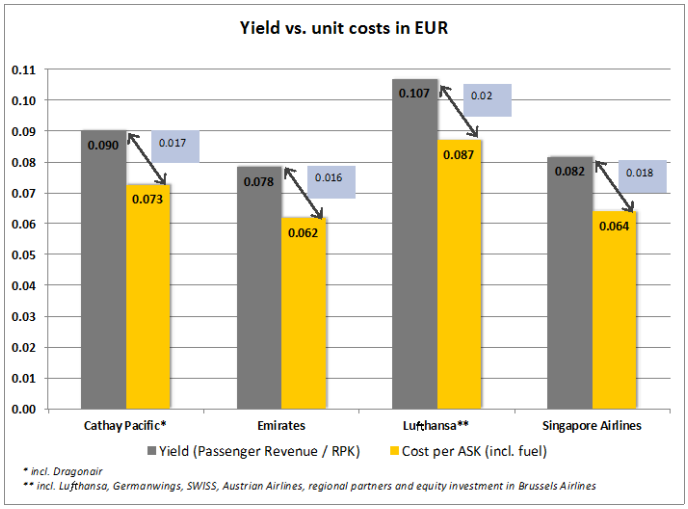


Figure 10: Comparison of yield per RPK and unit costs per ASK in EUR for 2012

Source: Cathay Pacific, Emirates, Lufthansa, Singapore Airlines (2013)

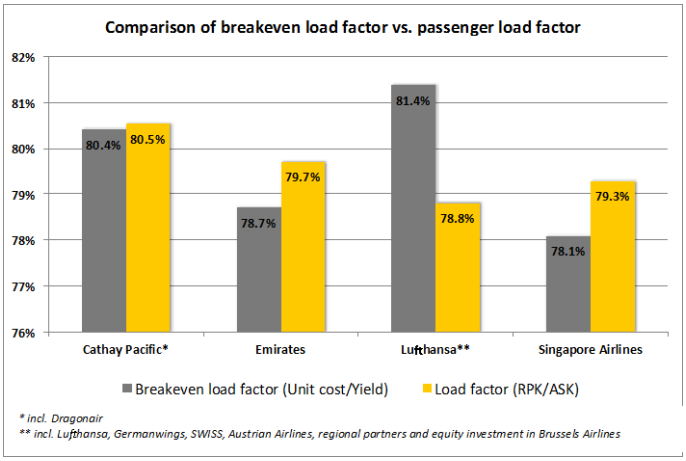
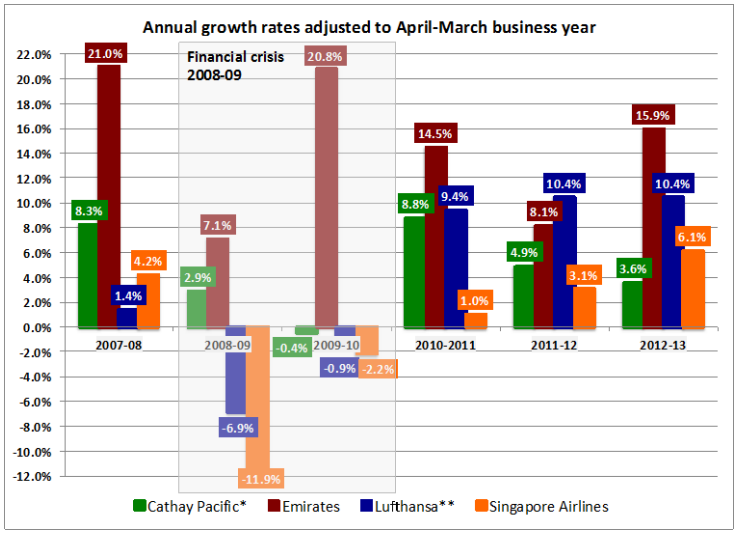


Figure 11: Comparison of breakeven vs. Passenger load factors in 2012

Source: Cathay Pacific, Emirates, Lufthansa, Singapore Airlines (2013)

4.1.2. Survey about perceptions

In terms of the traveller and travel management surveys, most of the individual travellers (38% online and 70% airport) are from Germany and 73% of the travel managers are responsible for the global travel programme of their company (incl. Germany). Therefore the results from the survey are only used for Germany, since significant differences were observed between different countries. Based on the German responses, differences exist between purpose of travel (leisure vs. Corporate travel), but all groups had similar important criteria for choosing an airline: cost/value, reliability, assurance and flight pattern (even so the ranking is different). A detailed presentation of the survey results is shown in Appendix 5.



** incl. Dragonair*

*** incl. LH Regional Partners & from January 2013 onwards Germanwings*

Figure 12: Annualised growth rates for each airline

Furthermore, Emirates have witnessed a positive growth of passenger numbers across their global network, even during times of a global financial crisis (Figure 12). In direct comparison to Lufthansa, Emirates only had less growth for the business year 2010/11. In addition, Emirates is continuously growing its number of destinations within Asia, and even so flight times might be longer, the survey showed that passengers are willing to travel longer, even so there might be no monetary savings connected to longer travel times. Despite the high appealingness of Lufthansa, due to the fact that the travellers perceptions of Lufthansa fits most with travellers criteria of choosing an airline, the passenger numbers via Dubai are growing, as is the brand image of Emirates. Hence, Emirates is a continuous threat to Lufthansa traffic between Germany and Asia, especially for those airports in Germany that would require one transfer (like Dusseldorf and Hamburg).

If Emirates manages to cut down their travel time by increasing frequencies, getting permission to operate from more German airport (like Berlin or Stuttgart), increasing their fit between travellers criteria for choosing an airline and their perceptions of it, and at the same time managing to keep their lower airfares, Emirates or any other airlines operating under similar conditions become strong competitors.

4.1.3. Resource mapping

The identification of key resources, established through the resource mapping exercise from statements of their Chief Executive Officer's (CEO) made in the last annual report, supports the process to narrow the variable down to 3 (each one for one airline, and one without) that fulfil the VRIO approach. One of the statements only offered limited information and therefore the screening was extended to year-in-review sections for each airline. The findings of the four annual reports are represented in Table 6 and

Airline	Resources	Airline	Resources
Cathay Pacific	• Passengers • Employees (best cabin crew 2013 awarded by Skytrax) • Route network • Service standards • Product set up (cabin classes, lounges) • Capacity management • Award winning business class (best business class 2012 awarded by Skytrax) • Investment in new aircraft • Fuel hedging	**Lufthansa**	• Passengers • Destinations • Home base (Germany) • First class cabin • Rating among investors • Services • Products • Flight schedule • Economies of scale through partners • Airport infrastructure • Partnerships
Emirates	• Passengers • Emirates brand • Reputation among investors • Airport infrastructure at Dubai • Employees • Services (language skills cabin crews) • Products • Route network • Capacity management	**Singapore Airlines**	• Passengers • Employees • Services • Products • Route network • Innovation • Technology and IT • Capacity management • Partnerships

Table 6: Results of resource mapping based on annual report statements

the list of the initial screening from the annual reports for resources and factors can be found in the appendix. the only resources stated once by each airline are:

- Cathay Pacific: Fuel hedging
- Emirates: Emirates brand
- Lufthansa: Flight schedule
- Singapore Airlines: Technology and IT

Based on these findings, resource maps were drawn to visualise the dependencies between the individual resources and their flow, which are all shown in the appendix. These resource maps are later used to structure and design the system dynamics model.

4.1.4. Key variables

Based on the above findings, the following key variables are considered for the model:

- Airfare
- Appealingness
- Travel time

The differing resource of technology and IT, as stated by Singapore Airlines, falls into the general appealingness of the airline and is therefore not regards as an individual key variable. Moreover, innovation is one the least important criteria of travellers and travel managers choosing an airline. Therefore it should have fewer effects on the external demand; even so it might drive processes and service delivery. However, in order to establish these linkages, more insight would be needed that was not available for this study.

4.2. Formulation of dynamic hypothesis

Based on the above findings, the following hypotheses are formulated (Figure 13).

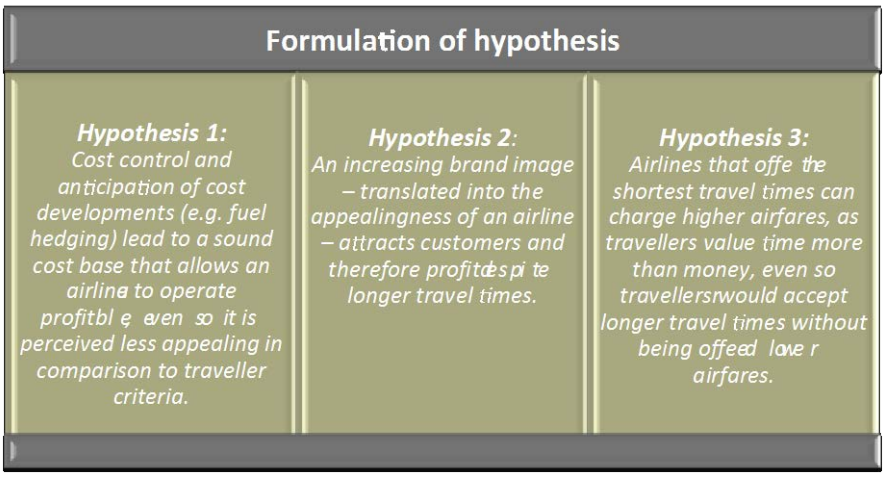


Figure 13: Three hypotheses are formulated based on the research

4.2.1. Model boundaries

In order to answer the overall question of this case study, the dynamics between airfare, appealingness and travel time have to be addressed. The conceptualisation exercise from the resource maps forms the basis of model boundaries. Since the different resources of each airline would need to be anticipated in the overall model, these needed to be incorporated with the findings from the surveys.

The online and travel management survey both found flight patterns (schedule, frequency), cost/value and assurance (safety record/employee capability) the most important criteria for choosing an airline, while the face-to-face survey at Dusseldorf airport showed assurance, cost/value and reliability are the most important one for leisure purpose, while corporate travellers value flight patterns higher than cost. These findings are similar to the one in the literature and therefore seen as viable and reliable factors involving the choice of an airline. Hence, these factors will have to play a vital role in influencing the endogenous components, if the airline wants to attract such customer bases. In addition factors like market demand, fuel prices, and airport charges and taxes have vital effects on the operating profit of the airline, as these influence airfares and costs.

Endogenous components	Exogenous components	Excluded components
Capacity	Market demand	Inflation / deflation
Airfare	Jet fuel prices	Unemployment rate
Frequency	GDP	
Load factors	Airport charges & taxes	
Forecasted demand	Appealingness (own and competitors)	Consumer Price Index
Desired capacity		
Cabin crew		
Other costs (maintenance, depreciation, etc)		
Wages		
Travel time		
Assurance		

Table 7: Model boundary chart

Together with the resources identified in the resource maps, the model boundary chart (Table 7) highlights the most important components in a general airline model, as well as those that are excluded.

4.2.2. Causal loop diagram

Based on the above components further identified through the model boundary chart, the following causal loop diagram was developed. In order to achieve the overall diagram, the task was split into three, namely demand (Figure 14), capacity (Figure 15) and costs (Figure 16). Although revenue is an important aspect, since the profitability has to be established, this aspect was directly incorporated into the demand and cost diagrams.

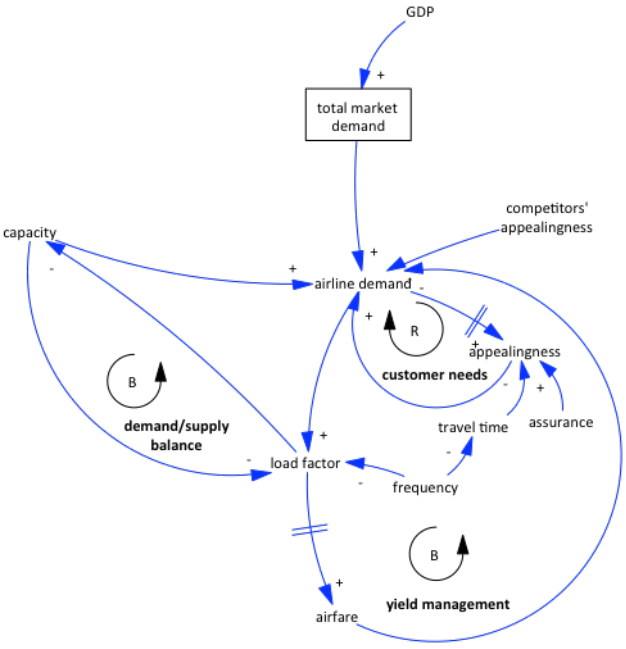


Figure 14: Initial airline demand causal loop diagram

For simplicity reasons and to enhance the factor, the demand, capacity and cost side is split into corporate and leisure travel. Business travellers normally are the high yield customers, as many of them are allowed to fly business class on long distance, and leisure travellers normally spend less money on the airfare and therefore fly economy class with restricted low airfares. Although the model will not distinguish between different wages for cabin crews in the economy and business class, or have different proportions on fuel costs, the potential demand can be very different, as the factors important for each of the travel groups is different. Therefore one side of the causal loop diagram looks into the demand, capacity and cost patterns of the corporate traveller who flies business class and the other side look into the economy class flying leisure traveller. This approach will further allow the modeller to examine different

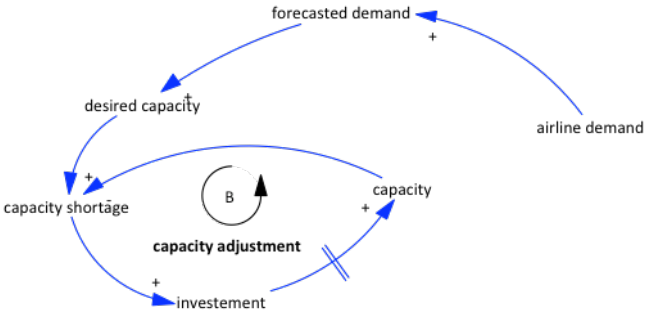


Figure 15: Initial airline demand causal loop diagram

capacity needs for each group and airline, because if one airline starts attracting more corporate travellers in business class and so exceed their capacity, the decision has to be made within this model, to buy a new aircraft and so attract more leisure travellers as well. The model does not consider extending the number of business class seats within the aircraft.

Through the exercise of mapping the causal loop diagrams for demand, capacity and costs, four loops were identified:

- Customer needs
- Demand/supply balance
- Yield management
- Capacity adjustment

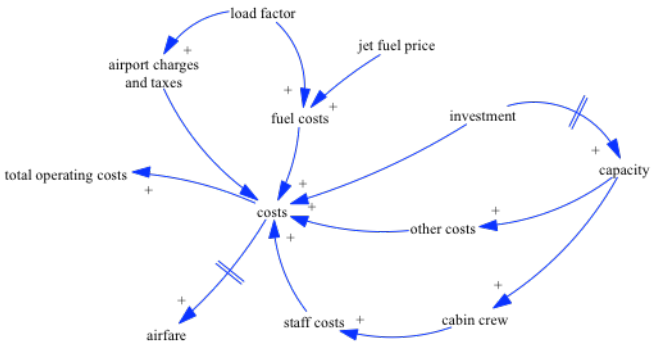


Figure 16: Initial airline demand causal loop diagram

Three of them have a balancing effect (shown as B with a circular arrow), e.g., capacity adjustment, as a capacity shortage due to higher anticipated demand lead to investment into new capacity and therefore easing the shortage, i.e., balancing it. Customer needs is identified as a reinforcing loop, as an airline with increasing appealingness increase its demand, and through an increasing demand, the airline itself becomes more appealing to new customers.

Figure 17 shows the complete model.

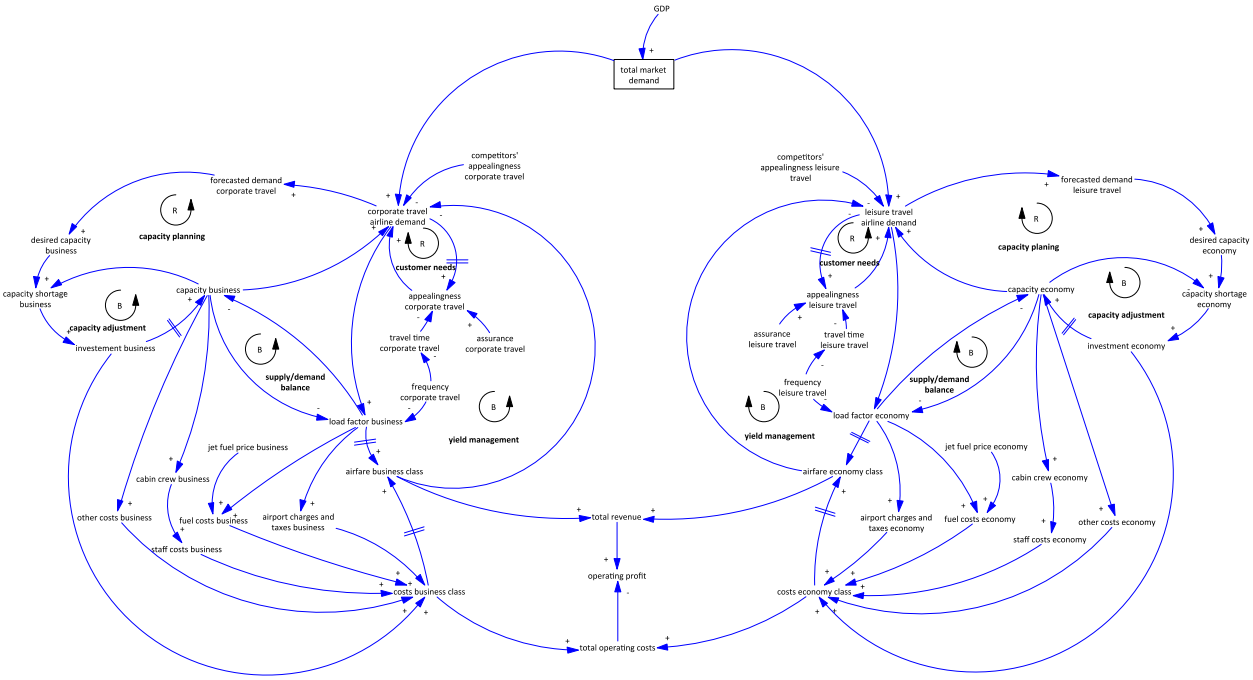


Figure 17: Initial airline causal loop diagram

4.3. Model Formulation

The formulation of the model utilised all available data that was collected from research about the airlines and surveys in order to establish the base passengers, market share and assumed load factor for each airline, as well as an equation to calculate the dynamics of changes in airfare, travel time and appealingness. The

formulation process further considered all cost variables like fuel, wages and airport charges. The whole process of establishing the variable and those finally used for the model are presented in Appendix 6.

4.4. Testing / Simulation

Based on the previously established parameters, the following model (Figure 18) was build that incorporate all four airlines into one model, and so allows testing the dynamics between the different resources and how they alter if one airline change their appealingness..

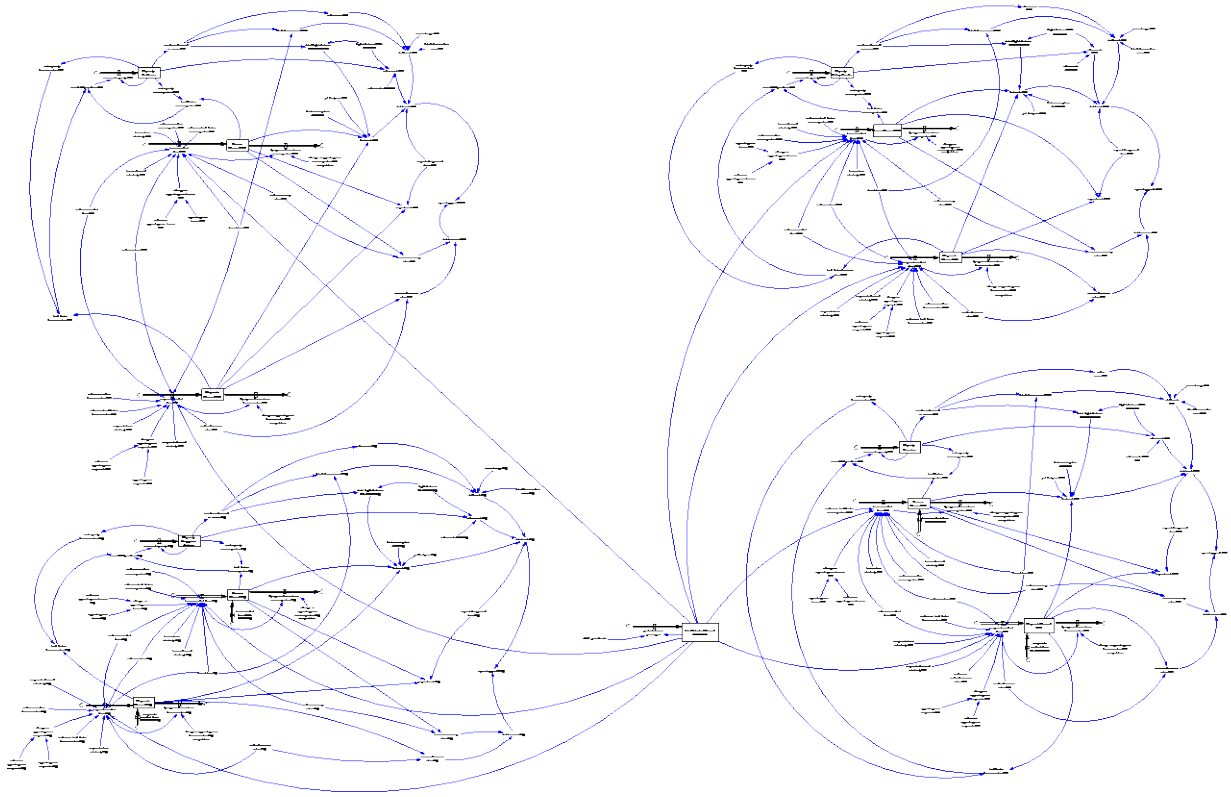
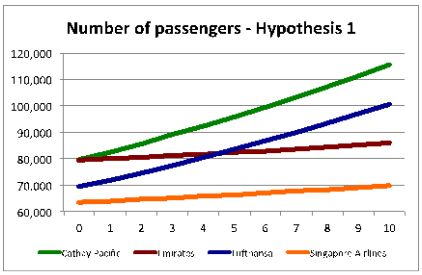
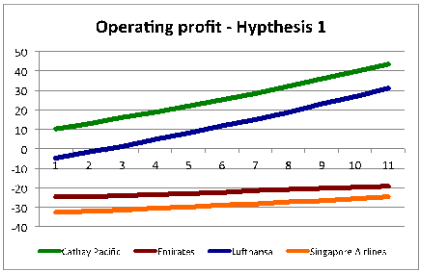


Figure 18: System dynamics model of airline competition

4.4.1. Testing Hypothesis

In order to test hypothesis 1, the model is run for 10 years (time steps) without changing any of the key variables (Figure 19). For hypothesis testing 2, the appealingness of Emirates leisure and corporate rating is increasing by one point until it reaches its maximum, like in the case of the leisure appealingness, or the time span ends, like for the corporate appealingness (Figure 20). And to test hypothesis 3, Lufthansa business class fare is increased by € 200 and economy class fare by € 50 a year (time step) (Figure 21). In the case of hypothesis 2 and 3, the first two year, i.e. from 0 to 1 and 1 to 2, no changes are applied, in order to see how the model reacts to changes.





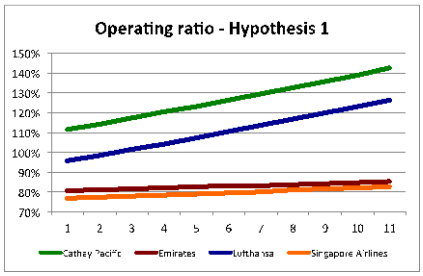
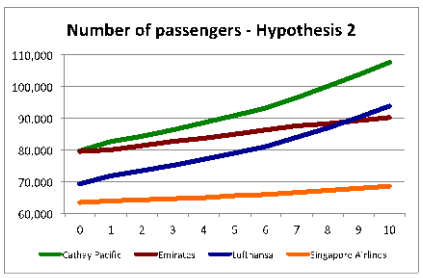
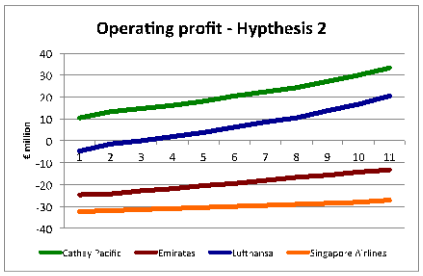


Figure 19: Testing hypthesis 1





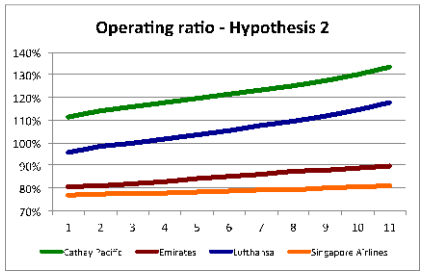
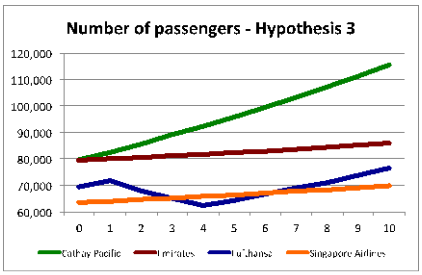
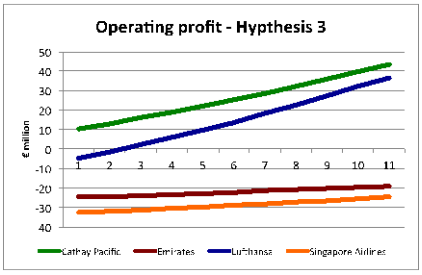


Figure 20: Testing hypthesis 2





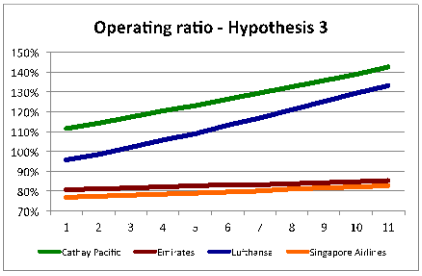
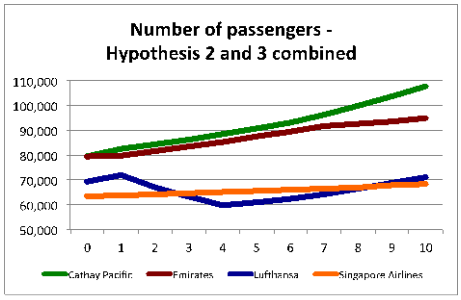
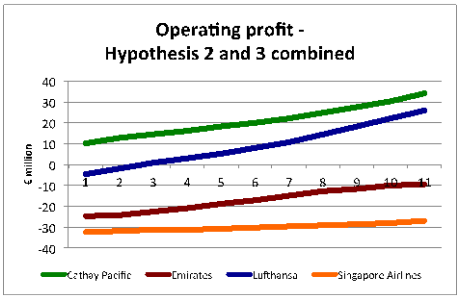


Figure 21: Testing hypthesis 2

Besides the individual hypothesis testing, the model also runs one whole time span with combining hypothesis 2 and 3, in order to see the effects, when two airlines are making changes simultaneously. These changes are shown in Figure 53 und Figure 54 below.





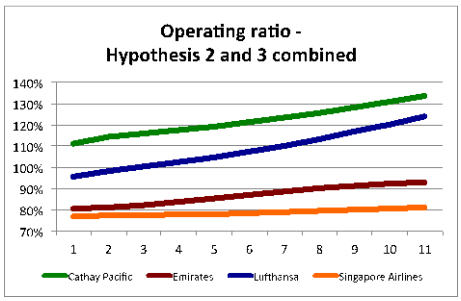
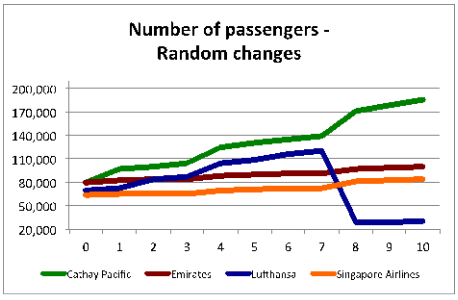
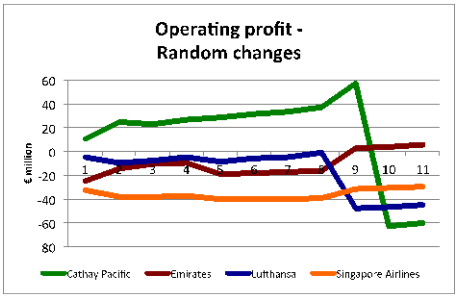


Figure 22: Testing combination of hypothesis 2 and 3





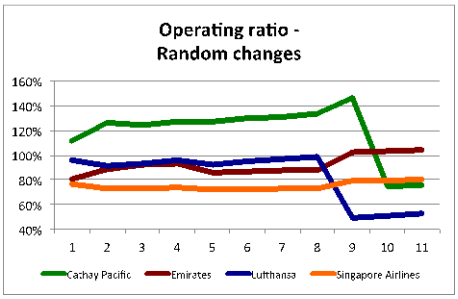


Figure 23: Testing random variables

5. Results and Discussion

5.1. Results

The simulations of the three hypothesis show that all statements are confirmed, as shown in Table 8.

	Hypothesis 1	Hypothesis 2	Hypothesis 3
Statement	*Cost control and anticipation of cost developments (e.g. fuel hedging) lead to a sound cost base that allows an airline to operate profitable, even so it is perceived less appealing in comparison to traveller criteria.*	*An increasing brand image – translated into the appealingness of an airline – attracts customers and therefore profit despite longer travel times.*	*Airlines that offer the shortest travel times can charge higher airfares, as travellers value time more than money, even so travellers would accept longer travel times without being offered lower airfares.*
Findings	The model run for ten years without any adjustments and experience exponential growth across all four airlines. Since the cost factors are based on actual numbers and broken down either to ASK, per staff, fuel consumption or passenger as in the case of airport charges, only Cathay Pacific starts with a positive operating profit, while the others stay below. Lufthansa starts negative but picks up and turn the negative profit around. This base model over 10 years only controlled by entries in year 0 and the annual GDP growth of 3.8%, the high load factor of 69.3% and non-changing costs contribute to the positive result of Cathay Pacific.	The appealingness of Emirates for leisure and corporate travel were increased by one point per year from year 3 onwards. Through these changes, the demand grows by 10,000 passengers over the complete 10 years, in comparison to 5,000 passengers from the model simulation for hypothesis 1. The same effect can be witnessed for operating profit, which even so still negative, manages to improve itself by 8 million €. Hence, if Emirates manages to build up their brand image and only through this get more attractive, while not adjusting its travel and everything else being equal, Emirates will manage over the long run to positively influence its financial position, while offering the same service.	The key variable for Lufthansa were changed. As could be seen from the base model in hypothesis 1 without changing any variables, Lufthansa manages to break-even in year 3. Through increasing business class and economy class fares by an equal amount for each year, the demand right away drops since no delays are incorporated into the model. However, the operating profit is continuously growing exponentially, and after three years of decreasing demand, the demand starts increasing again. It has to be noted that the economy airfare is only increased for 3 years as a set limit of 1,000 € is reached – i.e. a higher airfare than the highest airfare of a competitor within the model. Hence, as soon as the economy fare does not increase anymore, the GDP growth kicks back in to keep pushing up the demand. Therefore it can be assumed and due to the demand elasticity, a 50 € increase in economy airfare ahs a higher impact than a 200 € increase in business class airfare.

Table 8: Summary of findings for each hypothesis

In addition to the three simulations two further runs were made. One by combining hypothesis 2 and 3 and another one with random changes to the key variables of Lufthansa and Emirates. Both showed the dynamics of the model (Table 9), leaving space for further exploration.

	Combination of hypothesis 2 and 3	Random changes
Findings	By combining the changes of variables from hypothesis 2 and 3, the dynamics of the model is clearly seen in Figure 53. Lufthansa's demand is decreasing as long as the economy class airfare is increased, and Emirates demand growing steeper until the appealingness reaches its limit for Emirates leisure class travellers and the effect of Lufthansa loosing passengers that move to the three other airlines due to the increase of economy class airfare is revised, as it cannot be increase anymore. This change can be seen in year 7 with Emirates, when the demand slope gets flatter.	The random changes of key variable from year onwards, like increase in airfares of Lufthansa, fast flight times with Emirates and various "sales" actions with low airfares for a year, clearly show how these dynamics influence passenger demand and lastly in operating profit.

Table 9: Summary of findings from combination of hypotheses and random changes

5.2. Discussion

The applied system dynamics modelling approach showed how the researcher goes through many steps of evaluating the current situation, the past that might have led to the problem and if internal resources under the RBV perspective are available or can be obtained. In the case of this model, the researcher had to rely on publicly available information and the one gained through other research papers, as well as the working experience within the business travel industry. However, more access to real data from the airlines, at least

from one, so better assumptions could be drawn for the other players in the model, would be very beneficial. Especially, if data on costs and revenue, as well as current load factors for a specific route are available. Hence, it is highly recommended to run this model with the support of an airline, so the real life can be even better implemented and considered.

Another recommendation is based on the customer survey. First of all, the expectations and criteria of choice should be more similar, so it would be possible to better distinguish, if there is gap between these two. Furthermore, a Five Gap Theory that assess the differences between how the airlines think they are perceived by the customers and how customers actually perceive them, could lead to even more insight into the resources, as well as which resources are a trigger point to increase demand.

A further recommendation will be to get direct access to airports like Frankfurt that host all airlines in the model and on the routes being analysed. As this access was not granted by the airport, it was not possible, but for the future, access to these travellers and explore if those, who actually can fly non-stop – not like in the case of Dusseldorf where many travellers are forced to transfer – would consider moving to another airline. In addition, the connection of monetary savings with longer travel times might need to be further exploited. As this study showed, more travellers are actually willing to fly longer when they are asked about this without showing savings on airfares. A concrete example of a flight on airline A from Frankfurt to Singapore non-stop for price A and flight time A, or on airline B for a lower price B, but longer flight time B.

6. Conclusion

By applying system dynamics in combination with RBV, it was possible to identify the competitive resources of each airline, as the annual statements were used to extract a list of resources and compare them among the four airlines. The resources mentioned only by one airline were considered to be of a competitive resource, and through this identifying the resources as mentioned in objective 1 (Figure 24 for review of the objectives).

Through the literature review and building the case study, it was possible to explore airline services and products that led to questions for the survey, in order to assess, if the products and service being offered by each airline are the products and services the customer are looking for. Hence, objective 2 and 3 were answered.

Figure 24: Inter-related objectives based on overall research aim

The exploration of the three competitive resource that could be found, it was possible to design three variables that would 'control' the model – namely airfare, travel time and appealingness – and therefore model how changes in one of them with one airline affect not only the system of the airline, but can affect the system of all players in such game. Consequently, objective 4 was delivered into model build with the Vensim software.

In order to address objective 5, the generation of three dynamic hypothesis led to a simulation of the model and critically evaluate the findings from the simulation. By adding two more scenarios that were the combination of hypothesis 2 and 3, as w ell as having random changes to the key variable of Emirates and

Lufthansa, it was possible to see how dynamically the output in terms of passenger demand and operating profit got adjusted with each change.

The recommendation of next steps were covered in the previous section.

However, it was not possible to assess how an airline like Emirates can offer lower airfares and according to the published annual account stay profitable. Nevertheless, through addressing system dynamics and the RBV and applying it with the case study approach, it was possible to explore and describe the current situation, the problem that can evolve from it, and which tools are available to research these issues. Thus, the overall aim was partially achieved, as the given tools of system dynamics and RBV in the context of a case study allowed to provide a direction for further research in this area of airline competition.

Over all, the combination of case study approach and system dynamics allowed a clear structured research path that had to be analysed again and again, due to the nature of system dynamics forcing the research think about the problem, the resources that might be available, how resources flow within a system and stocks can be accumulated.

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