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Logistics and Air Traffic Management

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Dynamic airline in-flight entertainment systems using predictive analysis

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List of Abbreviations:

% - Percent

AI – Artificial intelligence

AR - Augmented reality

BYOD - Bring your own device

CAGR – Compound annual growth

CDN - Content distribution networks

CSP - Content service providers

DVD – Digital versatile disk

EDME - Emerging markets and developing economies

e.g. – exempli gratia

Etc. – et cetera

GDP – Gross domestic product

HBO – Home Box Office

IATA – International Air Transportation Association

ID – Identification

IFC – Inflight connectivity

IFE - Inflight entertainment

IFEC - Inflight entertainment and connectivity

MVPD - Multichannel video programming distributors

PA - Predictive analysis

PED – Personal electronic device

ROI – Return on investment

RPK - Revenue passenger kilometers

SDK - Software development kit

TV - Television

US – United States

US$ - US Dollar

VR – Virtual reality

wIFE - Wireless in-flight entertainment

WTTC – World Travel and Tourism Counsel

Executive Summary

Continual technology advancement in the onboard entertainment segment brings in higher customer expectations. Advanced inflight entertainment (IFE) systems have become an essential competitive advantage and a significant business opportunity for the commercial airlines.

This research paper answers following questions:

- How can the airlines offer exclusive and personalized entertainment to the passengers during the flight?
- How can the airlines monetize on the customers?
- How can the airlines up-sale products and services to the customers by integrating joint ventures and partnerships into the IFE system offerings?

Abstract

This research paper delivers an important and unique issue of understanding airline customers much better than the companies currently do. The goal of this paper is to find how to offer passengers exclusive and personalized entertainment during the flight and how to monetize on it. This has been done by analyzing the inflight entertainment industry and identifying the significance of data analytics in commercial aviation and content distribution industry. Upon examination, it has become clear that implementation of the predictive analysis into IFE systems not only improves customers satisfaction but also increases bottom line of the airlines.

Key words

In-flight Entertainment, Connectivity, Dynamic In-flight Entertainment, Data Analytics, Predictive Analysis, Big Data, Dynamic Advertisement, Monetization.

1. Introduction

The interconnected world and global markets fuel businesses to advance. Growing data availability not only changes existing markets and shapes the new ones, but it also improves society in general. Data analytics and predictive analysis (PA) algorithms are transforming the way businesses operate in the modern era.

Today it is nothing extraordinary to travel long distances by air. Every year the number of air passengers grows with rapid speed making commercial aviation constantly developing and adjusting to global trends rapidly. Competition in the commercial passenger industry is intense due to the significant number of various providers and services. In this context, it is critical to understand what can make airlines to stand out and attract new customers.

Individualized flying experience and innovative IFE is extremely valued among the travelers. Today passenger-appealing IFE systems and extensive content selection have become a significant competitive advantage that improves the customer experience and increases the airline's bottom line.

The current thesis is focused on delivering a thorough methodological research based on the detailed analysis of the entertainment segment of the airline industry and related technology industries, latest researches in data-science field and analysis and conclusions provided by the author. The following study identifies the importance of in-flight entertainment and connectivity (IFEC) as one of the important decision-making factors when choosing an airline to fly with. This thesis emphasizes on how data analytics can help airlines to adapt to changes in demand and supply in the onboard entertainment. The author aims to present a next-generation in-flight entertainment model that provides a personalized experience for every traveler and additionally helps the carriers to secure greater ancillary revenues.

1.1. Purpose of study

The purpose of this scientific research is of the high value for the companies within the commercial aviation industry and its customers as it reveals valuable information on topics crucial for the future development of the in-flight entertainment segment.

The purpose of the thesis is to:

1. Define the current state of IFE systems and how they contribute to the airline's success.
2. Analyze the role of PA in global industries and describe the ways to incorporate it into airline's IFE operations.
3. Develop ways to offer passengers exclusive and personalized entertainment during the flight.
4. Offer a strategy to increase airline's bottom line.

1.2. Research objective

Before going into detailed research, it is important to define objectives on which this thesis will be oriented. The objectives of the given study are following:

1. Explore the market of modern IFE systems and discover current trends and developments on the market.
2. Delve into the on-the-ground content distribution platforms and existing algorithms for content recommendation.
3. Study how data-driven industries prosper and show how airlines and IFE sector can benefit from PA utilization.
4. Describe the ways of incorporating PA into airline's IFE operations and integrating airline's app with social media to create dynamic and personalized in-flight content offering.
5. Suggest the ways of cutting down the cost of acquiring content and monetizing on the new dynamic IFE systems.

1.3. Methodology and structure

The current thesis is organized as follows. Introductory part presented in chapter 1 lays out the subject of the research and its goals. It describes the relevance of the topic and the steps of how the current research will be conducted.

Chapter 2 portrays in-flight entertainment systems and their significance in the airline's success on the market. It shows what is currently available among the IFE systems and what do the world's largest airlines offer to their clients. The chronicles of the IFE development give a visual presentation of the twentieth and twenty-first centuries innovation. Inflight connectivity (IFC) as a crucial component of a modern IFE system and its increasing importance is introduced in this chapter as well as future developments and trends in the IFE worldwide.

Chapter 3 examines distribution market of entertainment video content, networks that currently exist and the ways they operate. Additionally, the chapter explores the data algorithms and recommendation systems that power the content distribution networks (CDN). Furthermore, inflight content distribution, licensing, budgets and market players are reviewed here with the intention to identify the gap for future improvement.

The main part of this paper involves PA, its value in the modern world and particularly in the airline industry. Chapter 4 explores how PA can be utilized in IFE, how to source data, how to structure data to essentially develop personalized, efficient and dynamic content offering for IFE systems.

Chapter 5 addresses recommendations for possible monetization strategies to increase ancillary revenue such as dynamic and targeted advertisement and marketing campaigns.

Finally, Chapter 6 summarizes the provided research and lays it out in a step-by-step integration plan.

Conclusions and learned lessons are presented at the end of the paper.

For the research and data analysis following sources have been used:

1. Corporate data of major companies and organizations in the commercial aviation industry.
2. Data from content distribution networks and other media companies.
3. Reports and publications of social media companies.
4. Articles and published papers in the tech industry.
5. Research publications on data analytics.
6. Aviation industry forecasts.
7. Government publications.
8. Economic and demographic data and forecasts.
9. Forecasts of global consulting companies.
10. Reports on data analytics.
11. Journalistic investigations and publications regarding inflight entertainment industry.

Within the scope of the current research it was important to collect information from multiple industries such as commercial aviation, entertainment, technology and social media to be able to conduct an in-depth study and to identify the ways to deliver a new-generation dynamic IFE system that can be adopted by the airlines around the world.

2. In-flight entertainment systems and their role in the airline's success

With global internet access and social media, businesses have expanded their reach to a level that has never been seen before. The question is how businesses adjust and take advantage of these new opportunities. How do the airline industry and its significant onboard service – IFE - adjust to the changing digital landscape?

IFE is known to be onboard entertainment that airlines offer to the passengers during the flight. IFE systems vary from one airline to another and can range from the simplest to the most exquisite ones. Even within one airline IFE hardware and content could be different depending on the type of aircraft operating the route etc.

In 2016 3.7 billion passengers were carried on commercial planes (The World Bank, 2017), the number of passengers is expected to double by 2035 and reach 7.2 billion (IATA, 2016).

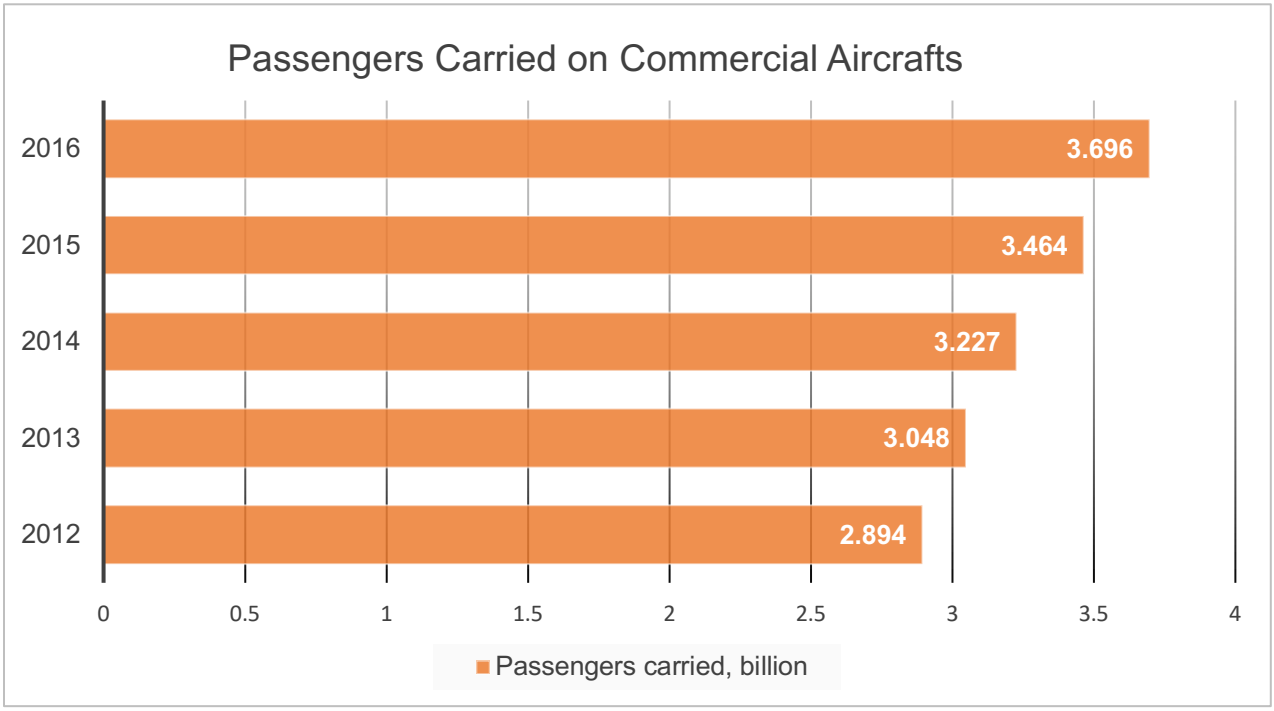


Figure 1 Passengers Carried on Commercial Aircrafts[1]

[1] Self-composed based on data from (The World Bank, 2017).

As the number of travelers grows annually, airlines are stimulated to upgrade the fleet with bigger aircraft equipped with the latest onboard technology updates. As a result, more passengers are becoming exposed to IFE systems.

Experts in the industry are expecting the global IFE market to reach US$6.91 billion by 2022. Between 2016 and 2022 the market's compound annual growth (CAGR) is awaited to be 13.8% (MarketsandMarkets, 2017). Given these numbers, it becomes clear to understand the importance of IFE systems as a critical element to the customer flight experience satisfaction and increased revenue of the airlines. It encourages the airlines to invest more in the technology, make it more refined and partner up with various companies to enhance IFE capabilities and improve its offerings.

This current chapter will look into the existing IFE systems of the leading airlines in four regions across the globe. It will explore the latest onboard technology trends, as well as challenges and most recent developments of the airline entertainment industry.

2.1. Current in-flight entertainment systems

For the past decade, technology has progressed dramatically. Ten years ago, it was standard to have audio access from a control panel on a seat armrest. The current standard is a seat-back touchscreen monitor with a vast number of exclusive movies and shows. More recently, the more significant number of airlines are adding features to the IFE systems to send and receive emails, surf on the Internet and to stream content directly on the passenger's personal electronic device (PED) via wireless setup. In the constant advancement of the technology, the IFE stopped being about the latest movies, music and TV. Instead it became more about customer interaction and experience with dynamic maps, Wi-Fi connection, upgraded screens, and even online shopping.

To understand current IFE offerings, standards that exist across the regions and alliances as well as trends in the development of the systems, the leading airlines and their IFE systems from around the world have been reviewed below.

The following four airlines displayed in the figure have been chosen based on their revenue passenger kilometers (RPK)[2] and regions they represent. ((IATA World Air Transport Statistics, 2017). The companies are Delta Air Lines[3] with 308,088 RPK, Emirates 270,797, China Southern Airlines 205,720 and Lufthansa 149,702 (IATA World Air Transport Statistics, 2017).

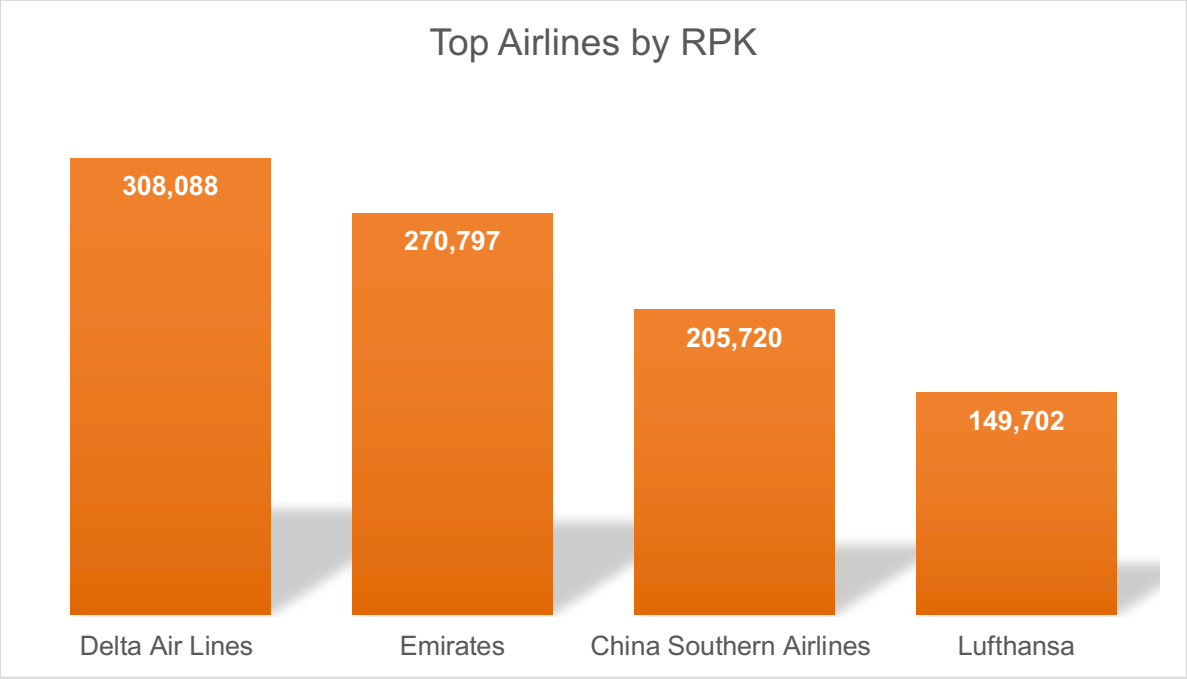


Figure 2 Top Airlines of North American, European, Arabic and Asian Regions by RPK, 2017[4]

Starting with the airline with the largest RPK among the chosen carriers, Delta Air Lines provides entertainment service Delta Studio on its flights. It is available on seatback screens and also passengers' PED via app. Delta Studio entertainment offers movies and TV shows, live satellite TV, music, podcasts and games. The company went forward with

[2] Revenue passenger kilometers (RPK) is the number of revenue passengers carried on each flight multiplied by the flight distance (IATA, 2017).

[3] Although according to the (IATA World Air Transport Statistics, 2017) the top three airlines represent United States are American Airlines (320,044), Delta Air Lines (308,088), United Airlines (299,080), the author of this study chose to examine Delta Air Lines instead of American Airlines because of its most advanced IFE system among the US airlines.

[4] Self-composed based on data from (IATA World Air Transport Statistics, 2017).

development of their mobile IFE app and added streaming services as Amazon Prime Video and Netflix that passengers can access via the in-flight Wi-Fi network. Among all US airlines, Delta was the first one to recently offer a free in-flight entertainment recently. (Delta Air Lines, 2017).

Emirates airline known for its high-class onboard service, was one of the first airlines to introduce a personal seat-back entertainment system on the aircraft. Emirates entertainment suite includes complimentary Wi-Fi[5] and offers entertainment options such as movies, TV, music, radio and podcasts, as well as educative and informative options such as latest news, real-time sporting events and information on airline's home base – Dubai. The system also has onboard opportunities for learning foreign languages and includes LinkedIn Learning[6] courses. The airline emphasizes the importance of connectivity and how it is becoming the foundation of the passenger experience (Emirates, 2017).

IFE system by China Southern Airlines is relatively simple compared to the other represented airlines. It has a standard video, audio and game system using seatback screens. The program on the fleet is updated every three months. IFE is also available on portable multimedia devices provided by the airline. Carrier's IFE offering varies with the aircraft the flight is operated on and the route. For instance, real-time map, online duty-free shopping, PDF document reader only available on the wide-body aircraft such as A330, A380, Boeing 787. Also, Wi-Fi is free for business and first class and only offered to the limited routes within mainland China, to and from Australia and The Netherlands[7]. Economy class passengers need to apply for Wi-Fi service in advance and it is usually available for travelers who have a mainland China phone number and it is limited to laptops and tablets since mobile phones are not allowed to be turned on during the flight (China Southern Airlines, 2017).

[5] Emirates is one of the few airlines in the industry that offers free connectivity on the board.

[6] LinkedIn Learning is a data-driven online platform powered by the LinkedIn that enables personalized learning experience (LinkedIn Corporation , 2016).

[7] More routes are planned to follow.

Lufthansa is the only airline in the industry that has developed its entertainment and connectivity suite through its subsidiary Lufthansa Systems. The company is using it on its flights and also offers it and many other IT solutions to a vast number of airlines around the globe.

Lufthansa's entertainment system BoardConnect offers movies, TV shows, interactive moving maps, games and music with the feature of creating personal playlists. The airline also added live features such as live TV streaming and sporting events as well as various reading materials like magazines and audiobooks. BoardConnect has also integrated shopping and food ordering services (Lufthansa Systems, 2017). IFE is available on both seatback screens and PED app (Lufthansa, 2017).

It is seen that although all airlines have common IFE features, they prioritize it differently. The following chart summarizes what services are provided on board of the largest airlines in North America, Middle East, Asia and Europe.

	Delta Air Lines	*Emirates*	*China Southern*	*Lufthansa*
Free Wi-Fi	Available for purchase	+	Limited routes, classes, devices	Available for purchase
Phone calls	Texting, no calls	+	No use of mobile phones	-
Movies	+	+	+	+
Music	+	+	+	+
Games	+	+	+	+
Live TV	On select flights	Regular TV	Regular TV programs	+
Live sports	-	+	-	+
Live news	+	+	-	+
Video streaming e.g. Netflix	+	-	-	-

Podcasts	+	+	-	-
Audio books	-	-	-	+
Educational courses	-	+	-	-
Shopping	-	+	limited	+
Food orders	+	-	-	+
PED app available	+	-	-	+

Figure 3 In-flight Entertainment Services Comparison Chart [8]

As seen from the IFE system comparison chart, standard entertainment services such as movies, TV, games and music are provided by many airlines. However, the difference in the IFE systems lies in the advanced features that contribute to standing out among the others and rendering excellent services that other airlines can't provide.

As all the technology, IFE systems are continually improving and variety of services that are getting included on airlines, aircraft and routes increases. Despite that, there are some carriers out there that do not tend to upgrade their IFE systems providing very limited entertainment content. In fact, there are carriers that are still charging[9] the passengers for renting headsets and entertainment tablets.

Nonetheless, because of the intense competition, airlines can no longer afford to ignore the importance of IFE. In fact, quite often carriers copy and adopt changes of their competitors. For example, after a few months of Delta Air Lines announced its free IFE systems in 2016, American Airlines released its free IFE available on both seat-back screens and airline app on selected US flights (American Airlines, 2016).

[8] Self-composed based on the official data of Delta Air Lines, Emirates, China Southern Airlines and Lufthansa.
[9] For example, Hawaiian Air, Alaska Air, United Airlines.

2.2. History of in-flight entertainment

More than 100 years passed from the day of the first commercial scheduled passenger flight in January of 1914. Since that day there have been significant changes in the commercial aviation industry regarding fleet, destinations, technology and of course onboard entertainment.

The chart below displays development of the in-flight entertainment from the early days of the first movie shown onboard of the commercial aircraft to the IFE systems of today and technology behind it.

1921	First movie shown on board of the Aeromain Airways flight around Chicago.
1925	Imperial Airways from London to Paris showed the first silent movie blockbuster.
1931	Introduction of live radio broadcast.
1941	Live music and singing onboard during a private press event.
1961	Development of a 16mm movie system for screens on large series of commercial aircrafts.
1961	First movie screened on the regular scheduled flight.
1964	Introduction of headsets for the audio.
1971	Release of 8mm film cassettes enabling to change movies in the cabin during the flight and to have multiple movies on the aircraft screens.
1975	First video game presented on Braniff Airlines flights.
1982	First onboard map.
1988	Introduction of seat-back screens.
1991	Seat-back screens for all cabin classes on Virgin Atlantic.
1996	First TV broadcast on Delta Air Lines.
2001	First in-flight internet access for email services.
2006	In-flight broadband services.
2015	Virtual reality onboard of Qantas and Virgin America.

Figure 4 In-flight Entertainment Development Time Chart[10]

It is very impressive to see how the IFE advances over time even though the utilization of the technology and its adoption for the aircraft environment brings its challenges and requires additional effort. Next sections will reveal the latest developments in IFE systems, the challenges that exist and the future innovation the industry players are working on.

2.3. Increasing demand for in-flight entertainment systems

In 2016 the number of passengers globally was 3.5 billion. According to IATA's 20-year forecast by 2035, the number of air travelers worldwide will reach over 7 billion (IATA, 2016). With the continual annual growth of the passengers, airline competition is becoming more severe and it pushes the carriers to constantly improve their services to win more passengers invariably.

Although North America is the global leader in the passenger ticket sales[11] and a forerunner in the in-flight connectivity (IFC) and IFE, Asia Pacific and emerging markets are expected to have fast increase in the number of flyers in the following years (Harteveldt, 2016). The World Bank predicts emerging markets and developing economies (EMDE)[12] to have a faster gross domestic product (GDP)[13] advance over the next five years than in high-income countries (World Bank Group, 2017). An annual RPK growth of 5.6% between 2016 and 2035 is foreseen for the EMDE (Airbus, 2017).

Other regions such as Middle East, Africa and South America are to follow in the increased number of travelers each year[14]. South America is expected to have an

[10] Self-composed based on data from (The Telegraph, 2016) and (Virgin, 2015).
[11] With over 1,000 billion RPK (legs) in domestic USA traffic flow in 2016 (Airbus, 2017).
[12] EDMEs according to the World Bank: China, Indonesia, Thailand, Russia, Turkey, Poland, Brazil, Mexico, Argentina, Saudi Arabia, Iran (Islamic Republic), Egypt (Arab Republic), India, Pakistan, Bangladesh, South Africa, Nigeria, Angola.
[13] GDP is the total market value of all the goods and services produced in a country (or any particular geographic region) in a year for final use (Burda & Wyplosz, 2013. p.4).
[14] According to World Travel and Tourism Counsel (WTTC), countries like Colombia, Malaysia, Indonesia, Iran, Saudi Arabia and Vietnam will grow faster than BRIC (Brazil, Russia, India, China) countries.

extensive growth in the aviation sector due to the growing number of travelers and tourists, will most likely experience a substantial necessity in IFE systems (Harteveldt, 2016).

With the increasing number of passengers every year, customer expectations to service, entertainment and in-flight experience in general will also grow. Each carrier will try to gain more market share by trying to distinguish themselves from their competitors. They will offer better IFE systems to satisfy increasing customer expectations of frequent flyers and attract new customers.

2.4. In-flight connectivity

Onboard Wi-Fi connectivity (IFC) and broad application of mobile devices have dramatically challenged the classic IFE systems. As the world and society on the ground are becoming more interconnected, customer expectations towards the internet accessibility onboard are growing. It brings new possibilities for upgrade and innovation for the airlines that want to be ahead of the industry and satisfy customer needs by delivering progressive and sophisticated IFE systems.

A lot of airlines see the increased use of bring-your-own-device (BYOD) among passengers as a challenge. They see the PED and the standard seat-back IFE system as redundant. Some carriers see it as an opportunity to remove heavy IFE hardware from the fleet to cut down the cost of the electronic screen as well as fuel. As an example, early 2017 American Airlines announced they are awaiting for delivery of Boeing 737 Max with no seat-back screen feature (Schlangenstein, 2017). Airlines spend a significant amount of money on IFE screens installation. For instance, the cost of equipping Boeing 757 with seat-back screens is in average US$3 million per aircraft. (Schechner, 2012).

To compensate the lack of screens the carriers that are getting rid of traditional IFE screens invest in improving the quality of onboard connectivity to make the network coverage better and internet streaming services faster.

According to a Global Passenger Survey[15] conducted by IATA in 2016, travelers voted to have valued a much better travel experience on the flights that had in-flight Wi-Fi (IATA, 2016). A survey by Honeywell Aerospace showed that 21% of the passengers polled in 2016 would switch without hesitation from the airline they frequently fly with to an airline with better IFC option. The importance of the available Wi-Fi onboard and the expectations of the robust and fast connection is growing especially among the Millennials[16]. Millennials have recently become US largest living generation, they are most digitally connected generation and are becoming a significant client to a lot of industries they are getting into their best spending years (Honeywell , 2016).

Considering the BYOD tendency, it might be a beginning of the wireless in-flight entertainment (wIFE) era. In 2016 about 51% of the air travelers used their own PED, which is 12 percentage point more than in 2015. The number is expected to be significantly higher in 2017 and the consecutive years (IATA, 2016).

wIFE gives an advantage of delivering the content very fast directly on the PED via the onboard installed platform[17] because the content is stored on the server onboard and streamed locally. This way IFE could deliver an unlimited number of videos on PED as opposed to the limited library on the flight that currently exist.

The wIFE could be extremely flexible, save space and weight on the aircraft by eliminating old embedded IFE systems and replacing them with powerful connectivity devices to enable passengers to use PED and to stream content through them. By reducing the in-flight entertainment and connectivity (IFEC)[18] weight, airlines can significantly cut the fuel cost. The average cost of fuel consumed on the aircraft type like Boeing 767 with 260 seats caused by the weight of cabling and seat-back screens alone can reach $90,000 per plane a year.

[15] Around 7,000 travelers of all ages from 140 countries were interviews for this survey.
[16] People born in between 1981 and 1998 are referred as Millennials. By 2015 the Millennials generation became US largest living generation (Pew Research Center, 2016).
[17] Referred to providers like Gogo Air, Global Eagle Entertainment, Panasonic Avionics, Honeywell etc.
[18] IFEC is understood as screens, servers and other additional supporting equipment.

However, despite the economic and technological advantages mentioned above, there are markets like the Middle East and the Asia Pacific where travelers prefer classic IFE systems with embedded screens. To satisfy the needs of the customers, airlines with the origin from those regions and airlines serving those regions work on both aspects of better entertainment systems – improve the onboard connectivity and regularly upgrade IFE systems because their customers value them so much.

It is difficult to determine only one best option for development of IFE systems – both aircraft installed IFE systems and BYOD policy deserve the right to be present in the industry as they both have definitive competitive advantages. Using PED for IFE purposes might be more convenient for younger generations and it also contributes to cutting the cost of extra fuel since there is no more need for installing heavy equipment on the plane. To the contrary, the diversity of the travelers contributes to the fact that some passenger groups[19] might experience possible inconvenience using wIFE systems and would want classic in-seat IFE screens. Depending on the carrier's strategy and mission, cultural and behavioral patterns of the regions they are serving, every airline has to decide either to invest in the constant improvement of aircraft IFE hardware or to work towards wIFE.

[19] As mentioned previously, some geographical areas and not tech savvy passengers might expect availability of traditional seatback IFE systems.

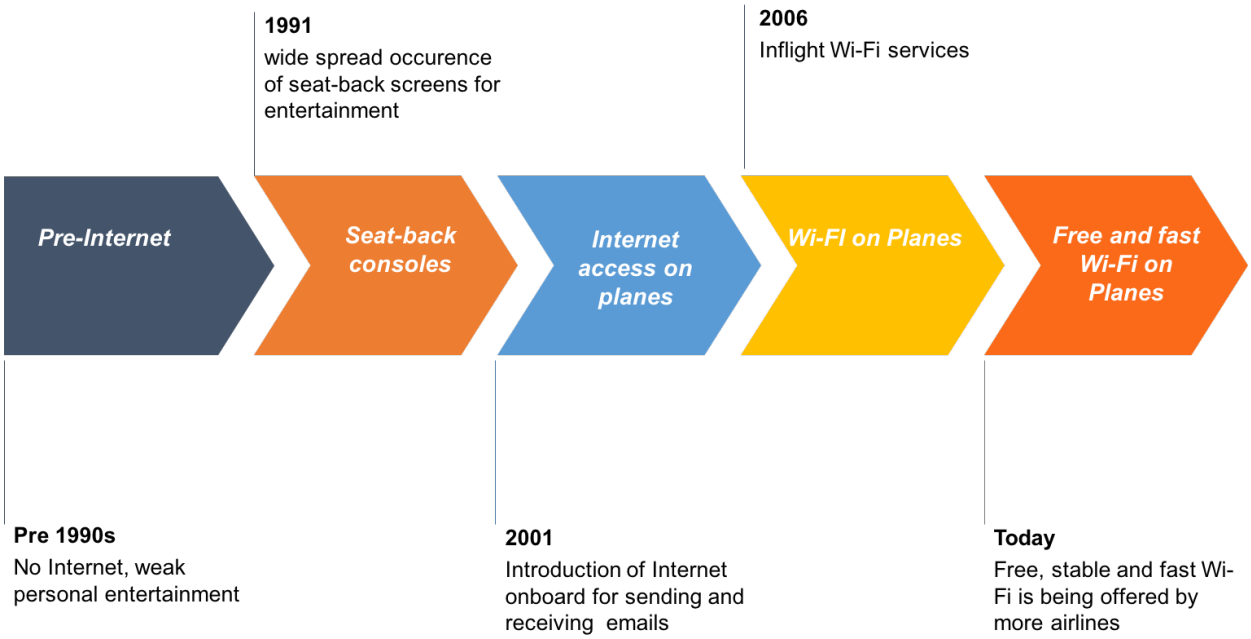


Figure 5 Evolution of the In-flight Connectivity[20]

The IFC is becoming more utilized and its market is continuously growing. As internet access during the flight is becoming more common, more carriers include it in their services. The companies that hesitate too long will be disadvantaged. For airlines IFC is distinctly an emerging source of profits. Better and steady connectivity on the plane contributes to a larger demand of IFE.

However, current IFC technology has challenges like limited bandwidth and coverage, capacity issues due to the limited satellite capabilities and lower speed compared to the internet connection on the ground. Nevertheless, as the onboard Wi-Fi technologies advance, these challenges will disappear.

Because of the IFC complexity, it involves significant investments to install the equipment. In order to cover the cost of the service, most of the airlines charge their passengers for using Wi-Fi. A common practice the airlines are using is segmented pricing for internet services, the price and condition for which varies depending on the flying class, route, frequent flyer loyalty program, etc. Those fees pay off the acquired equipment and

[20] Self-composed based on data from (The Telegraph, 2016) and (Virgin, 2015).

contribute to increasing the satellite coverage in order to have robust system onboard and to make sure it can handle the passenger demand.

Some of the airlines[21] offer free in-flight internet[22] that is covered by ancillary revenue streams. For example, US carrier JetBlue provide complimentary Wi-Fi that is sponsored by well-established companies like Amazon or Wall Street Journal (Gogo LLC, 2014).

With the new advanced technologies in the IFEC systems it is essential to train the crew and educate the passengers to let them know the wireless connectivity is there for their use and to experience the IFE in a full capacity. Quite often passengers have to proactively inquire about the IFEC availability and prices during the flight. It is not always clearly announced by the crew. However, airlines that offer complementary IFEC services present it as one of their competitive advantages in the industry and take a lot of effort to advertise it to their clients.

2.5. Future of in-flight entertainment systems

This section uncovers main developments such as connectivity, virtual reality (VR), social media implementation for passenger seating and integration of artificial intelligence (AI) personal assistants that will define the future of IFE systems in the nearest years.

IFC. Considering the fast advancement of IFE systems over the past years, a significant rise in development is expected in the next 5-10 years. Implementation of improved onboard connectivity is something the carriers and their technology partners are already working on. With fast and robust Wi-Fi networks onboard, PED content streaming through the CDN is no longer a long-term dream but a compelling solution in the nearest future. In 2016 74 airlines offered Wi-Fi services onboard. By 2025 more than 16,000 aircraft will be equipped with Wi-Fi according to Airbus market forecast (Airbus, 2017).

[21] Current airlines that offer free Wi-Fi on the aircraft as of 2017: Air China, China Eastern, Emirates, JetBlue Airways, Nok Air, Norwegian, Turkish Airlines, Qatar Airways.
[22] Various restrictions such as additional bandwidth may apply depending on the airline.

In-flight Virtual Reality implementation. Another technology that is entering the aircraft space and can change the perception of IFE is VR. VR can be a potent tool to satisfy customers' demand for emotional experience. Some airlines have already incorporated VR on their flights. For example, Australian airline Qantas has launched VR integration for the first-class guests in 2015. Through the Oculus designed app, passengers can experience the airline's flown destinations and movies using Samsung Gear VR headset provided by the company (Oculus, 2017).

From 2015 to 2020 the CAGR of 181.3% is forecasted for the VR and AR market. The market is anticipated to grow from US$5.2 billion in 2016 to US$162 billion in 2020 (International Data Corporation, 2016).

Following the example of the increased popularity of BYOD for IFE applications, airlines that are working with VR are using this to their advantage and encourage the passengers to not only use the airline provided VR hardware but to bring their own VR headsets and use them during the flight for IFE.

Social Media. IFC and PED utilization encourage passengers to browse more. A significant part of connectivity is social media and airlines want to take advantage of it. A pioneer in it is a Dutch carrier KLM that implemented a Social Seating concept. The idea behind it is that any traveler can choose a person to sit next to or connect with on a personal and business level to make the best of the travel (IATA, 2017). Startups also following the trend to create various social media seating profile applications. Social seating start-up Planely launched its app with the intention that any passenger can access an aircraft seating layout with social media data on other passengers to connect with them (Planely , 2016).

AI personal assistants. As voice-controlled devices are becoming more popular, the travel industry is looking for ways to incorporate it in business for travel search, flight planning and information inquiring. One of the example is the recent feature the company

Spafax[23] has enabled for the airlines it provides services to. Travelers can ask voice-controlled assistant Alexa[24] what movies and on what languages would be available during their next travel. Google Home Assistant can search for flights and optimize routes through Google Flights. Most recently passengers of Korean Air were enabled to ask Alexa about the status and route of any Korean Air flight. (Steele, 2017). This is just the beginning of new possibilities connecting airline IFEs to AI operated personal voice-controlled assistants.

The concept of personal experience is now becoming extremely important for the consumers in various industries and facets of life. It is becoming essential for a traveler to not just to get the service but to have an experience. The aspiration of the personalized experience and accessibility of the technology is driving most of the industries to innovation, the airline industry in the forefront. As the digital world is constantly continually changing and developing, IFE systems should also be constantly undergoing digital evolution.

3. Content distribution networks

This chapter focuses on examining entertainment video content market on the ground and in the air by looking into CDNs, broadcasting networks and multichannel video programming distributors (MVPD)[25], social media companies whose core business is video content and content distribution process for IFE systems.

After defining CDNs and describing what led to their rise and popularity over the past few decades, the world leading content platforms will be analyzed to understand how video content distribution works and to find out how those existing business processes and data

[23] Spafax Group Company is a media and content marketing provider with a focus on in-flight entertainment, audio and video production and PR.
[24] Alexa is an operating system and assistant for a voice-controlled device Amazon Echo developed and sold by Amazon.
[25] MVPD makes multiple channels of video programming available for multiple subscribers or customers for purchase. It could be cable operator, broadcast satellite service, television program distributor etc. (The Communications Act 47 U.S.C. § 522(13)).

analytics in particular can be adopted and employed in IFE systems to create a unique personalized entertainment experience for passengers.

Three world-leading content companies have been taken as examples in this chapter to examine what unique features and mainly what algorithms contribute to their success. The first company explored is Netflix - the leading CDN that started with on-demand DVD rentals and was able to switch into a subscription-based model in the dawn of the Internet streaming era. The second video content example is a social media pioneer video platform YouTube that has over a billion of active subscribers. The third company examined is a social media giant Facebook that has an enormous user base of over two billion people. Although it is widely known as a social media network connecting people, the company's innovative approach, understanding of data and vision of the video content as a key element of the business in the future is essential for this research.

3.1. Modern types of content distribution networks

The Internet has undoubtedly revolutionized the world by opening access to information and transforming well-established media businesses and its content. Popularity and affordability of PED with internet connection have made the leading TV networks shift towards commercial-free on-demand content systems that are accessible 24/7 on a computer or mobile apps. Internet TV has altered familiar linear TV experience making it personalized, available any time on any screen in any quantities. Existing for over a decade now, Internet TV is driving TV networks and new innovative market players to form CDNs and to create the most exceptional apps for content streaming to get more viewers and therefore more revenue.

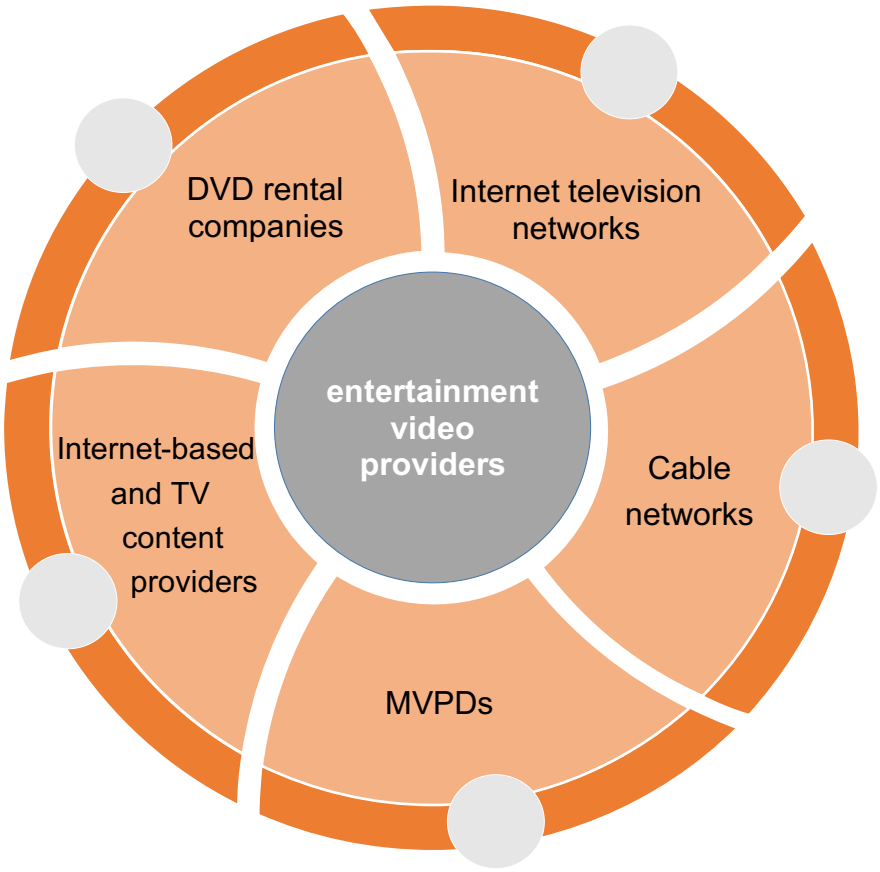


Figure 6 Entertainment Video Providers[26]

There are a lot of entertainment video providers on the market, they operate differently, offer various services and bring in different value to the customers. The figure above describes the main entertainment video providers, among them internet television networks[27], cable networks[28], MVPDs[29], internet-based and TV content providers[30], DVD rentals, video gaming providers and other entertainment sources in a broad sense such as social media video platforms.

There are several economic models in the entertainment video content market that currently exist. The most popular is Internet followed by cable and TV networks that offer

[26] Self-composed based on the data from (Netflix, 2017).
[27] Such as Netflix, Amazon, Hulu.
[28] Such as HBO, ESPN.
[29] Such as AT&T, Comcast, Verizon Communications.
[30] Including pirated content.

subscription-based services. DVD rental outlets are using transactional model, whereas internet-based and TV content providers bring ad-supported and even piracy-based content.

Entertainment video market is very competitive because CDNs get revenue from monthly membership fees for content streaming services. Competition between the market players for new subscribers is extreme. Furthermore, the core of the business – content is also what the companies are competing for. CDN providers go up against each other in bidding for time-based content licenses and original content productions.

Following three sections will give a detailed look into operations of the world leading video content distribution platforms to understand what makes them so unique and successful.

3.1.1. Netflix's current system

Netflix is the world's leading video content streaming platform that for a flat fee offers entertainment movies and TV series content. It operates in 190 countries, has 104 million users and has more than 125 million hours of content per day (Netflix, 2017).

Company's operation started in 1997 as a DVD rental outlet. Back in the early days of its business when the company was sending content per mail, it was actively using data analytics to correctly predict the demand and be able to administer logistics by understanding what titles and what quantities need to be in the warehouses ready to be mailed.

With the fast development of internet infrastructure in the United States and the dot-com era in the early 2000s, the company's operation model shifted from a DVD sending service to a content streaming platform by 2007 (Netflix, 2017). Today the company has three business segments: domestic streaming, international streaming and domestic DVD rental (Netflix, 2017).

In 2013 Netflix has expanded its operation and started to produce original content which currently brings more value to the brand and more subscribers as a result. In 2017

company spent over US$6 billion on content creation, over US$1 billion on research and development of the platform and over US$1 billion on marketing to promote the shows and to get more subscribers (Netflix, 2017).

Over the years the company has built a vast user audience and with the start of original content production Netflix has done something that no other CDNs have ever done before. Whenever a new show or a new season of an existing show is coming out, the entire season all at once is released on the platform. This is very different from what other entertainment video providers offer and is undoubtedly very appealing to the users. The company uses it as a significant advantage against over broadcasting networks[31].

Recently the company has introduced an offline streaming feature for PED. It enables the users to download specific content[32] to access it any time later without using the internet data. This feature is very convenient when there is no internet access for example during the flight, that is why it is becoming very popular among the regular travelers who want to continue watching their favorite shows but the IFE system on the airline they fly with is limited.

Seeing the benefits of data analysis in the past DVD era, Netflix brought it forward and engineered a dynamic feature that creates unique recommendations for users on home screens that are relevant to their individual taste and viewing history. It is a reliable tool to anticipate demand when creating original content and to promote the shows company has a strong interest in – original series, newly acquired licenses and other high-profit content. Netflix is shaping the need for content development by analyzing the user base in various regions, their watching behavior, interests and viewing history.

According to the company, in 2013 about 75% of the users' viewing preferences and activity were coming from recommendations as opposed to other companies where most

[31] Netflix's competitor in the United States HBO is on the contrary releasing on episode at a time and thus keeping the intrigue throughout the season.
[32] The number of the content available for this feature is currently limited.

of the views and purchases are coming from search. The number is expected to steadily grow every year (Netflix, 2013).

There are numerous aspects that influence the outcome of the recommendation analysis. Company's algorithm uses a wide range of factors that are analyzed to make unique recommendations for every user. Each of the factors forms a decision tree that makes handling of the input data efficient and flexible.

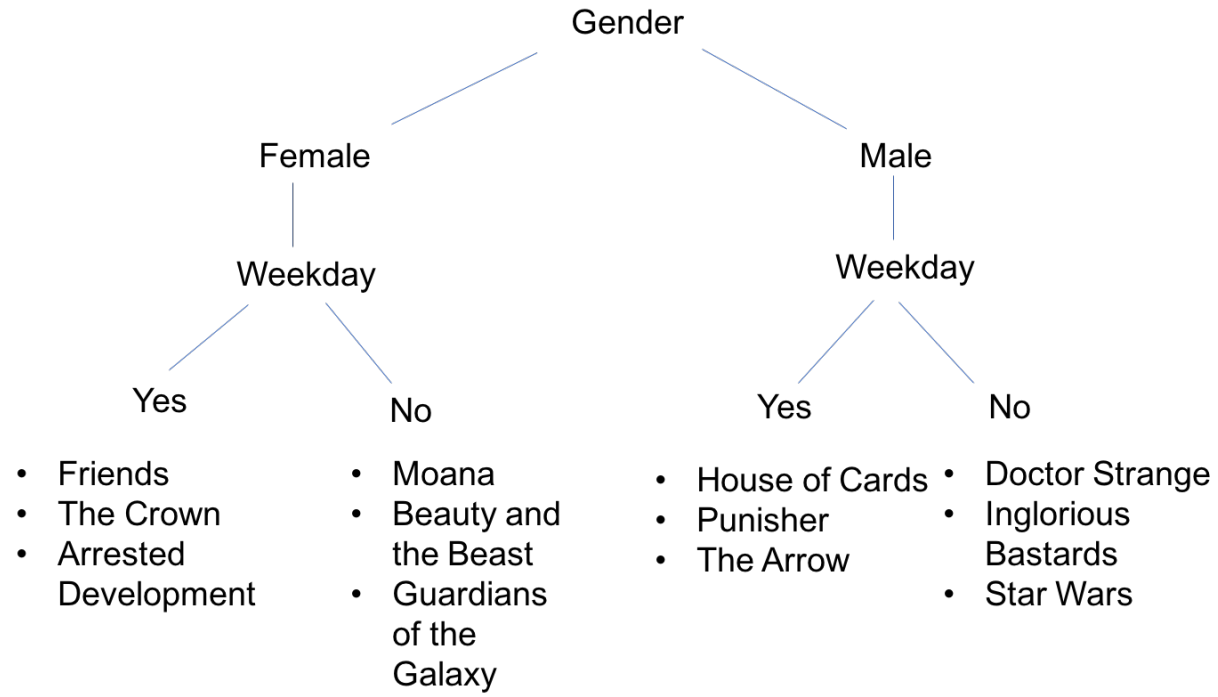


Figure 7 Example of a Decision Tree for Recommendation System[33]

This is an example of a high-level decision tree that forms a list of matching content recommendations by looking at the viewer's gender and day of the week – weekday versus weekend. Every decision influencing the recommendation outcome is being analyzed in the same way. Some of the analyzed factors that make unique recommendations are listed as examples below (Chowdhury, 2017):

[33] Self-composed example of a decision tree based on data from (Chowdhury, 2017).

1.	Type of series or movies watched.
2.	Time of the day the content watched.
3.	Nature of interruption like pause, stop, rewind or fast forward.
4.	Audience's reaction to previews.
5.	Users search and browsing history as well as scrolling behavior.
6.	Type of content downloaded for offline viewing on the mobile app.
7.	Type of devices used for streaming by different groups of customers.
8.	Correlation between the change of the device and genre of content.
9.	Pattern and correlation of various age groups, zip codes they live in and preferred shows.

After the data is collected and analyzed, it shows patterns of similar viewing that represent similar user preferences. Thus, the preferences of a particular user can be concluded based on choices of similar users. Identifying preferences of similar users helps to target those specific groups with personalized marketing campaigns and content promotion.

Regarding the content, it also undergoes analysis to aid recommendation algorithm. Similar to factors for analyzing user groups, there is a vast number of criteria to influence recommendations. Here are the most significant examples:

1.	Shows that have a similar genre to the ones the user has watched.
2.	Shows that have similar ratings to the ones the user has watched.
3.	Shows that are similar to the ones saved in the user's list.
4.	Shows that have been released in the same year to the ones the user has watched.

After the algorithm has finished its complex data analysis of users watching behaviors, it can produce most sophisticated and individualized content recommendations to satisfy the viewers. In addition, the analyzed factors and obtained results will help Netflix and its

production team to create content that they know existing users will like and it also helps to attract new subscribers.

With a big user base, personalized promotion of specific content, exclusive subscription licenses with various movie producers, original content and no need to compete with other TV networks for prime-time slots, Netflix has become the world-leading CDN.

3.1.2. YouTube's current system

YouTube is the biggest platform in the world for creating, finding and sharing content. It was bought by Google in 2006 a year after its launch. After going live in 2005 and 12 years in operation, it has reached the number of 1.5 billion active monthly users and billion hours of videos watched daily (Constine, 2017). YouTube is operating in 88 countries on 76 languages (YouTube, 2017).

YouTube's platform is much more complex than social media or a video distribution platform. It offers products for recording and watching TV broadcasts; videos and original content; gaming; music applications for online and offline streaming; a subscription-based video service for ad-free content - YouTube Red, a special segment for children content, business service for advertisement and VR segment for watching 360 original videos and classic rectangular content in 3D. YouTube was one of the first content media platform to implement a VR immersive feature.

To make it a unique experience for the users, the company has created an algorithm for recommending personalized content. However, unlike other streaming platforms, the content library here is being rapidly updated since the frequency of new videos uploaded is close to be 500 hours every minute as of 2017 (Hutchinson, 2017).

Such an unusual regularity of uploaded content brings its challenges to the recommendation algorithm. For example, the depth of the content library and hereto related difficulty finding it. Due to the significant number of videos uploaded, older videos have fewer chances of being noticed by users or being noticed but the search algorithm itself. Another challenge is related to finding the proper piece of content. Social media

factor contributes to the fact that a large number of the users who upload videos are amateurs. Inevitably it leads to incorrect and incomplete titles, video descriptions etc. which makes it harder for the algorithm to find and match the required piece of content to the appropriate user and search request.

YouTube recommendation system is outlined in the Figure 8 YouTube Recommendation System Architecture Funnel.

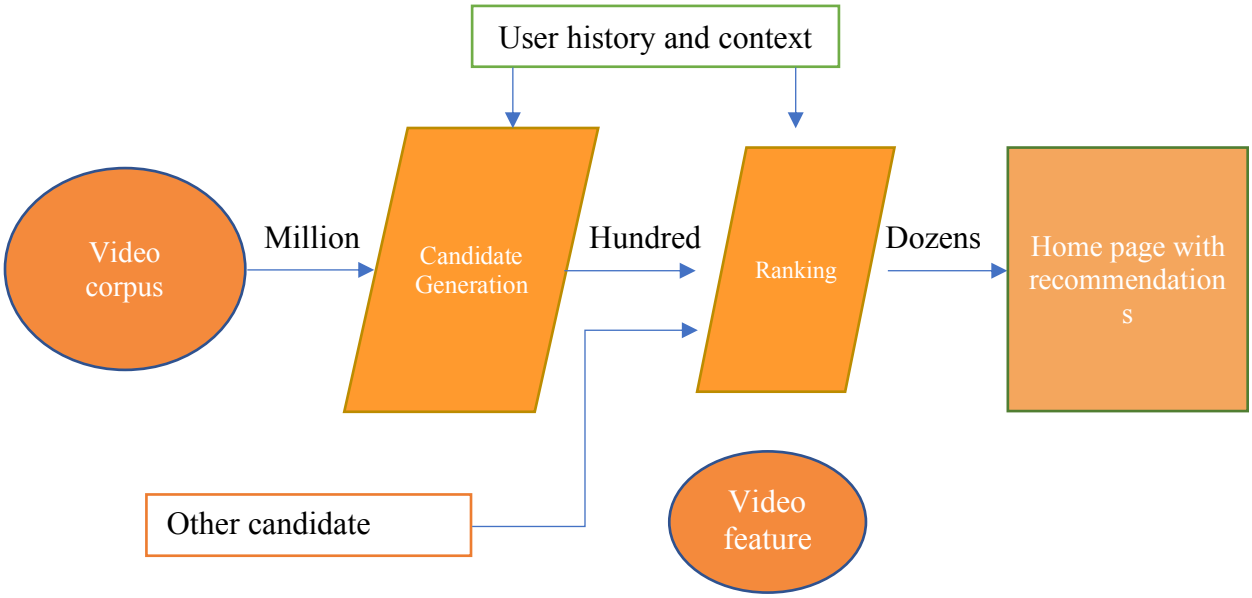


Figure 8 YouTube Recommendation System Architecture Funnel [34]

The entire recommendation system is built on neural networks[35] that consist of two parts: candidate generation and ranking. The first network stands for candidate generation. This network analyzes user activity and finds data on the relevant videos viewed by other users who watched or searched for similar and related videos[36]. This step contributes to determining a broad spectrum of videos that might be suggested for personalized

[34] Covington, Adams, & Sargin. Deep Neural Networks for YouTube Recommendations, 2016.
[35] In information technology, a neural network is an artificial system of hardware or software that carries similar patterns of recognition and matching than a human brain and excels mathematical function approximation (Zhang, 2010).
[36] Video ID is considered here as a feature to retrieve the data from.

recommendations. It helps to filter down the number of possibly relevant videos from millions down to hundreds.

After the first step, the second network follows. This step is called ranking, and it helps to narrow down results to find the best recommendations for the user. The way it works is that it gives a rank to a video based on the preferred functions and also deploys features[37] of the video and the user to determine the rank. The ranked videos are then presented to the user on his or her homepage. Recommendations go from the videos with the highest score at the top of the page down to the videos with the smallest score at the bottom. At the final step the number of potentially recommended videos is narrowed down from hundreds to dozens (Covington, Adams, & Sargin, 2016).

Such an algorithm helps to deal and respond to the vast amount of video uploads in real time, to process them correctly and to keep track of the viewing and browsing history of each user.

3.1.3. Facebook's current system

Facebook is the world's largest social media platform with over 2 billion active monthly users (Constine, 2017) and 1.32 billion active daily users or 60-70% retention rate on a daily basis (Facebook, 2017).

Founded in 2004 as a student network, it has developed into a much more complex platform that covers all the globe and includes subsidiaries such as messaging services[38], photo social media platform[39] and VR[40]. Alongside with YouTube, Facebook was one of the first platforms to integrate 360-degree video design into their system.

What makes Facebook so valuable and desirable not only among the users but also among the companies that want to promote and grow their businesses online? First,

[37] This might be activity data such as user's ranking of the video by liking/disliking, view time etc.
[38] Facebook owns two messengers, its own development Messenger and acquired in 2014 WhatsApp (Covert, 2014).
[39] Facebook bought startup Instagram in 2012 (Covert, 2014).
[40] Oculus VR was acquired by Facebook in 2014 (Solomon, 2014).

Facebook is a reliable source for creating social media outreach. Secondly, active user engagement and provided information within Facebook is a powerful resource to get to know the users, discover their preferences, likes and dislikes, learn their passions, backgrounds, know who their friends are, what the groups and communities they belong to, what education and careers they pursue. In the age of social media and digital marketing, data has already become extremely attractive for businesses to target audiences for public relations, promotion of their products and services and so many other things.

Affordability of PED and internet connection contributes to fast and easy information access, making the cost of its distribution very low. With more than 2 billion active monthly users, Facebook has the most extensive social media database in the world that is being cultivated through various formats such as texts, articles, photos, videos, live feeds and stories, 360-degree and VR videos.

The company emphasizes the importance of the news in the fast-changing world and the necessity of being up-to-date which they manage to deliver through the unique algorithm determining every activity and operation on the social network.

To fully understand the value of the data Facebook holds and its power, it is essential to look into the foundation of the algorithm that runs the news feed ranking. The algorithm is what makes every news feed unique. It ranks the content and narrows down the amount of news the users see on their screens every time they are online to the most important and critical ones.

The sophisticated algorithm as the company describes it is a set of four sequental steps that solve the news feed ranking problem (Mosseri, 2017). It is outlined below in the Figure 9 Facebook News Feed Ranking Algorithm.

Figure 9 Facebook News Feed Ranking Algorithm[41]

Step 1 Inventory. The first step represents a starting point of the algorithm. At this stage, relevant information about every user is being kept and collected. This is unique information consisting of what has been posted by a user, all user's friends as well as pages, communities and publishers he or she follows.

Step 2 Signals. The following step of the algorithm estimates how interested the user might be in each posted story. Predicted interest is determined by a vast number of criteria that contributes to its accuracy. Some of the examples of the factors influencing the prediction are given below however not limited to them only:

1.	Type of the posted story.
2.	Date and time of the posted story.
3.	Story's author and publisher.
4.	Time at the moment when the user checks his or her news feed.
5.	Type of the electronic device the user is using at the given time.
6.	The frequency of posts from the same publisher.

Step 3 Predictions. This step calculates the probability of an event. It estimates the likelihood of the user's engagement in a specific piece of content based on the qualitative data. Following activities could be described as qualitative data during this step: viewing,

[41] Composed based on the company's report (Mosseri, 2017).

commenting, liking, sharing of the story, time spent reading the story. This data is then consolidated into relevancy score which is the last step of the algorithm.

Step 4 Score. The final phase of the ranking algorithm is refined down to a score. The score[42] in this context represents a number that shows the best estimation of how the Facebook's algorithm thinks the user might be interested in the particular story.

The same process of following all four steps is happening with every story that each of the billions of users might see every time they are active online. In such a manner, every user has a unique news feed on his or her PED. Interesting enough even the same piece of content can be ranked differently depending what user is sees it.

The video content format that is becoming more powerful than others. The media world is currently experiencing significant changes due to a big shift from text and pictures to video content. As of November 2016, the video makes about 50% of all mobile data traffic. It is anticipated that by 2022 it would be 75% (Ericsson, 2016).

Facebook emphasizes the value of video format and prioritizes it over other formats when ranking the content. The algorithm puts video content on the top of its users' newsfeed predicting what the users will like and what not. The need for better video experience certainly grows as the technology improves. Modern society has become very advanced in implementing gadgets and video formats in their daily lives.

Following the philosophy of the video as a shared experience, Facebook launched several formats for a dedicated watching - video app for TV and 360-degree immersive videos. A 360-degree format was introduced in 2015, within only a 1.5 year of existing, the number of published immersive videos exceeded 1 million videos. In 2017 the company is focusing on improving the quality of the content in 360` format to make it more accessible to larger groups of people (Danker & Connoly, 2017).

[42] Facebook agrees that although the steps of the algorithm and the conclusion of the final score is backed up with data engineering made with scientific approach, it is still an educated guess (Mosseri, 2017).

Facebook's extensive user database and all the information it contains makes it a compelling marketing and technological resource for various industries. Its vision of the importance of the video content and its role in the shaping of the future world has contributed to the idea of creating a dynamic and personalized IFE access in the current thesis.

3.2. In-flight entertainment content distribution

The previous chapter has described how IFE systems have developed over time, what they are today and how they contribute to the customer's satisfaction. This section will study the central aspect of what makes an IFE system pleasant, exciting and worth the time spent onboard – the content and its distribution.

The critical point to the thoroughly engaging IFE system is a vast library with regularly updated content. According to IATA Global Passenger Survey from 2016[43], about 77% of the interviewers were watching movies during the long-haul flight, the number on the medium-haul is less and makes 42% (IATA, 2016). What amount of work stands behind a nice-looking IFE library, what parties are involved in acquiring the content, what are the ways to help airlines monetize licenses and what challenges exist along the way, will be explained in this following section.

The in-flight movie industry is growing together with IFE popularity. As IFE systems evolve, airlines adjust the ways of acquiring licenses, finding new content sources and the means to monetize on them. The graph below displays significant parties dealing with in-flight video content distribution and acquisition. These are of course the airlines as an end customer and movie makers such as movie studios and independent producers. In addition, there are intermediate parties that are involved in helping accommodate video supply and demand.

[43] About 7,300 travelers from around the world were interviewed for this survey.

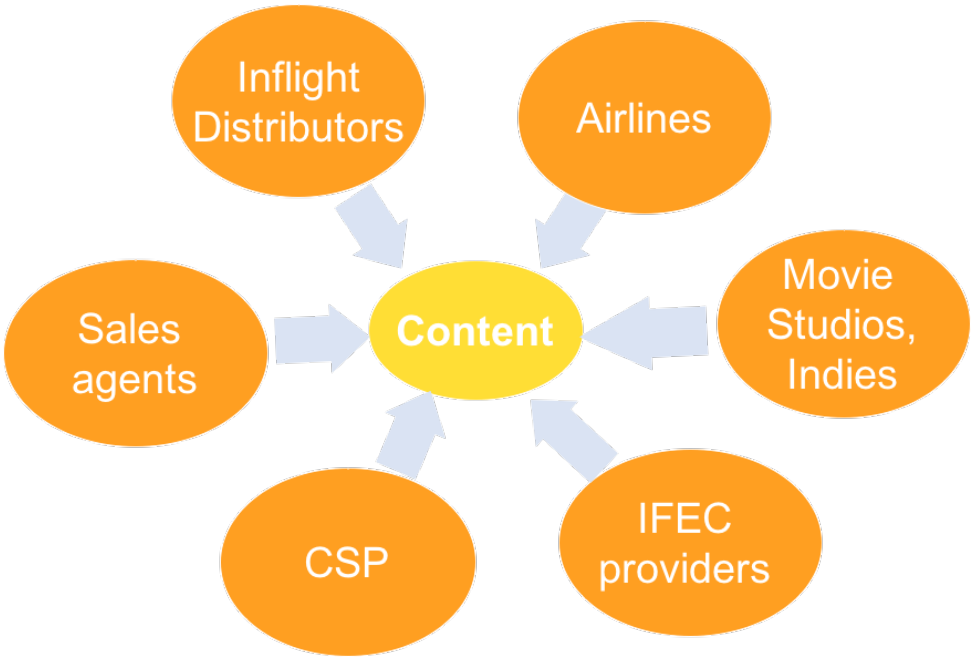


Figure 10 In-flight Content Distribution Parties[44]

In-flight content supply chain could be as simple as involving two direct parties but also could be as complex as including a large number of intermediate agents. Both direct and indirect content acquisition pipelines are examined below.

Direct content acquisition shown in figure 9 involves a unique deal between an airline and a content owner and is different for every airline and every picture. Generally, major movie studios, independent producers are commonly known as indie producers or indies, broadcasting networks domestically and internationally are known as content owners. Nowadays the direct relationship with content owners is not a widely used practice in the in-flight content industry - as most of the deals are made through middle men - content service providers (CSP) due to the fact that not all the airlines have big IFE departments, and the number of monthly screenings and reviews might be beyond the capacity the airline can handle.

[44] Self-composed graphic.

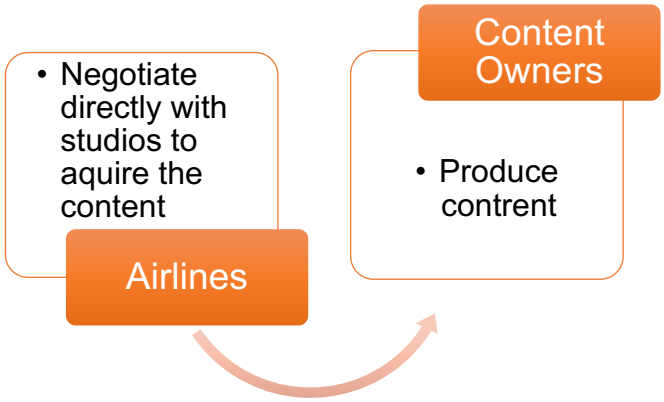


Figure 11 Direct IFE Content Licensing Pipeline [45]

More often however airlines seek the help of third-party content providers like inflight distributors and CSPs [46] to outsource movie selections, manage content acquisitions and negotiate with movie studios and producers. The pipeline is illustrated in the following figure below.

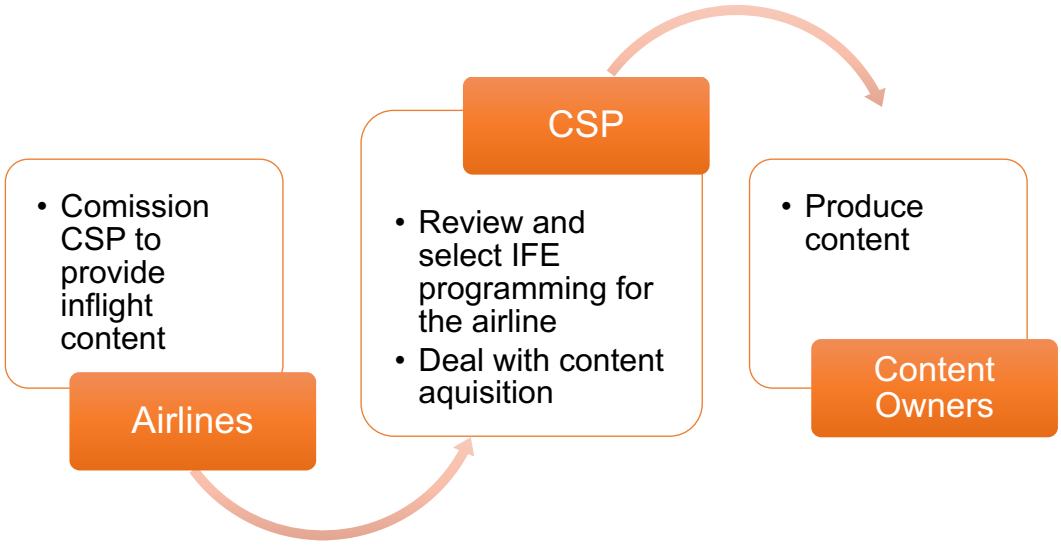


Figure 12 Indirect IFE Content Licensing Pipeline[47]

[45] Self-composed based on data from (Serafini, 2016).
[46] Example of content service providers is Global Eagle Entertainment, Marina Del Rey, Spafax etc.
[47] Self-composed based on (Serafini, 2016).

Most common CSPs are appointed by airlines to handle the process of acquiring the in-flight content. CSPs acquire movies and TV shows from local and international movie studios, indies, sales agents as well as in-flight distributors[48]. Airlines can work with either one CSP or get services from multiple providers.

As earlier mentioned, generally airlines have IFE departments to screen a vast number of movies to choose those that match their preferences and tastes. Airlines make lists of content they would like to book for their IFE libraries. However, because of the significant number of the movies released each year, this can be a very complicated task and not every airline has a full division to be in charge of it. That is why CSPs whose primary expertise is content, also provide content suggestions for their clients. After the selections have been made, CSPs on behalf of the airlines negotiates prices and licensing terms with studios and other content owners. The airline is not directly participating at this point.

In addition, in-flight content can be granted by IFEC hardware providers[49] who offer specific content as a part of in-flight connectivity packages for the airlines. Some IFEC providers[50] make partnerships with content suppliers or even acquire content supplying companies to become system integrators and to move to the content delivery with the intention to dominate the industry. This will enable connectivity providers to supply exclusive and international content as well as live TV services (Grand View Research, 2016).

The in-flight content industry is a niche market and as a research of the current thesis identified, there is not much information available in open access to industry operations and its value. Less information is attainable on how much airlines spend on video content and what conditions do they license content on.

The most frequently encountered numbers on content deals has been published by CNN in 2014. According to the news media's anonymous source in the industry, significant airlines spend up to US$20 million on IFE content annually. Alone the business insider's

[48] Example of inflight distributors are companies like Encore Inflight, Skye Inflight, Jaguar Distribution etc.
[49] Companies such as Gogo Air, ViaSat, Panasonic Avionics Corp. etc.
[50] For example, Panasonic Avionics Corp. and Row 44.

employer – one of the main CSP in the market has closed deals for entertainment content for approximately US$3 billion in 2012, the number is expected to reach US$10 billion by 2030 (Durston, 2014).

Leading international airlines can have up to 100 movies in the IFE library, where the average license fee for only few months can be US$90,000. There are different license models available, they vary for every picture, country and vary from airline to airline. A license can have an upfront fixed fee per film, an upfront fee plus a fee per every view, fee for every time the movie is played, a license fee per flight, per specified period for example annually or per package or other options.

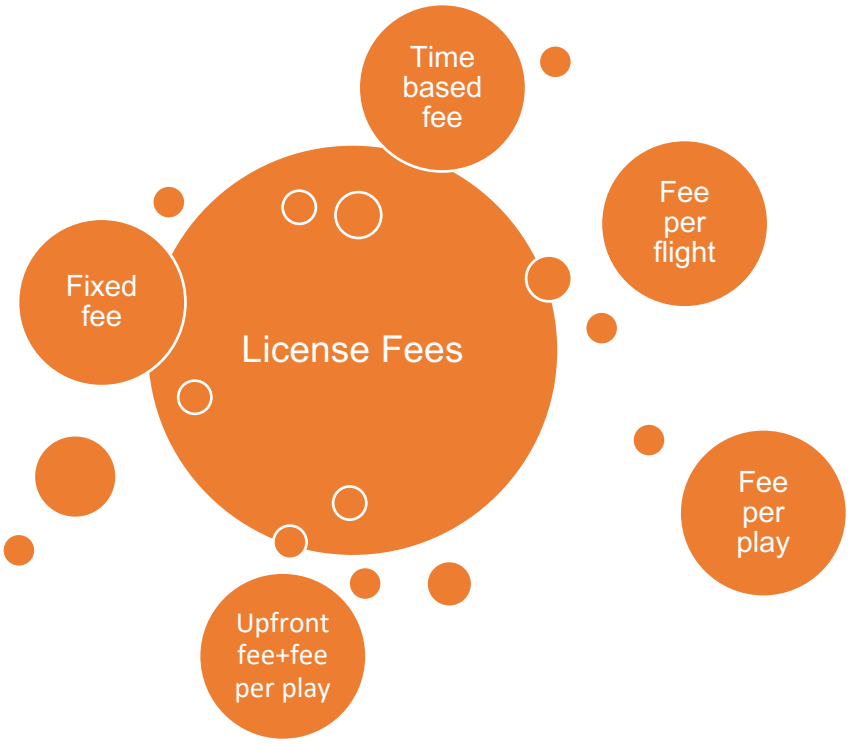


Figure 13 In-flight Film License Types[51]

In the recent years, passengers are challenging airlines with rising requirements about the content. It has become imperative for the travelers to have exclusive movies and early window content[52] available during the flight. It might be a more significant issue for long-

[51] Self-composed figure based of (Durston, 2014).
[52] Film features that are available shortly after the theater premier are known to be early window content.

haul flights however not precisely for short, and medium-haul flights since more people on the long-haul flights watch movies to be entertained.

Recognizing and seeing IFE systems as a competitive advantage, carriers are eager to feature a large number of fresh and exclusive movies and shows onboard. Airlines want to have as many early-window features as possible. However, it is often expensive for an airline to get the newly released piece of content. An extensive content library creates the need for a greater media storage and security requirements which again boosts the capital expenditure.

Quite often new movies are being licensed by the airlines at the time or even before to the release date for the home entertainment video. Usually, an airline window is between 40 and 90 days from the movie release in theatres; it gives enough time for the airlines to promote the film in the printed and digital in-flight magazines as well as on their websites. Usually studios can guarantee no exclusivity to airlines but for those features that do get acquired exclusively, timing is precious to get the necessary editing and dubbing.

The movies on board are being edited to satisfy the requirements of the modified screen and tastes of the diverse group of travelers. The airline industry is known for stringent censorship. It is quite common to edit out language, violence, cultural, political and religious sensitive content as well as avoid full features with airplane crash scenes and cut out competitors' product placement scenes. Depending on the airline's country and region of origin, the content on the IFE will vary.

Various parties provide editing depending on the airline's requirements. It could be in-flight distributors, CSPs, theater distributors or movie studios. As far as dubbing, main languages are usually provided by the content owners; however, specific languages are done by CSPs.

As the in-flight content industry goes forward, it looks for the ways to make actions beyond integrated license sales to expand services offered by IFEs. Broadcasting companies[53]

[53] Broadcasting companies such as Fox Group The non-theatrical mergers within the Fox Group bring in more excessive content possibilities for airlines. For example, the partnership with National Geographic

are working on co-branding of channels for IFE systems as well as co-developing exclusive licenses for the content to provide to the airlines as well as (Simson, 2017).

4. Using predictive analytics to improve content distribution network on airlines

This chapter discusses what predictive analysis (PA) is, how the airlines are currently using it and how PA can be employed to improve airlines content distribution network.

In addition, this chapter identifies three potential issues with using PA on airline CDN. The first issue is how to make content offerings more efficient per flight without sacrificing the quality of the content library. Second is how to make acquiring the content much more efficient and cost-effective. And third, how to organize pricing structures for dynamic content offerings.

4.1. Predictive analysis

As the importance of internet interconnectivity and big data arises, predictive analysis and its applications become more relevant for a growing number of industries; predictive analysis helps to understand and process big volumes of data by correctly identifying a problem and solving it before it becomes distinct (IBM, 2013).

"A predictive model is simply a mathematical function that can learn the mapping between a set of input data variables, usually bundled into a record, and a response or target variable. Machine learning algorithm discovers patterns and constructs mathematical models using these patterns" (Guazzelli, 2012). These models are then being used to make predictions of new data.

PA is a mix of statistics, advanced mathematics, data management and AI. Companies use PA to enhance existing processes, quickly conclude efficiency of the future steps, find the likelihood of future outcomes, determine potential risks, anticipate problems, make decisions and understand customer behavior (Eckerson, 2006).

established in 2015 provides content not only for cable television in households but also for airline IFEs (Simson, 2017).

Unlike historical analytics that helps to observe and determine trends, PA does not require a lot of time to observe the situation to conclude. Business decisions that rely on algorithms to predict outcomes of future trends even when past experience data is absent (Guazzelli, 2012).

In the age determined by digital technology, big data[54] is getting more valuable and is used in a lot of industries. It is more important than ever for companies to understand the significance of big data to adjust to current changes and be able to monetize its usage even if it is outside of their core business.

The goal of the current thesis is to discover how PA integrated into IFE system algorithm can transform current IFE market and create a comfortable, dynamic and unique experience for every passenger by building in an algorithm to analyze the passenger's demographics and offer video content relevant to the captured data. Creating an IFE content recommendation algorithm and correctly implementing it in currently existing systems improves customers experience and increases overall customers satisfaction. Furthermore, it helps companies to make the right choice when creating custom content as well as determining what content might be relevant for particular groups of customers. Also, using PA for targeted marketing will significantly help building customer satisfaction and loyalty.

Catching up with technology development, companies within and without the aviation industry create next-generation IFE systems that are interactive and interconnected throughout multiple platforms. High cultural focus on technology and social media today brought by the Millennial generation and continued by Linksters[55] is on the peak of its popularity and is available to everyone who owns a mobile device with internet access. Social media has an essential role in IFE development and can utilize its power to make an airline stand out and drive business metrics. The proposed solution of social media

[54] Big data is a large amount of data that cannot be stored on a single hard drive and processed in a traditional way. The vast amount of data is processed on a number of cores instead (Danyel, DeLine, Czerwinski, & Drucker, 2012).

[55] Linkster Generation or Generation Z is the next after Millennials. People in this generation are born after 2002 and they are estimated to make up to 18% population of the world. They are called Linksters because of the connection with the technology they have from the beginning of their lives (Blair, 2017).

integration into IFE structure contributes to the PA's ability to analyze unstructured data like texts, comments, shares etc. (IBM Sales and Distribution, 2014).

4.2. How the airlines use predictive analysis today

Use of big data has been historically utilized in the airline industry. In commercial passenger aviation PA is widely used for revenue forecasting. Airlines apply PA in forecasting systems to predict demand for the flights which allow to variate prices for different customer groups and to foresee cancelations and no-shows. The factors such as price, schedule, route directly influence airline's revenue and demand for tickets. Forecasting tools consider past bookings and use that to predict future revenues. Those tools monitor the correlation between schedule changes and revenue changes. For an example: if the daily flight from San Jose to Atlanta changes from a 10 a.m. departure to a 9 a.m. departure, PA tools find out how it affects the revenue. It measures the impact on revenue if prices of flights are increased for example by 15%.

PA is also widely used in passenger class segmentation to be able to predict their travel preferences and spending behavior and offer of various travel add-ons. In addition to the PA revenue model, data analytics helps to allocate workforce on airport arrivals and departures efficiently by having the flight load factor data. It is also currently used to estimate fuel consumption, control air traffic, monitor engine systems and crew activity as well as many other areas of business operations to increase profits and improve business metrics (Agost, 2016).

The increasing amount of data opens an opportunity for the airlines and aircraft manufacturers to deliver more secure and reliable flights. Also, precious data about passengers on board is being utilized to contribute to increased customer satisfaction and retention. The real challenge here is IT infrastructure that is so critical for getting, storing and analyzing data in real-time. According to Oliver Wyman MRO Survey, by 2026 annual data generation by global fleet will reach 98 million terabytes, it is by up to 80 times more than what aircraft generate today (Hoyland, Spafford, & Medland, 2016).

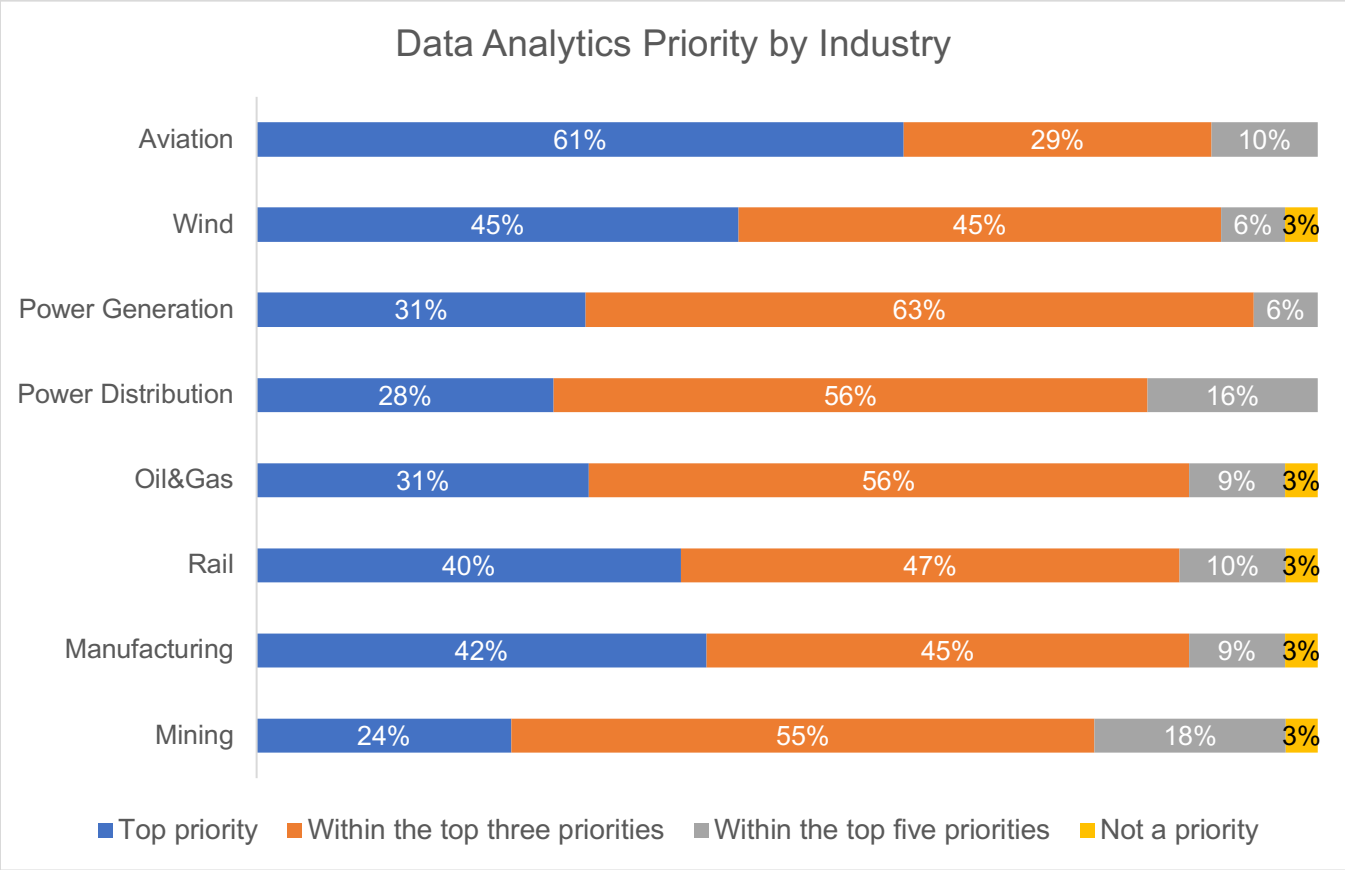


Figure 14 Big Data Analytics Importance by Industry in 2015[56]

Joint research of General Electric and Accenture showed that aviation industry is on the forefront to profoundly recognize the value of big data and is ahead of other industries in making it a priority to implement data analytics in its business operations (General Electric & Accenture, 2014).

From all the data created across all the industries in the past few years, only one percent of it has been analyzed (Henke, Libarikian, & Wiseman, 2016). Statistics from McKinsey regarding the success of data-driven companies show that companies whose processes are driven by data are six times more likely to retain customers, 23 times more likely to attain new customers and 19 times more likely to be more profitable (Henke, Libarikian, & Wiseman, 2016).

[56] Data taken from General Electric & Accenture, 2014. Industrial Internet Insights Report for 2015. p.6.

4.3. Making content offering more efficient per flight

Considering the advantages that big data provides, it is only natural to find more applications for it to transform and improve customers experience.

With more than 3.7 billion passengers flying annually, the importance of excellent onboard service has become critical. In the recent years, service industry the emphases individuality and personalized experience. On the ground, personalized entertainment offerings have become a new norm with growing popularity of content streaming platforms. The same idea can be utilized in the aviation with the help of predictive analytics.

Proper utilization of data leads to more efficient operations, increased sales, unique marketing campaigns and improved innovative IFE systems. All the things required are already there – the value of the data is known, the data is available, access to technology exists.

The figure below presents a complex approach to implementation of IFE systems driven by PA. Its foundation is a company's willingness to in fact become data-driven, to create connected data assets with timely clean data and to shift from large-scale IT-infrastructure programs. After the proper foundation is being built, the creation of tools capable of extracting insights from the data assets is needed. Next, take actions to translate the insights into workflows and business processes to deliver the result (Henke, Libarikian, & Wiseman, 2016).

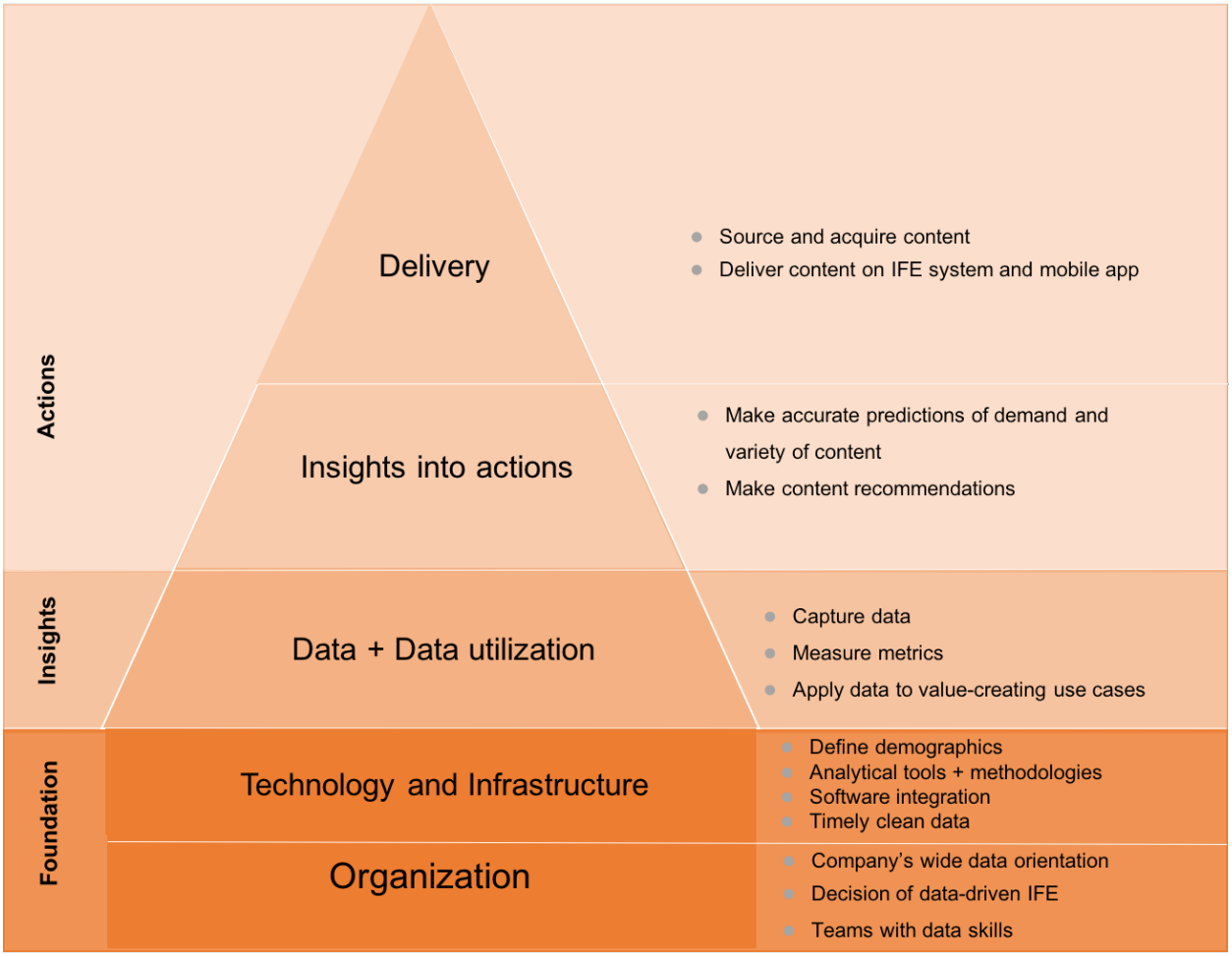


Figure 15 Predictive Analysis for Efficient IFE Content Offerings[57]

The current thesis proposes the creation of high-quality automated, dynamic and cost-effective IFE through the integration of airline processes with passenger data. A solution presents an integrated tool between the airline app and social media platforms e.g. Facebook that collects and analyzes passengers' structured and unstructured data. Structured data is a standardized format, about airlines, it could be data like numbers, clear transactions, reservations, records etc. (Inmon & Nesavich, 2007). Unstructured data in this relation is more social media focused, like pictures and videos, content engagement (shares, tags, likes, comments) etc. It gives a better understanding of user's social behavior, background and interests to identify user's viewing preferences and

[57] Self-composed based on the adopted McKinsey&Company exhibit from (Henke, Libarikian, & Wiseman, 2016).

tastes. Currently airlines are focusing on structured data. Through the suggested integrated approach, carriers will be able to also work with unstructured data from social media and more.

4.3.1. Example of using big data analytics for creating the original content and predicting its success

By the time Netflix was ready to start producing original content it already had a vast user base and a successful experience in collecting data and processing it in its operations back in the DVD time. Now as a fast-growing content streaming service on a search for ideas for original series, the company utilized data analytics to create its most popular shows. The most successful show in its production history has been "The House of Cards". Before creating a plot of the show and releasing it in 2013, the company did a research which revealed following trends represented in the Figure *16* Data Analysis of Viewing Behavior by Netflix.

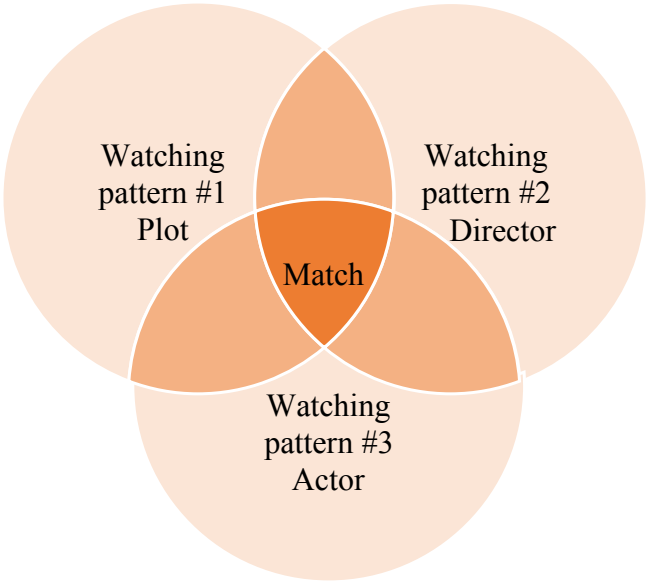


Figure 16 Data Analysis of Viewing Behavior by Netflix[58]

[58] Self-composed based on the Netflix's recommendation algorithm.

People who liked the original “The House of Cards” (watching pattern #1) show produced by BBC in 1990 also liked movies directed by David Fincher (watching pattern #2) and loved films starring Kevin Spacey (watching pattern #3) (Chowdhury, 2017). The metrics of the research showed that the show might be a huge success. Thus, the decision to produce a show adopting the original BBC plot to the USA environment with Kevin Spacey as a leading character and David Fincher as a director has been made.

In addition to the series production, the company used data analytics for marketing purposes to promote the show on and off the streaming platform. During the user-base analysis, ten groups were identified that carry similar characteristics, tastes or viewing preferences. To target those specific audience groups and meet their demand, ten different trailers were created. For example, fans of Kevin Spacey would have a trailer on their Netflix home page with a lot of scenes featuring the actor, where the female viewers or viewers with great appreciation of women-centric movies would see a recommended trailer filled with leading female actresses. Users who have been determined to prefer movies directed by David Fincher would have been suggested a sneak preview of the trailer featuring the director.

One of the advantages of the predictive analysis on content streaming platforms is that it helps to reduce the cost of producing the original content since the potential success could be precisely predicted based on the collected data. In such a fashion, data analytics increases success rates of the shows. Considering data results, there is no need for shooting pilot episodes to see ratings and to know viewers feedback[59] (Chowdhury, 2017).

Having this essential data can make an impact on lowering the cost of a content advertisement by targeting the right audience with appropriate promotional materials such as trailers and sneak previews. It also increases customer satisfaction through a unique

[59] Whereas before launching a new show most of the production companies make pilot episodes to test them on chosen focus groups and to forecast the success likeliness of the piece of content.

personalized experience which is extremely valued in the highly competitive entertainment content market.

4.3.2. How to make content offerings more efficient per flight

The way the content platforms use data backed-up scientific approach for content selection and acquisition can be implemented in the in-flight video content world for the creation of personalized watching experience. Predictive analysis is already a big part of airline corporate business intelligence. Applied correctly, it could be a huge step forward in revolutionizing IFE section to make it more dynamic and personal.

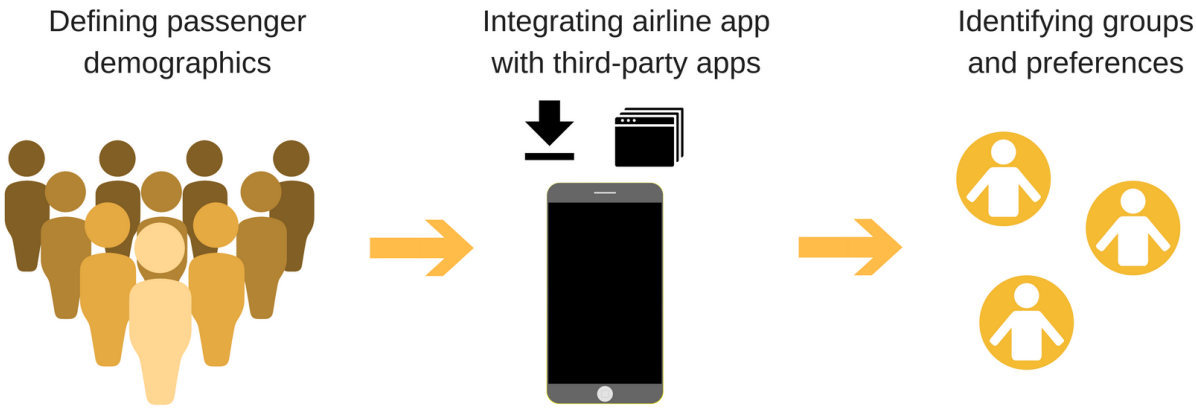


Figure 17 Defining Passenger Demographics and Preferences Using Integrated Applications[60]

Within the context of this thesis, three steps suggested to using PA for in-flight content offerings. The steps are to define passenger demographics, integrate the airline app with the social media app and to identify passenger groups and preferences.

[60] Self-composed figure.

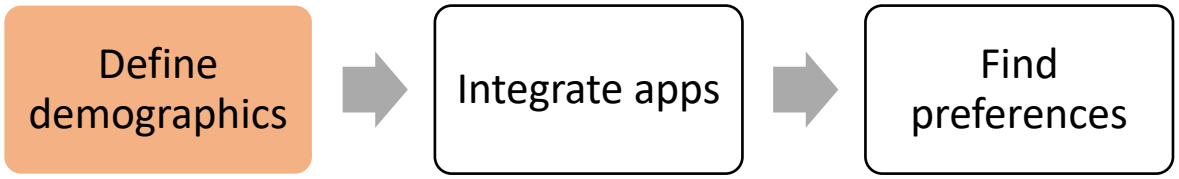


Figure 18 PA Implementation Roadmap Step 1

The best way that airlines can implement predictive analysis for IFE content offerings is by first defining the demographic of the passengers on the airline flights. By identifying passenger types and forming them into groups, it would be easier to conclude next steps of analyzing passengers and learning the likelihoods of possible content they might be interested in watching.

Figure 19 PA Implementation Roadmap Step 2

The second step is the installation of the airline's app on the passenger's mobile device. When the user first installs the airline app and signs up for the airline's loyalty program or enters the already existing frequent flyer number, the app will ask user's permission to access his or her Facebook and Netflix accounts. Having this access, the app then will collect data on the user's background, flying activity, personal interests and content viewing history. This full data integration creates a baseline for the PA model to understand who is operating on a particular flight. This data access is, of course, optional, and every passenger can always opt for not granting the access to the airline's app to have integration with Facebook and Netflix apps and use the data.

Figure 20 PA Implementation Roadmap Step 3

After the access to passenger's information is granted through the app, the PA-operated algorithm will be able to process the information with the purpose of identifying passengers' preferences to find the matching entertainment and edutainment[61] content.

For passengers who already have airline's app installed before the new IFE integration will be implemented and for the passengers with outdated app versions, special incentives can be announced. For example, the airline can send push notifications[62] on the passenger's PED with the invitation to upgrade the app within a precise timeline and to get a certain number of miles as a reward.

Figure 21 Predictive Analysis for Identifying Passengers Types and Matching IFE Content displayed below and the corresponding use case is explaining how integrated apps work utilizing PA. For the exercise, it is assumed that after analyzing passenger demographics three different types of passengers have been identified, they are graphically displayed on the figure.

[61] Edutainment is a term that stands for combining education and entertainment properties of content.
[62] Push notifications are the messages that appear on personal electronic devices and are sent by app publishers.

Figure 21 Predictive Analysis for Identifying Passengers Types and Matching IFE Content[63]

The first traveler type is the best with the app integration. This is the flyer who has opted into the app and has booked a flight for a future date. This is important because the algorithm can be run earlier on this passenger and the content he or she would be most likely to watch, will already be loaded in the queue for the onboard servers before the take-off. Given the fact that the travel is booked in advance, it is assumed with a high likelihood that this passenger is traveling for leisure. Through the app integration, this person has let the airline understand who they are and what interests they have. The PA model will be able to help this passenger the most since the full data on him or her is available. The algorithm will be able to understand who the traveler is, his or her preferences and what they most likely prefer to watch. Moreover, with this algorithm the airline will be able to target the right audience with appropriate advertising to increase ancillary revenue[64].

To make it more practical, the following example is given. First traveler type is flying from Seattle to Los Angeles. From the passenger's profile it is known that he is a 30-year-old

[63] Self-composed figure.

[64] More detailed information about accumulating ancillary revenue through dynamic advertising on IFE systems is described in Chapter 5 Monetization Strategies.

single man who is going to visit his family for a trip to Disney Land. From his Facebook page, it is understood that he likes Star Trek and Disney movies. Having this information PA-driven algorithm will be able to select interest-matching content for his flight.

As opposed to the first traveler type, the second traveler type is someone who opts into the app but has not booked a flight yet. Perhaps it is a business flyer and waiting for a meeting or job details to be confirmed to book the flight at the last minute. In addition, the algorithm found out that this flight is usually booked by 50% people that fly at the last moment and are flying to and from the destination within a week. Thereby it is assumed that this flight might have 50 % business flyers. The predictive analysis model will be able to identify the needs and preferences of this passenger type. For example, Martha regularly flies from San Jose to Atlanta for work twice a month. It is predicted that she will travel next month twice too. Examining the information provided in the app installed on her phone, the algorithm will be able to find the content matching her preferences. Moreover, data analyzed from all travelers' Facebook apps on the route, the algorithm has determined that out of those 50% business flyers most of them like the show "The Office." Having this information, the airline will make sure there are episodes of "The Office" loaded into the server.

Unlike the first two traveler types, the third type is the flyer who doesn't opt into the app creating a gap customer. It is a challenge to understand specific needs and to find the right content for the gap customers since they are not using the airline app, there is not much information known about them and there are only guesses about the purpose of their trip. The PA model will be able to handle this situation and provide a solution for content offering for this group to some extent. The PA will monitor destinations and anticipate what events are happening there on every flight date to select appropriate content for gap travelers. For a better understanding, the following example is given. A person is flying to Los Angeles for the weekend. Monitoring the events in Los Angeles, the algorithm has identified several entertainment destinations such as Universal Studios and Disneyland; it also found that there is a LA Rams[65] game being played on Saturday.

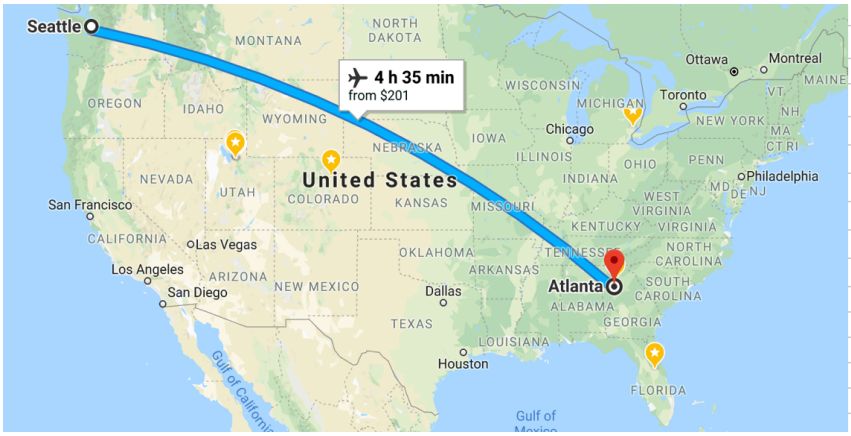
[65] Los Angeles Rams is a professional American football team based in Los Angeles area.

Because it is a weekend flight and there are a lot of events going on during those days, it is assumed that people are flying for leisure or returning home from a trip/business trip. There is a chance that some people flying in are LA Rams fans or the competitor team fans. There is also a chance that some people are planning to go to attraction parks. That means some generic leisure and sports content should be on the IFE to appease those travelers and fans. More detailed, the algorithm has determined that LA Rams fans tend to like the show "Two And A Half Man," so it would be reasonable to load that show into the server.

Additionally, regardless of the passenger type, for the existing flights the algorithm should offer content like documentaries, food shows or other related entertainment with the focus on destination lifestyle. In the example of the business traveler from San Jose to Atlanta, the IFE should address Atlanta's and Georgia's lifestyle, its traditions and customs through the appropriate content.

Using these tools, the airline can collect information and identify what interests and anticipated interests that passengers have on various flights. A graphical example is presented in Figure 22 Example of Finding High Demand Content Per Route. Knowing the preferences of all or almost all of the passengers on the flight from San Jose to Atlanta, the airline then can use predictive analysis to predict what are the top 20 entertainment offerings[66] - TV shows or movies that will be watched during that flight.

[66] The number of 20 content offerings is an example to show how estimation of the high-demand content is working per route. Used in the real life, this number can be modified to satisfy the airline's specific content requirements.



San Jose (SJC) to Atlanta (ATL)	
Top Content*:	
1	Avengers
2	Scandal
3	Grey's Anatomy
4	Zootopia
5	Peaky Blinders
* Suggested example	

Figure 22 Example of Finding High Demand Content Per Route[67]

4.3.3. A cost-effective strategy for content acquisition

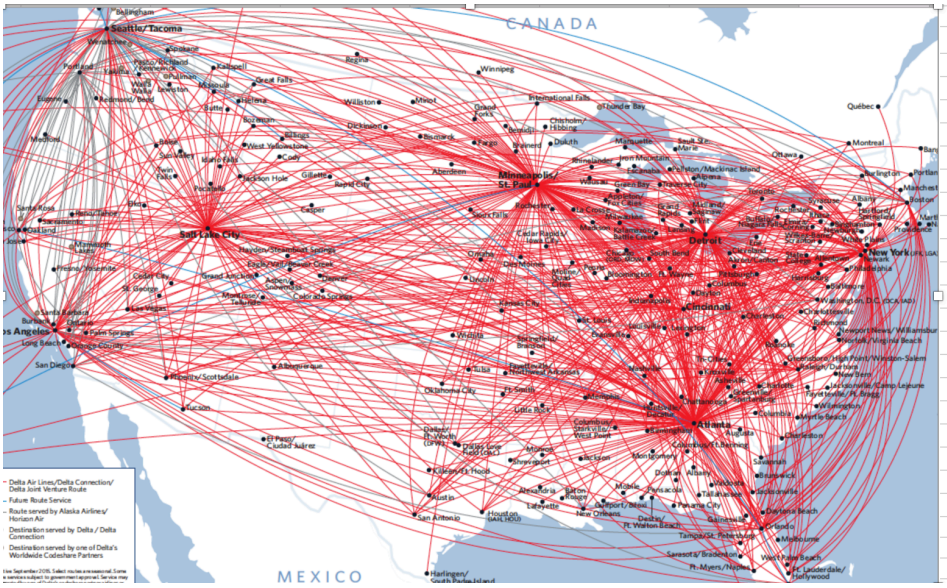
The current content purchasing model for airlines is supply driven. Airlines work with either movie companies and producers directly or through a middleman - CSP to purchase newly release movies for IFE systems. In this way, the movie studios and distribution companies hold the leverage. They have the licenses for recently released and most popular films, and they automatically assume that is what people want to watch.

Using PA in the IFE sector can give airline companies more of a demand driven model for content and thereby have a more personalized customer approach. Also, PA model will continuously monitor and update the content list to keep it fresh and dynamic.

Following the step of identifying traveler groups and their preferences, an airline has now defined content options of a single flight and can take it as a model to lay it over all of the routes. Expanding this model on all of the flights across the country or even internationally, the airline can accumulate an exact interest-driven content collection. Below is the process of how the PA-driven algorithm can process information from every route, narrow it down to the nationwide content list and finalize content purchasing options.

[67] The compiled list of content in the figure is a suggested example highlighting the top five of the hypothetical popular movies from the top 20 list on the route. It presents the idea of PA employment for high-demand content identification. Map source (Google Maps, 2017).

1. Identify top 20 high-demand content offerings per route on every route.
2. Combine content lists from all routes and find overlapping pieces of content.
3. Make the list of overlapping titles so that it exceeds the quantity of the film features the airline is purchasing annually[68]. For example, Delta Air Lines is currently offering about 300 movies on its IFE systems (Delta Air Lines, 2018). According to the suggested content acquisition model, the total suggested content list should be between 400 and 500[69] titles.



Nationwide Top Content:	
1	Avengers: Age of Ultron
2	Guardians of the Galaxy
3	House of Cards
4	Captain America: Civil War
5	Moana
6	Doctor Strange
7	The Crown
8	Finding Dori
9	Star Wars: The Last Jedi
10	Lord of the Ring
11	Peaky Blinders
12	The Office
13	Kubo
14	Baby Boss
15	Midnight in Paris
16	Up in the Air
17	Lion
18	Zootopia
19	Breakfast at Tiffany's
20	Two and a Half Men

Figure 23 Example of Finding High Demand Content Nationwide[70]

4. This should give the carrier a list of the top movies and TV shows that the PA algorithm has selected for the entire nationwide flight paths. In other words, using the PA model an airline can determine the content that most likely to be viewed for instance on the flight from New York to Denver. Then the model will predict what content will be most likely received on the route from Boston to Los Angeles. Next, using the model on all flight plans, the airline will get an extended list of in-demand movies for consideration and purchase from the movie studios.

[68] It might be a different number for every airline depending on its IFE strategy.
[69] These number are an example that the total list of content for purchasing should be bigger than the airline currently acquiring. The actual number may vary based on the airline's unique IFE context.
[70] Map source (Delta Air Lines, 2015).

5. Set the budget for the content acquisition the airline is willing to pay.
6. To cut the IFE content acquisition cost, it is essential to find the best possible combination of high-demand content within the set budget. In other words, in the example of Delta, to keep the same number of titles in the IFE library, it is necessary to narrow down the total title list using PA and to pick 300 movies out of the 400-500 list that is in high demand and has a lower price.

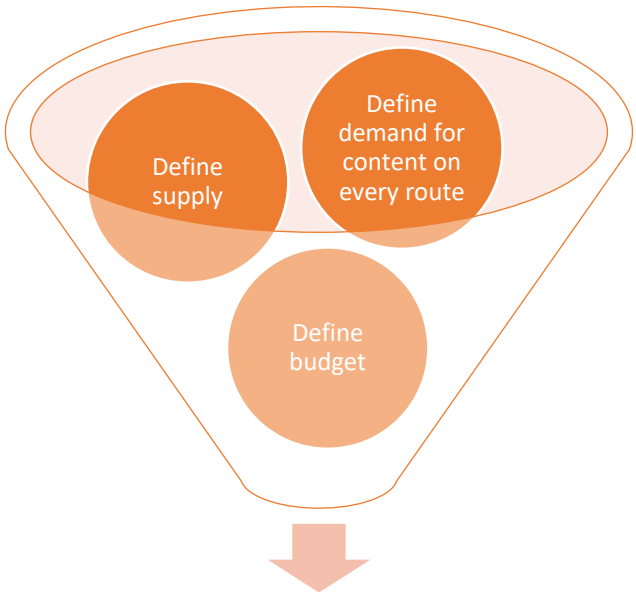


Figure 24 Cost Effective Content Acquisition[71]

For example, PA algorithm identified there are favorite movies within the same category as Avengers: Age of Ultron, Captain America: Civil War and Ant-Man that might be purchased for the IFE. By setting a preferred budget for content acquisition and choosing the best title that fit the budget, it is now possible to cut the cost and pay less for the content and at the same time still be able to buy the titles that passengers prefer watching.

Another suggestion for content selection criteria that can be built in the algorithm is to pick the content for specific routes by length so that it is no longer than the duration of the

[71] Self-composed figure.

flight. Thus, to have a variety of the content offerings depending on the plane and type of the operating aircraft.

4.3.4. Integration with Facebook

There is no doubt in the importance of the social media in everyday life of people around the globe. In the modern world people are spending more time online than they ever had before. What is the goal of people to be online? Ultimately it comes down to the following needs (Miller, 2017):

1. To feel good. People go on social media because they are bored, because they want to be entertained or because they want to learn something.
2. To look good. People need social interactions. They want to connect themselves socially with the world around them and make themselves look good by telling the world something about themselves.
3. To have a good life. People are looking for solutions that they need or to help people they come in contact with that could benefit from it and have a better experience.

For the businesses and airline industry specifically, social media is a powerful tool to build the brand, engage with customer audience and develop customer loyalty.

Integration of airlines' IFE applications with the third-party services undoubtedly pushes innovation forward making airline entertainment and other services more diverse and convenient. In the context of the current thesis, integration of the airline apps with third-party social media apps is seen as a solution to data access. Specifically, Facebook is suggested as the platform for integration because it is the largest social media network in the world – more than 2 billion users[72]. A built-in PA-driven algorithm is recommended to process the data and to use it to improve IFE systems and create dynamic in-flight content offerings.

[72] See section 3.1.3 Facebook's Current System for more information.

However, where a lot of travelers will be happy to support and enable a greater interconnectivity across devices and platforms, there always will be a critical issue of data privacy and surveillance that airlines need to address correctly to keep their reliability and competitive advantage. It is important to focus on cybersecurity and to constantly work on the improvement of tools providing it as the presence of technology in the airline business progresses.

Integration with Facebook can be done through Facebook software development kit (SDK)[73]. An airline app integrated with Facebook gets a lot of benefits the social media platform is offering. Integrated app access can be used to better listen to the customers and understand their needs in IFE. This integration will allow the airlines to access the data to know their passengers better and to adjust the IFE content offering according to the travelers' preferences.

It should be noted that It is crucial for the airlines willing to adopt dynamic IFE concept, to devote efforts to use the information in line with customer's expectations. In doing so to minimize the collection and processing of the personal data strictly to enabled features and services. It is essential for the airlines to guaranty the transparency and control over user's information while delivering the excellent service.

Integration with social media and personalized IFE experience will contribute to the airline's greater following on social media hence frequent flyers and repeat customers. For example, Delta Airline is one of the biggest airlines in the United States and has one of the most advanced IFE systems and mobile apps on the market[74]. As of December 2017, Delta Air Lines' Facebook page had 2,088,596 likes and 2,046,287 people following the page (Delta Air Lines, 2017). A lot of the Delta passengers already follow the company on social media and Facebook in particular.

Integration with the Facebook app will allow measuring such essential metrics as customer engagement and customer behavior. It also will help to create and run ad

[73] SDK is a set of tools and application programming interfaces to create software applications on particular platforms and extensions (Microsoft, 2016).
[74] See comparison chart of the airlines and their IFE systems at **Error! Reference source not found.**.

campaigns to grow customer engagement and retention and as a result increase conversion rates (Facebook, 2017).

Proper integration and utilization of Facebook and other related social media services can contribute to successful monetization of IFE systems through the personalized targeted ad and marketing campaigns to increase conversions.

Figure 25 Airline App Integration with Facebook[75]

Airlines can involve both internal resources and contracted external companies to make appropriate technological changes. Within the scope of this thesis it is recommended to have a well-balanced structure of Facebook integration and new built-in PA features of the airline app to establish new generation of IFE systems.

5. Monetization strategies

In the digital age the speed at which marketing trends change with is extremely fast and it is critical for businesses to be able to adjust to those changes in time in order to be ahead of the competition. Big data and data analysis is valuable in striving for technology, innovation and marketing.

[75] Self-composed based on Facebook data about Facebook SDK (Facebook, 2017).

Today airlines are shifting from in-flight entertainment to in-flight engagement platforms as passengers are becoming more active in entertaining themselves as opposed to just being entertained on the plane as it was not so long ago. With growing IFC and BYOD popularity, travelers want to always be online during the flight. They want to be actively entertained, to be able to plan details of the trip, book tours and restaurants[76], make last-minute changes and reservations or check out destination spots using IFE systems or their phones[77]. It is necessary to use it to the advantage of the airlines to generate more significant ancillary revenue.

The current chapter focuses on how airlines can monetize on data-driven IFE systems through advertising and partnerships. Although airlines have tested advertising and branded content on embedded and mobile IFE systems in the past, the idea of this paper is to streamline ancillary revenue significantly. This can be achieved through dynamic advertising that targets different passenger groups and offers one-on-one relationship and personalized experience during the flight.

Following sections will describe how precisely by using big data and PA, airlines can create new partnerships and joint-ventures, personalize inflight advertising and up-sale services to their customers.

5.1. Dynamic advertising

This section will look into using PA to understand airline's passengers needs and to create targeted ads based on those desired needs and preferences. A smooth IFE system with an extensive content catalog can increase customer's flying experience, customer loyalty, and the airline's brand in general. Personalized content as a key component of new

[76] For example, Finnair's IFE system Nordic Sky makes it possible to order ground transportation at the destination airport, search for and book local tours. In the future there might be even a feature of groceries pre-order (Garcia, 2016) (Finnair, 2017).

[77] Air China has partnered with local online retailer JD.com to offer onboard shopping with delivery option to passengers' homes through in-seat IFE system (Kollau, 2017).

generation IFE systems has been reviewed in the previous chapter; this chapter will look into targeted marketing and dynamic advertising.

Conditions for advertising on board of aircraft are incredibly favorable for the companies. Advertisement in in-flight magazines and IFE systems is a very widespread marketing practice and a very successful one since the travelers represent a captive audience during the flight. During the flight where internet connection is limited, most of the audience is very little distracted with their phones, emails or other digital interactions[78].

Usually airlines sell ads and sponsorship slots in in-flight magazines, IFE systems and PED apps through their CSPs[79]. Typically, these are ads for businesses that are traditionally related to traveling and air transportation like car rental companies, hotels, resorts, credit card companies etc.

In addition to the traditional advertising partners, airlines can partner up with other complementary businesses such as destination city restaurants, transportation companies, local vendors and businesses, retailers, events, and tours, etc. to explore more income streams and create an integrated retail environment on board,

Intercontinental long-haul flights that can be as long as 13 to 17 hours[80]. In 2016 77% of the passengers were watching movies and entertainment shows on IFE during the long-haul flights (IATA, 2016). Pre-roll ads are encoded into the IFE systems in the way that there is no option of skipping or fasting forwarding it. The reach of these ads is enormous because most of the passengers on medium and long-haul flights might watch more than one movie. On the contrary, due to the duration of short-haul flights, watching opportunities of news or series are limited.

[78] Comparing to the constant online availability on the ground.
[79] See more information about CSPs and their role in the inflight content distribution in section 3.2. Inflight Entertainment Content Distribution.
[80] As of 2017, the longest flight is being operated by Qatar Airways from Doha, Qatar to Auckland, New Zealand. The flight covers the distance of 9,032 miles and is scheduled to be 17 hours 30 minutes. Singapore Air is planning to launch a direct non-stop from Singapore to New York that will cover 9,500 miles (Calder, 2017).

However, audience engagement and conversion rates for the ads on the plane could be challenging. It is not easy for brands to engage with the audience considering the viewers are forced to watch the ads during the flight. It is undoubtedly a real challenge to make a commercial that is not only fun or catchy but also makes money.

Data analytics can undoubtedly contribute to understanding the audience. Knowing the passengers' basic personal information, entertainment preferences, food and restaurant choices, flying and purchase histories, can provide critical insight on how to engage with the audience. It also provides an individual approach when interacting with every passenger. Personalized customer experience maximizes conversion rates for airlines. Captured data from integrated apps gives opportunities to examine and understand the diversity of the passengers and to approach the audience through targeted content that is addressed to specific demographics, cabin classes, etc.[81].

IFE systems operated with PA algorithm will provide immense opportunities for ancillary revenues. The intention here is that knowing individual tastes and preferences of the passengers, it is much easier to encourage them to spend more money on additional services by targeting them with personalized ads for services that match their tastes and budget.

For the sake of showing how targeted advertising on IFE can increase ancillary revenues, the example of three passenger types from the Figure *21* Predictive Analysis for Identifying Passengers Types and Matching IFE Content in Chapter 4 will be continued.

[81] First class audience, business class, economy class, social media influencers, various generations, countries of origin, culture, etc.

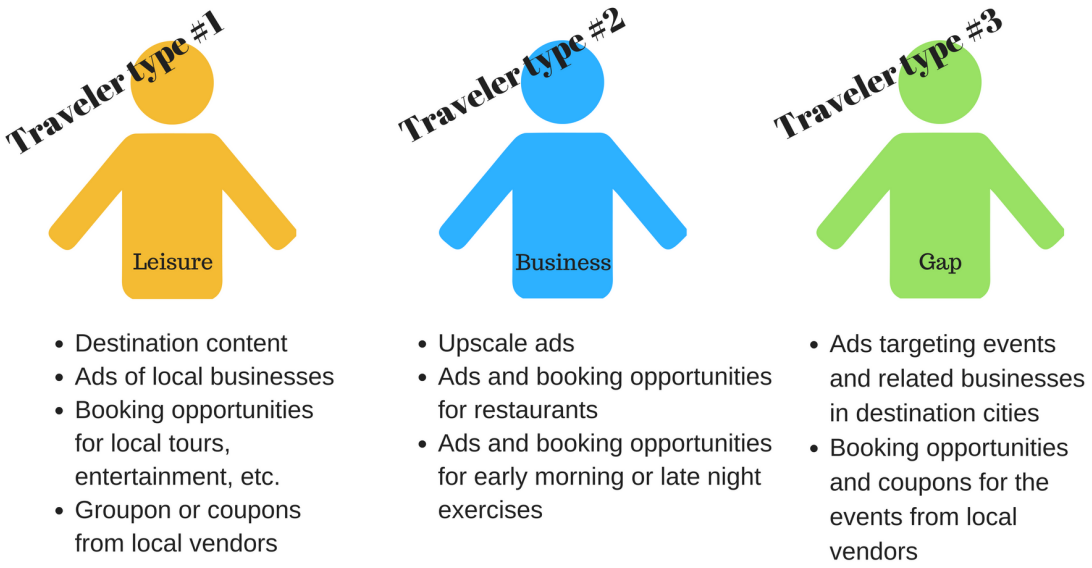


Figure 26 Personalized and Dynamic Advertising for Various Passenger Types[82]

To recap, analyzing passengers flying preferences and behavior obtained from integrated third-party apps, three traveler types have been identified.

Traveler type #1 is using the airline app and is assumed to be a leisure passenger based on the facts as his early booked flight and information from his social media about his plans for the trip. In his case, PA algorithm will select and show entertainment and destination content as well as ads for local businesses on his IFE screen. IFE system will present the passenger booking opportunities for local entertainment tours, restaurants, transportations, spas, farms etc. Local businesses can partner up with the airline to offer coupons with discounts for their services. Partnership and integration with Groupon or similar coupon services can be a great alternative to offer discounts and deals for travelers.

[82] Self-composed figure.

The second traveler type falls under the category of a person who travels for business on a regular basis. Because of the nature of her travels, her budget and needs in the destination city or country might be different from other traveler types. IFE algorithm will select and show a different kind of content, advertising and booking options as opposed to the content offered to the traveler #1. IFE system will play upscale ads, recommend and up-sale services such as local restaurants, early morning or late-night exercise classes and nearby gyms, and other services located close to the financial and industrial districts as well as major hotels.

As far as dynamic advertising for the third traveler group or the so-called gap passengers, the algorithm will look for ads similarly as it was searching for the matching content for this group. More specifically, it will look for ads that are targeting events and related businesses in the destination area on the dates close to the flight date. Also, the algorithm will search for ads that have booking opportunities and coupon options from local vendors.

Using the algorithm, airlines can easily up-sale their products and services through IFE systems in a more effective way. In 2016 combined ancillary revenue of ten most popular airlines[83] was more than US$28 billion and is projected to grow with the rapid speed (Sorensen, 2017). Having analyzed the passengers' behaviors and needs, carriers will know precisely what services they can additionally offer to the passenger during his or her current flight or for the upcoming flight.

With PA-driven algorithm incorporated in IFE systems, existing services that are widely offered for purchase by the airlines can be targeted precisely to the passengers that most likely need them. These could be services like on-demand snacks and a la carte dining, Wi-Fi connection, co-branded credit cards, sale of frequent flyer points, class upgrade to the passengers in economy or comfort class for the next connecting flight or the next trip, travel retail etc.

[83] United, Delta Air Lines, American Airlines, Southwest, Air France/KLM, Ryanair, easyJet, Lufthansa, Qantas, Air Canada.

In the way of targeting the ads, every passenger will see advertising that can relate to their specific needs and therefore has better chances of making a profit and to keeping the customers satisfied.

5.2. Various tiers of advertising

In addition to the mentioned algorithm-based group advertising previously, it is suggested to have a complete differentiation of ad types for a better match with passenger's interests.

The following advertising opportunities have been identified and formed into three levels fully described below:

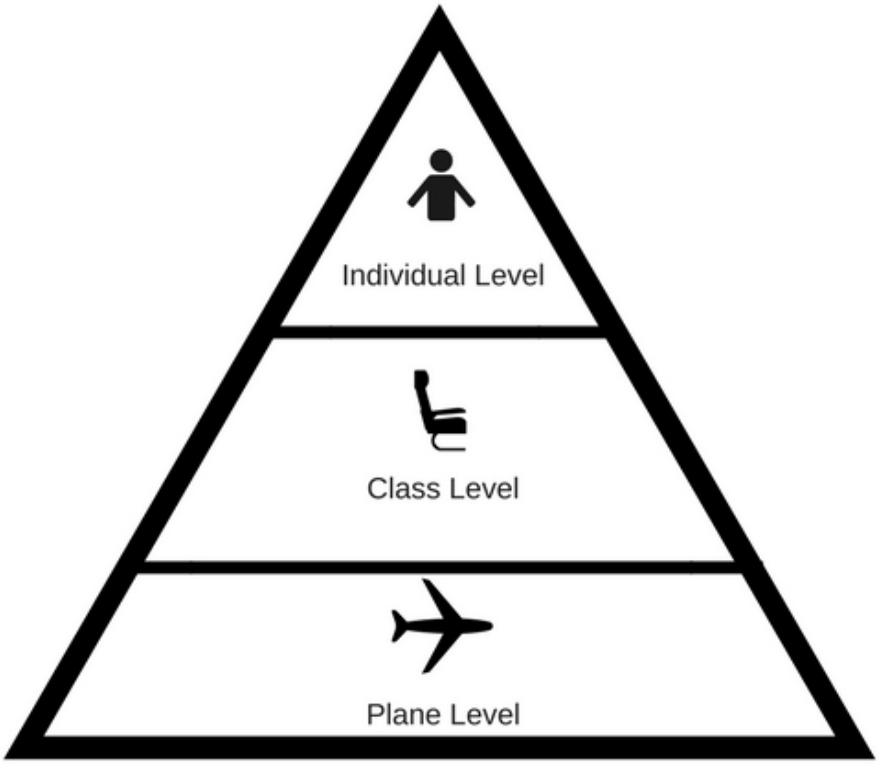


Figure 27 IFE Advertising Tiers[84]

[84] Self-composed figure.

5.2.1. Plane level advertising

Plane level advertising represents advertisement based on the data about the flight, destination and passenger demographics. Similar to the individually recommended content on the content streaming platforms, advertising on IFE systems will be tailored to meet the demand and interests of the particular group of travelers.

On this advertisement tier airlines will work with businesses that are typically associated with airlines and traveling in general. Those partners are car rental companies, hotels, credit card companies etc. Following examples of various services are provided below to give a better understanding of how plane level advertising can work.

1. Plane level advertising of rental cars. It would be appropriate to advertise rental services for fast cars for an excellent autobahn experience on the flights to Germany that is famous for its superb quality highways with no speed limit. On the planes to Italy, ads for small convertibles would be more appealing during the spring and summer season for travelers who want to take a road trip throughout the country or simply use the vehicle on the small city streets. On the flights to the United States, rental commercials would offer large SUVs or trucks to cruise the interstate highways.
2. Plane level advertising of destination content. It would be reasonable to put up content discovering the Oahu island on the Hawaiian Airlines flights to Honolulu. Content that presents local cultural traditions such as hula dance, Hawaiian music, surfing competitions etc. In addition to the infotainment[85] content, commercials for local businesses as best hula schools, ukulele stores and classes as well as surfing gear shops and lessons, can follow.

5.2.2. Cabin class level advertising

Cabin level advertising is thought to target passengers in different airfare classes and to cover various tiers of experience. It is suggested that the advertised goods and services

[85] Content that is intended to be both informative and entertaining.

vary depending on the cabin class with more premium brands in the business and the first class. That can be any products and services that match the airline's marketing strategy and are appropriate for the passengers.

In a coach cabin, advertising will include familiar airline partners as well as Duty Free shopping services or other retail goods. Business class IFE systems will offer to advertise for upscale products and services like private limos with drivers, designer products, premium electronics, etc. Passengers of the airlines that have first-class cabins will see ads for exclusive luxury products and services. An example of diversified advertising for various cabin classes follows.

On the flight from Hong Kong to Los Angeles coach passengers will be offered ads for standard goods from the in-flight shopping catalog, maybe up-and-coming designers from Hong Kong and America or current exhibitions and events in Los Angeles. Business and first-class travelers will have access to commercials of most recent gadgets, Tesla car rentals and purchase, fine jewelry, fragrances and accessories from top Hong Kong and American based designers, bookings or investment opportunities for upscale districts with shopping and living quarters in South California.

5.2.3. Individual-level advertising

Individual-level advertising is a more unique and personalized type of advertising. Ads in this category are addressed individually to every passenger and to meet his or her needs. Preparation and selection of ads start long before the passenger steps on the plane. The idea of the access to customers' data and its analytics has already been explored in the previous chapter nevertheless here is a summary of the fundamental steps.

When the passenger first installs the airline's app, the app will ask for permission to enable access to the passenger's Facebook account. When this setting is enabled, the app starts collecting and analyzing data about passenger's travel and entertainment preferences, lifestyle choices, purchases etc. The data is collected across multiple platforms from laptops to mobile devices to get the full picture.

This type of comprehensive information analysis allows the airline to be closer to its passengers and to understand their needs entirely. Every airline sells ad slots on either digital or printed IFE platforms to the advertisers. The list of the products and services advertised is very diverse. The suggested PA-driven algorithm plays an important role in personalizing ads as it enables airlines to rethink and change the way the ads are shown during the flight. Data analytics will be useful here on multiple levels. First, it will simplify the process of selection of advertising clients and content on the initial phase. Second, with this model the precious ad real estate on the IFE systems will be utilized freshly by targeting every traveler individually and increasing the likelihood of their interest in the ad content and at this moment improving conversion rates. Ways to apply this type of advertising tier are comprehensive and versatile to any marketing strategy of the airline.

Here is an example of how it works on a practical level. From the obtained data of all the passengers on the flight from San Francisco to Singapore, the IFE algorithm has identified those who have interest in sustainable energy and cutting-edge technologies and selected ads for Tesla cars to show on their IFE screens. On the same flight jewelry ads will show up on the screens of female passengers whose birthday is coming up soon or of male passengers who have an anniversary coming up in the nearest future.

5.3. Destination advertising

Another way of presenting differentiated advertisement is destination advertising. It is a way of adapting advertising to aim various potential needs of passengers in the country and the city of destination. It is used today in the form of airport infomercials or articles and commercials about particular businesses on the in-flight magazines to some extent. Destination advertising can involve much more variations such as commercials for the cities, different outstanding places or local upcoming events, local businesses, etc.

Usually, most of the passengers using IFE during the flight want to access their movies immediately and not waste even time on ads and other unrelated animation. By making advertisements creative, fun, informative and offering something unique to the customer, can intrigue the viewer to watch the full ad.

Destination ads is an essential type of commercials every airline needs to show on IFE. Almost every traveler flying to a new destination is wondering what the place would be like and what it has to offer. Travelers might be interested in learning about the local culture, food, traditions and fashion. Passengers are looking forward to exploring exiting spots and local shops. IFE system can be a crucial element in offering informative and entertaining information in the form of commercials. The key is the ad explicitly tailored to destination cities including features as coupons and a call-to-action coupon for local restaurants and entertainment.

For example, on Delta Air Line's domestic flights going to Salt Lake City, IFE systems will feature commercials for the local restaurant Café Rio. The ad will encourage viewers to watch it until the end to get a discount coupon or to receive "buy one get one free" coupon by signing up for the Café Rio's app and using the code "Delta."

Destination ads can feature traditional airline partners like hotels, rental cars, travel insurance companies or other services tourists or business travelers might find appealing and want to use at his or her destination. Also, it also could be companies representing local businesses and services, touristic spots, transportation companies, designers, wellness services etc.

PA implemented in IFE systems can also influence the dynamics of destination ads. Analyzed passenger's information can contribute to defining and narrowing down global and local products and services that will be appear on IFE screens and be extremely appealing to the passengers. Thus, from the perspective of a personalized experience, described above three advertising tiers can be extremely beneficial to approach every passenger on a personal level and thereby make the audience more engaged and thereby advertising more effective.

6. Detailed integration plan

Next, after describing the significance of the new generation dynamic IFE systems powered by PA, it is essential to go through its in-depth implementation process. A detailed step-by-step integration process of dynamic IFE systems will be outlined in this chapter.

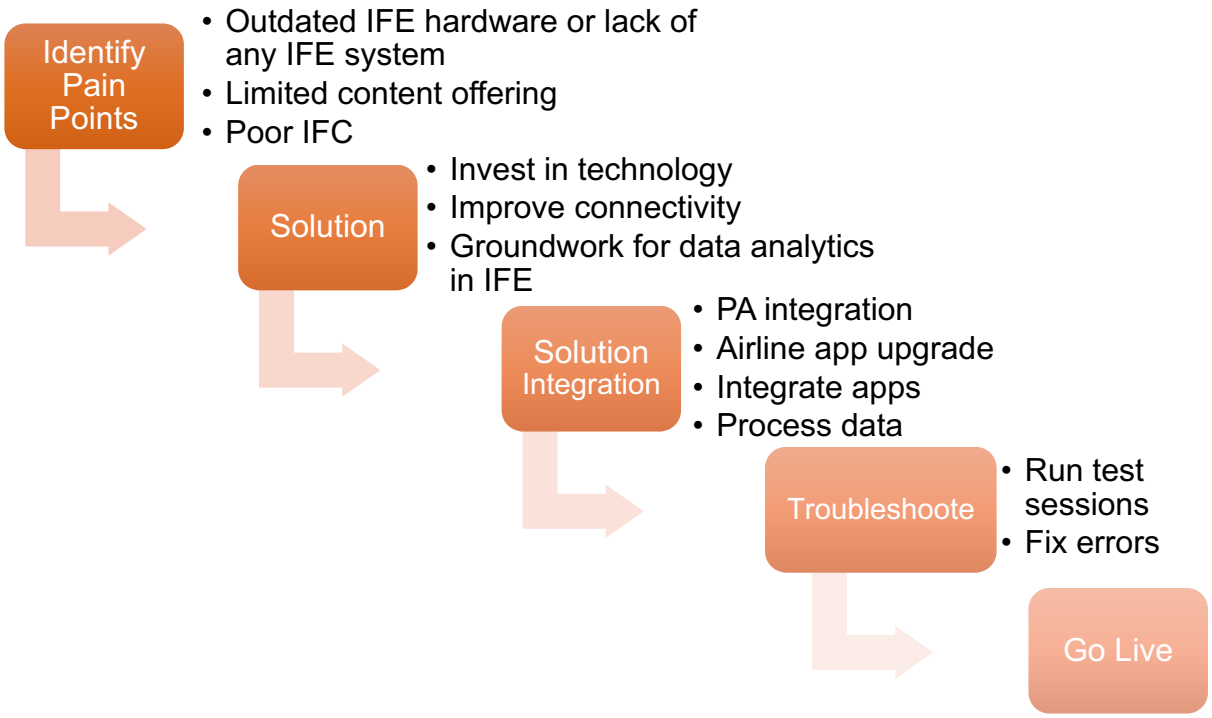


Figure 28 Integration Process Chart[86]

1. Preparation step to the integration will be to identify pain points of the consumers. This involves a comprehensive analysis of factors that the passengers are dissatisfied with. After conducting a research in the context of this thesis, one of the most common points travelers are not satisfied with, is the quality of

[86] Self-composed figure.

entertainment systems onboard. Following main reasons for poor passenger IFE experience have been identified:

a. Lack of IFE systems on small and regional aircraft and airlines.
b. Outdated IFE hardware, especially the systems installed on older aircraft.
c. Limited content library. Content offering is very limited and often varies within the same airline depending on the route and aircraft type.
d. Poor IFC. Main challenges here are lack of onboard Wi-Fi, costly Wi-Fi services or very slow connection.

After the pain points have been identified within the airline, it is much easier to move forward with the solution and its further integration.

2. This step involves proposing a solution based on the results of the research from the previous step. It is a complex approach that looks into these components:
    a. Invest in technology. Create a technologically steady foundation for transitioning mainly into BYOD entertainment systems. Encourage passengers to use their own PED for airline entertainment portal. Keep embedded IFE systems for specific like the Middle East and the Asia Pacific where customers are more inclined to using traditional seat-back IFE screens.
    b. Improve onboard connectivity. Focus on upgrading IFC systems and invest in fast and robust cabin internet. Wi-Fi services that are either completely free or have a very reasonable price together with outstanding and innovative IFE can be an integral part of the core business for airlines.
    c. Lay out the foundation for data analytics utilization in IFE systems to provide dynamic content by creating connected data assets with timely clean data.
3. Next step is the integration of the solution that consists of the following parts:
    a. Building in a PA algorithm into airline's IFE business operations to be able to deal with data.
    b. Significantly upgrade an airline app and built-in integration features that will capture, read and process passenger's data. To predict customer preferences and wishes and offer personalized content on board.

   c. Set servers and necessary hardware to provide the support to process a significant amount of new data.
   d. Integrate airline app with Facebook through Facebook SDK to get data and analytics on the passengers.
   e. Organize the analyzed data and merge it with IFE systems. Organized and processed data will accommodate content acquisition, marketing campaigns, and placement of advertisements.
   f. Content management. Arrange new deals with content partners in accordance to the received data.
4. Troubleshooting is a critical step since it identifies challenges and issues with integration. There are several phases of tests that a necessary to run on to see where the problems might arise.
   a. Run small-scale test sessions on selected flights with a small group of passengers.
   b. Identify problems that the users are coming across during the test sessions and troubleshoot the bugs.
   c. Run test sessions on a larger scale. After fixing the bugs on the previous tests, try the updated solution on a bigger scale involving more routes and more passengers. Include international routes into the solution over time after all technical issues have been fixed.
5. Live phase. This is the last step of the integration process where the dynamic IFE system will become available on all of the airline's flights.
   a. Marketing campaigns need to be conducted before the project goes live to bring awareness to the airline's customers and partners.
   b. Train cabin crew members on the new IFE systems. Create short training videos about the upgraded IFE featured for the passengers.

After a full integration of dynamic IFE systems and its troubleshooting, carriers can enjoy its benefits. Personalized IFE systems that are intuitive and smooth in operation will keep the consumers happy and loyal. Users that enjoy dynamic entertainment onboard will be more satisfied which builds up airlines' brand and attracts new customers. This also

affects the companies and their shareholders as the customer retention will be increased and the bottom line will be improved as there will be more net profit for airlines.

Conclusion

The goal of this thesis paper was to discover how to make in-flight entertainment dynamic, so it creates personalized experience during the flight for each passenger. It has been achieved through implementation of predictive analysis in the IFE systems. This suggestion has been based on the analysis of the content industry and the airline revenue management that have successfully adopted and are utilizing PA in the present.

During the research it has been recognized that the quality of the IFE systems directly influences passenger's experience. Data-driven dynamic IFE systems provide tools for a comprehensive analysis of the passengers to increase customer's loyalty and airline brand experience in general. It was found that airlines that are utilizing data analytics are more efficient and able to increase revenue. It has been shown that PA-driven IFE systems can improve content offering, advance the content acquisition process and significantly cut down related expenses. Dynamic IFE has also shown the ability to offer analytics to improve the quality of marketing campaigns to engage a larger number of advertising partners and conclusively bring in more ancillary revenue. Individual approach to every passenger based on data analytics, contributes to up-selling of airline's products and services.

This research has shown that the airlines have started to recognize the emerging BYOD trend and are responding to the growing interconnectivity of devices as the technology progresses. Although there are still many carriers that keep investing in upgrading seat-back video and audio systems, a large number of the airlines have eliminated embedded IFE systems. Instead those airlines invest in good and stable inflight Wi-Fi and power supply to encourage passengers to use PED for IFE purposes. Elimination of heavy embedded IFE systems has proved to cut down the cost of fuel due to lighter weight of equipment on the board. Wireless content streaming and free in-flight Wi-Fi service has been identified as a future direction in the IFEC sector.

The most reasonable solution for creating a personalized IFE experience has been found to be an integration of the social media platforms with airline's system to properly extract

and process passenger's data. The data received from social media has been recognized to shift the concept of IFE experience into in-flight engagement platforms.

This research is of a great significance to the commercial aviation industry as it shows how dynamic IFE can change the future of onboard entertainment and create a unique flight experience regardless of the cabin class or flight duration. In the future, it can be broadened beyond the scope of customer data analytics for the benefit of content acquisition and airline's marketing.

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Affirmation

I affirm that current thesis was composed by me and no other source of information was used, except of the sources mentioned in the bibliography list. Ideas taken from any used sources are indicated as such.

Santa Cruz, 13.04.2018 Elena Hawk