Mansoura University
Faculty of Tourism and Hotels

Studying the Possibility of Internet of Things in EgyptAir, Post Covid-19, Using House of Quality

By

Dr.Helen Abd El-Hamid Abd El-Hakim Mohamed

Tourism Studies Lecturer, Higher Institute of Specific Studies , Heliopolis, Cairo.

RESEARCH JOURNAL OF THE FACULTY OF TOURISM AND HOTELS
MANSOURA UNIVERSITY
ISSUE NO. 11 (PART 2), JUNE. 2022

الملخص

تتم الآن مناقشة استخدام تقنية إنترنت الأشياء في مجال الطيران. إن الخيارات الإبداعية لإنترنت الأشياء اصبحت تجذب الاهتمام على مدى السنوات القليلة الماضية، حيث يُنظر إليها عمومًا على أنها ثورة تكنولوجية جديدة مقارنة بتقنيات الهاتف المحمول أو منصات التواصل الاجتماعي. يهدف المؤلف إلى اكتشاف الاستخدام المحتمل لإنترنت الأشياء في الخطوط الجوية المصرية وتطوير الحلول التي تم تنفيذها بالفعل من قبل مصر للطيران بعد جائحة كورونا كأثر إيجابي للجائحة، مع تسريع تطبيق التكنولوجيا الجديدة.

يساهم البحث في خاصيتين

1) اعتماد إنترنت الأشياء من قبل مصر للطيران (الحياة المتصلة).
2) إطلاق رحلة مصر للطيران من البداية إلى النهاية.

ترسم الدراسة الوضع الحالي لمصر للطيران باستخدام مصفوفة بيت الجودة في عصر إنترنت الأشياء، سعياً وراء الرحلة المثلى لمصر للطيران.

الكلمات الرئيسية: انترنت الاشياء، الطيران، انترنت الاشياء في المجال الجوي، بيت الجودة، ومصر للطيران.

Abstract

The use of IoT technology within aviation is now being debated. Creative options of Internet of Things achieve traction for a few years, mostly because they are viewed as another technological revolution comparable to the development of mobile technologies or social media platforms. The author targets to discover probable usage of IoT and develop solutions that have already been implemented by EgyptAir especially, after covid-19 pandemic as a positive impact, speeds up applying the new technology. The research contributes two properties: 1) adopting IoT by EgyptAir (connected life). 2) launching end-to-end EgyptAir flight. The study draws current profile of EgyptAir simulating to HoQ matrix in the era of IoT, pursuing the optimal flight of EgyptAir.

Keywords: IoT, Aviation, IoTA, HoQ and EgyptAir

1. Introduction:

The phrase Internet of Things (IoT) was first used in 1999 by Kevin Ashton. The perception of IoT stands to connect the real-world objects with speech, vision, hearing, smell, and touch, so non-living things can accomplish jobs more accurately, responsively, collaboratively with knowledge. IoT transformation can be executed within innovating set of technologies that appropriate industry generally with applicable IoT characteristics (Amy et al., 2016).

Internet of Things (IoT) becomes more and more important in many industries. Although the IoT evolution happened more than a decade ago, its impact on aerospace systems is limited due to the landscape of aerospace systems which perform safely critically. Digital Technology evolution happens rapidly fast, what consequently, within no time, impact all business sectors. Thus, it is fundamentally an obligation by organizations to innovate which add value to both, customers, and own business (Dunbrack et al., 2016).

Aerospace and Defense (A&D) industry grow rapidly. Growth of travel demand, development of new technologies and security threat for nations lead to increasing of, aircraft production, defense budgets and need for global supply chain (Bénaroya & Malaval, 2013). Airbus global market forecast predicts that air traffic will grow at 4.5% annually and more than 30,000 aircrafts will be required over the next 20 years (Global Market Forecast, 2016).

IoT technologies grow wilder than expected, which can change the product scenery of aerospace industry as well. Thus, IotA is generated to express Iot in Aerospace sector (IotA).

2. Objectives

2.1. Analyzing the current situation of Egypt Air.

2.2. Studying some international Airlines implement Iot.

2.3. Accelerating IoT adoption by Egypt Air (connected life).

2.4. Creating end to end passenger journey within Egypt Air.

3. Hypotheses

3.1. H1: There is a correlation between IoT and the elements of EgyptAir system.

3.2. H2: IoTA can be implemented by EgyptAir.

4. Literature review

There are many IoT characteristics can add value to aerospace systems via, on one hand, reducing the traveller discomfort such as flight cancellation, flight delays. On other hand fuel saving, Zero downtime and Route optimization. The presented characteristics reflect two views for IotA, one for passenger and other for airline which can be achieved by improving the vehicle performance which is provided more connected and smarter devices (Ramalingam et al., 2017). Direct cost of air transportation delay is USD 32.9 billion which incurs a loss of USD 8.3 billion to airlines (Ball et al., 2010). An exclusive benchmark analysis report published by IATA mentioned that USD 15 billion was spent on direct maintenance, with average maintenance cost of USD 295 million per airline and USD 1087 per flight hour (IATA, 2014). Identification of prospective systems and applicable characteristics is the key to implement and develop IoT systems in aerospace.

A qualitative analytical study analyzes current situation and evaluates performance of Egypt Air. The research studies some successful experiences, within some regions of the world, as models of the best performance of airlines applying Iot. So, these experiences can be simulated on Egypt Air, which can develop connected life via travelling and create end to end passenger journey within Egypt Air application.

Field study depends on google form, which is conducted to some experts of IT sector in EgyptAir during the period January – April 2022. The questionnaire aims to evaluate information technology sector within EgyptAir, focusing on tech-based flight experience. HoQ tool is practiced for interpreting answers of questionnaire. The E-mail approach was used to accomplish the survey.

4.1. Successful experiments

4.1.1. EasyJet

EasyJet may be a low-cost airline focused on moderate travel, but the company has done something truly significant on the Internet of Things (IoT) arena using wearable device. It has outfitted cabin crew and ground employees using wearable tech uniforms, boasting to be the first airline to do so. The new suit has built-in microphones for direct communication with passengers, pilots, and crew members, as well as LEDs on the shoulders and hems to guide passengers by visual direction. On the lapel jacket, the uniform seems to be a LED-based scrolling ticker that represents essential data such as the flight number, flight directions, and illumination instructions in the emergency situations. Drones are also being used by EasyJet to check its fleet of planes (https://internetofbusiness.com/easyjet-takes-flight-with-iot-, 2021).

4.1.2. Lufthansa Airlines

Lufthansa launched its RIMOWA Electronic tag, a mobility solution meant to trace bags from the airport to the aircraft. The RIMOWA Electronic Tag is an electronic luggage label that shows bags information on a digital screen incorporated into the luggage unit and situated near the handle, in the same format, size, and design as traditional paper labels. Travelers who have a Rimowa electronic tag-enabled luggage may use Bluetooth to submit their digital boarding information to check their bag before leaving home, with data shown on the bag's electronic screen. They have just given it out at the airline's computerized check-in counter once they get to the airport (https://www.lufthansa.com/sd/en/smart-bags, 2021).

4.1.3. Delta

Delta Air Lines teamed with Bit Stew Systems in October 2015 to put an IoT analytics system on a portion of its fleet to improve aeroplane maintenance. Bit Stew's Mix Core platform is aimed to combine billions of traditional soloed data points across aviation and air traffic management to boost awareness, find new business insights, and improve operations and asset performance, with the goal of improving aircraft performance.

Bit Stew claims that by interpreting and studying massive volumes of aviation data, it can assist airlines in minimizing downtime and saving fuel costs. Delta is also employing Sendum Wireless tracking technology to provide GPS tracking for pets sent. The system offers location, temperature, and humidity data in real time. The service was available at several U.S. airports since 2015 (https://internetofbusiness.com/10-real-life-examples-iot-aviation/, 2021).

4.1.4. KLM

KLM has been collaborating with Mendix, an application platform as a service provider, to improve engineering and maintenance efficiency. The Franco-Dutch airline collaborated with the IT firm and used its fast application development platform to create an asset tracking app that drew data from the national KPN LoRa network. Engineers can see where each piece of aviation maintenance equipment is situated in real time (on iPads). This improves engineer efficiency (spend less time), and KLM anticipates considerable cost savings and process improvements because of the initiative. It is also predictable to boost consumer satisfaction by offering more consistent and on-time flights. KLM and Schiphol Airport in the Netherlands have also invested, a domestic IoT start-up that employs mesh networking to find things in real time (https://internetofbusiness.com/klm-gets-connected-take-stress-flying/, 2021).

4.2. Egypt Air

4.2.1. IBM collaboration

IBM and EGYPTAIR Tourism and Duty-Free Co. have announced a new agreement in which the airline will leverage IBM Cloud to scale and modernize EGYPTAIR Duty Free back-end operations and host its SAP Travel Retail System. By adopting IBM Cloud, EGYPTAIR will also leverage IBM Watson Assistant to create an AI virtual agent to help transform their travelers' shopping experience.

With the Covid-19 pandemic, the airlines industry started to look for new technologies to reinvent their services and unlock an array of new experiences for their customers. EGYPTAIR Duty Free selected IBM as its technology provider for cloud architecture (Metwally, 2022).

4.2.1.1. Enhanced security through contract

With a hybrid cloud approach from IBM, EGYPTAIR Duty Free will migrate its ERP workload to IBM Cloud while staying connected and fully integrated with the Frequent-

Flyer Program of EGYPTAIR Airlines and Star Alliance companies to provide shopping services from EGYPTAIR's duty free outlets and help attract new customers. For example, EGYPTAIR Duty Free customers will make all payment transactions through a secured point of sale that is part of IBM Cloud infrastructure. With IBM Cloud, EGYPTAIR can leverage IBM's industry-leading security capabilities, which can include confidential computing and encryption capabilities backed by the highest level of security certification commercially available.

This gives enterprises the ability to retain control of their own encryption keys so IBM clients are the only ones who can control access to their data. "In choosing a hybrid cloud approach and migrating to IBM Cloud, EGYPTAIR can provide its customers with a secured and enhanced retail experience," said Harish Grama, General Manager, IBM Cloud (Metwally, 2022).

4.2.1.2. Modernizing Duty-Free shopping

IBM will provide technology and industry expertise to enhance the digital services for EGYPTAIR Duty Free by using IBM Watson Assistant, running on IBM Cloud. The AI virtual agent will be designed to provide EGYPTAIR Duty Free customers with a differentiated shopping experience, enabling them to do online shopping through the Duty-Free website including order placement, payment, and delivery inside the plane, thus providing a smooth retail experience. The new technology will help to reinvent services and unlock an array of new choices for customers. EGYPTAIR Duty Free by IBM and SAP technology, will modernize operations through the supply chain to meet the evolving needs of customers and suppliers.

This collaboration comes within the framework of EGYPTAIR's strategy in line with Egypt's digital transformation roadmap to create easy, digitized, and personalized customers' experiences. IBM has a long history of working within the airlines industry as well as leading the travel and transportation companies around the world. For decades, IBM has collaborated with EGYPTAIR to host core applications on both IBM hardware and software (https://www.biztechafrica.com/article/egypt-air-and-ibm-collaborate-modernise-duty-free-/16496/, 2022).

4.2.2. Star Alliance Digital Projects

4.2.2.1. Unpaid Seats Selection

◙ EGYPTAIR integrated with Star Alliance Digital Platform to become Seat Map provider for Star Alliance members.

◙ EGYPTAIR deployed in production with UA its seat Map so that UA consumes MS Seats on its digital channels.

4.2.2.2. Baggage Tracking

◙ EGYPTAIR deployed baggage-tracking service in which Customers can use this service upon arrival to their destination through EGYPTAIR mobile application on android or IOS under the baggage tab by scanning the QR code on the bag tag, or by entering the baggage tracking and flight numbers, then all the baggage details will be shown on the application (EGYPTAIR, 2019-2020 ANNUAL REPORT).

4.3. The internet of things is driven by a combination of the following engines (Mousa, 2019)

4.3.1. Sensors

World is given a digital nervous system. Location data uses GPS sensors, eye uses camera, ear uses microphone, and along sensory organs which can measure everything from temperature to pressure changes.

4.3.2. Connectivity

The input units (sensors\ things) are digitized and networking.

4.3.3. People and processes

The networked inputs can sequentially be combined into bi-directional systems that integrate data, people, processes, and systems for better decision making.

4.4. Airline Systems

There are many Airline systems and sub systems behind every successful flight. To establish the relationship between the IoT engines and EgyptAir Airline systems, the author decided to operate research topics listed in table 1. (EASN, 2017 and Mousa, 2019).

Table1. List of Airline Systems

Research
Booking
Payment
Check-In
Baggage
Passport
Security
Shopping and dining
Banking
Gate
Boarding
Entertainment
Communication system
Environmental System (temperature\ light\ noise)
Water and waste system
Energy\ fuel system
Smart Maintenance
Aircraft turn around management\ activity tracking
Ground Fleet Management
Fire protection system

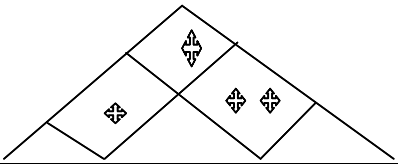
Source: European Aeronautics Science Network (EASN, 2017) and Mousa, 2019

5. Methodology

House of Quality (HoQ) tool was used to establish the connection between the IoT engines and the various aerospace systems within Egypt aviation. 'House of Quality' (HoQ), the basic design tool for the management approach known as Quality Function Deployment (QFD), is originated in 1972 at Mitsubishi's Kobe shipyard site (https://hbr.org/1988/05/the-house-of-quality, 2021). HoQ is one of the matrices of an iterative process called QFD. It is the nerve center that drives the entire QFD process which is most recognized and widely used tool for new product design. It translates customer requirements, based on market research data, into an appropriate number of engineering targets to be met by a new product design. It is performed by a multidisciplinary business critical team of the company (Shrivastava, P., 2016).

As table2 shows, successful flight systems related to traveling and tourism sector are listed on the left side of the matrix (Horizontal). IoT engines are listed in the top column of HoQ. Correlation matrix between airline systems and IoT engines are identified (level of strong, moderate, and weak relations) using the discussion with EgyptAir information technology experts (11 online interviews) during the period January – April 2022.

Table 2. EgyptAir HoQ according to the potential IoT cases in Airline



N.	Priority	IoT Engines / EgyptAir systems	Things	Connectivity	Procedure
1	5	Research	⊙	⊙	⊙
2	5	Booking	⊙	⊙	⊙
3	5	Payment	⊙	⊙	⊙
4	5	Check-In	O	O	O
5	5	Baggage	⊙	O	O
6	5	Passport	▲	▲	▲
7	5	Security	▲	▲	▲
8	4	Shopping and dining	⊙	O	O
9	4	Banking	O	O	O
10	5	Gate	▲	▲	▲
11	5	Boarding	▲	▲	▲
12	2	Entertainment	⊙	⊙	⊙
13	3	Communication system	▲	⊙	⊙
14	5	Environmental System (temperature\ light\	▲	▲	▲

		noise)			
15	5	Water and waste system	⊙	O	
16		Energy\ fuel system			
17		Smart Maintenance			
18		Aircraft turn around management\ activity tracking			
19		Ground Fleet Management			
20		Fire protection system			
Target			612	612	612
Weight \ Importance			334	274	259
Relative weight			0.55	0.45	0.42

N.	Priority	IoT Engines / EgyptAir systems	Things	Connectivity	Procedure
1	5	Research	⊙	⊙	⊙
2	5	Booking	⊙	⊙	⊙
3	5	Payment	⊙	⊙	⊙
4	5	Check-In	O	O	O
5	5	Baggage	⊙	O	O
6	5	Passport	▲	▲	▲
7	5	Security	▲	▲	▲
8	4	Shopping and dining	⊙	O	O
9	4	Banking	O	O	O
10	5	Gate	▲	▲	▲
11	5	Boarding	▲	▲	▲
12	2	Entertainment	⊙	⊙	⊙
13	3	Communication system	▲	⊙	⊙
14	5	Environmental System (temperature\ light\ noise)	▲	▲	▲

15	**5**	**Water and waste system**	⊙	**O**	
16		**Energy\ fuel system**			
17		**Smart Maintenance**			
18		**Aircraft turn around management\ activity tracking**			
19		**Ground Fleet Management**			
20		**Fire protection system**			
Target			**612**	**612**	**612**
Weight \ Importance			**334**	**274**	**259**
Relative weight			**0.55**	**0.45**	**0.42**

⊙	Strong 9
O	Moderate 3
▲	Weak 1

The HoQ indicator displays the value of IoT engines. Things, connectivity, and procedure all received a score of 334, 274, and 259 sequentially, representing relative weights of 55%, 45%, and 42%. It would enable entrepreneurs to invest in the development of new technology that may mature based on these engines. EgyptAir website is improved during time and is benefited numerous enterprises, according to research, booking, payment, check-in, baggage, shopping, dining, banking, and entertainment. Passport, security, gate, boarding, and environmental system are still challenges for IoTA. Now is era for EgyptAir to process IoT solutions utilizing accessible technology. As data is being analyzed and expressed, fuel system, smart maintenance, aircraft activity tracking, Ground Fleet Management, and fire protection system remain a struggle for IoT solutions. Till now, just around 1% of data is being used to make the decisions.

5.1. Validity and reliability

Table 3

Reliability and validity

Dimensions	N	Validity	reliability
EgyptAir systems	20	0.688	0.881

The validity and stability of the elements of the EgyptAir system (20) items were verified by Cronbach's alpha test, which amounted to 0.881, which indicates the stability of the elements of the EgyptAir system. Of the elements, the value of the total correlation coefficient was 0.688 as in Table No. (1)

H1: There is a correlation between IoT and the elements of EgyptAir system

Table 4
correlation between IoT and the EgyptAir system

Correlations					
		Egypt_air_system	things	connectivity	procedure
Pearson Correlation	Egypt_air_system	1.000	.862	.965	.948
	Things	.862	1.000	.703	.659
	Connectivity	.965	.703	1.000	.992
	Procedure	.948	.659	.992	1.000
Sig. (1-tailed)	Egypt_air_system	.	.000	.000	.000
	Things	.000	.	.000	.001
	Connectivity	.000	.000	.	.000
	Procedure	.000	.001	.000	.
N	Egypt_air_system	20	20	20	20
	Things	20	20	20	20
	Connectivity	20	20	20	20
	Procedure	20	20	20	20

To verify the validity of this hypothesis, the Pearson correlation coefficient test was conducted in the form of a matrix of correlation coefficients, to reveal the correlation between IoT tools and the EgyptAir system on one hand, and among Internet of Things tools on the other hand. It is clear from the schedule that there is a positive correlation between Egypt air system and things, its value is 0.862, which is a sign at a level of significance 0.000 .It is also clear that there is a positive correlation between Egypt air system and connectivity, its value is 0.965 at significance level of 0.000 .It is clear from the schedule that there is a positive correlation between Egypt air system and procedure, its value is 0.948, which is a sign at a level of significance 0.000. Regarding the relationship among IoT engines, there is a correlation between things and connectivity, its value is 0.703, which is a sign at a level of significance 0.000. There is also a correlation between things and procedure, its value is 0.695, and it is a function at the significance level of 0.01. Correlation is also found between connectivity and procedure, its value is 0.992, which is a function at the level of significance of 0.000.

H2: IoTA can be implemented by EgyptAir.

To verify the validity of this hypothesis, multiple regression analysis was carried out as shown in the following tables

Table 5

Model Summary							
Model	R	R Square	Adjusted R square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	Sig. F Change
1	.862[a]	.744	.729	1.79706	.744	52.196	.000
2	.999[b]	.998	.998	.15006	.255	2564.520	.000
3	1.000[c]	1.000	1.000	.00537	.002	13268.317	.000

a. Predictors: (Constant), things

b. Predictors: (Constant), things, connectivity

c. Predictors: (Constant), things, connectivity, procedure

d. Dependent Variable: Egypt_air_system

It is clear from the previous table that there is a correlation among the first, second and third regression models, and this is evident through the level of significance, as they are all significant at the significance level of 0.000. It is also clear from the table that the most influential regression model “things” in the EgyptAir system has a value of 0.744. Then the value of influence and change in the EgyptAir system through the second regression model "connectivity" is 0.255, while the least influential regression model is the third model. "Procedure" where the effect value was 0.002

Table 6
ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	168.563	1	168.563	52.196	.000[a]
	Residual	58.129	18	3.229		
	Total	226.692	19			
2	Regression	226.309	2	113.155	5025.178	.000[b]
	Residual	.383	17	.023		
	Total	226.692	19			
3	Regression	226.692	3	75.564	2622307.326	.000[c]
	Residual	.000	16	.000		
	Total	226.692	19			

a. Predictors: (Constant), things

b. Predictors: (Constant), things, connectivity

c. Predictors: (Constant), things, connectivity, procedure

d. Dependent Variable: Egypt_air_system

It is clear from the previous table that there are statistically significant differences among the three independent variables, which are things – connectivity – procedure on the dependent variable, which represents the elements of EgyptAir system. This is evident through the values of q and through the significance level, as all the elements are significant at the significance level of 0.000.

Table 7
Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients			Correlations		
	B	Std. Error	Beta	T	Sig.	Zero-order	Partial	Part
1(Constant)	.614	.555		1.106	.283			
things	.738	.102	.862	7.225	.000	.862	.862	.862
2(Constant)	-.010-	.048		-.202-	.842			
things	.311	.012	.363	25.891	.000	.862	.988	.258
connectivity	.685	.014	.710	50.641	.000	.965	.997	.505
3(Constant)	-.001-	.002		-.479-	.639			
things	.335	.000	.392	698.956	.000	.862	1.000	.249
connectivity	.310	.003	.321	94.142	.000	.965	.999	.034
procedure	.355	.003	.371	115.188	.000	.948	.999	.041

a. Dependent Variable: Egypt_air_system

It is clear from the previous table that the value of beta amounted to 0.862 for the variable of things, it also amounted to 0.710 for the variable of communication, and it amounted to 0.371 for the variable of action, which indicates that the most influential element is the variable of things

Thus, the regression equation can be written as follows
Y = 0.614+ 0.738x
Y= 0.01+ 0.685x
Y= 0.001+ 355x

Table 8
The Results of Hypothesis Testing

	Hypothesis	Results
H1	There is a correlation between IoT and the elements of EgyptAir system	Accepted
H2	IoTA can be implemented by EgyptAir	Accepted

6. Conclusion

The association between IoT maturity and its influence on aerospace systems has been demonstrated in the research study. The House of Quality tool assisted in identifying the positive co-relations between IoT engines. HoQ has aided in the identification of prospective Egypt aviation systems for IoT implementation. The technique outlined in the research can assist Egypt airline in better understanding IoT features and their influence on flights. The author highlighted IoT engines that are important to the aerospace sector. A literature review was used to identify the IoT attributes and successful flight requirements. Ultimately, according to field study a linkage between IoT engines and successful flight requirements from the viewpoint of

EgyptAir is formed. Also, the IoT engines are linked and weighted. Things, according to study findings, got relative weight of more than 50%. Connectivity ranked second then procedure ranked the last by more than 40% relative weight for each. As a result, these IoT engines are significant and accessible for adopting IoT in EgyptAir systems. Before investing in inventing IoT solutions, aerospace businesses should assess the evolution of these engines.

7. Recommendations

1- Before investing in and developing IoT solutions for aviation systems, aerospace businesses should follow up what's happening in other sectors.
2- Aircraft system vendors should stay up to date for possibilities to build IoT structures that will benefit their companies in the long run.
3- EgyptAir IT infrastructure must be developed including sensors, devices, communications, protocols, networks, huge storage media, machines learning, and sensing applications.
4- Security and safety innovation must be planned according to IoT characteristics.
5- Smart maintenance should be invested to reduce operational costs.
6- Data center must be prepared due to IoT.
7- EgyptAir must team up with Egypt airports for investing new technology IoT to produce end to end traveler experiment.

8. Future Guidelines

The goal of future study is to provide a solid approach for determining the development of IoT features with Egypt airlines market. IoT expertise is a strategic attention area of Technology Roadmap. It's a must to explore more use cases of IoT technology for Smart airlines.

IoTA future prospective use cases

- Energy\ fuel system
- Smart Maintenance
- Aircraft turn around management\ activity tracking
- Ground Fleet Management
- Fire protection system

References

- Amy, J.C., Charles, V., Govindarajana, U., Allen, C., John, J., (2016) *A Review of essential standards and patent landscapes for the IoT: Key enabler for Industry 4.0*, Advanced Engineering Informatics, P. 3

- An Exclusive Benchmark Analysis (FY2014 data) by Maintenance Cost Task Force published by IATA,

https://www.iata.org/whatwedo/workgroups/Documents/MCTF/AMC-Exec-Comment-FY14.pdf

- Ball,M., Barnhart,C., Dresner,M., Hansen,M., Neels,K., Odoni,A., Peterson,A., Sherry,L., Trani,A., Zou,B., (2010) *Total Delay Impact - A Comprehensive Assessment of the Costs and Impacts of Flight Delay in the United States*, Research Report published by The National Centre of Excellence for Aviation Operations, P.14

- Bénaroya, Ch. & Malaval, Ph., (2013) *Aerospace Marketing Management*, Berlin, Springer.

- Dunbrack, L., Ellis, S., Hand, L., Knickle, K., Turner, V., (2019-2020) White Paper, *IoT and Digital Transformation: A Tale of Four Industries*, Sponsored by: SAP, 2016

- EGYPTAIR, ANNUAL REPORT, P. 30

- European Aeronautics Science Network (EASN), (2017)

https://easn.net/ and https://easn.net/research-technology-areas/4/#60

- Global Market Forecast 2016-2035 - Airbus

- Mousa, A. (2019), IOT AND Cloud In Aviation /Internet OF Things AND Cloud Computing In Aviation, available at: https://www.researchgate.net/publication/333340873 accessed 2/4/2022

- Patel, K., Patel, S., (May 2016) *Internet of Things-IOT: Definition, Characteristics, Architecture, Enabling Technologies, Application & Future Challenges*, International Journal of Engineering Science and Computing, PP.6123

- Ramalingam, T., Benaroya, C., Wamba, S., (2017) Assessing *the Potential of IoT in Aerospace*, research gate, PP.1,3,5
https://www.researchgate.net/publication/320186118

- Shrivastava, P. (September 2016) “House of Quality: An Effective Approach to Achieve Customer Sat-isfaction & Business Growth in Industries” International Journal of Science and Research (IJSR) Volume 5 Issue 9, pp-1365.

- https://www.easn.net/#
accessed 28-10-2021

- https://hbr.org/1988/05/the-house-of-quality
accessed 28-10-2021

-https://internetofbusiness.com/easyjet-takes-flight-with-iot-rolls-out-sensors-and-wearables-to-staff
accessed 13-11-2021

- https://www.lufthansa.com/sd/en/smart-bags
accessed 22-11-2021

- https://internetofbusiness.com/10-real-life-examples-iot-aviation/
accessed 22-11-2021

-https://internetofbusiness.com/klm-gets-connected-take-stress-flying/
accessed 22-11-2021

- https://www.biztechafrica.com/article/egypt-air-and-ibm-

accessed 7-3-2022

- Mr. Reda Metwally Chairman and CEO, EGYPTAIR Duty Free, 2022