Sustainable Disruption of AI for Airport 4.0

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Abstract: ***The aim of this study is to develop an integrated, decentralized, streamlined system, as even with new initiatives, many systems and processes used remain siloed and fragmented. Connecting processes and stakeholders would be key to innovation and would result in an integrated system linking the Internet of Things to the User Experience in line with Airport 4.0. The data has been collected from various sources such as journals, articles, blogs, websites, books, research papers, government and regulatory documents, e-journals, magazine articles, presentations, and reports. Data analysis has been carried out by thematic analysis based on theoretical and conceptual frameworks. Theory is presented that emerged from the research findings and analysis on carrying out a thematic analysis. This study fills previous gaps in the literature on artificial intelligence and its customer-focused use leading to sustainability, in line with Airport 4.0.***

Keywords: Sustainability, Disruption, AI, Airport 4.0, Big Data, Blockchain, IoT

1. Introduction

Airports using Artificial Intelligence today are constantly undergoing changes (SITA, 2019; Ivanov, *et al., 2017).* "By 2036 an 89 per cent increase is predicted bringing 7.8 billion people through our skies annually, compared to the 3.8 billion that use air travel today" (IATA, 2019). As were moving towards Airport 4.0, On-time performance and Safety of Passengers being of key importance (Citymetric. com, 2019; Lasi, *et al., 2014;* Mckinsey, 2016*).* Airports are constantly undergoing disruption due to Artificial Intelligence (Forbes, 2019) (Buhalis, D., *et al.*, 2019*).* To sustain the disruption of a Technological Singularity and a Super-intelligent Runaway, Airports need to look at a new conceptual model of AI vs Airports as shown below (Singularity2030ch, 2019: Braga, *et al.*, 2019*).* This model looks at the Airport Business from an ethical passenger experience focused viewpoint (LEE, *et al.*, 2019*).* With the help of Big Data and Blockchain integrated into Internet of Things, this will help provide integrated ease of access to the passenger via their devices which will take into account the ethical transformation of the system (Sitaaero, 2019; AP Plageras, *et al.*, 2018). This will be done using Lean Six Sigma conceptual models to reduce wastage of time and costs and increase value to the passenger (Sia partners, 2018; Senvar O., Akburak D., 2019). This system will further personalize the passenger experience keeping in mind the key factors of safety, security (Pita, J, *et al.*, 2019) and on-time performance. This will bring about increased customer satisfaction and control (CAPA, 2019). Producing an ethical Artificial Intelligence system with awareness and moral values similar to humans would not allow any harm to come to any human (Russell, S., *et al.,* 2015). It would obey orders given to it by humans except in cases where there lies a potential harm to humans. This can be made possible using Bayesian Networks (Statmodel. com, 2019: Berry, D. A., 2004). Failure to produce an ethical Artificial Intelligence system could lead to the apocalypse in the near future (Issuesmagazine. com. au, 2019: Shanahan, M. & Liberated Library, 2015).

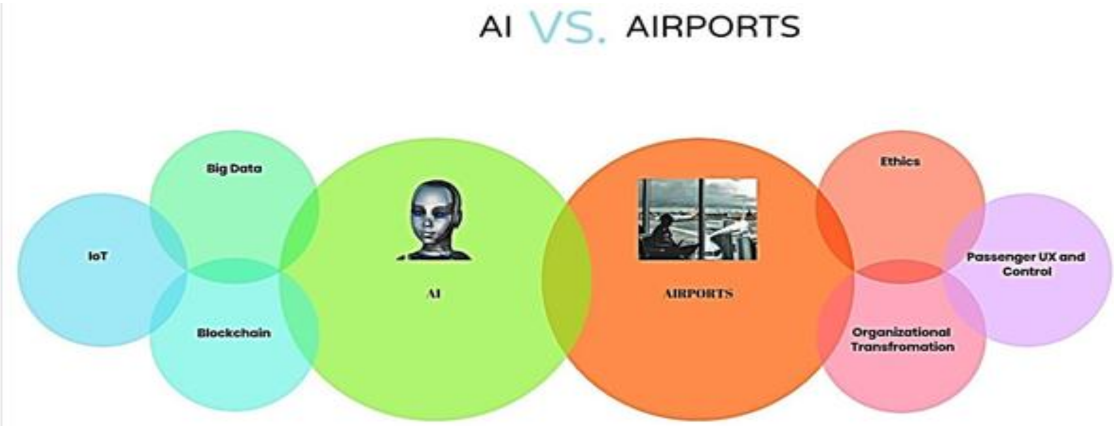

Figure 1: Conceptual Framework connecting IoT with the Passenger Experience in AI at Airports

2. Background

Big Data is a field that finds ways to analyse, systematically extract information from, or otherwise deal with data sets that are too large or complex to be managed by traditional data-processing application software (De Mauro, *et al.*, 2016). Big data includes capturing data, data storage, data analysis, search, sharing, transfer, visualization, querying, updating, information privacy and data source (George, *et al.*, 2016). It refers to the large, versatile sets of information that grow at increasing rates (Gandomi, A. & Haider, M., 2015). It encompasses the volume of information, the

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velocity or speed at which it is created and collected, and the variety or scope of the data points being covered (Johnson, J. S., *et al.*, 2017).

Blockchain is a digital ledger that enables multiple parties to reach an agreement on the authenticity of a transaction in a decentralized manner (Shermin, V., 2017). As businesses today has become more complex, data and transactions are increasingly being managed across untrusted parties. Blockchain technology can help increase trust and simplify operations for enterprises though a more transparent and secure approach to transactional relationships (Cisco. com, 2019; Karame, G., & Capkun, S., 2018). The true benefit of Blockchain is its ability to automate trust in the enterprise (Biometric Technology Today, 2018). This allows consumers, enterprises, and governments to automate how they manage transactional relationships. Blockchain needs to still get into the quantum encryption phase to maximize its ability (Fedorov, A. K., *et al.*, 2018).

Internet of things (IoT) is the concept of basically connecting any device with an on and off switch to the Internet and/or to each other (Forbes, 2019). It is the extension of Internet connectivity into physical devices and everyday objects (Ahmed. E, *et al.*, 2017). Embedded with electronics, Internet connectivity, and other forms of hardware such as sensors, these devices can communicate and interact with others over the Internet, and they can be remotely monitored and controlled (Atzori, L., *et al.*, 2017). It is a computing concept that describes the idea of everyday physical objects being connected to the internet and being able to identify themselves to other devices (Floris, A., & Atzori, L., 2015). The term is closely identified with RFID as the method of communication, although it also may include other sensor technologies, wireless technologies or QR codes (Techopedia. com, 2019; Atzori, L., *et al.*, 2017). The relationship will be between people-people, people-things, and things-things (Forbes, 2019).

UX stands for user experience, which is the process of researching, developing, and refining all aspects of a user's interaction with a company to ensure the company is meeting the user's needs (Hubspot. com, 2019; Rajanen, D., 2017).

UI stands for user interface (meaning various device interfaces like on laptops, tabs, cell phones, etc.). A UI designer's responsibilities are more cosmetic than a UX designer's: a UI designer is responsible for the presentation of a product and for how everything on a page aligns in relation to each other (Hubspot. com, 2019; Kim, S. W., *et al.*, 2011). The visual elements you see on a page, such as buttons and icons, and the interactivity of a product, falls on the UI designer (Hubspot. com, 2019; Kim, S. W., *et al.*, 2011).

Ethics is a branch of philosophy that involves systematizing, defending, and recommending concepts of right and wrong conduct. The term is derived from the Greek word 'ethos' which can mean custom, habit, character or disposition (BBC, 2019). The field of ethics, along with aesthetics, concerns matters of value, and thuscomprises the branch of philosophy called axiology. It is a system of moral principles. They affect how people make decisions and lead their lives (BBC, 2019). Philosophers divide ethical theories into three areas: meta-ethics, normative ethics and applied ethics (BBC, 2019; Dimmock, M., & Fisher, A., 2017).

Moor's 1985 paper describing the analysis of the nature and societal impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology, established him as one of the pioneering theoreticians in the field of computer ethics. IEEE in its paper on Ethics for Big Data and Analytics has listed various codes and conducts of ethics related to Big Data Analytics and Internet of Things (IEEE, 2016). Digitization and Automation gives AI an independent decision-making ability (Mayer-Schönberger, V., & Cukier, K., 2013).

Stuart Russell describes the development of algorithms that mimic autonomous human ethics (Wolchover, 2015). Autonomy in refers to the ability of a computer to follow algorithms in response to environmental inputs, independent of real-time human intervention. Meaning, autonomous robots and AIcan thus figure out things out for themselves (Science Daily, 2015).

In AI we concentrate on concepts of moral values and awareness on a whole. We aim to bring about an ethical transformation of AI, using organizational transformation merged with ethics to produce a new passenger experience (Annualreviews. org, 2019; Elliott, A., & Radford, D., 2015).

The Singularity is the idea that ordinary humans will someday be overtaken by artificially intelligent machines or cognitively enhanced biological intelligence, or both (MIT Press, 2019). The technological singularity (or the singularity) is a hypotheticalfuture point in time at which technological growth becomes uncontrollable and irreversible, resulting in unfathomable changes to human civilization (Economist, 2015). Strong AI might bring about a 'super-intelligent explosion', a term coined by I. J. Good in 1965 (Mindstalk. net, 2019). According to the intelligence explosion, an upgradable intelligent agent such as a computer running software-based artificial general intelligence, would enter a "runaway reaction" of self-improvement cycles, with each new and more intelligent generation appearing more and more rapidly, causing an intelligence explosion and resulting in a powerful superintelligence that would, qualitatively, far surpass all human intelligence. AGI would be capable of recursive self-improvement, leading to the rapid emergence of artificial superintelligence (ASI), the limits of which are unknown, shortly after technological singularity is achieved (Mindstalk. net, 2019).

Control and value. The purpose of this study is to address the gaps in literature by providing a new conceptual framework Integrating IoT into the Passenger Experience at Airports. The analysis is carried out to show the relation between IoT and UI/UX Passenger Experience while leading to sustainability.

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Figure 7: Conceptual Framework for a Sustainable Passenger Experience in AI at Airports. (Ai-mseu, 2019)

In the Methodology, we refer to the Sanders Research Onion and determine the six layers used in this research. We will be carrying out a thematic analysis in the analysis and findings section, carried out on the secondary data in an attempt made to find patterns in the data. This is carried out using the NVIVO software and coding the data.

3. Literature Review

3.1Technological Singularity as a Disruption

Under this topic we look at two main laws; the Moore's Law and the Law ofAccelerating Returns (*The Technological Singularity*, Murray Shanahan, 2015).

Moore's Law states that; processor speeds or overall processing power for computers will double every two years. The rate of increase in speed of computers varies as alternate inventions but is rapidly increasing and is fast enough to cause an impact but not at the rate as mentioned by Moore owing to physical barriers in technological progression, although it is exponential. This allows computers to simultaneously grow smaller and more powerful. It does seem plausible and is certainly achievable to create a computer that can outperform a human's brain, thus the technological singularity is very possible. The Law of Accelerating Returns states that a specific paradigm (e. g., shrinking transistors on an integrated circuit as an approach to making more powerful computers) enables exponential growth until its potential is exhausted. When this happens, a paradigm shift (i. e., a fundamental change in the approach) occurs, which enables exponential growth to continue and recur. This now seems to be doubling every year (Moore's Law, 1993; Kurzweil, R., 2006; 21stcentech. com., 2016).

The Law of Accelerating Returns also states the possibility of infinite loops of the recurring occurrence of one singularity within another. This would occur in a shorter time frame each time around, like a constant; as similar to the speed of light. This process would eventually turn out to be so quick that it would be impossible to follow it, let alone control it and would quite dispel the illusion of us having our hand on the plug.

The technological singularity would thus be a disruptive force when it comes to AI. We can make AI sustainable by embedding ethics in AI to prevent a technological singularity from occurring and improving passenger experience and control at airports.

3.2 AI Ecosystem in Airports

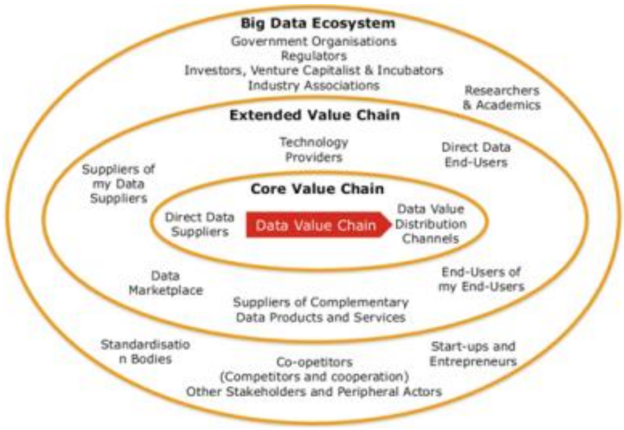

Figure 11: Big Data Ecosystem based on Moore's Business Ecosystem (Moore's Ecosystem, 1993).

Aviation is in need of more security especially after the implementation of Artificial Intelligence in its operation. IOT driven Blockchain will help enhance efficiency of the aviation business and address gaps in security and integrity of data flows.

IoT driven Blockchain:

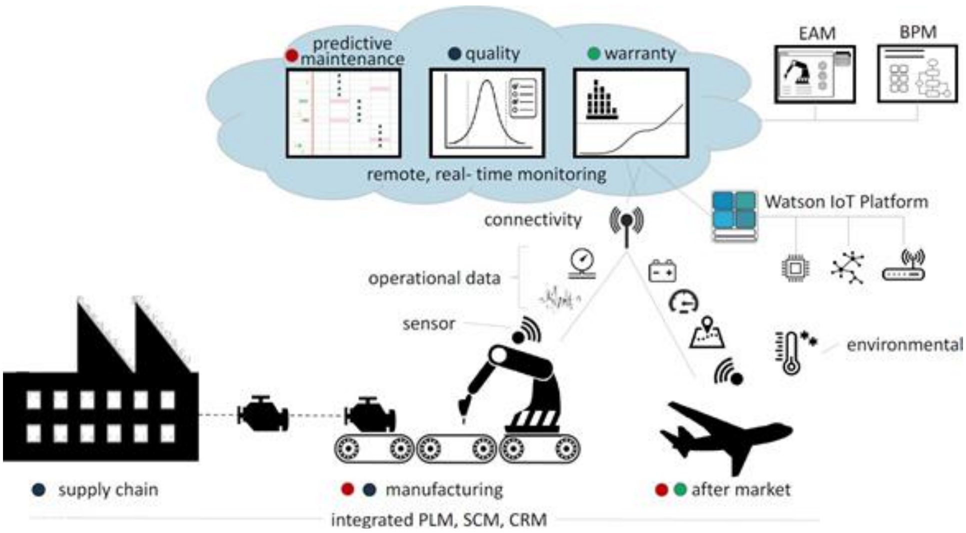

Figure 12: Conceptual Framework of IoT driven Blockchain (SITA, 2019)

Blockchain is decentralized and holds information on all components and parts. The data got from big data on fuel efficiency, smart maintenance, airline safety or customer sales can all be stored in the Blockchain and accessed by

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each manufacturer in the production process, the aircraft owners and maintainers, and government regulators. This will allow us to anticipate and troubleshoot problems before they occur and improve predictive maintenance as well as reduce the occurrence of accidents and incidents. This is also improves security and minimizes risk. This also improves customer transparency and brings more value to the passenger who is then capable of making more informed decisions leading to more options for passengers and avoidance of disruption with high business potential for airports (Biometric Technology Today, 2018).

Figure 13: Percentage of Airlines and Airports that have or are planning Blockchain and R&Dprograms by 2021 (SITA, 2019).

This enables more trust and transparency and allows for sharing of information with customers or passengers, helping them make more informed decisions as well as gives good visibility to all stakeholders in the chain. Additionally this reduces costs, risk and time extensively and decentralizes the system. This helps increase efficiency by mapping the lifecycle of a passenger or customer and the lifecycle of an aircraft and applying this system to it and making it easily accessible to the stakeholders in real time. This technology is huge on cost saving and on reducing staff required to do the job at airports.

Figure 14: Percentage of Airlines and Airports with established partnerships for IoT and Blockchain (SITA, 2019).

Blockchain and IoT is expected to be used in ticketing, loyalty, security and identity and maintenance in the near future (Accenture, 2019).

Blockchain is inevitable and has huge potential when it comes to airports and cyber security. In this study we will go over how Blockchain is used at airports. Since increasing number of developers and enthusiasts are using Blockchain technology, it has been evolving at a quicker pace than suspected. Blockchain communities are working on building a more secure and user-friendly Blockchain ecosystem to make it more versatile. "According to IDC estimates worldwide spending on Blockchain solutions projected around $2.9 billion in 2019, an increase of 88.7% from 2018. It is expected to reach $21 billion in 2025, wherein Aerospace industry executes Blockchain technology in 75% of the overall activity, i. e., 754 billion dollars per year in industrial settlements and payments, digital identity management, procurement transformation in B2B businesses, etc. " (Tarun Rama, 2019).

"The potential growth of Blockchain in the aviation industry leads to a 7.6 trillion dollar industry" (Tarun Rama, 2019). As new technological adaption will be essential for future airports, Blockchain will be of core importance in reducing costs and maximizing efficiency.

The benefits are seen from simplification of the contracts, contract enforcement, preventing disputes by having a single source of the truth, monitoring of service delivery during the fulfilment stage and introducing real-time service acceptance, along with streamlining the process of accounting, reconciliation, invoicing and settlement.

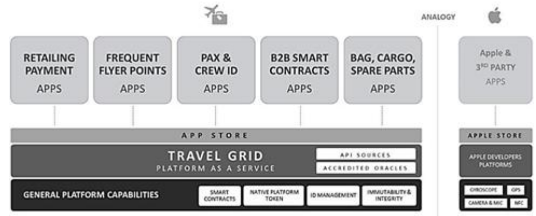

Figure 15: The Blockchain Travel Grid. (Tarun Rama, 2019).

The Blockchain is mathematical proof that something happened (Adam Draper, 2019).

As Internet of Things, Artificial Intelligence, Machine Learning, AR/VR, and Automation will be streamlining in days to come, It is believed that Blockchain technology will play an important role in making these innovations environmental friendly for a sustainable future (Tarun Rama, 2019).

Figure 16: Key Pillars of Blockchain as used at Airports (Tarun Rama, 2019).

Figure 17: IoT information value loop (Deolitte, 2019).

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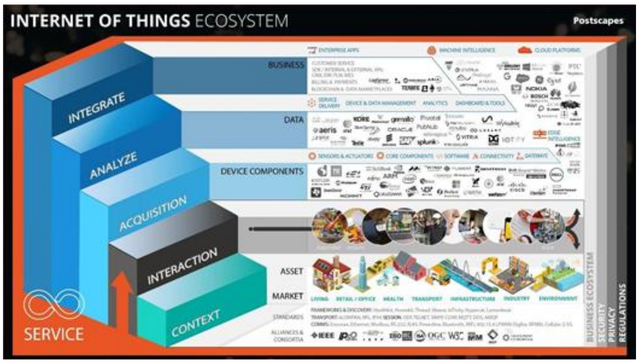

Figure 18: IoT Ecosystem. (Europa. eu, 2019)

In the future, the Internet of Things may be an open source network in which auto-organized or intelligent entities like web services and virtual objects like avatars will be interoperable and able to act independently and collectively; depending on the context, circumstances or environments. This will also lead to integrated solutions and more streamlined operations (Novatec-gmbh. de, 2019).

Airports will benefit from including RFID tags to track baggage and resolve baggage issues using IoT (Ieee. org, 2019). What these first movers are finding is that an investment in smart devices is only part of the puzzle. They must also plan carefully for the architecture that links data, decision, and action into a self-driving loop" (Deloitte, 2019).

3.3 Robotics and Autonomous Vehicles at Airports

Thankfully with the help of AI and machine learning smart robots have now developed the ability to learn and expand their knowledge to provide more relevant information to passengers and better operational capabilities to airports (Ivanov, *et al., 2017).* This will soon play a crucial part in the near future in building that bond between passengers and airports in the future as it tends to improve passenger experience and reduce stress levels (Ivanov, *et al., 2017).*

3.4 AI and Immersive Experiences at Airports

With Virtual Reality and Augmented Reality in growing demand, some airports and airlines have begun to create more immersive experiences both in the terminal and in-flight. Clearly, airports and airlines see some potential in AR and VR, but were still unsure as to whether the technologies will bring about entirely new forms of in-flight and in-lounge entertainment that will stand the test of time.

3.5 Cybersecurity

The risks associated with cybersecurity and identity theft seem to be on the rise with terrorism and without Blockchain in place in the current system top secure airports digital identities of passengers. The use of a centralized system makes it easier to hackand obtain the digital identity of a passenger and misuse it. Once decentralized with Blockchain this will be increasingly difficult.

3.6 Assistive Technology

Airports and airlines around the globe need to pay more attention to assistance given to passengers in need, which is much similar to merging occupational therapy with airports and aviation to provide means for disabled passengers to have a good passenger experience and be able to travel independently and easily. There is good potential to increase business and bring more value to passengers with additional needs at airports (Fosch-Villaronga, E., & Millard, C., 2019).

3.7 Business Capabilities

While in terms of business we can achieve the following;

a) Prediction (strategy and decision making)
b) Correlations with data (consumer behaviour vs conversions)
c) Agile and adaptable (easy contingency and re-planning in case of disruptions)
d) Machine learning (learning from experience) (IATA, 2018).

Figure 29: Business capabilities in service execution management at airports using sustainable AI. (Servicemax. com, 2019).

Figure 30: AI Technology Innovation using Cloud-Pipe-Device Architecture (Kshitij, 2017; Slideshare, 2019).

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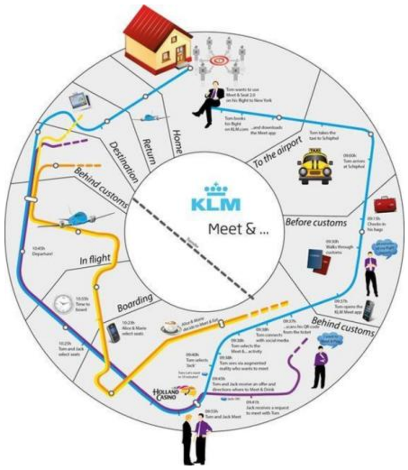

Figure 37: Target passenger journey (Behance, 2019)

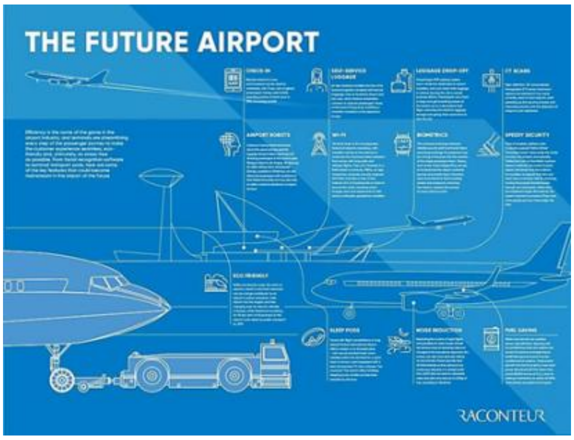

Figure 39: The Future Airport (Raconteur. net, 2019).

4. Conclusion

Thus, as Innovation is of key importance to sustainability, we need to develop an integrated system using the above frame works to connect the dots. Moving towards Airport 4.0 is bringing about a digital ethical transformation and this will increase complexity at airports.

1) Strategy
2) UI/UX Design
3) Sustainability
4) Digital Transformation

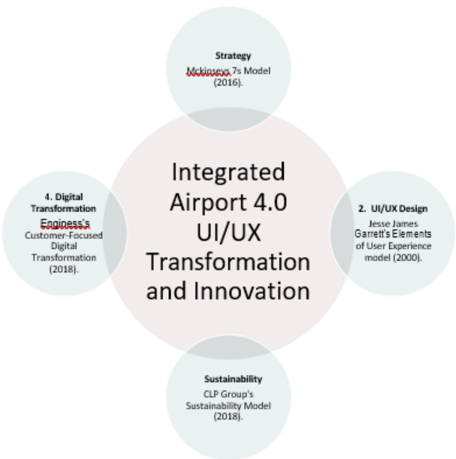

Figure 45: Integrated Airport 4.0 Digital Innovation Model

5. Summary of Discussion and Findings

Passenger Traffic is on the rise globally and it is predicted to increase in the future while airports are undergoing a customer focused transformation to improve value to passenger, airline routes as well as revenue (IATA, 2019). Competition being the main driver of innovation, providing a differentiated passenger experience which is secure and time saving is of key importance for sustainability (Acm. org, 2019). Theincrease in passenger traffic is poses a capacity and cybersecurity threat at all airports. Technology and Artificial Intelligence are core to bring about an improved ethical passenger experience. Passengers want to be able to have good accessibility and transparency through information and options for decision making as well as control at their fingertips on their device or interface of choice.

This direct connection with an individual passenger, using a single authentication point via their user interface to access multiple touch points and the streamlined convenience and control given to the passenger will make the digital airport of the future their hub of choice, resulting in passenger loyalty in business, sustainable growth and better accessibility.

Analyzing ecosystems and bringing about a holistic experience to customers and passengers is a key driver for Innovation and Sustainability. Value and Differentiation as mentioned by Porter is critical to the successes of aviation businesses worldwide. By increasing transparency to passengers, it enables them to control, select and adjust their value offerings leading to quality of service. Similarly, service providers using IoT can have access to Big Data and information that can allow them to adjust their differentiation in their offerings to passengers to provide the most relevant offers for passengers and results for the airport business. Whether variables are psychographic or demographic, it can be used to provide contextual and personalized and relevant services to the passengers, which will in turn increase customer or passenger engagement (e. g., digital advertising), which will further result in increase in passenger traffic, airlines, market share and revenue.

The presence of new generation travellers will significantly influence and force and drive change upon airport operations, strategies, as well as the technology and tools needed to provide an impactful passenger experience (Sean Graham; aviation pros, 2018).

6. Further Research

This research is limited to qualitative data and secondary data and further research can be done using empirical data later. This study however only concentrates on AI at airports. This research can be generalized to other fields of application of AI as well if suited. This research can also be improved and is open to further research on this topic.

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