**Exploring 3 Tier Architecture System And**

**Sustainable Software Design In Airline Reservation Systems**

**Prepared For**

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**Introduction**

This report aims to explore the idea of **3-Tier Architecture System** in software design and also explore the ecological impacts of **Airline Reservation System ,** therefore exploring the relationship between technological infrastructure and sustainable development. The main rationale of this report is to highlight as to why 3-Tier Architecture System is chosen for software design and also to discuss in what way does Airline Reservation System impacts the environment.

**3-Tier Architecture System**

**Definition of 3-Tier Architecture System**

The traditional architecture that has been used in most of the legacy systems is the monolithic architecture. In this design of a software program, all of the components of a system are strongly coupled and are strongly dependent on each other (Awati & Wigmore,2022). This has various advantages but the disadvantages of using this software design pattern outweighs all of the advantages combined. To tackle this, the concept of 3-Tier Architecture system was introduced. In this design, the data process is divided into three tiers(Jun et al,2011):

* Presentation Tier
* Application Tier/Business Logic Tier
* Data Storage Tier

A diagram of a computer server

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Figure 1 3-Tier Architecture System (Jun et al,2011)

**Presentation Tier**

This is the tier that acts as the interface between the user and the application, providing the user with friendly access to the system. It includes all the necessary graphical components that the user can access to access the application logic (Jun et al,2011). The main responsibilities of this tier is to **display important information, handle user interaction and deliver the requests to application tier for processing** (Hajdas,2023)

**Application Tier / Business Logic Tier**

This is the middle tier that acts as a bridge between user interface and the database models, it contains all the business logic that is necessary to implement the software solution, it also abstracts all the implementation details from the user (Chen et al,2003). Components or functions in this tier receives the request from the Presentation Tier , processes it , performs the necessary functions and then queries the Data Storage Tier. The main responsibilities of this tier are **managing transactions, communicating with data tier and performing business logic** (Hajdas,2023)

**Data Storage Tier**

This tier manages all the application and user data and responsible for modelling information needed for the system. Data that is needed to process business logic is retrieved from the data tier that is then sent to Application Tier, where after performing the business logic either the data is stored back in the Data Tier or sent to the Presentation Layer for the user to see it (Chen et al,2003) .The main responsibilities of this tier are **ensuring** **data accuracies and integrity, managing database transactions and storage of data.** (Hajdas,2023)

**Benefits of 3-Tier Architecture System**

This design offers various advantages in the development of the software system.

1. The most important benefit of this pattern is **Separation of Concerns (SoC),** each tier in this pattern is responsible for a certain set of requirements which leads to isolation of a component and thus can be managed independently, which also provides an ease in **maintainability**.(*What is three-tier architecture,* n.d.)
2. This also leads to ease in **scalability**, as each component can be scaled independently without having to change the other tiers/components.(*What is three-tier architecture,* n.d.)
3. Failure of one tier is less likely to cause an impact to the other components in the system, thus leading to an increase in **reliability** of the system.(*What is three-tier architecture,* n.d.)
4. Since the components of the system are modular , they can be reused in different aspects of the application , **saving time and manual effort.** (*What is three-tier architecture,* n.d ; Hajdas,2023)
5. Efficient resource utilisation is encouraged thus leading to a cut in **operational costs.** (*What is three-tier architecture,* n.d ; Hajdas,2023)

**Environmental Implications of Airline Reservation System**

**Airline Reservation Systems**

Airline reservation system is a comprehensive computerized system used by airlines to manage and facilitate air travel-related activities, including flight bookings, inventory control, and passenger management. It incorporates various functionalities such as airline schedules, fare tariffs, passenger reservations, and ticket records. The system allows airlines to sell their inventory, manage seat assignments, and store flight-related information. They interface with **Global Distribution Systems (GDS)** to make their services available to travel agencies and online booking platforms (Saiyed,2024)

**A diagram of a system

Description automatically generated**

Figure 2 Various aspects of airline reservation system (Namita,n.d.)

**Environmental Impact Of Airline Reservation Systems**

Airline reservation systems utilise a lot of resources through their operational and non-operational functions, they use data centres to store the large amount of data collected from the systems, then the Global Distribution Systems **(GDS)** connects a single system to many travel agencies and online booking platforms which leads to much more consumption of energy leading to an increase in the carbon footprint generated by them (*Global Distribution System Airlines,* n.d.) . A recent report by Amadeus (Becken & Pant, n.d) states that the total amount of carbon emitted by airlines in total would increase by 3.6 times in 2050 and if it is not put to halt, the airline industry could play an integral part in contributing to the Greenhouse gas effect. Another report by McKinsey (Ahmad et al,2022) states that most of the passengers prioritise price and connections over the sustainability in booking decisions over the reservation system. It also states that most of the present reservation system only allow to sort the flights by connections or the price of the flight but there is no filter to sort them based on the basis of how sustainable they are or what amount of carbon footprint are they leaving behind. According to a survey of Institute Of Travel Management. (Walson,2022), 75% of the people are dissatisfied with the online booking tools to include carbon budgets and the carbon emissions at the Point-of-sale which again scrutinizes on the fact of reservation system to be much more inclusive of the sustainability idea while the customer wants to book a ticket.

**Sustainable Solutions For Airline Reservation Systems**

Software can be used to optimize the resource usage within airline reservation systems to reduce energy consumption and minimize environmental impact. Also, quantifying emissions, the user shall gain valuable insights into the largest sources of carbon dioxide emissions associated with their business travel activities, allowing them to prioritize areas for improvement and develop an effective action plan for carbon reduction, this can be achieved by providing the data to user on the reservation app (*Co2 & Business Travel*,2021). Moreover, not all airlines contribute equally to carbon emissions, even when operating on the same routes. Acknowledging the significant impact of Carbon-dioxide emissions associated with flying, one effective approach would be to assess the environmental impact of different airlines serving the routes frequently travelled by them employees and compile a list of the most carbon-friendly options (*Co2 & Business Travel*,2021). Several criteria can be considered when evaluating the eco-friendliness of airlines. Examining the amount of CO2 emitted by specific flights and airlines provides valuable insights into their environmental performance and should be made available to the customer on the airline reservation system. One such solution by an airline, Air Canada ,whose reservation system now allows the users to choose the carbon offset provider while booking their flights, which also helps customers learn about GHG emissions and how to compensate for them during their travel (Air Canada,2022).

**Software Solutions For Airline Reservation Systems**

Airline reservation systems often handle a large volume of transactions and user interactions. A three-tier architecture should be implemented here as each tier can be scaled independently based on demand. For instance, the presentation layer can handle user interface interactions, the application layer can manage business logic and transaction processing, and the data layer can handle data storage and retrieval. This modular approach enables the system to handle increasing loads effectively without compromising performance thus decreasing the energy usage and leading to much less carbon footprint (Jun et al,2011). Then we also have the issue to store large amount of data, tackling these problems in such large-scale systems can be solved by the help of database sharding as well, wherein you can partition the database system horizontally which again leads to much more reliable systems and also provides with reduced resource utilisation(Drake,2022). Another aspect of large scale systems like airline reservation is the use of data centres, in this case cloud computing can help them reduce their carbon emissions by 50-60% compared to traditional data centres. The providers are making sustainable data centres a reality by using alternative power sources and offsetting their carbon footprint (BBD,2023)

**Conclusion and Reflection**

Reflecting on the significance of sustainable software design defines its pivotal role in shaping the future of technology and environmental stewardship. Understanding the environmental impact of systems like airline reservations not only prompts us to address immediate challenges but also inspires innovation towards greener solutions. Balancing technological advancement with environmental responsibility necessitates a paradigm shift in software development practices, prioritizing energy efficiency, resource optimization, and low carbon-footprint principles. By integrating sustainability into software design processes, as has been discussed in this report ,we pave the way for a more sustainable future, where technology serves as a catalyst for positive environmental change rather than contributing to ecological harm.

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