Using Airport Geographic Information Systems (AGIS) to develop a comprehensive digital library for Erbil International Airport

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Abstract. Based on the principle and general implementation process of GIS and the characteristics of airport pavement management, this paper describes the implementation process of GIS for Erbil Airport planning and design. To organize the spatial entities effectively, some layers are set according to the characteristics of spatial entities. The spatial database is established, and then the function design of GIS software is presented including map exploring, map locating, spatial query, rendering style of map and output of map. Airport managers are finding that an integrated geographic information system (IGIS) can help them to better manage both air- and ground-side operations. In this paper the section on the ground was the case study, representing the AGIS in building infrastructure layers of Erbil international airport buildings and pavement. The results were a map includ multi layers; each layer has information that contains a comprehensive database. Even more the digital library for Erbil International Airport involves general information about aircraft noise pollution and studying its effect on the surrounding area of the flight track generating a noise pollution map. Digital library also helps in controlling pavement characteristics changes and determining airports’ future developments.

Keywords
AGIS, Airports, Digital Libraries, Digital Maps, GIS, Mapping, Photogrammetry and Transportation

1. Introduction
Travel demand grows today due to population demand are increased, which leads to airports are evolving rapidly. Consumers and travelers are causing the airports' operators to think about new ways for meeting their needs, while new airports are daunting prospects of building new facilities that are wholly integrated on both ground and air sides, and connected through integrated services that allow for higher levels of data management and enablement of digital services to travelers [1].

Large airports might contain constant services for base operator, air traffic control, seaplane docks and ramps, emergency services, and passenger facilities such as lounges and restaurants.

Also, an air station or airbase is called as military airport, as it's clear in figure (1) [2].
2. Case study

The Erbil International Airport (EIA) has been selected to be a case study for this paper. It was built on the same area, which was in the past used as a military base and an airfield until 1991. After 2003 Erbil city was becoming the destination area of foreign investments [4]. The old airport of Erbil had a gross area of 7000 m² and was separated into arrival and departure halls. The old airport in the past had three gates and one runway, which was originally allocated for military purposes, was 2,800 m long and was provided with An Instrument Landing System (ILS) which is, a highly accurate radio signal navigation aid consisting of two antennas which transmit signals to receivers in the aircraft cockpit.

A glide path tower located next to the runway at the northern end, while a localizer antenna at the southern end. These antennas provide the pilot with vertical and horizontal guidance when landing in low visibility. An ILS is not used by departing aircraft [2]. The new airport with its terminal building was opened in 2010. It was built on ground area of 27,000 m².

Both digital and analogue data are gathered for the study area including: A digital base map for Erbil airport site, which is illustrated in figure (2).
3. Building the Themes of Pavements of the Digital Map

Before generating a pavement digital map, it is necessary to make in-situ investigations and thus figuring out that the Erbil International Airports roads pavement are divided into three groups, each group contains different pavement layer represents different airport road parts as mentioned in Tables 1, 2, and 3, and shown in figures 3 and 4.

| Table 1. Composite Pavement (Rigid and Flexible) used in Airport Runway |
|-----------------------------|------------------|
| Layer                      | Thickness        |
| Surface Course layer        | 23 to 40 cm Portland cement concrete material  |
|                            | + 5 to 10 cm Asphalt surfaces                      |
| Base Course layer           | 15 to 30 cm crushed stone or gravel material       |
| Subbase Course layer        | 30 cm lower quality granular aggregates            |
| Subgrade                    | Natural Soil layer                                   |

| Table 2. Flexible Pavement used in Airport Taxiways |
|-----------------------------|------------------|
| Layer                      | Thickness        |
| Surface Course layer        | 5 to 10 cm Asphalt surfaces                          |
| Base Course layer           | 15 to 30 cm crushed stone or gravel material         |
| Subbase Course layer        | 30 cm lower quality granular aggregates             |
| Subgrade                    | Natural Soil layer                                   |

| Table 3. Rigid Pavement used in Airport Aprons, Blast Pads & Helipads |
|-----------------------------|------------------|
| Layer                      | Thickness        |
| Surface Course              | 23 to 40 cm Portland cement concrete material       |
| Base Course layer           | 15 to 30 cm crushed stone or gravel material        |
| Subbase Course layer        | 30 cm lower quality granular aggregates             |
| Subgrade                    | Natural Soil layer                                   |
Figure 3. The developed themes of Erbil International Airport.

Figure 4. Erbil International Airport road pavements [7].
Feature dataset must have a spatial reference; this spatial reference is obtained from the satellite photo (import the reference) to ensure that layers of feature dataset (feature classes) are matched with the satellite photo. Another feature class inside feature dataset are developed (It takes the same reference of feature dataset, which will help us in defining the spatial reference only once in the feature dataset). Each feature class represents a layer and must be defined its shape as a polygon, line, point etc. In these layers more fields can be added for each data type [3].

The digital map was developed as shown in figure (5), which include (EIA total map, which represents in nine themes, scale bar and compass direction) [5].

![Figure 5. The developed digital map of Erbil International Airport [4].](image)

4. Airport Development Suggestions
The year of 2013 underscored the position of Erbil International Airport as a departure point and entry point of Iraq with passengers of 90.3% who arriving from, or departing to, international destinations with only 9.7% passengers travelling on the domestic routes. For this reason and other reasons mentioned before representing the growth of the city of Erbil and this in terms indicates the growth of its airport, a future plan should be made for developing Erbil International Airport. Three suggestions are proposed to do by starting from the main part of the airport, which is analyzing the runway of the airport master plan using Arc GIS software:

a) For increasing the capacity of the airport, it is suggested to build a new runway parallel to the current one. The spacing between parallel runways vary vastly; the wideness (spacing) can be divided into far, intermediate, and close, depending upon separation centerline distance among a pair parallel runway. Close parallel runways are spaced from a minimum of 213.36 m (700 feet) (for air carrier airports) to a less than 762 m (2500 feet). For this proposal it is used a close parallel runway spacing of 250 m [1]. see Figure (8).
Numerous airports own a pair or multiple runways in various orientations passing each other. These are mentioned to as intersecting runways. Intersecting runways are important when relatively strong wind takes place from many directions, resulting in extreme crosswinds when only one runway is used. When the wind is strong, only one runway of a couple of the intersecting runways can be provided, lowering the capacity of the airfield substantially. If the wind is relatively light, the two runways can be used simultaneously. The capacity of both intersecting runways relies on the location of the intersection (i.e., midway or near the ends), the manner in which the runways are operated for landings and for takeoffs, referred to as the runway use strategy, and the aircraft mix. Since the annual wind rate of the city of Erbil is north-easterly winds and the current runway is to the north, thus we have been proposed the establishment of a second runway eastward intersects with the existing runway to increase the capacity of the airfield [8]. See Figure (7).

Figure 6. development proposal1 (parallel runway) [4].
Figure 7. Development proposal 2 (intersecting runway) [4].

c) Third proposal involving on increasing the width of the existing runway by 10 m (75+15 m old to 85+15 m new), Taking into consideration modifying the existing buildings, roads and fences. While keeping the current length of the runway as an adequate, this proposal supports increasing the airport capacity by allowing large aircrafts to be landed freely. see Figure (8).
Figure 8. Development proposal 3 (widening existing runway) [4].

5. Conclusions

a) For Erbil International Airport becoming as one of the main entry and departure points for Iraq and in view of the clearly growth of the city of Erbil and this in terms indicates the growth of its airport, Assuming the airport is one of the outer gates of the city.

b) From current work results we recommend that future plans have to be made for developing Erbil International Airport and increasing the capacity of the airport, depending on the growth the airport passengers and cargo.

c) It is recommended to intersect the runways as relatively strong multi direction winds occur, which results in more crosswinds as one runway only is used. Both runways can be used simultaneously, when the winds are almost light.

d) It is recommend to increase the width of the existing runway by 10 m (75+15 m old to 85+15 m new), Taking into consideration modifying the existing buildings, roads and fences. While keeping the current length of the runway as an adequate.

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