Safe Flight 21 Airport Compliance Assessment Using GIS

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ABSTRACT

Airport geospatial features are studied, analyzed, and prioritized for Safe Flight 21, using GIS methodologies. Eighty airports in the U.S. were involved in the initial study that determined their degree of geospatial database compliance with DO-272. However, because of the nature of the preliminary results, further efforts were required. This study focuses on prioritizing the geospatial features in terms of flight safety. ESRI's ArcView/ArcGIS software were used in this study. Ten criteria, based on general flight processes were developed and imposed on each of the geospatial features and their attributes. This effort ensures that the appropriate weighting and ranking values are assigned correctly for prioritization of the geospatial features. Results would enable airports achieve compliance with DO-272 in a timely and cost-effective manner.

INTRODUCTION

Safe Flight 21 is a joint government and industry effort geared towards improving safety, efficiency, and capabilities of the National Airspace System. This effort uses Geospatial, Automated Dependent Surveillance-Broadcasting (ABS-B), Flight Information Service-Broadcasting (FIS-B), Traffic Information Service-Broadcast (TIS-B) technologies [1].

Surface Application is one of eight areas, where these technologies would be applied, so as to enhance the safety and efficiency of issues relating to airport surface. Tower displays, cockpit moving maps, and surface management systems (SMS) were three of the Federal Aviation Administration's (FAA) Top 10 Action Items List selected for consideration in the assessment of these new technologies [2].

In order to meet the goals of the Safe Flight 21, it was necessary to determine the degree of Safe Flight 21 database compliance; meaning verify compliance of FAA Safe Flight 21 airport map databases with RTCA requirements, as specified in document DO-272 (User Requirements for Aerodrome Mapping Information).

Figure 1. Safe Flight 21 airports used in this study.

Eighty airports from 37 states were analyzed (Figure 1). Each airport had 31 geospatial features and a total of 377 attributes (Table 1).

Results of the database compliance suggest that more work needs to be done in order to obtain meaningful/significant degree of compliance for almost all of the 80 airports that were analyzed in this study (Figure 2). For example, the highest average compliance obtained was 48.27% (1 airport) and more than 20 airports had less than 30% average compliance (see Appendix A).

After careful assessment of the results, it was decided that additional efforts be made to develop an optimum approach to getting airports attain compliance (meet their obligations), in terms of FAA Safe Flight 21 Goals (Figure 3).

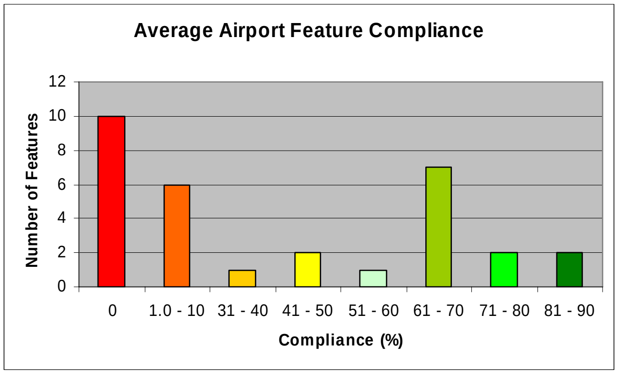

Figure 2. Safe Flight 21 average feature compliance color coded and categorized to show level of compliance for all eighty airports. Note that 10 features had 0% compliance.

Prioritizing all the geospatial features in terms of their importance and relevance in terms of flight safety could be a better approach to take [3]. As such GIS methodologies of weighting and ranking were selected as a cost-effective way of accomplishing this task [4]. If the features were to be weighted and ranked, airport authorities and managers would be able to better utilize their resources and thereby get into the FAA's Safe Flight 21 compliance faster.

MATERIALS AND METHODS

Materials for this study came from Safe Flight 21 database and RTCA DO-272 document; ArcView software was used to develop the GIS coverages. Weighting and ranking procedures were utilized in this study, since it provided a more convenient and accurate method of assessing and determining the relative importance of each geospatial features.

Because of the nature of this method it could easily be applied and/or duplicated in other areas of flight safety [5].

Two approaches were used in ranking (determining the importance) the 31geospatial airport features in the database. The first approach (a generalized approach) uses 10 criteria to assign weighted values to the features (see Appendix B).

A flow chart was developed in order to ensure that a feature gets assigned a proper weighted value (WV). Thus by imposing the criteria on each feature, the impact of the feature in the database could be determined.

A weighted scale of 1 (little or no impact), 3 (moderate impact), and 5 (maximum impact) was used in assigning values to each feature. For example, assigning a WV of 5 would indicate that the absence of that feature may result in serious injury and/or property damage, a WV of 3 would indicate that the absence of that feature may result in no injury/moderate damage to property, and a WV of 1 indicates that the absence of that feature may not affect the safety of the flight process. Finally, the total weighted values (TWV) for all the features were computed and used in ranking the geospatial airport features (Figure 4).

Figure 3. Safe Flight 21 average airport feature compliance for mainland Unite States.

For example, if the geospatial database does not contain Runway feature, landing/taking off would be very difficult if not impossible; it might even result in serious injury and property damage. Therefore, a WV of 5 was assigned to the Runway feature. After this process, the rest of nine remaining criteria were imposed on this same feature (Runway). At the end, the total weighted values (TWV) for all the features were computed and used to rank the geospatial features in order of their importance to flight safety.

The features with higher TWV are ranked most important or higher priorities, while the features with lower TWV are ranked lower (see Figure 4).

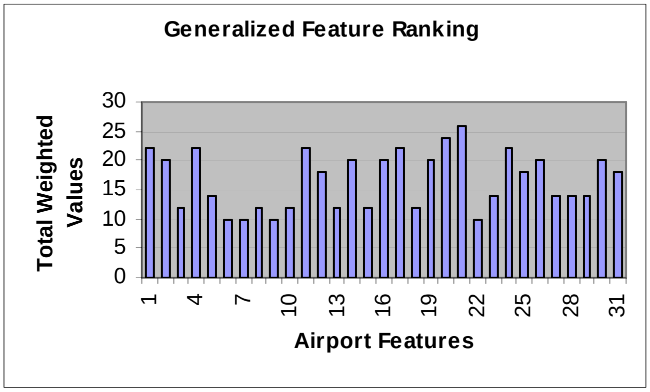

Figure 4. Generalized ranking of airport features.

In the second approach, the flight process was divided into three phases. Phase 1- Take-off/Landing phase, Phase 2 - Taxi-to/from Gate phase, and Phase 3- Gate/Apron Phase (Boarding/Deboarding/Servicing) Phase.

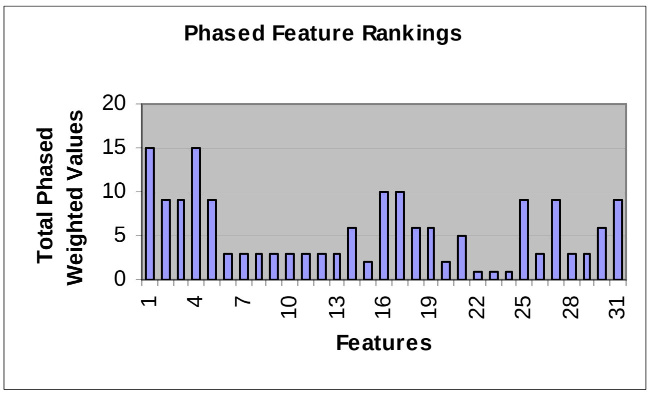

Figure 5. Phased ranking of airport features.

Each phase was weighted based on the complexity of the process. A phase weighted value (PWV) scale of 3, 2, and 1 was used, where 3 means that the process is very complicated and that the result could be severe if something should go wrong, 2 - means that the process is critical but not as complicated as the first one, and that the result could be less severe if something should go wrong, and 1 means that the process is not complicated and that the result would not be severe if something should go wrong.

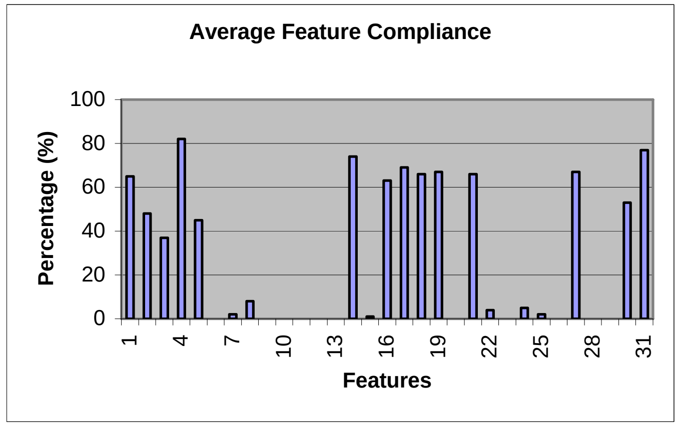

Figure 6. Average airport features compliance.

The 31 features were placed in one of the three phases based on their relevance, and weighted values (WV) of 1, 3, and 5 assigned to each feature just as was done in the first approach. At the end, the total weighted values (TWV) were computed by multiplying the PWV by the WV values. The total weighted values were then used to rank the geospatial features in the database (Figure 5).

RESULTS AND DISCUSSIONS

Analyses of the results for both the generalized and phased ranking approaches resulted in 8 ranking categories. In the generalized ranking approach, 22.6% of the features (including the Runway and Apron) were in the top three categories, while four features (12.9%) were in the bottom category (Figure 4).

In the phased ranking approach however, 32.25% of the features (including Runway, Runway Markings, and Taxi Guidance Line) were in the top three categories with only three features (9.7%) were in the bottom category (Figure 5).

A general comparison of the ranking results with the average feature compliance, suggests that features with higher rankings had higher average compliance, while those with lower rankings had lower average compliance. For example, in the generalized ranking approach, ten of the 31 features (31.25%) with 0.0% average compliance were also ranked in the lower categories (Figure 6).

One feature (Deicing Area) however, with an average compliance of 1.75% was ranked higher (number 3 in the generalized approach), indicating that in some areas of the nation and also depending on the time of year, it could be placed in a lower priority or raised up to a higher priority level.

It must be noted that this study does not imply that lower rankings do justify lower average feature compliance. In fact, it advocates the importance of all the geospatial features, and encourages all 80 airports to attain a 100% compliance with the FAA's DO727.

CONCLUSION

A lot of time was spent going through several sources of data files, documentations, and databases. Some of the information was in publications such as books. Over 947,360 pieces of data had to be analyzed for this study.

However, this study successfully demonstrated the applicability of GIS methodologies in enhancing the process of flight safety by cutting down on time and saving money. Creating GIS coverages of all the airport geospatial their feature attributes, provided an easy way of revealing patterns and editing/updating the data. As airport officials and resource manages improve their level of compliance, so too can the process of updating the system.

Because the safety of air travel in the future (when Synthetic Vision System –SVS is implemented) would depend to a great extent on the integrity (accuracy/reliability) of the geospatial database, compliance becomes critical.

In conclusion, this study serves as an instrument that could assist airport officials and resource managers prioritize and allocate resources better, thereby get into FAA Safe Flight 21 compliance in more cost-effective manner.

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APPENDIX A.

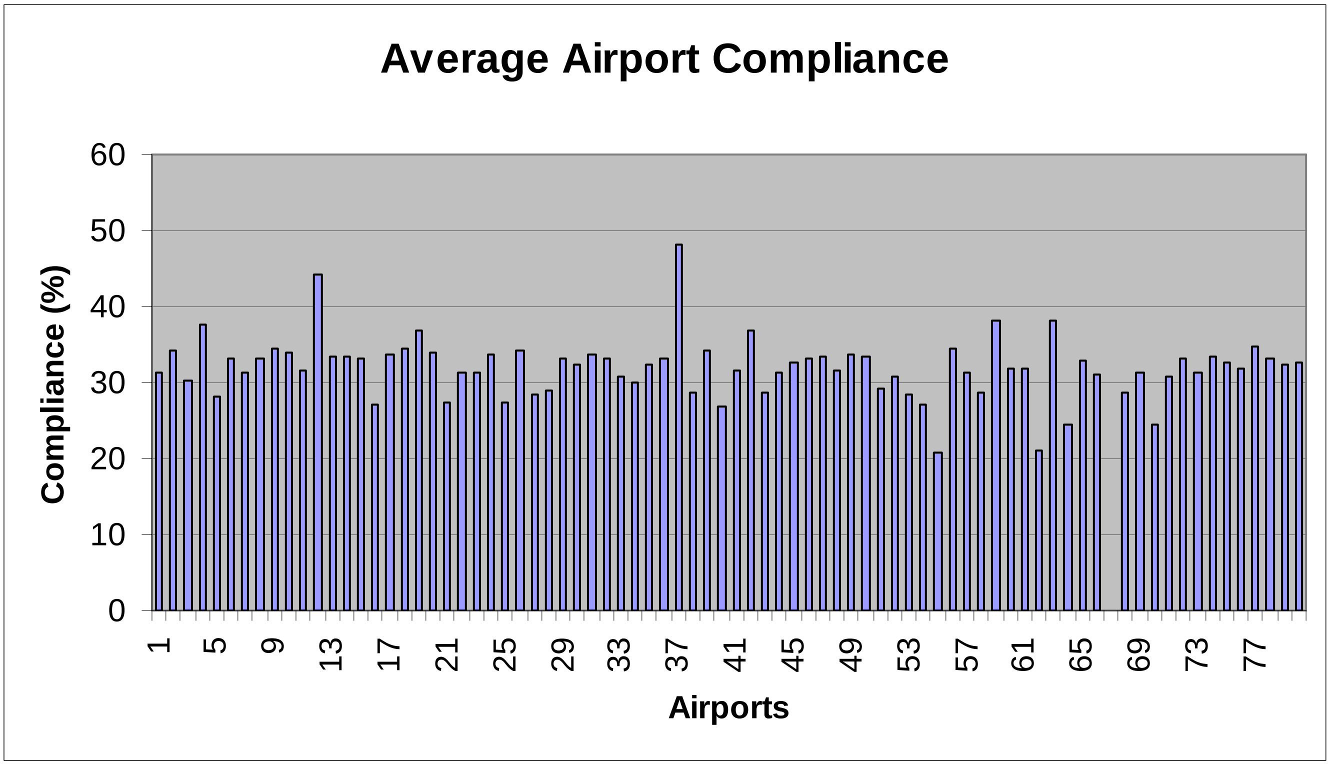

Figure 7. Average airport compliance of the 80 airports, which were analyzed in this study. Please note that data file for airport # 67 was empty, thus showing a 0% compliance.

APPENDIX B.

TABLE 1. Safe flight 21 geospatial features.

#	Airport Features	Feature Type		
		Point	Line	Poly
1	Runway			X
2	Runway Intersection			X
3	Threshold	X		
4	Runway Marking			X
5	Centerline		X	
6	LAHSO		X	
7	Arresting Gear Location		X	
8	Runway Shoulder		X	
9	Stopway			X
10	Clearway			X
11	FATO			X
12	TLOF			X
13	Helipad Threshold	X		
14	Taxiway Segment			X
15	Taxiway Shoulder			X
16	Taxiway Guidance Line		X	
17	Taxiway Intersection Markings		X	
18	Taxiway Holding Position		X	
19	Exitline		X	
20	Frequency Area			X
21	Apron			X
22	Stand Guidance Line		X	
23	Parking Stand Location	X		
24	Parking Stand Area			X
25	Deicing Area			X
26	Aerodrome Reference Point	X		
27	Vertical Polygon Structure			X
28	Vertical Point Structure	X		
29	Vertical Line Structure		X	
30	Construction Area			X
31	Survey Control Point	X		

TABLE 2. Selected criteria used in the general weighting and ranking of airport features.

#	**Criteria**
1	Landing and taking off
2	Getting the aircraft from landing to the apron/gate
3	Getting passengers on and off the aircraft
4	Supply the aircraft (refreshments, consumer products)
5	Servicing the passengers (check loading baggage
6	Servicing the aircraft (refueling, deicing)
7	Loading the aircraft
8	Environmental impact (pollution and degradation)
9	Impact on properties (airport complex including building and equipment) and residence around airport
10	Impact on other aircraft (on the ground and in the air)

References

[1]User Requirements for Aerodrome Mapping Information. RTCA/DO-272. Washington DC. October, 2001.

[2]Lugsch, Bill, Mike Fox, Axel Friedrich, Thorsten Wiesemann. Characterization of Existing Terrain, Obstacle and Airport Databases. Version 1.2(9). Jappesen, June 25, 2001.

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[5]Bernhardsen, Tor. Geographic Information Systems. John Wiley & Sons. New York, 2002.

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