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WHAT TO CONSIDER WHEN IMPLEMENTING REMOTE CONTROL TOWERS? COLOMBIA CASE STUDY

Abstract: The aim of this article is to assist anyone considering implementing these systems. Along the document the main differences between conventional and remote control are stated, with the intention to clarify what advantages they can bring, the changes involved when adopting remote towers, and a brief outline of a transition plan for adopting these systems. Subsequently, the benefits to a country's air navigation from utilizing these systems is discussed by studying the case of Colombia, a country with a unique orography. In addition, the specific characteristics of the airports are analysed to propose the candidates which may have the best outcome if remote tower systems are implemented.

Keywords: remote tower system, air navigation, change management, cost-effectiveness, transition plan

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Introduction

Remote towers transform the conventional provision of air traffic services (ATS) for air traffic controllers, allowing operators to monitor the activity of several aerodromes from a remote tower center (RTC). In this way, the performance of Air Navigation Service Providers (ANSPs) is optimised through cost reduction and efficiency benefits being a direct consequence of the avoidance of the construction of a conventional control tower.

The provision of air traffic service represents between 20 to 50 percent of the total costs of operating an airport, so optimizing the way in which it is given is an important issue as it could radically change air traffic control. Cost-effectiveness in the operation of airports is a major concern. 47 percent of European airports are lossmaking, and 75 percent of those, with fewer than 1 million passengers per year, are not generating any profits. (Nyström, 2019)

Remote tower systems (RTS) were initially developed for low-density aerodromes to achieve a more beneficial method to provide ATS centralising resources and allow exceptional flexibility in service provision. The main incentive for the implementation of RTS is to find an efficient option that can tackle conventional control, ensuring the same levels of safety and security.

The remote aerodrome concept allows the provision of ATS from remote facilities to the controlled areas, without the need for direct observation. Therefore, the service is provided through surveillance systems that monitor the airfield and its vicinity by using cameras and sensors that transmit images via a digital network to the operators.

Although there is not an established regulatory framework for the conversion from conventional to remote tower, new operational procedures are needed, in addition to detailed instructions, for operators to ensure a smooth transition between both operational modes. These innovative systems demand a change management which needs to cover the operational and human environment to guarantee their safe and proper functioning.

Remote control vs. conventional control

What does it change? Remote towers offer the possibility to control the operations of one or more aerodromes or airports from one single position. Due to the surveillance systems installed on runways, taxiways, and hotspots at the airport operated, air traffic control operators (ATCO) and aerodrome flight information service operators (AFISO) are capable of monitoring the operations from a remote tower center (RTC). An RTC is the geographical independent facility from which ATS is provided by indirect observation via surveillance system. For low-density aerodromes or airports, it is possible to control several small airports from a single RTC.

Regarding conventional control, ATS is provided from a control tower located in airports, from which operators monitor the operation of aircrafts in the manoeuvring area and its surroundings guiding them to and from the airport with radio communications, digital aids, and direct visual surveillance. Although situational awareness on digital towers can be controversial, as ATCO and AFISO do not have direct out-of-the-window (OTW) view, it has been demonstrated that the combination of advance surveillance systems and radio communications in RTS is better compared to conventional towers by allowing greater situational awareness.

The ground-breaking feature of RTS implementation was inconceivable until the first airports began to adopt them in 2015. The location of the control tower becomes independent of the controlled aerodrome. Consequently, the position of RTCs can be chosen after conducting a study on the most beneficial areas that allow an efficient use of resources. Nevertheless, RTS could be placed at the same conventional tower in the aerodrome or at a considerable distance in a strategic location with the best conditions for its operation.

If ATS is expected to be provided by the conventional method at an airport or aerodrome, it would require the construction of a fully equipped control tower. In contrast, digital towers offer a more pragmatic solution which leads to a reduction of cost and time until it becomes operational, as there is no need to build a conventional control tower.

Moreover, these systems are commonly used to complement a traditional tower and thus, increase the information received from blind spots that are not visible from the control tower. Also, RTS could integrate a conventional tower to be used as a back-up system if by any reasons traditional systems are not operative. Therefore, the service provision would always be guaranteed in the event of unforeseen situations or maintenance tasks.

What are the benefits? Remote towers can be operated in two different modes: single or multiple. Single operational mode only differs from conventional towers by allowing the tower to be located away from the airport, but only controls one airport at a time, reducing the potential to save capital. With multiple mode, two or three airports with low/medium traffic could be controlled from a single RTC at the same time. Multiple remote towers can create cost savings via economies-of-scale. Clearly, the potential for cost savings is larger for multiple remote towers than for single remote towers. The regulatory framework to operate multiple towers is, as of today, not in place (Nyström, 2019).

Remote towers represent a solution for non-towered aerodromes when considering service provision. RTS can offer a feasible alternative to the time-consuming construction of a conventional control tower. Low density aerodromes can use remote devices to develop them and stimulate those with growing demand. The instalation of a digital tower can be an exceptional feature not only for those airfields under ATS supervision, but also for controlled airfields in remote areas that are difficult to access and could be controlled from one single location.

Airports with a large manoeuvring area can cover the blind spots with remote tower systems, adding them to the conventional tower. Likewise, high efficiency in the use of capital and human resources can be achieved by avoiding the construction of a second control tower and its corresponding equipment with all devices and the personnel required for its operation. RTS can improve operational safety through new technologies, reducing delays, expediting arrivals and dispatch of aircrafts with no need for the construction of an additional control tower.

They can also ensure the provision of service in case of planned or unplanned maintenance without having to reduce the airport's capacity or for contingency plans in case of unforeseen failures of conventional systems offering an effective solution.

Furthermore, airports with a high rate of low visibility conditions and H24 airports could also benefit from its implementation, to enhance the control of operations during low visibility conditions or at night, to complement service provision with infrared and high-definition cameras. As for scheduled airports, RTS can offer service that can adjust perfectly to their specific demand allowing time-sensitive control for airports at the required times, offering a high degree of flexibility.

From the perspective of an ANSP, in charge of the control of airports with low operations, remote locations and/or difficult access, using RTS would not only mean a reduction of cost in service provision, but could also be beneficial for ATCO/AFISO personnel. They would be able to control these airports from a single center without having to be physically at the airport. Consequently, it could be beneficial to choose a location for the RTC in an appealing area for staff, which would enhance hiring.

What does the change involve? Over the last decade remote towers technology has been developed to become a feasible solution to control air operations. To cope with a change of such magnitude in which the operation becomes fully digital, dealing with new devices and systems, the importance of achieving an effective change management becomes a critical factor.

Safety. For the time being, implementing RTS involves a significant change to the functional system concerning ANSP, airspace users and regulatory agencies. It does not require any specific safety assessment methodology apart from the requirements specified by European Union Aviation Safety Agency (EASA) or the Federal Aviation Administration (FAA).

As part of the safety assessment for an airport operated remotely, it is a prime necessity to include a transition plan outlining the differences when using RTS. In addition, safety risks should be managed from the point of view of the changes involved when implementing digital towers, identifying internal and external changes that might have a negative impact on safety and a hazard identification for any changes.

When operating with RTS the operation becomes fully digital relying on IT, so importance should be given to the transfer of data between surveillance, communications and management systems. The operational devices and data bases must be shielded to guarantee acceptable levels of safety and security facing potential cyberattacks.

Moreover, the ANSP is responsible for identifying all hazards of any change in the functional system compared to conventional control in addition to those features that are not related to RTS. However, the use of these systems may have a different impact on the probability of occurrence of these hazards, and the actions to be taken and the effects of the impact must be recorded.

Human Factors. The first to be affected by the transition to digital towers are controllers as they must adapt to new systems, meaning new operational procedures. The human factor is the key element to guarantee a successful transition to these systems. Operating in remote towers, controllers can obtain more information from other sources, therefore, it is necessary to study how this new operating scenario affects personnel.

The main change that controllers will face is adapting to not having OTW view and accommodating to the screen which may not have the same resolution as a direct visual and will allow an augmented vision. For this reason, the high definition of the cameras placed at the airport and the angle of vision they can cover is essential. Consideration should be given to how the screens will affect ATCO/AFISO when multitasking, how long they can be looking directly at the screen, and how to distribute the attention when operating with these systems.

Another important factor is to analyse how it affects ATCO/AFISO receiving all information from digital devices controlling their workload and how screens can affect the operator fatigue and workload. Especially when operating in multiple mode, providing service to two airports, ensuring that the information is clearly received by the personnel without mixing parameters from different airports.

Human factors assessment examines the suitability of the technical components involved in an ATS task, to be successfully accomplished by ATCO/AFISO. It should cover all the relevant areas affected by the change.

- Human Machine Interface (HMI).
- Working environment.
- Procedures and working methods.
- Organisation and human-human interaction.
- Change management.

Moreover, it must be defined how tasks are going to be managed with these systems. It should be re-established the roles and responsibilities for each position determining the operational methods and the duty at each position. It must be defined the changes and the impact it may have on personnel not only in their performance but also in their long-term satisfaction.

Transition Plan. It is the core element that will ensure the correct operation of a digital tower. The importance of creating a transition plan will allow a proper conversion from conventional control to remote towers. It is the duty of ANSPs to coordinate with the airport operator to establish the transition plan for providing remote ATS.

The procedures in which ATCO/AFISO should operate in every scenario should be stated and even though it is not mandatory, consideration should be given to including a training plan that ensures that personnel are suitable to provide service with these systems.

Shadow mode operation is a validation technique prior to an operational remote tower in which ATS is provided conventionally at the airport but remote tower systems receive all the information from the environment. Shadow mode can be:

- Passive, without interfering with service provision but receiving live information of the aerodrome and its vicinity.
- Active, in which the new system can provide service to a user in parallel with the conventional control to test the performance of RTS.
- Advanced, when RTS will be fully active in operation and run in parallel with the conventional system as back up if by any reasons there is a failure in RTS.

The transition to RTS must be performed in three phases. First, the conventional tower provides ATS. In the next phase there should be some control transfer in which the service is still provided by the conventional tower, but the data and parameters are also received at the remote tower under shadow mode to initiate system test procedures. Finally, if the shadow mode operation is successful, the remote tower will be able to provide ATS on its own.

Colombia case study

Colombia has a unique geography with three mountain ranges in the central part that cross the country from north to south, and the Amazon in the southern regions. Therefore, it is hard to reach certain areas and, in some cases, can only be reached by plane. In addition, the country has a large number of airports (represented in Figure 1 as green dots), most of them with low or medium density, which is perfectly suitable for the provision of RTS services.

One of the solutions provided by digital towers is to solve the problems of accessibility in specific areas with difficult access by being able to control one or more airports from a RTC that could be in a city with easier access. This could also be a great advantage for attracting ATCO/AFISO personnel.

These systems can transform a country's air navigation, and Colombia is a country with remarkably favourable conditions, which can have a positive result if remote towers are deployed at some key airports.

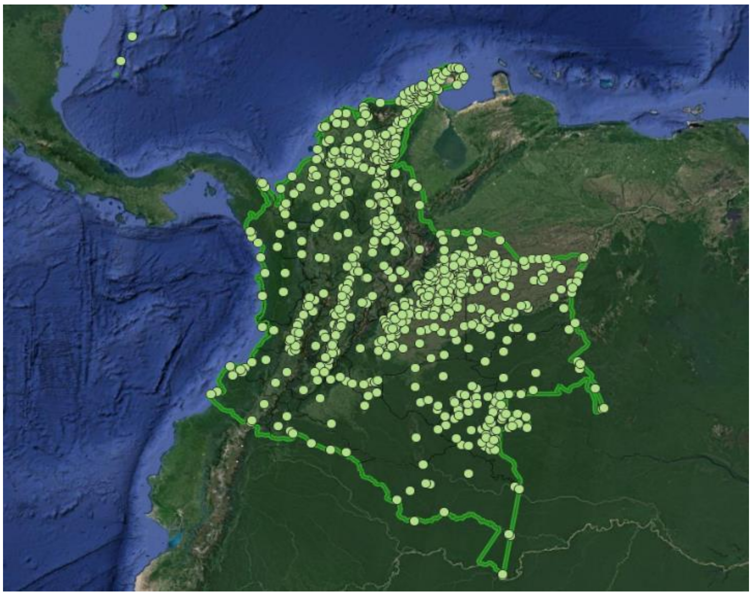

Fig. 1. Colombian airports.
Source: own elaboration based on QGIS

Digital towers allow a better use of human resources and capital. Therefore, regarding the placement of RTCs, it is considered that the biggest population centers in Colombia offer better accessibility than smaller cities and may be more attractive for hiring qualified personnel in Bogotá, Medellín, Cali and Barranquilla (represented in Figure 2 as blue dots)

Table 1. Biggest population centers in Colombia

City	Population
Bogotá	7.149.540
Medellín	2.359.801
Cali	1.811.385
Barranquilla	1.115.490

Source: Departamento Administrativo Nacional de Estadísitca de Colombia (DANE, 2018)

The criteria applied to carry out the study of which airports may have the best outcome if RTS are implemented is based on grouping them in four areas covering all airports in the north, south, east, and west regions of the country. It is a prime necessity that the data is capable to be transmitted with the lowest latency possible between the different airports and aerodromes.

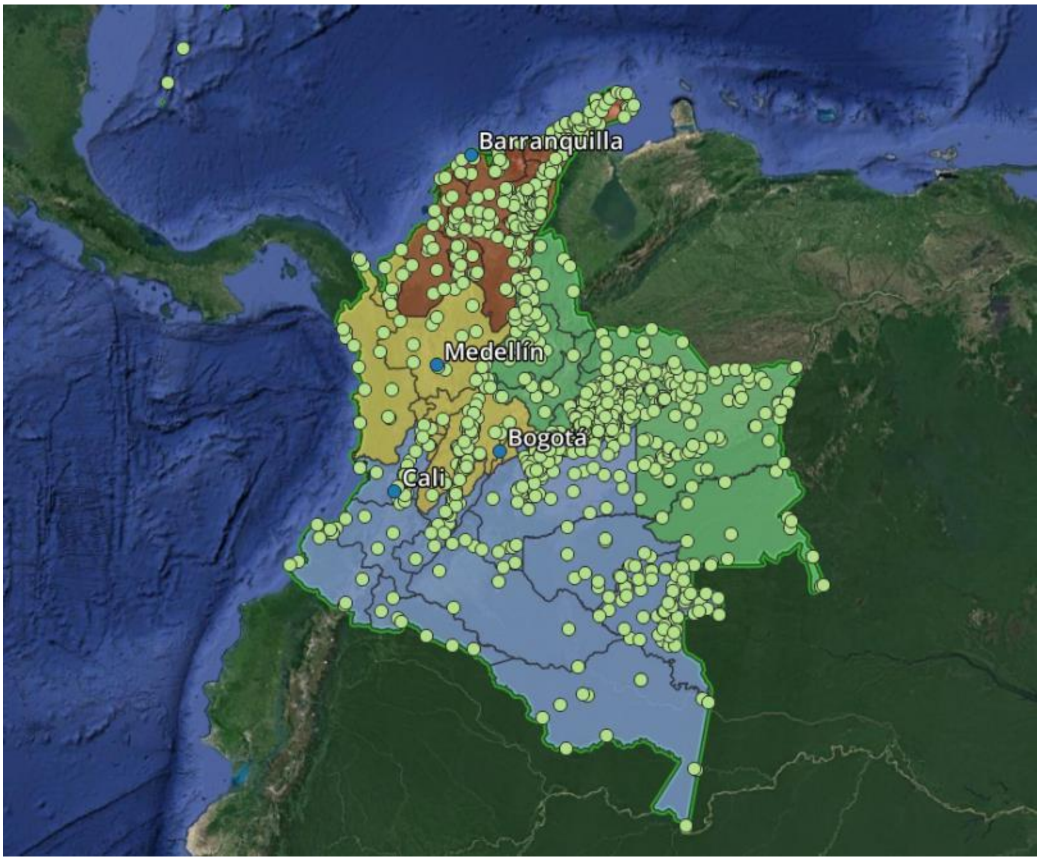

Fig. 2. Airports distribution
Source: own elaboration based on QGIS

Since the multiple operating mode on remote control is under development, and so far, only the provision of the same type of ATS has been approved for several airports, only those airports that share the same ATS are taken into consideration to be controlled by the same RTC. This does not imply any restriction in the provision of service, being able to switch between the different operating modes adding, closing, or transferring airports.

An additional critical factor when deciding the location and area of responsibility of the remote tower is the size and number of aerodromes that can be controlled in multiple mode. The complexity of the traffic, the individual operational aspects of each airport, the geographical location, and traffic levels are analysed. It has been demonstrated that the level of air traffic and its complexity has the greatest impact on the workload of air traffic controllers, so only those airports that receive the same type of traffic and have a compatible number of operations, are combined.

For the exact location of the digital towers, it would be necessary to carry out an additional study, assessing on a case-by-case basis whether it is more convenient to transform conventional towers into RTCs in the selected airports or establish a different place for the location of the RTC.

Candidate airports

Once all of the airports in relation to the criteria exposed were studied, the following were selected as the airports of major importance.

Table 1. Candidate airports

Airport	City & Population	Airport operator	Traffic	Air operations 2020	Air operations 2021
Palonegro	Bucaramanga 523.426	Aeropuertos de Oriente	National & International IFR/VFR ATC	10.144	15.562
Camilo Daza	Cúcuta 624.729	Aeropuertos de Oriente	National & International IFR/VFR ATC	4.708	9.505

Source: Unidad Administrativa Especial de Aeronáutica Civil (Aerocivil, 2018)

Camilo Daza International Airport, located in Cúcuta, capital city of Norte de Santander, and Palonegro International Airport in Bucaramanga, capital city of Santander, are two airports located in the eastern mountain range of Colombia. With the intention of improving the ATS services in Colombia, these airports are proposed to be remotely controlled from a digital tower located in another city with better access.

Both of them have very similar characteristics as they are both controlled airports that admit flights under visual and instrumental flight rules (VFR/IFR). In addition, they receive and dispatch both domestic and international flights, and although Palonegro

Airport has a greater number of operations, both could be controlled with RTS. Both airports are operated privately by the company "Aeropuertos de Oriente de Operados por KAC," so the implementation of the digital tower would require negotiations and agreements with this company and also with the Colombian institution "Aerocivil."

Due to the fact that both airports are located in the eastern Colombian ranges, it is estimated that the access to Bucaramanga and Cúcuta is likely to be more difficult than to other cities outside the mountain range. Regarding the location of the remote tower, it is considered that the city of Medellín (280 kilometres away from the Palonegro International Airport and 390 kilometers from Camilo Daza International Airport) would be the an attractive location for the establishment of a RTC. Thus, the RTC could be placed in Medellín, from which, the airports of Palonegro and Camilo Daza would be controlled.

Fig. 3. Camilo Daza and Palonegro candidate airports
Source: own elaboration based on QGIS

Conclusions

Establishing a network of remotely controlled airports is a revolutionary change for a country's air traffic control service. Nevertheless, the capital required to carry out the project is expensive, as these systems require significant investment. In addition, the return on investment is quite long, an average of about twenty years. This is one of the main barriers to the implementation of the service, as it is focused mainly on small and medium sized airfields.

Even though remote towers support the concept of reducing costs and optimising resources, in many cases the same modus operandi as in conventional towers are still used, trying to minimize the differences which reduce the potential for savings. It is true that there are certain technical issues which concern the multiple operational mode of remote towers which is still in development, but there is some reluctance to change, as it implies reducing ATCO/AFISO personnel.

Remote aerodrome concept is a revolutionary idea that can bring significant benefits to air navigation; however, it is taking a long time to be implemented globally as there are no standards that indicate how to implement them in different scenarios.

Colombia is a country with very favourable conditions for the implementation of remote control towers, not only reducing costs for ANSPs, but also solving accessibility problems. In all South America, there is only one operational remote control tower at Santa Cruz airfield, a military base operating in single mode. If these systems are adopted in Colombia, it would be one of the pioneer countries in the continent.

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