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DEPARTMENT OF PHYSICS

"GLOBAL AIR TRANSPORTATION NETWORK"

By

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“Global Air Transportation Network”

1.Introduction

The air transport network is a key infrastructure asset. It is the only worldwide passenger and cargo transportation network, providing an essential link between individual countries and the wider global economy. We analyze the global structure of the worldwide air transportation network, a critical infrastructure with an enormous impact on local, national, and international economies. We find that the worldwide air transportation network is a scale-free small-world network. In contrast to the prediction of scale-free network models, however, we find that the most connected cities are not necessarily the most central, resulting in anomalous values of the centrality. We demonstrate that these anomalies arise because of the multi-community structure of the network. We identify the communities in the air transportation network and show that the community structure cannot be explained solely based on geographical constraints and that geopolitical considerations have to be taken into account. We identify each city's global role based on its pattern of intercommunity and intra-community connections, which enables us to obtain scale-specific representations of the network.

1.1 .Overview

The worldwide air transportation network is responsible for the mobility of millions of people every day. Almost 700 million passengers fly each year, maintaining the air transportation system ever so close to the brink of failure. For example, U.S. and foreign airlines schedule ≈2,700 daily flights in and out of O'Hare International Airport (Chicago) alone, >10% of the total commercial flights in the continental U.S. and more than the airport could handle even during a perfect “blue-sky” day. Low clouds, for example, can lower landing rates at O'Hare from 100 per hour to just 72 per hour, resulting in delays and flight cancellations across the country. The failures and inefficiencies of the air transportation system have large economic costs; flight delays cost European countries 150 billion to 200 billion Euro in 1999 alone These facts prompt several questions. What has led the system to this point? Why can't we design a better system? To answer these questions, it is crucial to

characterize the structure of the worldwide air transportation network and the mechanisms responsible for its evolution. The solution to this problem is, however, far from simple. The structure of the air transportation network is mostly determined by the concurrent actions of airline companies, both private and national, that try, in principle, to maximize their immediate profit. However, the structure of the network is also the outcome of numerous historical "accidents" arising from geographical, political, and economic factors.

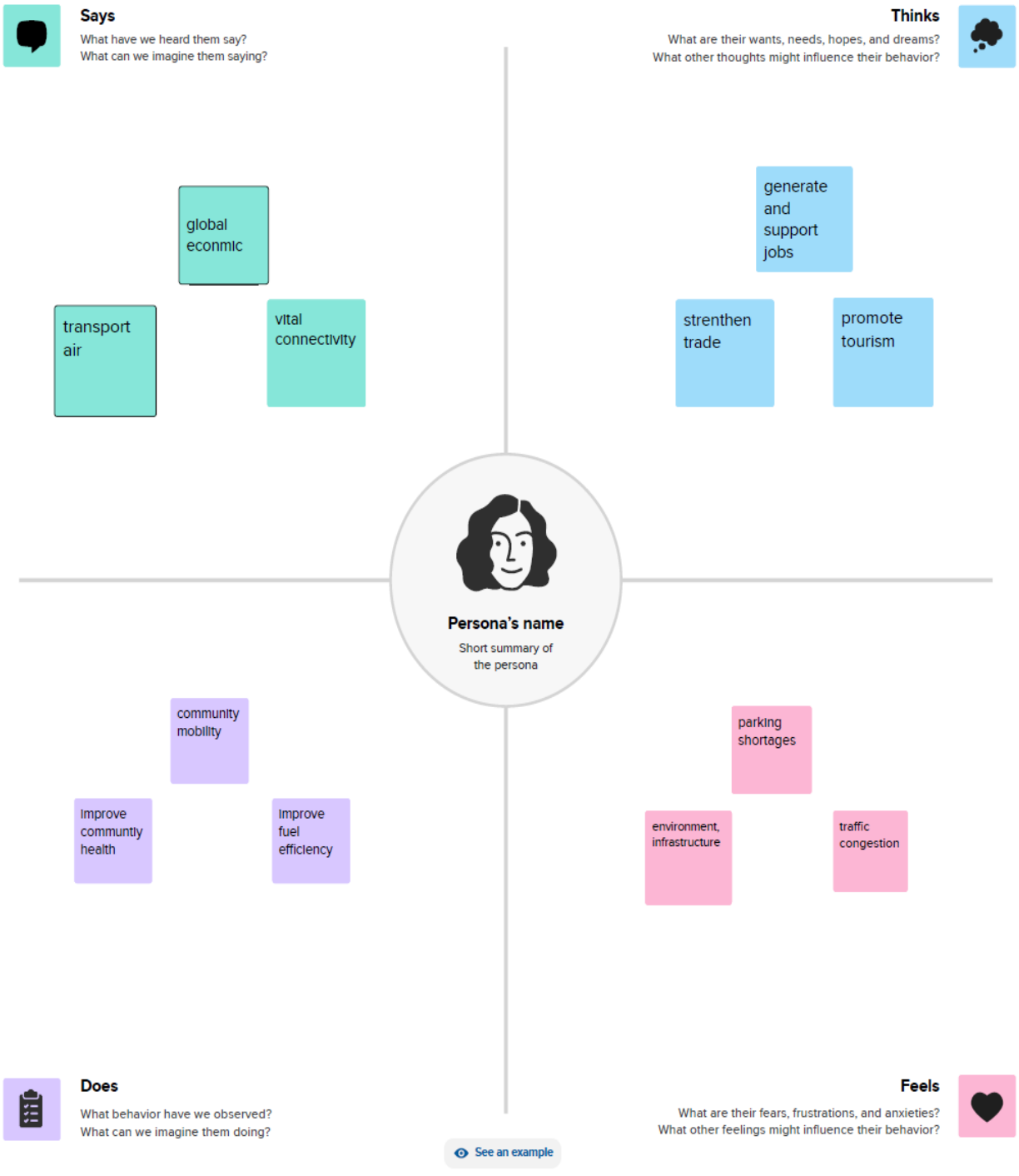
1.1. PURPOSE

1. Problem definition & Design Thinking

The Small Aircraft Transportation System (SATS) is envisioned as relying on increasingly sophisticated and affordable small aircraft flying between small airports in lightly used airspace. The system was proposed to provide a growing share of the nation's intercity personal and business travel. The development of such a system was considered to be justified by the potential to ease congestion in the existing aviation system and on highways serving densely traveled intercity markets. Without attempting to prejudge how advances in general aviation technology might evolve and affect travel markets, the committee that examined the SATS concept concluded that the concept is problematic in several ways as a vision to guide NASA's technology development. Although the cost of small jet engines developed in partnership with NASA could drop dramatically, small jets would still be well beyond the means of all but the wealthiest members of society.

The Small Aircraft Transportation System (SATS) program has been established by the Office of Aerospace Technology in the National Aeronautics and Space Administration (NASA). In the initial 5-year phase of the program, NASA is working with the private sector and university researchers, as well as other federal and state governmental agencies, to further various aircraft-based technologies that will increase the safety and utility of operations at small airports, allow more dependable use of small airports, and improve the ability of single-piloted aircraft to operate safely in complex airspace.

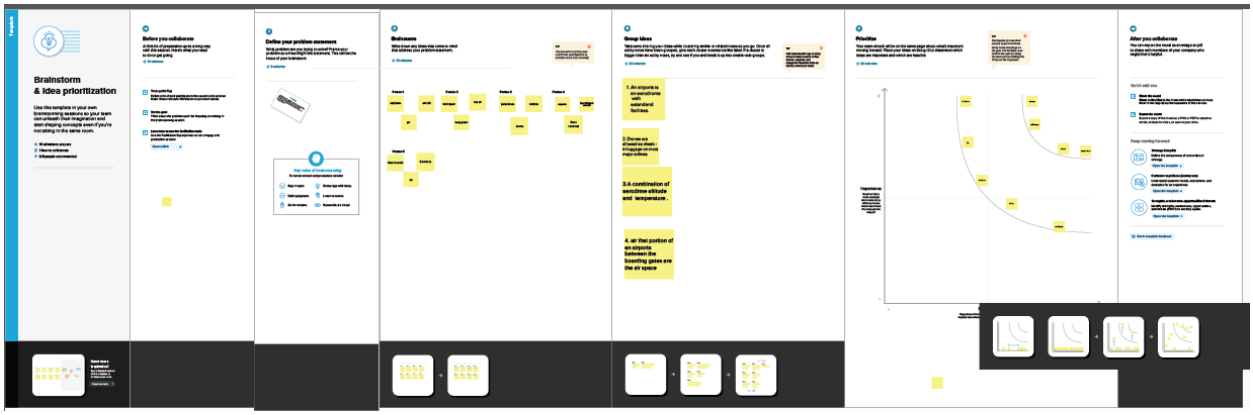
1.2 Empathy map



To answer this question, it is useful to consider a region such as Alaska. Alaska is a sparsely populated, isolated region with a disproportionately large, for its population size, number of airports. Most Alaskan airports have connections only to other Alaskan airports. This fact makes sense geographically. However, distance-wise, it also would make sense for some Alaskan airports to be connected to airports in Canada's Northern Territories. These connections are, however, absent. Instead, a few Alaskan airports, singularly Anchorage, are connected to the continental U.S. The reason is clear: the Alaskan population needs to be connected to the political centers, which are located in the continental U.S., whereas there are political constraints making it difficult to have connections to cities in Canada, even to ones that are close geographically. It is now obvious why Anchorage's centrality is so large. Indeed, the existence of nodes with anomalous centrality is related to the existence of regions with a high density of airports but few connections to the outside. The degree-between's anomaly is therefore ultimately related to the existence of communities in the network.

Fact that different networks seem to be formed by nodes with network-specific roles points to the more general question of what evolutionary constraints and pressures determine the topology of complex networks and how the presence or absence of specific roles affects the performance of these networks.

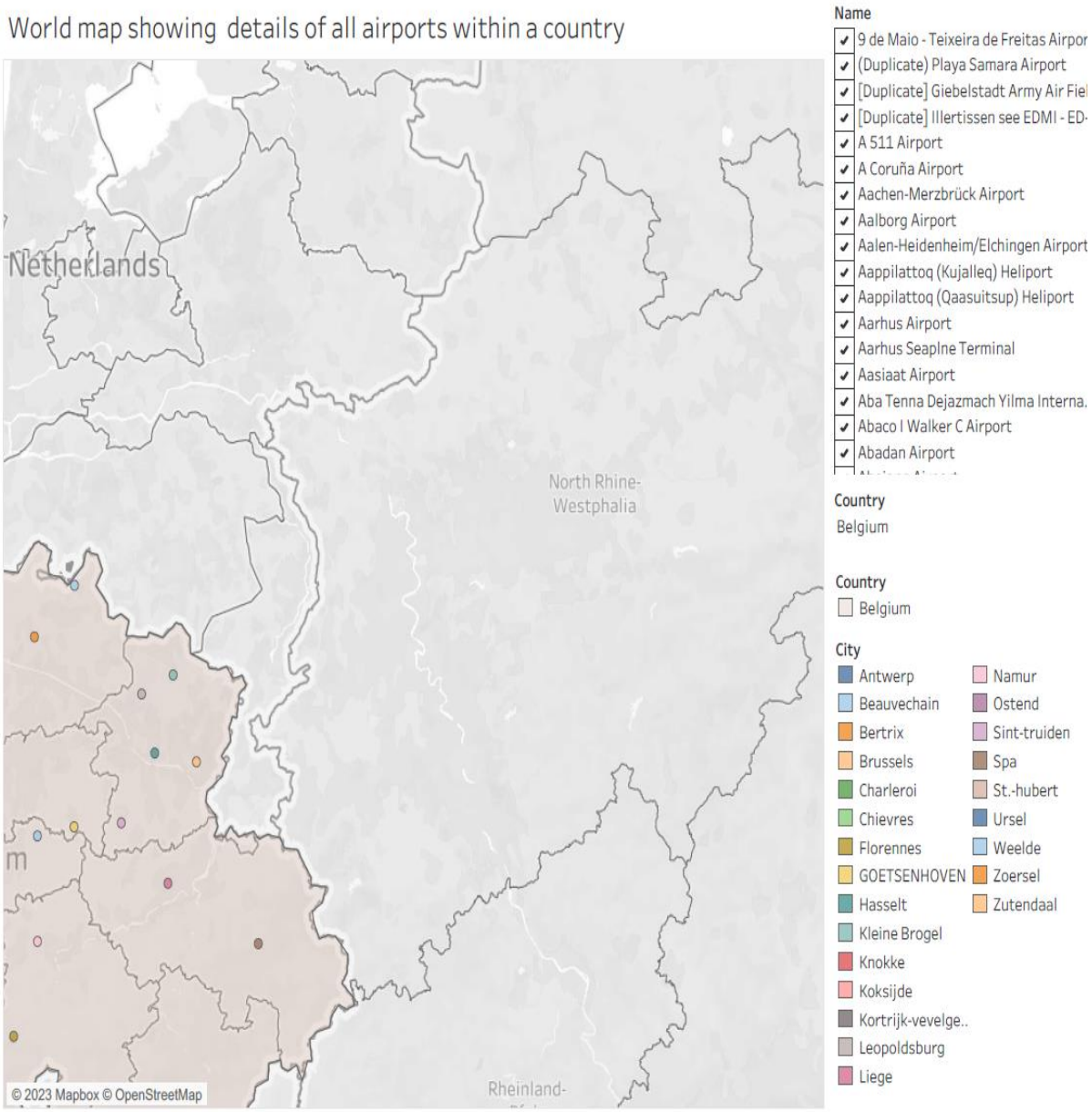
1.2 Ideation & Brainstoming map



Brainstorming is a great way to generate a lot of ideas that you would not be able to generate by just sitting down with a pen and paper. The intention of brainstorming is to leverage the collective thinking of the group, by engaging with each other, listening, and building on other ideas. Conducting a brainstorm also creates a distinct segment of time when you intentionally turn up the generative part of your brain and turn down the evaluative part. You can use brainstorming throughout any design or work process, of course, to generate ideas for design solutions, but also any time you are trying to generate ideas, such as planning where to do empathy work, or thinking about product and services related to your project.

2. Result

Dashboard



Airports at higher altitude within a country

Index	Name	City	Icao	
4,853	Bario Airport	Bario	WBGZ	3,350
4,851	Bakalalan Airport	Bakalalan	WBGQ	2,900
4,848	Long Lellang Airport	Long Datih	WBGF	1,400
4,849	Long Seridan Airport	Long Seridan	WBGI	607
5,153	Long Akah Airport	Long Akah	WBGL	289
4,847	Belaga Airport	Belaga	WBGC	200
3,103	Kluang Airport	Kluang	WMAP	150
3,111	Senai International Airport	Johor Bahru	WMKJ	135
3,110	Sultan Azlan Shah Airport	Ipoh	WMKI	130
3,080	Sibu Airport	Sibu	WBGS	122
3,109	Simpang Airport	Simpang	WMKF	111
3,078	Marudi Airport	Marudi	WBGM	103
3,083	Labuan Airport	Labuan	WBKL	101

Country
Malaysi

Active
N
Y

Airline within a country

Airline ID	Name	Icao	Callsign	
15	Abelag Aviation	AAB	ABG	
271	Allied Command Europe (..	ALF	ACEFORCE	
538	ASL	XXX	Null	
634	Airventure	RVE	AIRVENTURE	
1346	Belgian Air Force	BAF	BELGIAN AIRFORCE	
1373	Belgian Army	AYB	BELGIAN ARMY	
1428	Belgavia	BLG	BELGAVIA	
1515	Brussels International Air..	BXI	XENIA	
1531	Brussels Airlines	DAT	BEE-LINE	
1551	Belgian Navy	NYB	BELGIAN NAVY	
2235	Eurocontrol	EUC	Null	
2252	European Air Transport	BCS	EUROTRANS	
2431	Flying Service	FYG	FLYING GROUP	
2528	Gendarmerie Belge	GDB	BELGIAN GENERMERIE	
2800	International Air Carrier A..	ITC	Null	
3032	Jetairfly	JAF	BEAUTY	
3821	Ostend Air College	OCO	AIR COLLEGE	
4445	SITA	SIT	Null	
4734	Sky Service	SKS	SKY SERVICE	
4873	TNT Airways	TAY	QUALITY	
4896	Thomas Cook Airlines	TCW	THOMAS COOK	
5169	Thalys	Null	Null	
5333	Virgin Express	VEX	VIRGIN EXPRESS	
5383	VLM Airlines	VLM	RUBENS	
6002	TUI Airlines Belgium	TUB	BEAUTY	
10224	Zz	\N	Null	
17963	VG Airlines (IV)	FVG	Nico	

Country
Belgium

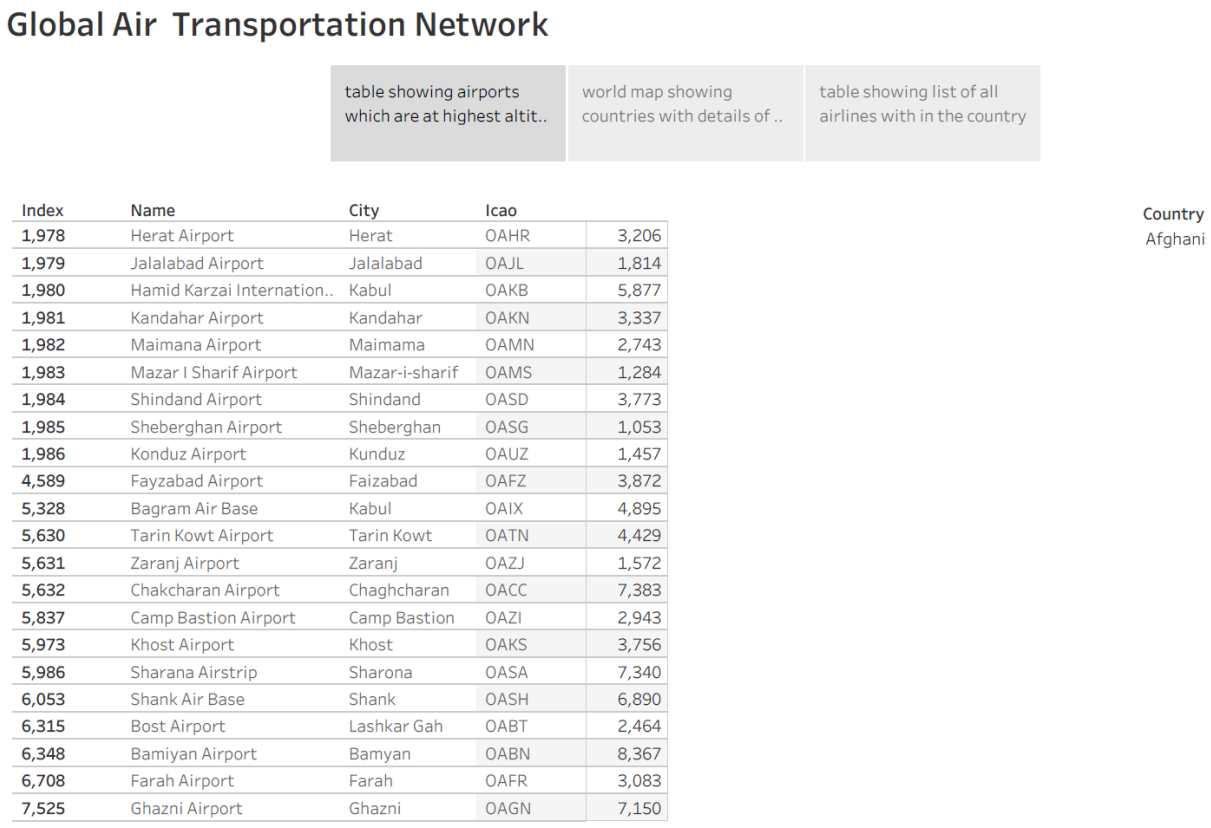
Active
N
Y

Dashboards offer a method of consolidating company data into one unified location with secure data storage. Dashboards are designed to offer a comprehensive overview of company performance, and do so through the use of data visualization tools like charts and graphs.

Story

The fractions of cities with each role in the worldwide air transportation network contrast with the corresponding fractions in a randomization of the network. In this case, the community identification algorithm still yields certain communities, but the network lacks "real" community structure. The identification of roles enables one to realize that these communities are somehow artificial. Indeed, many cities are either kinless hubs or kinless non-hubs because of the absence of a real community structure, and the network contains essentially no provincial or connector hubs.

Story 1



Index	Name	City	Icao	
1,978	Herat Airport	Herat	OAHR	3,206
1,979	Jalalabad Airport	Jalalabad	OAJL	1,814
1,980	Hamid Karzai Internation..	Kabul	OAKB	5,877
1,981	Kandahar Airport	Kandahar	OAKN	3,337
1,982	Maimana Airport	Maimama	OAMN	2,743
1,983	Mazar I Sharif Airport	Mazar-i-sharif	OAMS	1,284
1,984	Shindand Airport	Shindand	OASD	3,773
1,985	Sheberghan Airport	Sheberghan	OASG	1,053
1,986	Konduz Airport	Kunduz	OAUZ	1,457
4,589	Fayzabad Airport	Faizabad	OAFZ	3,872
5,328	Bagram Air Base	Kabul	OAIX	4,895
5,630	Tarin Kowt Airport	Tarin Kowt	OATN	4,429
5,631	Zaranj Airport	Zaranj	OAZJ	1,572
5,632	Chakcharan Airport	Chaghcharan	OACC	7,383
5,837	Camp Bastion Airport	Camp Bastion	OAZI	2,943
5,973	Khost Airport	Khost	OAKS	3,756
5,986	Sharana Airstrip	Sharona	OASA	7,340
6,053	Shank Air Base	Shank	OASH	6,890
6,315	Bost Airport	Lashkar Gah	OABT	2,464
6,348	Bamiyan Airport	Bamyan	OABN	8,367
6,708	Farah Airport	Farah	OAFR	3,083
7,525	Ghazni Airport	Ghazni	OAGN	7,150

We carried out a “systems” analysis of the structure of the worldwide air transportation network. The study enables us to unveil a number of significant results. The worldwide air transportation network is a small-world network in which (i) the number of nonstop connections from a given city and (ii) the number of shortest paths going through a given city has distributions that are scale-free. Surprisingly, the nodes with more connections are not always the most central in the network. We hypothesize that the origin of such a behavior is the multi-community structure of the network. We find the communities in the network and demonstrate that their structure can only be understood in terms of both geographical and political considerations.

3. Advantage & Disadvantage

Advantage:

1. High Speed

Air is the type of freight capable of traveling long distances in short periods of time. This makes this model an optimum choice if the client has an urgent need to ship a product or if their freight demands special standards of protection or acclimation. It is the quickest transport mode and is therefore ideal for long-distance transport of goods. It takes less time.

2. Fast Service

Air transportation offers convenient, reliable and fast services of transport. It is considered the cheapest way to ship peregrinated goods. It offers a standard, convenient, reliable and fast service.

3. Send almost everywhere your freight

In regions that are not readily accessible to other modes of transport, air transport is considered to be the only means of transport. Open to all regions, irrespective of land interference. A vast network of airlines covering nearly the whole globe is available for many airlines. This ensures that the package can be sent almost anywhere.

4. High Standard of Security

High standard of protection with a low risk of robbery and injury. Shipping by air has a high degree of security since airport safety restrictions on cargo are strictly enforced. Tightly controlled airport controls also minimize cargo theft and loss.

5. Natural Route

An aircraft can fly to any location without seeing any natural obstacles or barriers. Since customs formalities are easily compiled. It eliminates the need for more time to seek clearance. Air travel is used for relief operations during earthquakes, floods, accidents, and famines.

6. There is less need for heavy packaging

Air exports, in general, entail less hard packaging than ocean shipments. This ensures you save both time and money by not having to provide extra packaging services.

Disadvantage

- Require Special Chemicals. costly rather than food crop
- Environmental degradation: Cash crop farming can lead to environmental degradation if not done sustainably.
- Dependence on a single crop: Growing only one crop can lead to dependence on that crop
- You cannot cultivate any crop immediately after harvesting a crop like tobacco.

4. Application

Climate conditions that are adverse: Extreme weather will cause planes to be grounded and airports to close, halting shipments for several days and rendering the service ineffective.

1. Risky

Air travel is the riskiest mode of transport, since there can be considerable losses to goods, customer and crews as a result of a minor crash. Compared to other means of travel, the risks of collisions are higher.

2. Cost

Air travel is considered to be the most expensive means of transportation. The cost of maintaining aircraft is higher and the costs for the building of aerodromes and avions are much higher. That's why air travel is so expensive that it gets beyond ordinary people's grasp.

3. Some Product Limitation

There is a whole variety of materials not suitable for such products, from explosives, gase s, batteries, fired solids and liquids, which cannot be shipped by air to name but a few.

4. Capacity for Small Carriage

The aircraft have no room and therefore are not ideal for carriage of voluminous and cheaper materials. As is seen for rails, the load volume cannot be raised.

5. Enormous investment

Air travel calls for enormous spending in aerodrome building and servicing. It also calls for professional, qualified and qualified staff that needs a significant investment.

Future scope

The 21st century has seen the continued internationalization and globalization of the world"s economy. There is also evidence of deeper globalization of cultures and politics. Air transport has played a part in fostering these developments, but airlines, and to a greater degree, air transport infrastructure has to respond to changing demands for its services. Air transport is a facilitator and, as such, the demands or its services are derived from the requirements for high-quality, speedy, and reliable international transport. Globalization, almost by definition, means demands for greater mobility and access, but these demands are for different types of passengers and cargoes, to different places, and over different distances than was the previous norm.

International air transport is less than a century old, but is now a major contributor to globalization and is continually reshaping itself to meet the demands of the economic and social integration that globalization engenders. Economically, in static terms, globalization occurs to facilitate the greater division of labor and allows countries to exploit their comparative advantage more completely. Perhaps, however, more importantly, in the longer term, globalization stimulates technology and labor transfers and allows the dynamism that accompanies entrepreneurial activities to stimulate the development of new technologies and processes that enhance global welfare. To allow the flows of ideas, goods, and persons that facilities both static and dynamic efficiency on a global scale, air transport has played a role in the past, and it seems inevitable that it this role will continue in the future

CONCLUSION

The existence of communities and the understanding that different cities may have very different impacts on the global behavior of the air transportation system call for the definition of the role of each city. We addressed this issue by classifying cities into seven roles, according to their patterns of intercommunity and intra-community connections. We found that most of the nodes (95%) are peripheral; that is, the vast majority of their connections are within their own communities. We also found that nodes that connect different communities are typically hubs within their own community, although not necessarily global hubs. This finding is in stark contrast with the behavior observed in certain biological networks, in which non-hub connectors are more frequent