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PROPOSE OF PROCEDURE OF ANALYSIS CONSIDERING AIRPORTS AS TRAFFIC GENERATION POLES (TGPs)

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Propose of Procedure of Analysis Considering Airports as Traffic Generation Poles (TGPS)

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Abstract

The multiplication of entrepreneuring classified as TGPs (Traffic Generation Poles) could affect negatively the transportation performance in Brazilian cities. To study an airport as a TGP is to take into account its vehicular demand considering the lack production in the offers of the road space and consequently, an impact in the air quality within its area of influence. For this demand it is necessary an appropriate procedure of analysis. It was verified, after literature review, that the procedures was formulated normally for shopping centers. However, the airports have characteristics specific and complexity and need an adequate procedure. Moreover, it was evidenced that in the present time the concern of the airports administrators is the environmental impact (after the noise, it is the air pollution). This concern is essential for a sustainable development in this sector. Internationally, there are some studies that involve the monitoring of the air quality of the region reached for this type of polar area and as form to mitigate this problem appear proposals of multimodality with this sector. This article points the use of procedure of analysis adequate for the airport system considering the impact in the air quality. This is a first step for the development of PhD study. This will be done through the literature review and analysis of the available structures for TGPs and through appropriate computational tools. Those was been created to simulate the reality in order to evaluate the potential consequences caused by this type of entrepreneuring and also to offer technical subsidies which maximize positive consequences and minimize the negatives ones. To understand the characteristics that involve the area of study of an airport and searching softwares for the analysis of its impacts could be the key path for the urban and environmental planning.

Keywords

airport – traffic generation – environment – air quality

1. Introduction

The Traffic Generation Poles (TGPs) are big enterprises and it can attract a significant number of trips. This can bring a negative impact in the air quality.

It was verified that are few research about this. After the literature review it was discovered that the majority of researches focus only shopping centers as TGP. However, Menezes (2000) gave others examples (Table 1) where it is possible to comparer the trip generation and the urban-environment impact. He shows the importance of the influence area as space delimitation and the determination of trip patterns among the different activities:

> "There are some poles with same activities it shows differences among the trips, for instance: the size, characteristics socioeconomics, users, etc. Therefore, the application of one determined model of generation forecast and distribution of trips must be made only for polar regions that have similar characteristics, observing their peculiarities. If do not exist a specific model for the pole that it will be analyze, it must be create a new one."

The analysis of impacts produced for TGPs can be shared in two basic phases (Cavalcante, 2002):

a) definition of the problem – it is the final result after the application of the methodology proposal and the final consequences, and;
b) model specification – it is chosen, among the existing models, which essential parameters will be necessary.

The first step to create an analysis template is to understand the aircraft dynamics as a TGP. For this work is necessary to understand the aircraft impacts, the magnitude of its trips and the influence of its localization. The goal is to define parameters for the analysis.

Portugal & Goldner (2003) had made a survey of procedures for TGPs' evaluation and the impacts in the road systems and transports, detailed in item 3.1 of this article. The north-American methodologies are for new enterprises and, the models Spanish and Brazilian are for shopping centers, with emphasis in parking.

Then, the goal of this article is to suggest the use of basic elements, raised from literature review, to analyze an airport as TGP and its probable impacts in the air quality. An option to analyze the effect in the road net could be the computational tools. These have a considerable importance among the transport planners because it is possible to represent the reality making easier the process of decision (Tolfo, 2006).

2. Airport's characteristics

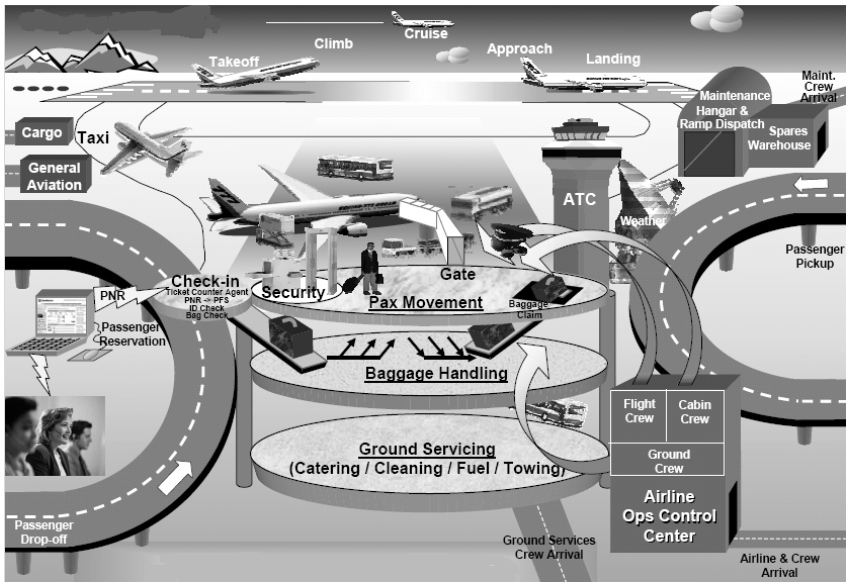
The majority access to the airport in Brazil is made by road - between 60% and 75% of car trips (Goldner & Andrade, 2001 and 2002). Moreover, the creation and/or expansion of TGPs face the lack of an integrated process of urban planning and transports, the absence of implementation of these and the disordered growth of the cities. Then, the implantation and the operation of generating trips cause negative impacts, with bottlenecks and low conditions urban-environmental (Kneib, 2004).

Internationally, the airports are served by transport systems of high capacity. Although, in a study made for the Airport of Munich, there is a significant amount of trips by particular cars (53%) and taxis (10%) (Munich Airport International, 2005).

Another factor could increase the traffic flow of cars around the airports is the world-wide trend looking at the airport as business. Besides the travelers, there is an objective to improve the income aircraft with stores, restaurants and hotels as well. Such attitude could bring some negative consequences to the air quality due to growth of the traffic.

It must be observed that an airport has a complex nature (Figure 1) and involves activities of impacts also environmental. Therefore, the airport needs a new planning to have such quality level, because the city-airports are growing with a proportional speed of air traffic (Teixeira & Amorim, 2005). To understand these aspects of road traffic is important to reach the objective of this article.

Figure 1 Air Transport System



Source: Gordon, 2002.

The urban growth of the city-airport could change the urban and environmental space around 40 km from the airport (Bernardes, 2006). To have an idea of this, Yoshinaga (2002) considered if an airport have a flow about twelve million pax/year, this could be affect the traffic around 5 km in the neighbourhood. And the atmospheric dispersion (considering the type and the concentration of the pollutants) could reach around 20 km from the airport (Whitelegg e Cambridge, 2004).

Thus, the main subject from the trip generation and the environmental impacts in the airport could be shared in two levels: critical area and influence area. In both scale there are the transport influence in the air quality. Besides this, it is possible to take into account the topography, the place where the airport was built (city center, periphery or in the coast) and if the region is mountainous. These are important criteria that could be influence the concentration or dispersion of air pollutants.

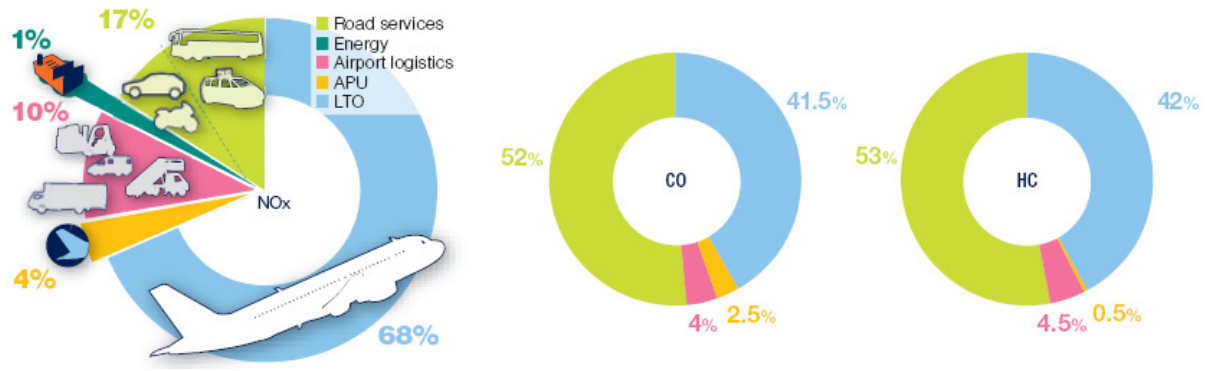
Near by the airport, the conflicts and consequences emissions of air pollutants are more visible and intense because of the number of vehicles concentrated around the road net. This is considered as critical area where the related points are: the accesses, the parking, the curb for arrive and departure, the areas of modal integration, the origin of the trips, and the necessities of circulation mainly of particular cars and taxis.

3. Literature Review

Many studies from emission of air pollutants considered only the aircrafts, but passengers, air companies, aircraft maintenance, ground service, etc, could increase the air pollution around 20 km from the airport. It is important to highlight that the urban occupation could influence the air quality because it is necessary to build the runway, terminals, parking, areas of various services and net transportation (Whitelegg & Cambridge, 2004). The airports have two traditional types of localization: one in the city center and another one in the outskirts, near to the countryside; and the more there is demand, the more will be the potential impact not only in the inhabitants but also in the local biodiversity.

The Figure 2 illustrates this information with the proportional percentage of the main aircraft emissions (NO_x, CO and HC) for each activity. This study was done in Paris for the Air France Report 2004/5.

Figure 2 Contribution of different activities to Air France emissions at Paris CDG



Source: AIRFRANCE, 2005.

The high number of TGPs' can contribute negatively with the transports system in the Brazilian cities. Moreover the demand can generate an exhaustion of road space offers and a consequent impact in the air quality where there is a TGP. Computational tools had been produced and created to evaluate the externalities caused by this type of impact. The simulation can contribute in the evaluation and it can offer subsidies technician to maximize positive points and to refuse the negative ones.

3.1 Procedures

The survey (Table 1) made by Goldner & Portugal (2003) approached TGPs in general. It was observed there is not one specifically for airports and air quality. However, when the author does not identify the TGP it is possible to perceive that some stages can be applied in airports.

Table 1 Stages considered in the structures of available models

Methodology	TGP	Stages
Consultores (1984)	Shopping centers	evaluation of performance in the road system; index of performance and; parking size.
Americana do Departamento de Transportes (1985)	New enterprises	Project study; future estimation without TGP and the schedule of peak-hour when the TGP is working; identification and analysis of alternatives of access to the TGP; negotiation between local and planning agencies and improvements.
Grando (1986)	Sundries	characterization of the problem; offer; modal choice; survey of the current situation; performance analysis; alternative solutions and decision.
ITE (1991)	Sundries	distribution models (the most used it is the gravitational one) and data (database social-economic and demographic detailed by area).
Espanhola (90‘s)	Shopping centers	analysis of the current situation; demand of vehicles and parking size; analysis and proposals.
Cybis et al. (1991)	Sundries	prognostic of the traffic growth; demand characterization for trips and road system and; probability evaluation.
Cavalcante (2000)	Mix use	context and object of study; model definition; data collection; estimation and model validation and; application.
Menezes (2000)	Sundries	determination of traffic flow; capacity and levels of service of the road net; environmental capacity and proposal of environmental levels of the road net; number of trips generated for the TGP; verification of the environmental levels and service for the TGP previous situation; distribution and allocation of the trips generated for the TGP; levels of road service in the influence area, determination and verification of the environmental levels after the TGP.
Vargas (2005)	-	The beginning (identify the necessity and create the structure of the problem); the planning (what it will be done, with details, by the project); the execution (to do what it was planned); monitoring and control (it occurs parallel to the operational planning and the execution of the project); the end (evaluation for similar errors do not occur again).

Source: adapted from Goldner & Portugal, 2003.

It was observed that those stages can easily be considered for the aircraft system. But, it is necessary to consider some specific data like the characteristics that involve the study of aircraft impact in the air quality. For this, it is possible to summarise a basic stage in the structure of a procedure:

a) characteristic of the problem - delimitation in the time and the space;

b) demand - the generation and the distribution of trips, beyond the modal choice;

c) offer - transport and storage;

d) performance - interaction between traffic demand and offer, as well as establishes who is affected and what is considered as impact (normally the highlight is for the users and the quality of service, express by time tables indicators and delays). Few studies highlight the environmental impacts and the air quality;

e) generation and analysis of scenarios - analysis of performance for zero's, five's and ten years. Such analysis will be made through computational tools considering the comparison of levels of service of the current situation being projected for a future situation, taking in to account the existence or not of the airport or its enlargement;

f) recommendations - the validation of the results, discarding the alternatives that had not been used filing for future works and arguing the committed imperfections to serve of base for other studies.

3.2 Computational tools

When an airport is considered like a TGP it is because its demand could generate an exhaustion of offers and a consequent impact in the air quality in its area of influence. It is possible to evaluate the probable impacts caused for this and to offer subsidies for mitigation through computational tools that simulate the reality.

According to Portugal (2005), the intention of the simulation is to represent or shape the behaviour and the interactions among the elements of the system to allow a previous evaluation of performance. Therefore, it is one practical and guided technique for the application, in which a simplified version of a real system is codified and transferred to the computer thus, the system can simulate the real set.

The simulators can be classified through the level of traffic representation in the net. There are: macroscopic (in general, deterministic, allowing the description the whole area), mesoscopic (generally used for simulation on traffic lights nets) and microscopic (consider the vehicles individually when they move through the net in very small intervals of time e its trajectories in time and space can be determined for each second) (Tolfo, 2006).

First it was made a survey of the tools considering the following points to reach the election of softwares:

- Availability to get information about the tool;

- Focus or availability for the atmospheric pollutants forecast and;

- The use, the applicability and the spreading of the tool not only in the academic way but also in the practical ones.

Therefore, in Table 2 is described, in alphabetical order and in summary, the types of existing simulators that correspond previously to the established criteria and the characteristics of each one.

Table 2 Survey of the existing computational tools

Type	Name	Characteristics
Microscopic	ALAQS (Airport Local Air Quality Studies)	GIS application to capture the sources of aircraft emissions.
	CORSIM (Corridor Simulation)	North American Model with two modules: NETSIM for nets and FRESIM for express ways.
	DRACULA (Dynamic Route Assignment Combining User Learning and Microsimulation)	Allocation model for urban traffic.
	INTEGRATION	Integration model for allocation and traffic simulation.
	HCM/CINEMA (Highway Capacity Manual)	Program of graphic animation.
	PARAMICS (Parallel Microscopic Traffic Simulator)	Traffic simulator that consider the characteristics of each vehicle.
	TRANSYT (Traffic Network Study Tool)	Traffic simulator on traffic light road net
	VISSIM	Simulate the traffic in express nets and ways.
Mesoscopic	SIDRA (Signalised and Unsignalised Intersection Design and Research Aid)	Analytic program to signal intersections and shunting lines.
	CONTRAM (Continuous Traffic Assignment Model)	British model developed for nets and express ways.
	DYMOS (Dynamic Models for Smog Analysis)	System that allows the prediction of the particle diffusion in function of meteorological parameters and conditions of emission and absorption.
	SIRI (Net Simulator of Traffic lights)	Brazilian model of traffic light programming.
	EMME/2 (Equilibre Multimodal / Multimodal Equilibrium)	Program for multimodal transports planning with tools for modeling, demand, analysis and net evaluation.
Macroscopic	FREQ	Deterministic tool.
	SATURN (Simulation and Assignment of Traffic to Urban Road Networks)	Simulator for traffic allocation.
	SIGNAL97	Based in the optimization of the HCM in 1997.
	SYNCHRO (Windows que contem: HCS, CORSIM, PASSER II e TRANSYT-7F)	Simplified model simulation of the amount of pollutants emitted for vehicles.
	TRANSCAD (Traffic Network Stud Computer Aided Design)	GIS for management, installations, logistic and public transport.

Source: adapted from DUCHENE, 2005; JACONDINO, 2005; PORTUGAL, 2005; SABRA, WALLACE, LIN, 2000; VILANOVA, 2006 e TOLFO, 2006.

After the analysis, some tools had presented various applications. The criteria for this previous election were to consider if these instruments have requirements for the analysis of atmospheric pollutants emission (direct - it is already inside the tool; or indirect - mix of two or more tools that it could be as base-analysis of the emissions). Some examples are:

- Duchene (2005) presented the ALAQS as a tool that captures various sources of air pollution internal and external of the airport and it processes the different types of emission in a standard format for a dispersion model;

- Gunnarson (2000) recommended CONTRAM as the most usual dynamic system simulator. It is possible control the traffic flow and the monitoring;

- TransSolutions (2002) presented CORSIM as a model base for internal and external analysis of the side land in the following airports: Intercontinental Houston George Bush (IAH), San Francisco International (SFO) and International Airport of Dallas Fort Worth (DFW);

- SEA (2006) applies DYMOS as assistant in analysis of TGPs. The subject was improving the Airport of Malpensa (Italy) in 2000;

- Silva (2006) presents TRANSCAD as the only tool that it is possible to have the four phases of the modelling in transports urban planning (generation of trips, distribution of trips, modal division and allocation of traffic).

- Reymond (2003) developed a study for the urban transport and the air pollution in Bogotá using the EMME2 as a tool.

- Ariotti & Cybis (2002) used SATURN to evaluate the accessibility and the traffic impact that the pole brings in this area of study.

- The engineering and planning company - SIMCO (2005) made a list of the following softwares: HCM-CINEMA for traffic analysis, and FREQ, CORSIM, SYNCHRO, for studies of planning of corridors. Some representative projects are: the restore and improvements on parking in airports.

Thus, from the data collected, those had shown more directly applicable are in Table 3.

Table 3 Classification of the simulators in function of the intervention

Intervention	Simulator
In the city and in the region (from the medium to the long run)	EMME2, TRANSCAD, SATURN e SYNCHRO (Macroscopic) CONTRAM e DYMOS (Mesoscopic)
In the district (short run)	ALAQS, CORSIM, FREQ, SIDRA, HCM-CINEMA e PARAMICS (Microscopic)

4. Proposal of a new procedure of analysis

In the Manual of Regional Transportation Modeling Practice for Air Quality Analysis made by DHS (1993) affirms that the local legislation can be an important base to create procedures. However, some important stages must be considered: data; validation of the obligator resources; time for improvements; the size of the area and the origin of the problem of air quality; the dynamics of the regional growth; the modal alternatives; the variety of alternative politics; vehicle per kilometre; speed; characteristics of the vehicle; trips per vehicle; establishment of the trips generation at least five intentions (house-work, house-shopping, house-school, house-other and from any another place), trips distribution and pick-hour; occurrence of acceleration and delays; idle time; zoning; auto-roads net; ground-use; traffic indication; estimative/inventory of emissions; zoning control and urban drawing; net models and socioeconomics data.

From this and from the critical analysis of the available procedures, there is a proposal that considers the aircraft specificities and the characteristics that involve the study of impact in the air quality.

There are in the problem characterization: the space delimitation subdivided in area of influence and critical area; time delimitation and impact environmental. The dynamism of the human activities influences directly the space, time and environmental urban. The continuous knowledge of this it could be a basic role in the efficient management of the urban traffic (Meneses & Loureiro, 2003).

In the space delimitation, the area tends to be bigger than a shopping, for example - in this case, the influence area is configured when it finds another commercial center. In the aircraft system this fact does not occur. Except for instance when there are two airports with similar

characteristics. Then, the influence area tends to cover the entire city. An airport catches passengers of all places. Already in the critical area, around the airport, suffers the direct influences from the demand variation tourist, business, and the multiple uses that this TGP have.

In the time delimitation, it is define the day(s) and the hour(s) of project that it is better to estimate the trip production. It is good to add the size of the internal components like: the parking, loading and unloading area, area of arrive and departure, accesses, etc (Frenkel, 2006).

After that there is two related stages, that it must be considered - demand and offers:

- Demand: trips generation, distribution and modal choice (Goldner & Goldner, 2006). In this last one it must be study the intense participation of the taxis, and it must be concern about the size of the accesses;

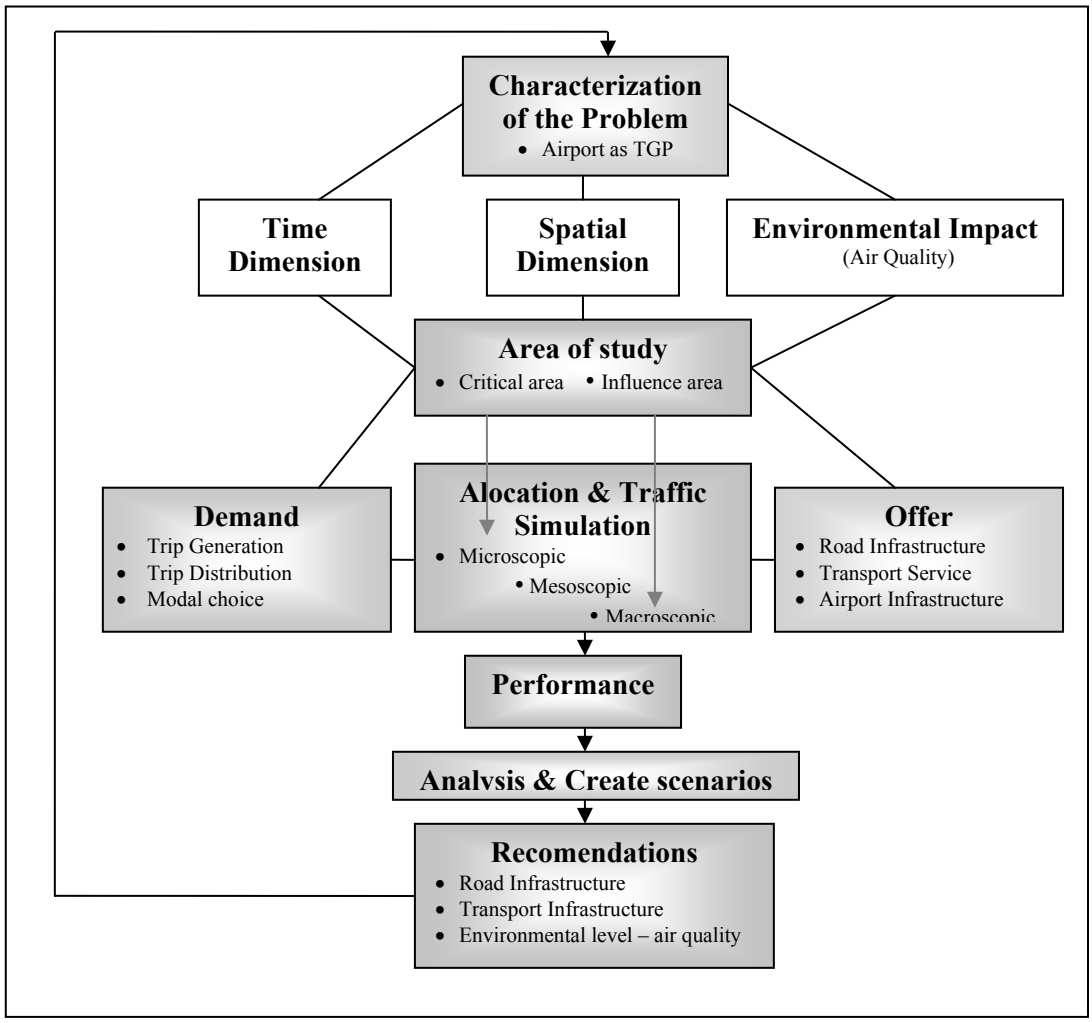
- Offers: transports and storage (bus stops, taxis, load/unload and parking) (Goldner & Andrade, 2001).

Based on the interaction between the demand and offers it defines the performance. This is the effect in the users of the road system and each modality of transports, in the circulation, in the parking, in the fluidity of the traffic, the security and the air quality. Such performance and the understanding of the causal factors, makes possible to generate and to analyze alternatives, to be evaluated and selected the most indicated, that must be implemented and be monitored. In this point also it defines the necessity to use a computational tool. Freitas (2004) suggests following some criteria to base the choice. These are: the model is suitable for work (size of the net, capacity of representation and "in/out" of the model); availability data (items to consider, localization of the known system elements, set of candidates installations to the opening, demand, taxes and costs of transport, timetables, costs in general, capacities in the transport ways and current standard); ease in use (pre-requisite in any type of model); necessary sources (GIS databases, optimizers to solve the models and companies to insert the model); the description of insertions and; the valuation and calibration.

The analysis of the impact of the air quality will happen through current flows, determination of the critical places (parking access, ways adjacent and net in general), taxes of traffic growth and qualitative allocation of generated traffic.

Thus, Figure 3 for the case of analysis of the airport as TGP is the following:

Figure 3 Project of analysis procedure



It is important to highlight that to trace and to define a specific project for analysis of airports five stages had been observed as basic: time delimitation, demand, offer, determination of the critical area and the inclusive area. Those one was observed as necessary in a study of parking size or in an expansion of airports, but anyone never put it together. However, some authors already mentioned this: Menezes (2000) affirms that some studies can be extended for other TGPs being used in the quantification of the atmospheric pollution related with the produced trips; the work of Cavalcante (2002) did an approach for poles with different activities; Goldner & Andrade (2001) approaches the airports as TGP, etc. However, from the methodological point of view, it can be said that there is rare applications for enterprises of mixing uses (Cavalcante, Arruda & Ratton Grandson, 2003). Moreover, it was not verified, after the literature review, study considering the interference between the aircraft movement

and the road traffic and its probable impact in the air quality.

5. Conclusions and recommendations

It is very complex to study an airport as TGP and its impact in the traffic engineering. There is different behaviour among the users (passengers, employee of the air companies and the administration of airport, the crew, the visitors, etc) in relation to arrive and departure of the airports (Goldner, Goldner, 2006).

To define criteria for an aircraft analysis is not an easy work. This article does not have the pretension to place as standard the stages suggested here. The main intention is to contribute with some relevant data for the subject. After all there are a few Brazilian literatures about airports as TGPs (Goldner, Goldner, 2006).

Besides this, this paper could be a reference to guide and to promote reflections. To join a great volume of data in useful information for the managers requires procedures in addition with a set of analysis tools that allow results in a perceivable way.

Then, the importance of this study was to highlight which parameters are necessary to change. For this it must be considered the airport specificities and the concern with the air quality. So it is suggested establish the delimitation space-time in two levels:

a) Critical area - characterized through the aircraft localization (center, periphery, the coast), the topography, that have direct influence in the dispersion of atmospheric pollutants and; the concentration of vehicles of the road around the airports (accesses, parking and kerb of arrive and departure);

b) Influence area - characterized by number of generated trips and the space distribution. Both influenced and proportional by indices of growth in the air traffic.

Understanding this it is possible to analyze the stages that involve the airports and its influence in the trips generation. Moreover, the use of computational tools for analysis of projects can bring significant profits in the decision-maker and it is basic in the urban and environmental planning. Proposing improvements that could help the growth of the aircraft sector in sustainable way is to affect in a positive way the transport system as a whole.

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