

## *Innovation planning for eco-efficient fuels for air transport*

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### **ABSTRACT**

*It is anticipated that the next twenty years the air transport will present an increase of almost double the growth rate of world GDP. This accelerated expansion of the sector has caused some negative consequences, such as the significant increase in carbon dioxide emissions. The aviation industry has already committed in changing this scenario and the target is to halve CO<sub>2</sub> emissions by 2050. To achieve this goal, it is necessary to planning eco-efficient aviation fuel, which allows the reduction by 80% of CO<sub>2</sub> emissions. The identification of alternatives to this replacement has been carried out in different research groups; however, it is clear that the planning of innovation has been carried out not integrated manner. In this sense, this study seeks to fill this theoretical gap and to contribute to this issue proposing a management tool to guide innovation in this sector. From Delphi method, it was found that the proposed scheduling method, identified as IPMEF-AT, would be considered applicable to the context in which it is intended, the innovation planning of ecoefficient air transportation fuels. The result obtained demonstrates the viability of IPMEF-AT and suggestions of experts were used in order to improve it.*

*Keywords: Air transport. Eco-efficient fuel. Management of innovation.*

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## 1. INTRODUCTION

Considering the increasing carbon dioxide (CO<sub>2</sub>) caused by air transport, with estimates predict an increase of 100% of emissions from the period 2012-2037 (AIRBUS, 2013), the aviation industry has determined targets to reduce global emissions of greenhouse gases (GHG), including CO<sub>2</sub>. Of all global emissions of CO<sub>2</sub>, 25% is linked to transport (IEA, 2009), considering that air transport represents 2% (IATA, 2013). Unlike other transport industries, which are already commercially use alternative to fossil fuel, directly responsible for the emission of greenhouse gases in the atmosphere, as shown in Blottnitza e Curran (2007), this reality does not happen intensively with the airline industry yet (MANIATIS *et al.*, 2011).

Alternative fuels are considered as promising solutions to reduce environmental impacts (IATA, 2013b). Indeed, in modern jet engines, fuels derived from renewable sources can replace non-renewable sources, such as petroleum products (Nair and Paulose, 2014). Faced with this possibility of substitution, efforts to identify alternatives to fossil fuels have been carried out in different research groups (CHIARAMONTI *et al.*, 2014). However, despite the various proposals and numerous test flights, such eco-efficient alternatives have not become widely commercialized yet (GEGG *et al.*, 2014). Thus, the mitigation of environmental impacts has become a major research stimulus in the airline industry (IATA, 2013b).

Initiatives such as the "Flight Path to Aviation Biofuels in Brazil: Action Plan", result of a partnership between Boeing, Embraer, Support Foundation of São Paulo (FAPESP) and the State University of Campinas, 2013, as well as training organizations for sustainability, such as the Sustainable Aviation Fuel Users Group (SAFUG), by airlines aim to accelerate the development and marketing of eco-efficient fuels for aviation. The study Unicamp *et al.* (2013) consists of a national assessment of the challenges and technological opportunities, economic and sustainability associated with the development and commercialization of sustainable fuels for aviation in Brazil because Brazil's potential as eco-efficient fuel supplier for domestic aviation and international it was proven by the study.

One of the incentives in the resolution of environmental issues is through innovation (YORK; VENKARATAMAN, 2010). In a study by Caetano (2014), research on the use of

alternative energy sources in transport are in one of the most representative themes of logistics

innovation management, with a percentage of 14% of the analyzed studies. Another aspect highlighted by the author is that most of the items identified in the study were developed recently (2011-2013), showing the contemporary concern for clean energy in transport. The study also shows that the proposals do not systematize the process of innovation in transportation.

Also Scott (2005) shows that most of the problems of companies related to the innovation process focuses on planning. Faced with the high representative of this stage, there is a necessity of a good plan and the use of planning support innovation tools.

Although Tuominen and Ahlqvist (2010) propose a technology roadmap to develop logistics systems in Finland, lack in this proposal an approach on the activities to be performed or the conditions so there is the integration of new technologies in processes along the chain supply, as the authors present only necessary technologies, actors and markets according to user needs.

Focusing this integration of approaches to the process of innovation, recent studies have emphasized the growing importance of external sources of ideas on an approach of open innovation (DEWES *et al.*, 2010), which can be defined as the various forms of relationship between innovative companies and external agents (DAHLANDER, GUNN, 2010; DEWES *et al.*, 2010). This type of relationship can be seen in cases such as the cities of Toulouse (France), Seattle (United States) and Montreal (Canada), showing positive results, such as technological and production expertise, and economies of scale identified in the aeronautical sector due to the development of regional productive systems of innovation or technology parks specializing in R&D (ABDI, 2009). Producers, users and government agencies, when working in networks, share skills and allow for more successful innovations (FRENKEN, 2000).

Caetano and Amaral (2011) highlight the inclusion of elements of open innovation to the planning of new technologies, products, services or processes according to market opportunities and proposes a technology roadmap that considers the market to be exploited, the product to be developed, major and complementary technologies, resources and partners. The proposed model serves as a guide in planning the technology and relationship

management between partners. In addition to this, there are in the literature several instruments to aid the innovation planning in organizations such as the Technology Development Process (TDP) and Product Development Process (PDP) (CAETANO *et al.*, 2012), T-plan (PHAAL *et al.*, 2001), Stage-Gate (COOPER, 2008), TRIZ (TRAGUETTO *et al.*, 2013), Technology Roadmapping - TRM (KAPPEL, 2001), among others.

These instruments could bring benefits for planning innovation in eco-efficient aviation fuel, as would provide support for the planning of this innovation, which is of great interest to society and organizations of the potential social, economic and environmental benefits of this sector.

In addition to the social interest, planning innovation presents a stream of complex activities (KOEN *et al.*, 2001). Thus, the present study aims to present a proposal for planning the innovation eco-efficient aviation fuel from a method of guidance to the innovation planning in this context.

## 2. CHALLENGES OF FOSSIL FUELS IN CIVIL AVIATION

For both the carriage of passengers and the cargo, the airline industry has increased its representativeness. It is expected that from 2013 to 2033, the air transport sector will present an increase of almost double the growth rate of world GDP. It is projected that while this period of twenty years, GDP will grow 3.2%, air and passenger traffic present the average growth of 5% over the same period (BOEING, 2013). In addition, the commercial airline industry comprises 56.6 million jobs and 2.2 trillion of global GDP (IATA, 2013b), demonstrating the strong industry representation.

Studies on the sector have shown the economic and social contribution that air transport promotes to a country (GINIEIS *et al.*, 2012). However, these benefits can be achieved at a very high environmental cost, especially the significant increase in aviation greenhouse gas emissions (MACINTOSH; WALLACE, 2009). Given this expansion of aviation in the global economy, the Intergovernmental Panel on Climate Change (IPCC) began in 1999 studies to evaluate the effects of aircraft on climate and atmospheric ozone, with the report "Aviation and the Global Atmosphere", aiming to provide of accurate,

impartial and relevant information to serve the aviation, industry, communities of experts and policy-making (IPCC, 1999).

Against the backdrop of harmful effects from CO<sub>2</sub> emissions caused by air transport, equivalent to 2% of total emissions caused by human action, in order to reduce their impact on climate urges the need to develop eco-efficient solutions to the sector.

A possible promising innovation in pursuit of environmental balance is present in innovation planning of eco-efficient fuels for aviation. In the development of eco-efficient fuels, different research groups have been investigating a number of technological options to replace the fossil fuel (CHIARAMONTI *et al.*, 2014).

In order to study the feasibility and impact of the use of alternative fuels in aviation, the European Commission for Energy and Transport started the study Sustainable Way for Alternative Fuels and Energy in Aviation (SWAFEA), consortium of research institutes, universities and industries. It is hoped that the study to develop a comparative analysis of different options of fuels based on an evaluation of available data. The study also aims to create a possible roadmap for future alternative fuels deployments (SWAFEA, 2013).

Also initiatives such as Sustainable Aviation Fuel Users Group (SAFUG), Round Table for Sustainable Biofuels (RSB), Round Table for Sustainable Palm Oil (RSPO) and European Directive on Renewable Energy Sources (RES) are bringing together farmers, companies, non-governmental organizations, experts, governments and inter agencies governmental stakeholders in the development of eco-efficient fuels, discussing issues related to the sector and develop global standards in the production of fuels with environmental and social criteria that companies must meet. However, these initiatives do not demonstrate how the planning activities are necessary to achieve these standards should be conducted, resulting in a lack of integrated planning mode of innovations.

The study "Flight Path to Aviation Biofuels in Brazil: Action Plan" (UNICAMP, 2013) identified the conversion and refining technologies with the potential to be considered in the production of eco-efficient aviation fuel. They used the roadmapping in search of identifying priorities (gaps and barriers) action plan to promote the use of this alternative energy. The stimulating discussions took place through workshops, conducted between May and December 2012, bringing together perspectives and perceptions of stakeholders, showing that the study turned to limiting factors and policy recommendations. Chiamonti *et al.*

(2014) list the main possibilities for the development of eco-efficient fuels following both the study of SWAFEA (2013) and the study of Unicamp (2013).

Another representative study was developed by the International Air Transport Association (IATA), the IATA Technology Roadmap, which intends to assist in evaluating the potential of different technologies that contribute to the improvement of fuel efficiency and consequent reduction of emissions (IATA 2013).

### 3. SUPPORT TOOLS OF THE INNOVATION PLANNING IN AIR TRANSPORT

Planning innovation covers the stage prior to the development of technology projects and product (KOEN *et al.*, 2001). By reason of being a stage that causes high impact in the innovation process as a whole, it is the moment they occur decisional activities as its alignment with the organization strategies, identification and evaluation of opportunities, generating ideas and defining products (KHURANA; ROSENTHAL, 1998). Managers, consultants and academics have developed several tools aimed understanding of practical issues and conceptual characteristics of this phase (KOEN *et al.*, 2001; PHAAL *et al.*, 2004; NOBELIUS; TRYGG, 2002; COOPER, 2008).

The definition of a formal process of planning innovation proves to be useful and beneficial for the entire innovation process (COOPER, 2001). Thus, models with phases and activities suggested for the innovation planning has been proposed by several authors. Caetano *et al.* (2012) present a comprehensive innovation process on a proposal of integration between Technology Development Process (TDP) and Product Development Process (PDP) as the difficulty in integrating technology-product prevents management effective innovation process (NOBELIUS, 2004).

Another model of the innovation process is proposed by Cooper (2008), which is called "Stage-Gate" and consists of five stages (stages) and five decision points (gates). The gates act as point analysis on the feasibility of the idea in order to decide whether or not to continue the investment and the stages make up a list of activities carried out by the team responsible for the project (COOPER, 2008).

The precursor method to stage-gate was developed in 1960 by NASA (National Aeronautics and Space Administration), called for "phased-review-process", used as a management tool. However, it did not consider the innovation process as a whole, from

concept to launch. The focus was only on the physical design and product development, acting more as a control and measuring tool to ensure that the project was in progress (COOPER, 1994).

Phaal *et al.* (2001) presented the T-plan, a mapping tool of technology innovation, in which decisions are aligned with product plans and adjusted with the business and market needs. This kind of proposal is characterized as Technology Roadmap (TRM) (GEUM *et al.*, 2013). Practical and geared for action, the TRM is a tool that aims to guide the efforts of the innovation process from a map (roadmap) with technological routes of the organization (PHAAL *et al.*, 2004). The integration of market, product and technology results from the application of TRM, as the paths that particular technology should follow to reach the market through products, services or processes are defined (KAPPEL, 2001).

The wide range of contexts to which the strategic tool TRM can be characterized as applied to an inherently flexible technique. Thus, various forms of road maps have already been developed (PHAAL *et al.*, 2004).

Recent studies of the innovation process have stressed the growing importance of external sources of funds, the so-called open innovation (DEWES *et al.*, 2010), which can be defined as the various forms of relationship between innovative companies with external agents (DAHLANDER; GANN, 2010; DEWES *et al.*, 2010).

Among the many studies of open innovation, Caetano and Amaral's proposal (2011) stands out with a model in its conceptual basis provides for the presence of employees and workers in a mapping that considers the market to be explored, products be developed, main and complementary technologies to be developed, and resources partners need to be triggered in the innovation process. Cooper (2008) suggests that the identification of the market to be explored are necessary data for the size of this market, exemplified by the volume of business generated in recent years, as well as the expectation of future growth.

The level of involvement with the technology to be developed classifies partners in employees or co-workers in a relationship a win-win (THOMPSON; SANDERS, 1998). While the first group has a co-development relationship, the second is characterized by lesser involvement and commitment to results.

Also the Theory of Inventive Problem Solving (TRIZ) presents a methodology of solving problems focused on efficiency, effectiveness and creativity, which can contribute to the process of innovation in organizations (SAVRANSKY, 2000). The basis of TRIZ theory

consists of several tools that can be classified into five fields, which should be addressed in the resolution of a problem, as follows: 1) current status - in this field must question that resembles current situation, 2) resources - the question would be what resources are available?, 3) goals that must be met; 4) target state - as the future situation should be? And, finally, 5) transformation - how the current state can become the target state? (MOHERLE, 2005).

Traguetto *et al.* (2013) propose the application of TRIZ as a planning tool of the new disposition of cargo in the warehouse of a terminal air cargo. The study shows that the use of this instrument can provide innovative management practices that lead the system to optimize the use of resources as they have been proposed actions such as changing the layout of cargo storage. As well as TRIZ proved useful in planning innovation in a cargo terminal, it is expected that the application of it and other planning instruments cited innovation can be used in planning the innovation in eco-efficient aviation fuel, for through the use of these instruments are established guidelines and procedures guiding the activities of the innovation process.

#### 4. MATERIAL AND METHODS

The most appropriate procedures for conducting the study was adopted by the Delphi method, considered an appropriate method to situations of lack of historical data or when you want to encourage the creation of new ideas. This method boils down to a query to a group of experts about future events through a questionnaire, which is passed on as often as necessary until to reach a group consensus. These feedback responses, the anonymity of respondents and statistical representation of the distribution of results are characteristics of this method (WRIGHT; GIOVINAZZO, 2000).

Delphi method based on consultation with leading experts, was used in studies on innovation, as Schuckmann *et al* (2012), Adams *et al* (2006). Some characteristic negative processes of Delphi traditional method, such as the lack of real-time presentation of results and difficulties in monitoring progress over time can be avoided with the application of the technique via internet (SCHUCKMANN *et al.*, 2012).

In this study, to analyze the perception model of the application feasibility in real situations, experts representing supply and demand for this fuel in a number of three to ten panelists were selected, considered enough to generate relevant information.



The first contact with the experts took place via electronic mail with the formal invitation to participate in the study and containing a letter of explanation about the study. After acceptance, the questionnaire accompanied by an annex to the explanatory video of the proposed method, with 2 minutes 19 seconds period was sent to them to take prior knowledge of the method.

The proposed method, named IPMEF-AT as the acronym to its main function, an innovation planning method for eco-efficient fuels for air transport.

For the answers to the questionnaires was adopted on issues closed a Likert-type items, according to five degrees of compliance with decreasing values 5-1, where 5 is completely applicable (CA) 4 - Applicable (A), 3 - Partially applicable (PA), 2 not applicable (NA) and 1- Completely Non-applicable (CNA). To this end, the following affirmatives were considered: 1) The method can be applied to the development of fuels with improved environmental performance for air transport, 2) There is possibility of involving partners in the implementation of the method, 3) High impact of the method in the marketing of eco-efficient fuel for the airline industry, 4) Utility of the method in other areas, 5) The model should address the issue of costs, 6) The number of days for each stage shows to be feasible to apply context.

Open questions, such as "If you disagree with the amount of days provided for each activity, what is your suggestion for the period of each?" And "If you want to make any additional comments on this questionnaire and the proposed method, by please use the space below" also composed the questionnaire in order that the expert can expose their opinion without any explicit reference.

The first applying step of the questionnaires took place in an international event. In the second stage, the questionnaires could be answered as the convenience researched period as they have been sent by e-mail, along with explanatory video on the IPMEF-AT. The total of respondents on each step is presented on results.

## 5. RESULTS

The international event on which the first of the questionnaires application stage was the 24th IAMOT Conference, organized by International Association for Management of Technology, with the theme "Technology, Innovation and Management for Sustainable

Growth", held in Cape Town, South Africa, from 8 to 11 June 2015. The event was attended by researchers, academics and participants from around the world industry. After the presentation by the researcher, eleven experts who attended the method of explanation answered the questionnaire. Table 1 contains the distribution of responses received after the presentation at the international conference. The six questions were answered according to five degrees of suitability.

Table 1 - Replies to the questionnaire (IAMOT)

Question	Adequacy degrees in the application of IPMEF-AT					Total answers
	CA	A	PA	NA	CNA	
1	3	<b>8</b>	-	-	-	11
2	<b>6</b>	5	-	-	-	11
3	2	<b>6</b>	3	-	-	11
4	<b>4</b>	3	3	-	-	1 Did not answer
5	3	<b>5</b>	2	1	-	11
6	-	<b>6</b>	3	1	-	1 Did not answer

Source: research data (2015).

According to Table 1, the levels of most frequently in the responses highlighted in bold, shows that the majority considered that the method is completely applicable or enforceable on the disputed items.

The responses obtained in the questionnaire in IAMOT event showed the feasibility of the method and served as a test for consulting the experts characterized as potential users, and enable it to be identified the need to include lines for additional comments on each of the issues the questionnaire in the next round.

The second stage consisted of sending the questionnaire via email and with the collaboration of five experts, who are characterized as potential users of the method for exercising functions related to innovation management in organizations, focused on the development of technological solutions, eco-efficient fuels, consulting, among others. This number of experts, considering the Delphi method and the literature on case studies (EISENHARDT; GRAEBNER, 2007), are sufficient for the construction of theories on the subject.

Each of these experts could contribute to each of the issues in an open manner, with comments that were very useful for the improvement of the model. The Table 2 shows the distribution of responses received after sending e-mails with explanatory video and questionnaire.

Table 2 -Replies to the questionnaire (IAMOT)

Question	Adequacy degrees in the application of IPMEF-AT					Total answers
	CA	A	PA	NA	CNA	
1	-	<b>4</b>	1	-	-	5
2	3	<b>2</b>	-	-	-	5
3	1	<b>3</b>	1	-	-	5
4	2	<b>3</b>	-	-	-	5
5	<b>3</b>	1	-	1	-	5
6	-	1	<b>4</b>	-	-	5

Source: research data (2015).

With regard to Question 1 shown in Table 2, one of them show the existence of several standards in this sector, which corroborates with the statement submitted by Unicamp (2013) which states that the complexity of standards and certification processes both in environmental issues as in fuels require adaptations of the entire production chain. Also in this issue one second respondent asserts the need to identify the main driving fundamentals for the development of fuel, especially issues related to the mix of components, as presented in the study of Unicamp (2013).

The partnerships considered by experts in Question 2 involves open innovation, consisting of various forms of relationship between innovative companies and external agents (DAHLANDER; GUNN, 2010; DEWES *et al*, 2010). The relevance of partnerships was treated in the model of Caetano and Amaral (2011), which provides in mapping the presence of employees and co-workers.

It is observed that in Question 3 the experts believe that the IPMEF-AT can impact the marketing of eco-efficient fuel. This runs counter to the fact that, in general, the instruments to support the innovation planning play this preparation paper to launch in the market, as the "Stage-Gate" of Cooper (2008), composed of five stages (stages ) and five points decision on the continuation or otherwise of investments in the project (gates).

The possible application of IPMEF-AT in other areas cited in Question 4, was deemed applicable by 3 experts and fully applicable by 2. The comment of one of them stating that the method would be valuable for use in fundraising or due diligence processes, it demonstrates what has been said about the flexibility of planning tools such as TRM applicable to a wide range of strategic contexts.

The lack of integration costs in IPMEF-AT was the target of comments in Question 5. Among the five experts, three believe it is completely applicable to the issue of cost method because it is believed that the cost is a determining factor in the verification of commercial viability. One of the experts said that stakeholders will want to know how much it would cost them to participate in this project. As already highlighted, the costs were not a focus of this work, but it is suggested as a target for future research.

Regarding the number of days allocated for each step of IPMEF-AT, four out of the five experts marked that the proposal is partially applicable, or needs modifications. Therefore, all comments made on this issue were considered, analyzed and served as reference for the changes to the method. The works that approach to this issue of period of each step in a roadmap (Catenao and Amaral, 2011; Cooper, 2006) were also used. In Table 3 are listed the main considerations made by experts in each of the survey questions.

Table 3 – Key consideration of experts (e-mail)

Question	Key Considerations
1	<ul style="list-style-type: none"> <li>- Identification of industry standards;</li> <li>- Good tool for a high-level start;</li> <li>- Respect the fundamentals / fuel specifications for air transport.</li> </ul>
2	<ul style="list-style-type: none"> <li>- Formation of partnerships;</li> <li>- Seek support / partnership "senior staff" who knows and has experience in the industry;</li> <li>- Check the process from the farm to the fuel</li> <li>- Tip of 06 months to identify the partners</li> </ul>
3	<ul style="list-style-type: none"> <li>- The fuel development process value Statement</li> </ul>
4	<ul style="list-style-type: none"> <li>- Can be used in fundraising and the due diligence process</li> </ul>
5	<ul style="list-style-type: none"> <li>- Stakeholders have an interest in knowing about the cost</li> <li>- Cost is a determining factor for the commercial viability</li> </ul>
6	<ul style="list-style-type: none"> <li>- Always it takes longer than expected when working with the development of technology platforms.</li> <li>- Doubts as to the deadline for partnerships</li> </ul>

Source: research data (2015).

Following considerations suggested by the experts (Table 3), some changes were made in IPMEF-AT resulting presented in the following method.

## 6. THE IPMEF-AT PROPOSAL

A summary of the stages of IPMEF-AT with their activities prior to each of them and the average expected in days for each activity is shown in Table 4. This improved version of the method already incorporate amendments suggested by experts regarding the implementation of the method.

Table 4 - Steps of the proposed method

	<b>Activities</b>	<b>Period (days)</b>	<b>Predecessor</b>
<b>A</b>	Environmental impacts	<b>10</b>	-
<b>B</b>	Reality of the diagnosis	<b>7</b>	<b>A</b>
<b>C</b>	Available resources	<b>7</b>	<b>A</b>
<b>D</b>	Goal Setting	<b>10</b>	<b>B,C</b>
<b>E</b>	Identification market	<b>20</b>	<b>D</b>
<b>F</b>	Product concept definition	<b>14</b>	<b>E</b>
<b>G</b>	Identification of standards of ASTM / competent organs	<b>5</b>	<b>E</b>
<b>H</b>	Government support / Partners	<b>180</b>	<b>E</b>
<b>I</b>	Map drawing	<b>5</b>	<b>F,G,H</b>

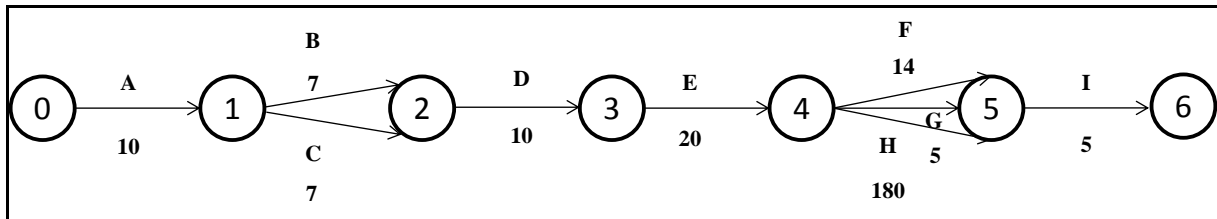
Source: research data (2015).

Table 4 lists all the activities of IPMEF-AT, in which the 0 event marks the beginning of the network, followed by other activities, as shown in Figure 1.

It is necessary to point out that the innovation planning covers the activities carried out before the development of technologies and products (KOEN *et al.*, 2001). Since this is a method that guides the innovation planning, the focus is on activities related to this phase with the appropriate deadlines for the implementation of IPMEF-AT.

For the construction of the diagram considered the beginning of the network in the event called "0" with the necessary subsequent activities until the final design when planning map - event "6". The period in days for each activity is represented by the number located beneath the letter of the respective activity.

Figure 1 - Structure of the proposed method



Source: research data (2015).

It is noteworthy that the initial activity, in Figure 1, has no predecessor, i.e., the environmental impacts are the initial cause for the following activities, which are the activities B and C, diagnosis of reality, based on the question of which resembles themselves to the current situation and what resources are available for an average of seven days each. The ten days of initial activity are intended to identify the harmful effects caused by the impact. For the establishment of that order, followed by the consideration of one of the experts - "With regard to the method imagine that the activities Diagnosis of reality and available resources should precede the definition of the goals. It is essential to know the current situation and the resources available to know how much it is possible to improve, or to make achievable goals". The basis for the D step of the method is the proposed questions of TRIZ. Event 2, based on the question of which goals must be achieved, is motivated by the goals determined by the aviation industry to the global reduction in emissions of greenhouse gases (GHG), improvement of 1.5% per year on efficiency fuel by 2020. The neutral growth in carbon, which assumes that the total CO<sub>2</sub> emissions from international air transport in 2020 will continue to be equal to the emissions in 2005 and to halve carbon dioxide emissions by 2050, considering the levels 2005. As a parameter for the estimation the period of activity D - setting goals – the reference is the time period of the 38th ICAO Assembly, held in Montreal, Canada, from September 24 to October 4, 2013.

The event 3 is marked by activity and market identification, as required by the method proposed by Caetano and Amaral (2011). About twenty days are allocated to activity, as suggested by the expert B and considering that the specialist and stated that "15 days to market identification is little time."

In the event occurring 4 activities related to product definition of the concept, including the identification of regulation and building partnerships. The definition of the

product concept is based on the proposal of Koen *et al* (2001), who in his model suggests the phase of "the definition" related to the PDP and PDT, but that is in the planning phase. The number fourteen days proposed for this phase was indicated by the expert C. In the event 4 was to include the identification of standards for qualification and certification of alternative fuels by ASTM and regulation made by the competent bodies.

Note that this does not refer to the operation of the regulatory requirements, but to identify which laws and standards for the product to be certified. In addition to certification of ASTM, the international certification of industry standards in Brazil to fuel certification must be validated by the ANP (National Petroleum Agency), which can last an average of five days.

In addition, there is at this stage the presence of the partners, which in this case could be characterized as research institutes and higher education institutions (HEIs), which can act as technology partners co-workers as they allow access to technical information. It is worth noting the importance of government support at this stage of planning innovation because government actions directly interfere in the development of a product. This entire process would take about six months, as suggested by those skilled C, which coincides with the 180 days proposed by the skilled D. Finally, the map drawing occurs in the last step, with an average period of five days, which was made a map with partners, goals, resources identified for this market.

## 7. CONCLUSIONS

Airlines, aircraft manufacturers, governments, various agencies and institutions have proven favorable and active towards the reduction of environmental impacts caused by aviation, which can be achieved through integrated innovation planning. The proposition of the guidance method for innovation planning in the context of development of eco-efficient fuels for aviation - IPMEF-AT - was reported as a proposal towards this integration partners identification planning. One of the main advantages of the method proposed, as demonstrated by studies of open innovation, is the incorporation of partnerships is a strong tendency in the innovation process.

The results indicate opportunities for future research in order to increase and validate the method on real cases planning of eco-efficient fuels and the inclusion of the cost analysis,

which could be investigated in detail, as suggested by experts in the field, which can influence at various stages of the method. An analysis of the role of public policy could still be made, featuring the state's role in fostering and encouraging the planning of eco-efficient fuel.

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