7M Method for Operations Variable Assessment

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Abstract. *This article shows a new method for operations variable assessment, the 7M. The aim is to present a new approach using a systemic method to evaluate the variables involved in a transportation engineering operation problem. Every kind of variables, from a global to a local point of view, are contemplated and can and should be considered. As so, not only engineering, but also legal, economical, political, security, safety and human factors, among others, related variables are used in the method. The method is applied to the case of offshore personal transportation on the Pré-Sal operation. Within these variables, for this case, one finds not only technical variables linked to the transportation modals (i.e., aircrafts, ships, mainly), but also variables associated with the legislation, local, state, federal, and international; the air control; safety and security; SAR; certification of equipment, companies, aircraft, pilots, engineers, and trainees; technical and academic studies; contracts and financing, of banks, royalties or special participations; industry and market; culture; language; environmental management; support and transport infra-structures; just to mention some. From the available information linked to the current Petrobrás personnel transportation situation, and considering its time-history evolution, one concludes that the solutions presented and used up to now are not the best ones. In terms of the forecast involving the exploration of the Tupi area (so called Pré-Sal) it is evident that new solutions need to be considered and implemented, in a way that the wanted and accepted high levels of logistics, safety and economical effectiveness can be reached. In summary, it is paramount that operations such as these need to be thought, studied and implemented by technically, managerially and intellectually prepared professionals, effectively and within the correct timing, with the partnership of institutions imbued with one focused strategy. The strategic decisions ought to come from decision-makers which can relay on an efficient method to get "the big picture".*

Keywords*: 7M Method, Operations, Variables, Transportation, Helicopter, Safety, Offshore, Pré-Sal.*

1. INTRODUCTION

In any technical activity, especially engineering and management, decisions have to be made based on the decision-maker technical knowledge on the area and the available information on the subject. Many times, the consequences show that the decisions made were the wrong ones. But, in fact, the decisions were the right ones, considering the available information. So, the problem was the lack of information, not the analysis made.

Because in the aeronautical/aerospace business mistakes usually lead to high impact consequences, with the loss of a great number of lives, it is of primary importance that a simple and clear, but effective method/tool is available so all the information can be gathered.

The aim of this paper is to present a new methodology which allows a systemic approach to the assessment of all the variables (data) involved in a logistics flight operation.

2. METHODOLOGY

The first step to implement a management or engineering algorithm for any operation is to assess all the variables involved. Only then, the problem entire view, and so, the problem complete notion can be achieved. Given that, and only in that point, the best solution is attainable.

The present methodology makes use of a general operation diagram, and a set of words and questions, to guide the manager or the engineer in the assessment of all the variables involved in the operation.

2.1. 7M Method

The 7M method consists in a systemic method to evaluate the variables involved in a transportation engineering operation problem. Starting from a set of words, with a broad meaning each, a new set of words is point-out for each of the words, these ones with a smaller meaning than the ones before, and this goes one until it is not possible anymore to divide the meaning of the words. Note that to check the meaning of a word, and to understand it, its definition must be considered. At that point all the variables, which correspond to the words, are found. To make it easer to use the method, a mnemonic and a diagram have been created.

2.2. 7M Diagram

For a better understanding of all the variables and their relative position on the operation, a diagram is presented (see figure1).

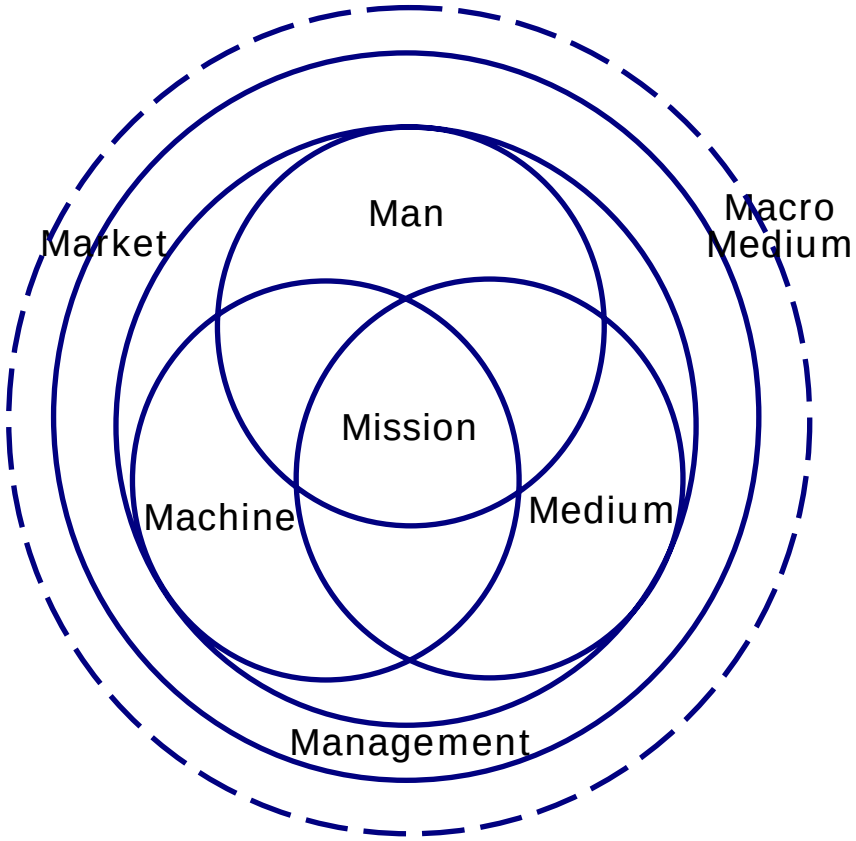

Figure 1. 7M Method Diagram.

2.3. 7M Mnemonic

For a better memorization, the 7M Method makes use of a mnemonic:

- Machine;
- Macro Medium;
- Man;
- Management;
- Market;
- Medium;
- Mission.

2.4. Definitions

The mnemonic, and so the method, is of no use if the user does not have the understanding of the meaning of each word. For that reason, the definition of each word used is presented next:

Machine

Everything which is directly related with the aircraft, from its conception, design, calculation, test, certification, production, maintenance, service, operation and history, performance, crashworthiness and survivability, and noise and is quantitatively measurable.

Macro-Medium

Everything which is directly related with non-controllable environmental, political and legal factors, and is quantitatively or qualitatively measurable.

Man

Everything which is directly related with human factors, in every stage of the aircraft life, and is quantitatively or qualitatively measurable.

Management

Everything which is directly related with decision making, from laws, regulations or procedures, going through organization policies, and technical decisions, to crew options, and is qualitatively measurable.

Market

Everything which is directly related with offers and demands, including necessities reactions by other organizations or society, and is quantitatively or qualitatively measurable.

Medium

Everything which is directly related with infrastructures, and is quantitatively or qualitatively measurable.

Mission

Clear and concise statement of the objectives, goals and mission of the organization and/or operation, and is quantitatively or qualitatively measurable.

NOTE: Every factor should be considered only once, where it fits better, even if it can relate with more than one M.

NOTE: Qualitative evaluation will be transformed in quantitative one by the use of a 5 point scale considering the opinion of a number of representative persons involved in the case/operation.

2.5. Words

The way to find the variables consists in a sequence of steps. A simple set of steps, for the case study, is presented next for a better understanding of the method.

Table 1. First step word.

Variable	Definition
Machine	Everything which is directly related with the aircraft, from its conception, design, calculation, test, certification, production, maintenance, service, operation and history, performance, crashworthiness and survivability, and noise and is quantitatively measurable.
Macro-Medium	Everything which is directly related with non-controllable environmental, political and legal factors, and is quantitatively or qualitatively measurable.
Man	Everything which is directly related with human factors, in every stage of the aircraft life, and is quantitatively or qualitatively measurable.
Management	Everything which is directly related with decision making, from laws, regulations or procedures, going through organization policies, and technical decisions, to crew options, and is qualitatively measurable.
Market	Everything which is directly related with offers and demands, including necessities reactions by other organizations or society, and is quantitatively or qualitatively measurable.
Medium	Everything which is directly related with infrastructures, and is quantitatively or qualitatively measurable.
Mission	Clear and concise statement of the objectives, goals and mission of the organization and/or operation, and is quantitatively or qualitatively measurable.

Table 2. Second step words.

Variable		Definition
Machine	Aircraft	flying machine, qualitative.

Table 3. Third step words.

Variable			Definition
Machine	Aircraft	Helicopter	Flying machine with rotational wing capable of hovering, qualitative.

Table 4. Fourth step words.

Variable				Definition
Machine	Aircraft	Helicopter	Age	number of years/months since manufacture, quantitative in years or months (the less the better for maintenance).
			Price	cost of a new machine, quantitative in US$/R$ (the less the better for cost).
			Devaluation	ratio between the loss of second hand value of a machine, quantitative in US$/R$ (the less the better for cost).

Table 5. Last step variable.

Variable	Definition
Age	number of years/months since manufacture, quantitative in years or months (the less the better for maintenance).

The sequence to find the variables can take a long time, since it implies not only the words but also their definition. The reason why the author consider that the definition is so important has to do with the fact that the main problem in all kind of human relations/interactions is communication, since most of the time people have a different understanding of a word or phrase. In operations, specially one which involves people life, it his very important that everyone involved understands not only the operation, its part in that operation, but also what other people are doing and saying. This position is the only acceptable one in a safety cultural organization.

3. LITERATURE REVIEW

These methods/tools despite being very simple can be extremely useful. Of course, a method/tool is only effective if it is used in the area it was made for, and by a person which dominates it and has technical knowledge on the subject.

It is common practice in all analysis which involve a great number of variables to create a method/tool, using a mnemonic, to orient the gather of information or the analysis of a situation. Some examples of such tools are presented next:

5Ms of Management (Stoner, 1999, Carayannis, 2005)

These methods are used for creation, evaluation and optimization, among other, of organizations. The areas consider in these methods are:

- (Marketing); Machine; Man; Material; Method; Money.

5Ms of Development (de Witte, 2007)

This method is used for the identification of new market opportunities and demand development, considering the measurability of data and the ability to identify and predict market behaviour. The focus consider in the method are:

- Management; Mode; Media; Message; Metrics.

5Ms of Operational Risk Management (FAA, 2000)

This method is used as a framework for analysing systems and determine the relationships between the elements that work together to perform a task. The factors consider in this method are:

- Machine; Man; Management; Media; Mission.

5Ms Method of Moving Society to Change (Smith, 2007)
This method is used as a tool for the implementation of society opinion. The points considerer in the method are:

- Media; Members; Message; Mission; Money.

5M Factors (Wells, 1997)
This method is used as a model for examining the nature of accidents, so to ensure that all factors are considered. This method is the final actual version, made by E. A. Jerome, of the T. P. Wright model. The factors considered in the method are:

- Machine; Man; Management; Medium; Mission.

It is interesting to note that even experts create simple tools to allow them to, in a more easy way, better perform their function. The examples presented here are all, in some way, related to operations. None of the above mention methods considers the reality that operation is inside a global market, society and environment.

4. CASE STUDY

The 7M method was applied, in a first approach, to the Petrobrás offshore personal transportation on the Pré-Sal operation. Some of the variables found up to now are listed next in Tab. 1. Note that, since the work is not finished, some words are also presented (they are not yet proper variables because their meaning can still become smaller or more focused), and some of the definitions still need to be directed to the type of operation in study, and most of them (if not all) still need further information (like application, action type, reason of been, among other).

Table 1: Case Study Variables.

Variable	Definition
Accident Reporting	standard written report related to flight operations accidents, qualitative.
Accident Statistics	information related to flight operations accidents, obtained from mathematically treated operations data, quantitative.
Accountability	legal responsibility for all actions or decisions, qualitative.
Acquisition Cost	all the costs related to the acquisition of an aircraft, quantitative.
Air Traffic Control	international, regional or national laws and regulations for air traffic and airport operations, qualitative.
Aircraft Age at Acquisition	number of years/months since manufacture at acquisition, quantitative in years or months (the less the better for maintenance).
Aircraft Age at Beginning of Operation	number of years/months since manufacture at the beginning of operation, quantitative in years or months (the less the better for maintenance).
Aircraft Offshore Operations Adequacy	helicopter equipment and characteristics needed for a safe offshore operation (multi-engine, saltpetre resistance, instruments flight capacity, cargo capacity, transport capacity, reinforced landing-gear, emergency fluctuates, emergency transmitter, potency excess availability, sonar beacon), qualitative.
Airport / Heliport Tax	helicopter ground operations infrastructure standard value.
Airworthiness	ability of an aircraft or other airborne equipment or system to operate without significant hazard to aircrew, ground crew, passengers (where relevant) or to the general public over which such airborne systems are flown.
Autonomy	number of miles/km the aircraft can perform, quantitative in miles/km (the more the better for operation).
Certification	international, regional or national laws and regulations for operational certification of aircraft, crew, maintenance and operations personnel, qualitative.
Climate (natural environment)	encompasses the temperatures, humidity, atmospheric pressure, winds, rainfall, atmospheric particle count and numerous other meteorological

	elements in a given region over long periods of time.
Comfort	feeling of well-being experienced by the flight crew and passengers during flight, qualitative (the more the better for image).
Communication	process of transferring information from one source to another.
Companies	number of companies with offshore flight operation capability, quantitative.
Company Finance	offshore flight operators concepts of time, money and risk and their interrelation, for a sustainable long time operation.
Contract	exchange of promises between two or more parties to do, or refrain from doing, an act, which resulting contract is enforceable in a court of law.
Contractual Clauses	part of a contract, consisting of a phrase, where a specific agreed case is presented.
Cooperation	process of working or acting together, which can be accomplished by both intentional and non-intentional agents.
Crashworthiness	structures and systems performance during and after impact, qualitative (the more the better for safety).
Crew	number of flight crew members, quantitative in persons (the less the better for cost – not disregarding a minimum of two for safety).
Crew Availability	offshore flight operations prepared or experienced crew personnel which are available in the market, quantitative.
Crew Cost per Hour	calculated value in money of an hour of crew operation.
Crew Existence	offshore flight operations prepared or experienced crew personnel which exist in the market (but may not be available), quantitative.
Crew Future Necessity	offshore flight operations crew personnel predicted necessity in the future, quantitative.
Crew Options	all the available operational options which crew have during flight operation.
Crew Salary/Cost	offshore flight operations prepared or experienced crew personnel labour cost, quantitative.
Culture	integrated pattern of human knowledge, belief, and behavior that depends upon the capacity for symbolic thought and social learning, or set of shared attitudes, values, goals, and practices that characterizes an institution, organization or group. (national, organizational, operational, professional, personal and safety).
Devaluation	expected loss in value, quantitative in US$/R$ (the less the better for cost).
Engineer Availability	offshore flight operations prepared or experienced engineer which are available in the market, quantitative.
Engineer Cost per Hour	calculated value in money of an hour of engineer operation.
Engineer Existence	offshore flight operations prepared or experienced engineers which exist in the market (but may not be available), quantitative.
Engineer Future Necessity	offshore flight operations engineers predicted necessity for the future, quantitative.
Engineer Salary/Cost	offshore flight operations prepared or experienced engineer labour cost, quantitative.
Error-Resistant System	system designed to minimize or mitigate the occurrence of errors due to operators improper action.
Ethics (Applied)	philosophical examination, from a moral standpoint, of particular issues in

	private and public life that are matters of moral judgment.
Experience	concept which comprises knowledge of, or skill in, or observation of, some thing or some event gained through involvement in, or exposure to, that thing or event.
FDM/FOQA	FDM/FOQA equipments and systems installation (FAA and CAA offshore flight operations required)
Goal	projected state of affairs that a person or a system plans or intends to achieve.
Hangar	proper infrastructure for helicopter ground operation.
Helicopter	rotary-wing aircraft, with the ability to hover.
Helidecks in Intermediate Platforms	infrastructure (predictive) characteristics of offshore intermediate platforms helidecks.
Helidecks in Offshore Platforms	infrastructure characteristics of offshore platforms helidecks.
Helidecks in Ships	infrastructure characteristics of ships helidecks.
High Duty Cycles	number of hours/minutes the machine was used in envelop limits or off-limits, quantitative in time (the less the better for maintenance and safety).
History	activities during machine's life, qualitative (the more inside the predicted during design the better for maintenance).
Incidents Reporting	standard written report related to flight operations incidents, qualitative.
Incidents Statistics	information related to flight operations incidents, obtained from mathematically treated operations data, quantitative.
Industry-Components	national/regional industry capability to project and manufacture rotary-wing aircrafts components.
Industry-Helicopter	national/regional industry capability to project and manufacture rotary-wing aircrafts.
Industry-Systems	national/regional industry capability to project and manufacture rotary-wing aircrafts systems.
Intermediate Platforms	infrastructure (predictive) characteristics of offshore intermediate platforms.
Landing Points	predictive localization of future landing points at sea and land, quantitative.
Legislation	law which has been promulgated (or "enacted") by a legislature or other governing body.
Life-Cycle	predicted operations and maintenance activities during machine's life, qualitative (the more inside predicted the better for maintenance and safety).
Manager Availability	offshore flight operations prepared or experienced manager personnel which are available in the market, quantitative.
Manager Cost per Hour	calculated value in money of an hour of manager operation.
Manager Existence	offshore flight operations prepared or experienced manager personnel which exist in the market (but may not be available), quantitative.
Manager Future Necessity	offshore flight operations management personnel predicted necessity for the future, quantitative.
Managers Salary/Cost	offshore flight operations prepared or experienced manager personnel labour cost, quantitative.
Manufacturer Country/Area Implementation	manufacture services availability (the more the better for cost and maintenance).

Military Use	former military property or use, qualitative (the less the better – not disregarding the elimination due to that).
Number in Country/Area	number of the same version of the aircraft in country/area, quantitative in machines (the more the better for maintenance).
Number in Fleet	number of the same version of the aircraft in fleet, quantitative in machines (the more the better for maintenance).
Number of Blades	number of blades in main rotor, quantitative in blades (the less the better for maintenance – not disregarding the more the better for safety and comfort).
Number of Engines	number of engines, quantitative in engines (the less the better for maintenance – not disregarding a minimum of two for safety).
Number of Manufacture Aircraft in Country/Region	number of the same manufacture's aircraft in country/area, quantitative in machines (the more the better for service).
Number of Manufacture Aircraft in Fleet	number of the same manufacture's aircraft in fleet, quantitative in machines (the more the better for maintenance and service).
Offshore Future Missions	number of predicted offshore flight missions necessity for the future, quantitative.
Offshore Mission Necessities	number of actual offshore flight missions necessity, quantitative.
Offshore Mission Statistics	information related to flight operations missions, obtained from mathematically treated operations data, quantitative.
Offshore Passenger Cost per Hour	calculated value in money of an hour of passenger operation.
Operation Cost per Hour	calculated value in money of an hour of flight operation.
Operational Risk	operational precise probability of specific eventualities, quantitative.
Operational Rules	international, regional or national regulations for flight operations, qualitative.
Passenger Number	information related to passenger distribution for operations missions, obtained from mathematically treated operations data, quantitative.
Passengers and Crew Sea Survival Equipment	value in money of the individual sea survival kits equipment acquisition cost.
Passengers Training for Survivability Availability/Cost	value in money of the passengers sea survivability crash training cost, quantitative.
Personnel Selection	human resources procedures and practices, considering operational necessities and regulation and contract limitations.
Pilots Salary/Cost	offshore flight operations prepared or experienced pilots labour cost, quantitative.
Pilots Training Availability/Cost	value in money of the pilots training, quantitative.
Planning	organizational process of creating and maintaining a plan; and the psychological process of thinking about the activities required to create a desired goal on some scale.
Post-Crash Survivability	machine performance after crash, quantitative (the more the better for safety).
Radio Cost	value in money of the installation in each landing point of radio equipment for instrument landing, quantitative.
Redundancy	duplication of critical components of a system with the intention of

	increasing reliability of the system, usually in the case of a backup or fail-safe.
Refuelling	refuelling equipment/infrastructure localization at sea/land, quantitative.
Regulation	controlling human or societal behaviour by rules or restrictions.
Safety and Quality Assurance Personnel Training Availability/Cost	value in money of the safety and quality assurance personnel training, quantitative.
School	institution or organization designed to allow and encourage students (or "pupils") to learn, under the supervision of teachers.
Sea (natural environment)	large extension of cold, saline water.
Search and Rescue Capability	number, disposition, availability and time reaction of all means of search and rescue at sea, quantitative.
Seats	number of seats or passengers, quantitative in seats (the more the better for cost and operation – not disregarding safety and comfort).
Ships Type	machine/infrastructure characteristics of ships.
Store/Warehouse Cost	value in money of the infrastructure needed to store equipments and components to be used in maintenance activities, quantitative.
Survivability Adaptations Cost	value in money of the helicopter sea survivability equipment acquisition and implementation cost, quantitative.
Sustainability	ability to maintain balance of a certain process or state in any system.
Sustained Airworthiness	ability to maintain balance of the process or state which allow an aircraft or other airborne equipment or system to operate without significant hazard to aircrew, ground crew, passengers (where relevant) or to the general public over which such airborne systems are flown, during all its life-cycle.
Tail Rotor Type	tail rotor type, qualitative (fan-in-fin better for safety).
Technical Personnel Availability	offshore flight operations prepared or experienced technical personnel which are available in the market, quantitative.
Technical Personnel Cost per Hour	calculated value in money of an hour of technical personnel operation.
Technical Personnel Existence	offshore flight operations prepared or experienced technical personnel which exist in the market (but may not be available), quantitative.
Technical Personnel Future Necessity	offshore flight operations technical personnel predicted necessity for the future, quantitative.
Technical Personnel Salary/Cost	offshore flight operations prepared or experienced technical personnel labour cost, quantitative.
Temporal Passengers Distribution	predicted passengers distribution along different periods of time.
Warning Device	any system of technical nature deployed by an individual, system or machine to inform of a future danger.
Weather (natural environment)	set of all the phenomena occurring in a given atmosphere at a given time.

5. CONCLUSION

The number of variables involved in a complex situation, such as the one considered in the example, is very high (in this case 109 variables/words were presented but more than 250 have already been found). For that reason a good method/tool is necessary to secure that all variables are known; that method is presented in this paper. Of course, the

method capability is limited by the cultural, intellectual and technical knowledge of the user(s). Only after the use of this method the analyst can decide which variables to use, and the relative importance of them, in the analysis.

6. FUTURE WORK

A multivariable optimization code will be created to show that if different variables are considered, different results are obtained with the same analysis tool. The intention is to prove that for a correct choice the work must starts with the proper evaluation of variables.

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