POLITEHNICA UNIVERSITY OF BUCHAREST

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DOCTORAL THESIS

- SUMMARY

Quality and risk management applied in aerospace research

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<u>**Quality and risk management applied in aerospace research**</u>

PREFACE

With the integration of Romania into the EU market, it became necessary for Romanian organizations to increase the quality of both products and services within the Aerospace Domain.

The introduction of a Quality Management System in any industrial organization leads to the establishment of quality objectives, the need to achieve them, especially the objective of satisfying the explicit and implicit needs and expectations of customers.

The activities carried out in industrial organizations are strongly influenced by the inevitable existence of risks, which are not easy to quantify from the point of view of conducting the study in extenso.

The design of a Management System is based on quality management principles, formulated in accordance with the specifications in [73]:

- "Customer Orientation"
- "Leadership"
- "Staff commitment"
- "The management approach as a system (procedural approach)"
- "Improvement"
- "Correct decision-making based on existing evidence"
- "Relationship Management"

A system designed in accordance with the principles of quality, implicitly also satisfies the requirements of Risk Management (according to SR ISO 31000:2018), thus allowing optimal decisions to be made in conditions of risk and uncertainty. Not knowing the risks and assessing them incorrectly affects the performance and the final result of the respective activity.

The experience accumulated in over 30 years of work, in commercial companies (organizations) with state capital, commercial companies (organizations) with mixed capital (private and state), commercial companies (organizations) with private capital, determined me to understand the importance of studying the correct implementation of SMC in the organization of industrial design and production activities.

Knowing the environment in which an organization achieves its objectives, establishing policies and quality-risk objectives, assigning responsibilities, identifying and treating risks, allocating human resources, infrastructure and documentation are important components of Integrated Quality-Risk Management.

Establishing the client's requirements (commercial and design), making the supply component necessary for each activity/project, preparing the manufacturing process and making the finished product (technical reports, demonstrator) are part of the integrated quality-risk management of the industrial organization.

The monitoring, measurement, analysis and evaluation components consist of customer requirements assessment, internal audit and management analysis.

Industrial organizations efficiently determine and select the multitude of opportunities that thus achieve the improvement and the implementation of the necessary actions in order to successfully fulfill the customer's requirements in order to increase his level of satisfaction.

The integrated quality-risk management allows to increase the performance of the management systems implemented in an industrial organization, the unitary approach will lead to the optimization of the consumption of used resources.

I carried out the entire scientific research activity during the doctorate period with the support of collaborators and colleagues in the collective where I work and with the support of my family.

I wish to express my gratitude to Mr. Prof. univ. em dr eng. ec. Constantin MILITARU, for the outstanding scientific guidance carried out during the entire period of thesis development, in his capacity as PhD supervisor.

I would like to express my gratitude to the management of the POLITEHNICA Bucharest University, the Faculty of Industrial Engineering and Robotics, for the support provided during the entire period of carrying out the scientific work.

Also, I have a deep gratitude for Mr. Director General of the National Institute For Aerospace Research-Development "Elie Carofoli" - I.N.C.A.S Bucharest, dr. eng. mat. Cătălin NAE, for the special support given during the realization of the doctoral thesis.

Bucharest, 2022

INTRODUCTION

I have structured this doctoral thesis in a number of 5 chapters, totaling 151 pages, containing 56 figures, 22 tables, a annex, and 103 bibliographic references.

Chapter 1 is entitled "The current state of research regarding the implementation of the Quality and Risk Management System in the Aerospace Industry" a presentation of the current state of scientific research in the aerospace industry (national, international programs, the European Space Agency ESA, Public Private Partnership , Association of European Aeronautical Research Institutions) and some considerations regarding Quality Management, Risk Management and Project Management

Chapter 1 is structured in 5 subchapters, including concepts of quality for aviation, space and defense in accordance with SR EN 9100:2018 and Risk Management in accordance with the requirements of SR ISO 31000:2018, theoretical considerations on the concept of Project Management, considerations regarding the systematic application of policies, procedures, communication and consultation activities to establish the existing context, to evaluate, treat, monitor, analyze, register and report the risk.

In Chapter 2 entitled "Objectives of the doctoral thesis" the directions of scientific research that are addressed in Quality and Risk Management applied in the research of the Aerospace Industry according to the representation in the table, the delimitations of the research field, the establishment of the theoretical and applied objectives proposed in the thesis are highlighted .

Chapter 3 entitled "Developments and Theoretical Contributions on the Monitoring and Evaluation of Applied Aerospace Projects through the Implementation of a Quality Risk Management System" contains a "Study on the Implementation of a Quality Risk Management System in Aerospace Research". This study briefly presents the types of risks and their effects on a research project/programme. The FMEA-FMEA analysis method, adapted by the author for an aerospace project, was used to identify and assess risk. "Description of the Failure Modes and Effects Analysis Method (FMEA) and Failure Modes, Effects and Criticality Analysis (FMECA)" is presented in accordance with SR EN 60812:2009. The method described for risk assessment is described in SR EN 16601-80:2011 Aerospace project management. Part 80: Risk management.In the "Succession of the phases of a project" the Management phases of a Project are presented.

In Chapter 4 entitled "Applied contributions and case studies on project monitoring and evaluation" general considerations on the projects being evaluated in the thesis are presented.

In the "TandemAEROdays19.20 project example", general project data are presented and the phases through which the TandemAEROdays19.20 project was carried out are illustrated.

In "AFLoNext Project Exemplification, general project data and the author's risk assessment of the project are presented.

The projects were analysed by the author according to the template developed.In Chapter 5 it addresses "General conclusions regarding personal contributions, future developments and future ways of developing research results".

At the end of the doctoral thesis, the bibliographic references examined in order to elaborate the thesis are presented.

Chapter 1. CURRENT STATE OF RESEARCH ON QUALITY AND RISK MANAGEMENT APPLIED IN AEROSPACE RESEARCH

1.1 INTRODUCTION ON QUALITY AND RISK MANAGEMENT APPLIED IN RESEARCH IN THE AEROSPACE INDUSTRY.

In order to establish the current state of research on Quality and Risk Management applied to research in the Aerospace Industry, it is appropriate to present some general aspects of Quality and Risk Management (Chap.1.2), followed by Fundamentals of Project Management (Chap.1.3), research in Aerospace (Chap. 1.4).

1.2 GENERAL ASPECTS RELATED TO QUALITY MANAGEMENT AND RISK

1.2.1 The need for the emergence of the Quality System concept

The concept of Quality [91] is used in each of the fields of economic and social activity, with particular meanings for the specific fields/sectors. The concept of quality has been around since ancient times. In Europe, with the organization of professional craft associations in guilds, they established and respected rules of good practice. In the 18th century, the concepts of measure-measurement, standardization and metrology appear and develop, thus creating standard measures. In the 19th century, industrial development was achieved with the increase of labor productivity and profitability as indicators. The production activity was carried out with the performance of quality control and product inspections. In the first half of the 20th century, as a result of a massive food poisoning, product quality control was introduced in Australia, by inspecting them. In 1920, Eduards from WESTERN ELECTRIC, separates product quality inspection from actual manufacturing. The quality inspection function reports directly to management. In 1942, the military in the American factories introduced the methods of statistical control and sampling, as a result of the analyzes of non-conformities on the production line. In 1950, Feigenbaum, Deming, Juran develop quality control, drawing guidelines and enunciating quality principles (Total Quality Control-TQC). NASA's space race has as its strategy a rigorous quality program based on the requirements of the NBH 5300-41 standard/PROVISIONS OF THE QUALITY PROGRAM FOR AERONAUTICAL AND SPACE SYSTEM CONTRACTORS. The nuclear age opens: Civilian industry engages in the construction of nuclear power plants, and the US authorities thus institute a federal law: Appendix B-QUALITY ASSURANCE CRITERIA FOR NUCLEAR PLANTS. 10 CFR 50 Japan is rebuilding its industry, based on TQC principles. In Europe, TQC principles have been implemented since 1970. In 1979, the International Atomic Energy Development Agency (IAEA) publishes a code of good practice: CQA-QUALITY ASSURANCE FOR THE SAFETY OF NUCLEAR POWER PLANTS. In 1987, ISO introduced and disseminated the ISO 9000 series of standards. In 1989, the European Committee for Standardization-CEN develops and publishes the EN 45000 series of standards. In Romania, in 1992, the foundations of the conformity assessment system were laid within the Romanian Institute of Standardization - IRS. In 2001, LAW 608 came into force for the assessment of product conformity, amended in 2003, for alignment with the essential requirements of the European Directives. The evolution of the concept of quality goes through four distinct stages: 1. Product/service quality (CQ) 2. Quality Assurance (QA) 3. Quality Management (QM) 4. Total Quality Management (TQM). The concept of product/service quality was born and evolved after 1945, to reduce the harmful influence of Taylorism (stock management) and to facilitate the evolution towards the notion of quality assurance, on the occasion of the development in the Nuclear Domain and in the Space Domain. Since the beginning of the 80s (10 years later than the Japanese), there has been talk in Europe about the tendency to achieve total quality (TQM), after going through the stages of quality assurance and management, quality systems and quality management. The main objective of the TQM concept is to achieve synthesis and balance between quality, productivity and staff motivation. In the new quality vocabulary standard, SR EN ISO 9000:2001, the term TQM is no longer defined. Total Quality Management - TQM is the main tool through which the level of excellence can be achieved.

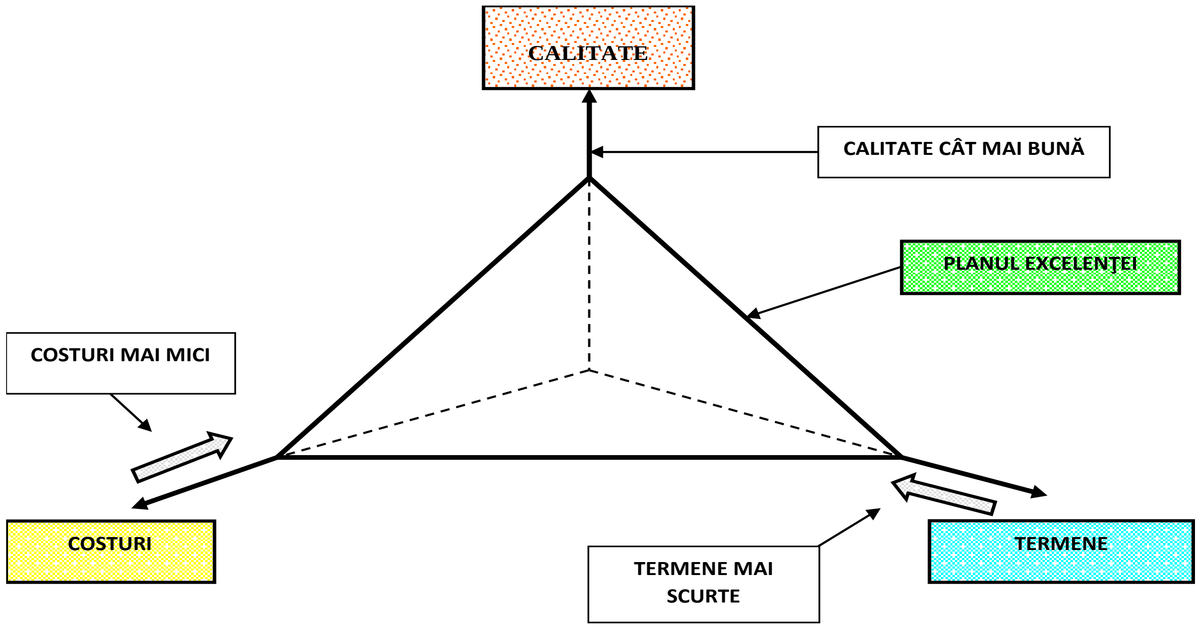


Fig. 1.1 Graphic representation for the level of excellence

The term quality has been associated with 13 definitions depending on the field of activity in which the term is used and the expert who defined them.

1.2.2 The concept of quality and conformity

1. The set of needs of industrial organizations

The first needs, the basic ones, are the physiological ones, those necessary to keep alive, food, water, shelter. Extrapolating these needs for an organization, it means providing products or services needed in the market for making profit, so no organization can survive only with loss/no profit.

To the extent that these are satisfied, higher-order needs appear, represented in Maslow's Pyramid:

- security needs (security) mean for the individual protection, tranquility, the security of goods, for an industrial organization it means the safety and security of goods and the safety of employees and shareholders;
- the needs of (social) belonging represent for the individual the position in society and the relations with its members, for the industrial organization it means responsibility towards the environment, towards the community, relations with other organizations;
- needs for esteem (appreciation) and recognition mean for the organization luxury cars, awards, offices and high-standard facilities, influences on the market and in the political field;
- needs for self-realization (self-transcendence) means for the individual training, using the full potential, and for the organization it means growth, accepting challenges and assuming risks.

2. Desires

Most of the time, needs turn into wants.

The need for food turns into a desire to eat a certain kind of food.

The need to travel turns into the desire to have a certain car.

Desires are on the border between needs and requirements. Desires are the tool used to clarify the ways in which needs are desired to be satisfied.

Desires are characteristic of both individuals and organizations.

3. Requirements

According to [90], requirement is defined as "a need or expectation that is stated and is generally implicit or mandatory".

Requirements clarify how we want the needs to be met. Requirements are the main tool for defining the product or service that is used to satisfy that need. If all requirements are not clarified and satisfied, the requested product or service will not lead to full customer satisfaction.

4. Expectations

Expectations are implicit needs and requirements that we consider built into products and services.

Expectations depend on the environment in which individuals and industrial organizations live and operate. For example, a mobile phone is useful to satisfy the need for communication for today's children, and the possession of a mobile phone is no longer an expectation, so it falls under the chapter of necessities, already representing an attribute of normality.

5. Compliance

Part of the characteristics of a product or service that define quality must be clearly specified in the product or service definition. The fulfillment/achievement of these characteristics must be controlled, ensured, managed, improved and demonstrated.

Compliance is the set of actions that ensure the provision of a product or service as defined.

Conformity has nothing to do with needs, wants, demands or expectations.

Quality starts from needs and requirements, compliance starts from clearly defined products and services. Quality is like a movie, in continuous motion, compliance is a picture, a sequence in the quality movie. This plastic description should help to avoid the very common confusion between quality and conformity.

Conformity assessment [67] is the process carried out by the manufacturer in order to examine the full compliance with all the intrinsic requirements of the product under study.

The standard that evaluates conformity is SR EN ISO CEI 17050-1:2010, Evaluation of conformity. Declaration of conformity given by the supplier. Part 1: General requirements[79]

1.2.4 The requirements of the SR EN 9100:2018 standard

The SR EN 9100:2018 standard includes the standardized Quality Management requirements for the aerospace industry. The standard has a common part (which has been tested and approved) with ISO 9001 and has been supplemented with the specific requirements of civil aviation / military space operations.

SR EN 9100:2018 (AS 9100D) was designed considering the fact that security is the most important requirement in the aerospace industry. The rules of aviation are standardized and therefore the possibility of making a mistake in aviation is desirable to be zero. Quality and risk are the most important factors in the requirements of this standard.

The fundamental element of aerospace QMS according to AS 9100D is MR. Requirements include supplier approval, verification of purchased equipment and supplies, traceability throughout the product life cycle, control of changes made in the production process, control of production equipment and materials, inspection and testing processes, identification of special processes, inspection and elimination of products that are inappropriate, are of particular importance and are made within the standard [73].

1.2.5 Risk Management Aspects

According to SR ISO 31000:2018 [82], risk means the effect (deviation from what is expected) of uncertainty on the objectives.

The notions related to the term risk are the following:

a. Source of risk, i.e. element that alone or in combination with others, has the potential to to generate risk.

b. Event (which can occur at least once and can have multiple causes and consequences), i.e. the occurrence or modification of a certain set of circumstances.

The event can be anticipated, but there is a possibility that it will not take place, or it can be something unpredictable, but which occurs, thus, the event constitutes a source of risk.

c. The consequence is a result of an event that influences the objectives.

This can be certain or uncertain, the consequence thus has positive or negative, direct or indirect effects on the considered objectives. The consequences are expressed qualitatively or quantitatively.

Any consequence is amplified by cascading and cumulative effects.

Plausibility (eng. Likelihood) represents the possibility that something will happen,

regardless of whether it is determined, evaluated, conditioned objectively or subjectively, qualitatively or quantitatively, or whether it is described in general or purely mathematical terms.

The effectiveness of MR depends on the integration in the leadership of the organization, including in decision-making.

The following terms are used in the standard:

-Effectiveness represents the evaluation method in which the activities programmed according to a plan are carried out and the planned results are obtained (the ability to obtain results) [24] .

Effectiveness=(the result achieved)/(the level of the proposed goal) [%] (1.1)

-Efficiency represents the relationship between the result obtained and the resources allocated (the ability to be effective with minimal efforts/costs.

Efficiency=(result obtained)/(means used (effort made)) [%] (1.2)

The principles of MR link the general framework and practice of MR to the organization's objectives, in order to create and protect the value of the organization.

In the application of MR, the dynamic and variable nature of human behavior and culture is taken into account throughout the entire process.

MR is an iterative system, although it is often presented as sequential.

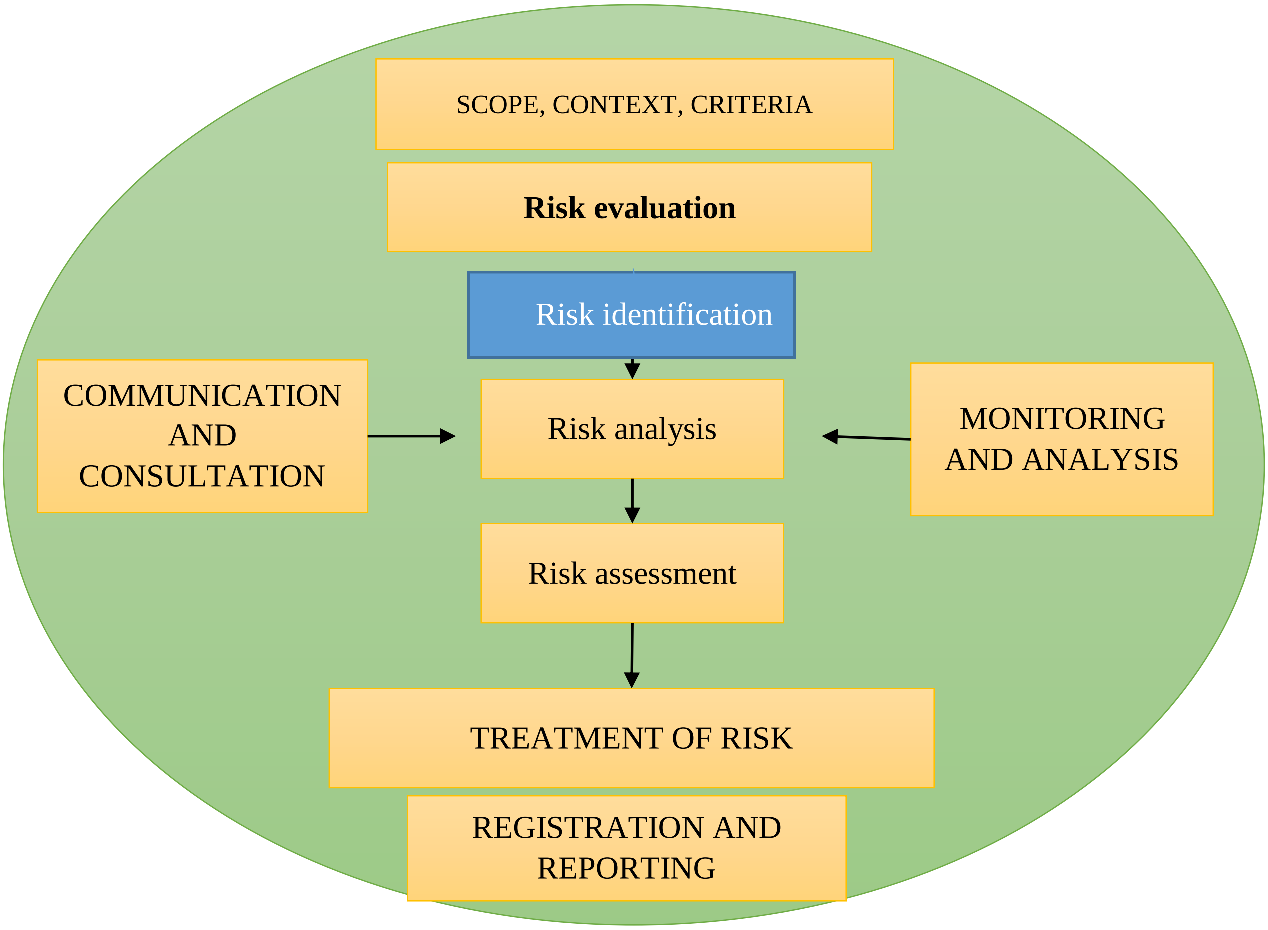


Fig. 1.4 The Risk Management Process [82]

1.3 Fundamentals of Project Management

According to the Explanatory Dictionary of the Romanian Language, the word "project" is associated with several meanings, of interest for the thesis, being:

- plan to accomplish something, to organize, to prepare something;
- project-the initial form of a plan (industrial, economic, social, financial, etc.) that continues through an analysis in order to obtain an approval to receive an official character and be implemented;
- the execution of a technical work in accordance with a given theme that includes a technical memorandum, drawings, the justification of the utility of the designed object, as well as its location.
- a temporary study submitted to create, with limited resources, a unique product/service [64].

The project can be characterized as a way to organize human factors, thus managing all activities, being a way of good organization and perfect coordination of the work process according to Fig. 1.5.

The project is focused in its integrity on a certain final result. When the final result is achieved, the project ends. [81].

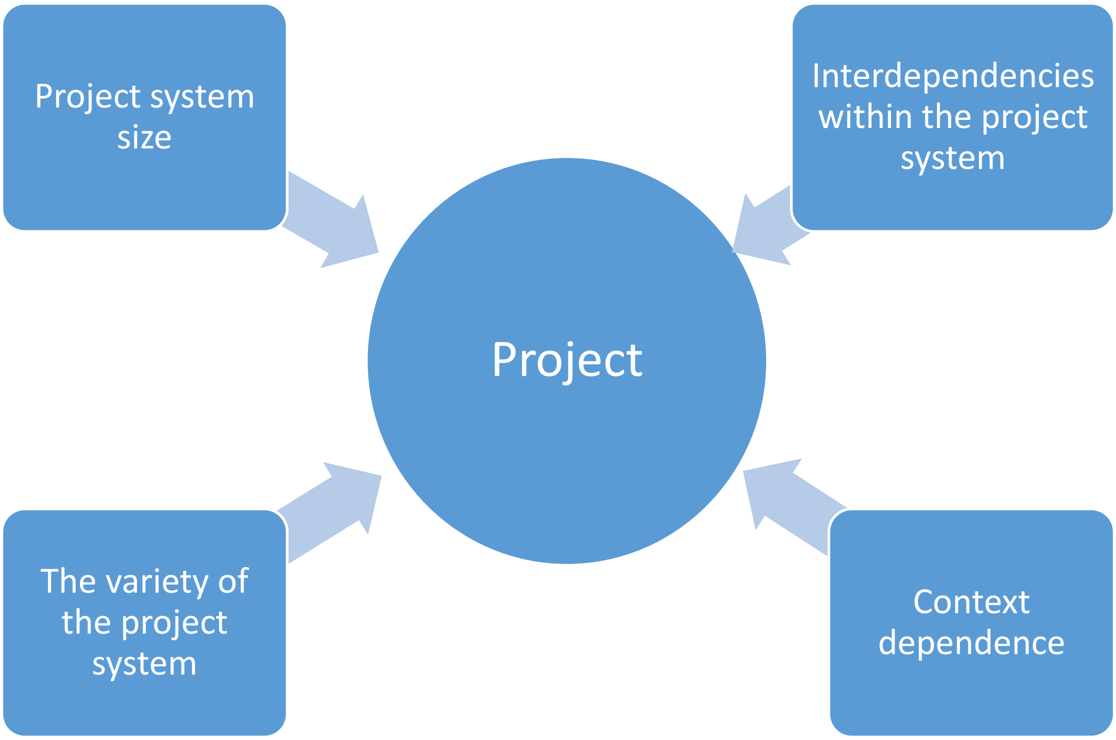


Fig. 1.5 Factors of project complexity [57]

Figure 1.6 describes how to relate MP concepts.

Organizational strategy identifies opportunities. Opportunities are evaluated and their documentation is required.

Through an economic-financial analysis, opportunities are selected and developed and may result in one or more projects, which create deliverables.

Deliverables are used to achieve important benefits.

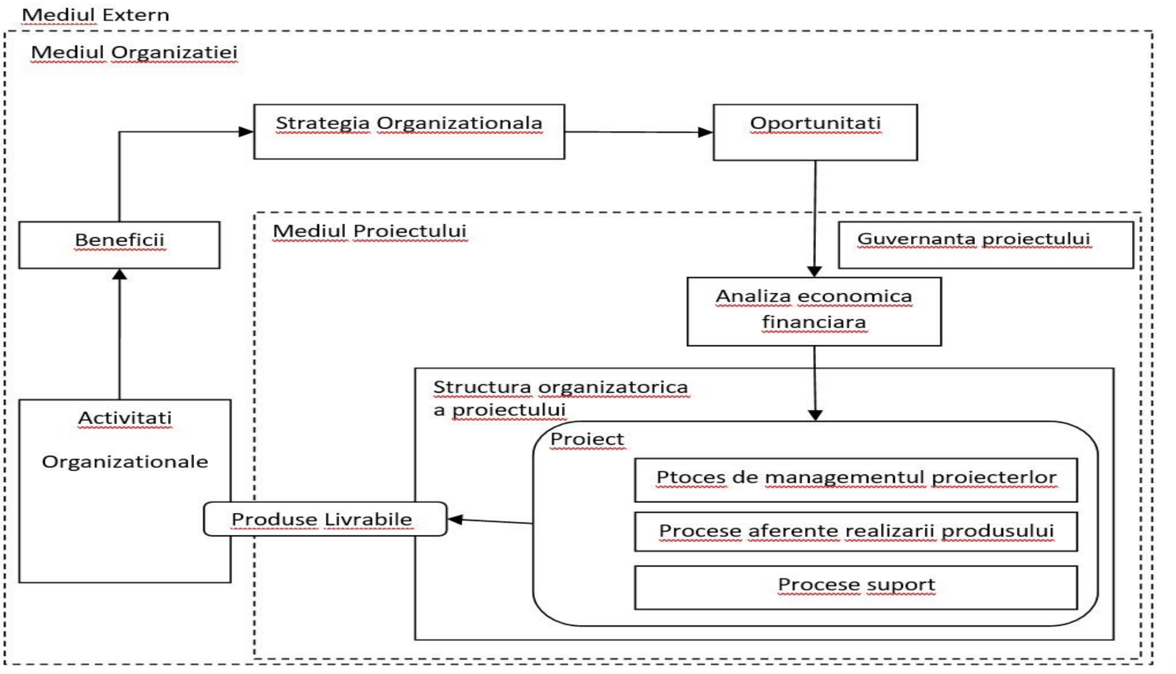


Fig. 1.6 Overview of Project Management concepts and their relationships [81]

1.4 RESEARCH IN THE AEROSPACE FIELD

Research is an important component of global economic development and job creation.

Research and development in the aerospace field has undergone essential changes primarily due to the fact that the entire air traffic environment is in a significant dynamic until the year 2050. This scenario is due to some forecasted concepts, namely unlimited development, development with regulations drastic, of the potential virtual disappearance of the sector, or a combination of the three, which will have the effect that the technologies will not remain the same, going through a process of innovative transformation [95].

The development of the research-development activity in international partnership is organized in research programs, as follows:

1.4.1 Framework Program 7 (FP7)

Romania was and is a participant in the Research-Development Framework Programs of the European Communities, thus benefiting from access to the latest generation technology, data and information.

1.4.2 Public Private Partnership [92]

The "Clean Sky Partnership", foreseen under the Horizon Europe program, aims to accelerate the development and application of integrated technologies in aircraft, a deep decarbonisation is sought, while ensuring safety and security. This partnership will contribute to increasing focus on sustainability goals, green technologies and engaging new stakeholders in electrification and digitization [53].

AVIAȚIE CURATĂ/CLEAN AVIATION	CER CURAT 2/CLEAN SKY 2

Fig. 1.10 CLEAN AVIATION Portal Structure[93]

A. Clean Sky 2/Clean Sky [92]

Cer Curat 2/Clean Sky (CSJU) is established as a partnership of various actors from the European aeronautical industry and the European Commission. The Clean Sky 2/Clean Sky

Program (CSJU) coordinates and funds research activities to deliver much quieter and greener aircraft. [92]

As such, Clean Sky 2/Clean Sky (CSJU) is intended to be the body that will primarily contribute to the achievement of the Advisory Council for Aeronautical Research in Europe (ACARE) 2020 environmental objectives for industry. These objectives are:

1. 50% reduction in carbon dioxide (CO2) emissions.
2. An 80% reduction in mono-oxides of nitrogen (NOx) emissions.
3. A 50% noise reduction for aircraft in flight.
4. Mitigating the environmental impact of aircraft and related products throughout their life cycle.

The Clean Sky 2/Clean Sky Steering Board (CSJU) consisting of representatives of the Aeronautical Industry and the Commission, identifies strategic areas where research and innovation are essential and launches "Calls for Proposals" according to the evolving requirements of the industry.

Small or medium-sized enterprises (SMEs), industrial leaders, universities and professional research organizations respond to calls with detailed plans for research activities and a forecast of the funding they will need to develop their new technologies.

To guarantee an efficient allocation of resources, applications are evaluated by a panel of independent external experts who advise CSJU on the proposals with the best potential for achievement. Winning proposals then receive funding and other support from CSJU.

1.4.3 Association of European Aeronautical Research Institutions [96]

The most important aeronautical research units in Europe have created the non-profit organization EREA (Association of European Aeronautical Research Institutions).

EREA, the Association of European Aeronautical Research Institutions that proposes to researchers Cerul Viitorului/Future Sky: a joint research initiative in which the development and integration of aviation technologies is carried out at the European level. Cerul Viitorului/Future Sky is based on the alignment of national institutional research for aviation by establishing joint research programs.

In Cerul Viitorului/Future Sky it is stated that there is a difference between basic and industrial research. In particular, for the aeronautical sector, this means that universities mostly focus on lower technological readiness levels (TRLs), while industrial research starts at a higher TRL.

EREA, the association of European aeronautical research institutions, has therefore launched Cerul Viitor/Future Sky: a joint research initiative in which the development and integration of aviation technologies is carried out at a pan-European level.

Cerul Viitor /Future Sky is based on the alignment of national aviation institutional research programs.

EREA believes that the cooperation of European research institutions is the best guarantee to ensure technological development for the benefit of European society and industry, beyond the current SESAR 2020 and Cer Curat /Clean Sky 2 calendars.

To prepare the future of aviation beyond next-generation vehicle and air traffic management, EREA took the initiative to define a strategy for the air transport system.

This strategy is based on the European aviation vision FlightPath2050, and the first elements have already been described in the EREA document on "The Future Air Transport System 2050". This so-called ATS-2 study was fully funded by EREA (during 2010-2011) and its members.

The overall program Cerul Viitor/Future Sky [108] is subdivided into six topics, according to Figure 1.22, each of them called "Future Sky Theme" and focusing on different aspects or challenges on the way to the future air transport system:

SIGURANȚĂ	TRANSPORT AERIAN SILENȚIOS	ENERGIE	MOBILITATEA AERIANĂ URBANĂ	SECURITATEA PENTRU AVIAȚIE	AVIAȚIA CIRCULARĂ

Fig. 1.11 The 6 themes of Cerul Viitor /Future Sky [96]

2. 2. OBJECTIVES OF THE DOCTORAL THESIS

2.1 Conclusions regarding current research trends in risk assessment and quality-risk integrated management

The development of applied aerospace projects is carried out within a regulated quality system, aiming not only to satisfy the explicit requirements of customers, through contractual and regulatory clauses, but also the implicit ones, through the identification, evaluation, treatment and monitoring of the risks related to each project .

Insufficient risk determination method, lack of adequate risk mitigation strategy, can lead to an erroneous result for the risk related to each project.

The international bodies within the European Commission actively participate in the development of research in the aerospace field, being initiated medium and long-term programs to solve some problems related to greening, noise reduction, space launchers, atmospheric physics, thus opening competitions in a varied range of domains.

The documents submitted within these competitions/calls refer to information about the organization and its experience in the field of the competition/call initiated.

Other information refers to technical aspects, work packages, risk analysis of the activities carried out, project phases, communication plan, work breakdown structure.

The content of the documents that contracting organizations require for entering competitions are in accordance with [64].

In the bibliography studied for this thesis, we did not find models agreed by all stakeholders (contracting authorities, aerospace research and manufacturing organisations, universities) on the content of the documents to be submitted by the bidder in an open competition.

In order to make them operational with these documents and to achieve the automatic retrieval of data from the documents in the archive, we proposed the creation of a table and graphical representation processor.

I believe that a template consisting of a processor of tables and graphs (a sequence of Excel spreadsheets that are interlinked) for each project would solve and lead to a saving of time and the collection of information related to the technical aspects of the projects from the bid submission phase. The time savings are also quantified in the reduction of staff costs involved in the drafting of tenders, thus saving at least one post.

This tool does not require any special qualifications, but only those of an average user of spreadsheet software.

The template consisting of a table processor and graphical representations (Excel spreadsheet) has the advantage of easy access and automatic updating.

2.2 Delimitation of the research field

The field addressed in the paper is the field of applied aerospace research.

The specific framework characteristic of this field is:

- the approach regarding Quality Management in an industrial organization that carries out its activity in accordance with EN 9100;
- the risk assessment of each project to which the organization applies is mandatory both due to the compliance standard and customer requirements;
- research and case studies on two applied aerospace projects.

2.3 The objectives of the doctoral thesis

As a result of the establishment of the general conclusions obtained within the framework of the completion of the current stage of the scientific researches of monitoring and evaluation of applied aerospace projects through the implementation of a SMCR, the following objectives are proposed in this doctoral thesis:

2.3.1 Original theoretical contributions

1. Developments in the theoretical evaluation of aerospace projects.
2. The design and development of a specific methodology for the realization in a determined time of project proposals using a processor of tables and graphs.
3. Risk estimation of a project/activities based on Failure Mode Effects Analysis (FMEA/AMDE) (case study).

2.3.2 Original practical contributions

1. Elaboration of a methodology for the timely realization of proposals for scientific research projects to a contracting authority;
2. Elaboration of a program that consists of the development of a processor of tables and graphs, for formulating the proposals of a scientific project.
3. Estimating the risk of a project/activities based on the Effects Failure Mode Analysis (FMEA/AMDE);
4. Monitoring and evaluation of all phases of an aerospace project;
5. Implementation of a processor of tables and graphs in the evaluation of aerospace projects in the organization.

3. THEORETICAL DEVELOPMENTS AND CONTRIBUTIONS REGARDING THE MONITORING AND EVALUATION OF APPLIED AEROSPACE PROJECTS THROUGH THE IMPLEMENTATION OF A RISK QUALITY MANAGEMENT SYSTEM

3.1 Study on the implementation of a quality risk management system in the field of aerospace research

The organization determines, implements and maintains a process for Risk Management in order to achieve the applicable requirements, which includes, as appropriate:

- assignment of responsibilities for Risk Management,
- defining risk criteria (for example, probability, consequences, risk acceptance),
- identification, evaluation and communication of risks during the production of the product;
- the identification, implementation and management of risk mitigation actions that exceed the defined risk acceptance criteria and the assimilation of risks remaining after the implementation of mitigation actions.

The probability of occurrence of an unforeseen negative situation, as well as a potential negative consequence, is illustrated in Figure 3.1. In the figure, the inputs (boxes with the names of the processes) refer to risk reduction actions and the outputs represent non-conformities resulting from the previously highlighted risks.

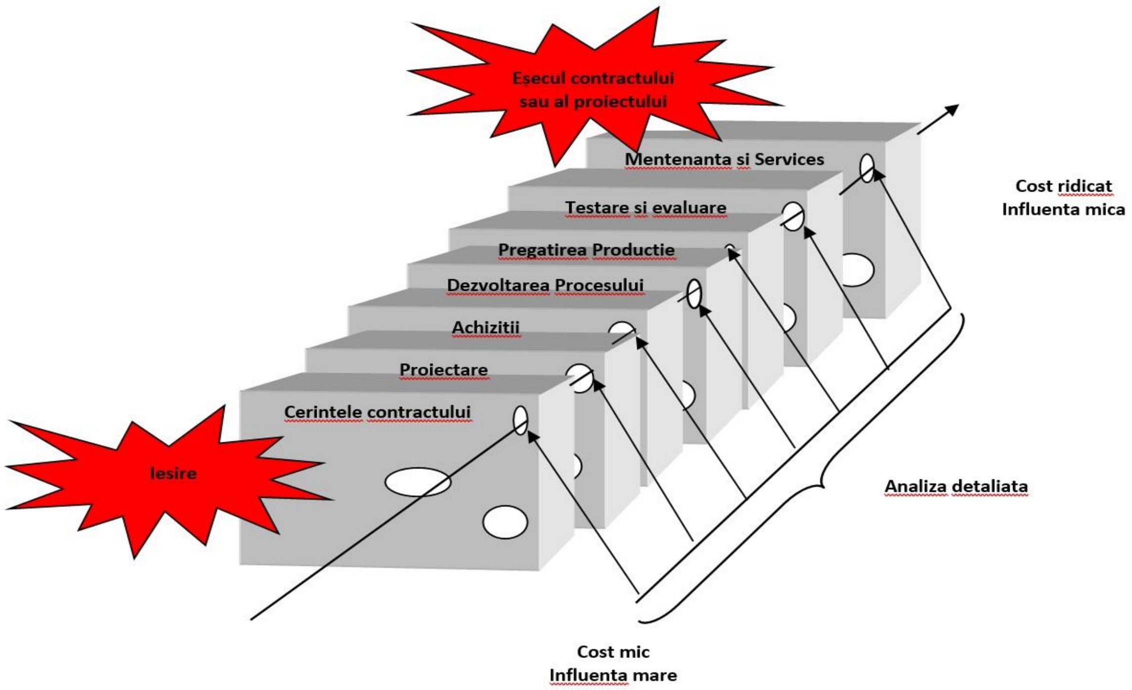


Fig. 3.1 Risks and their effects on a project/programme

Figure 3.1 presents the possible risks at each phase of a project/program. The slots in each component represent the step of the program and constitute a possible risk at this level.

If the risks are not mitigated (slots closed), there could be the possibility of a potential negative impact that is cumulative with the favorable outcome of the project (slots aligned and a line centering them).

Therefore, every industrial organization should review each contractual requirement and identify the risks that arise due to non-fulfilment of the requirements.

In conclusion, in a project that includes several processes, it is desirable that the risks (visualized as gaps) are minimized and in no case are they aligned, because the alignment of the gaps means a cumulative negative impact on the project.

To avoid a risk concentration point in the project, the identified risks should be analyzed and there should be assurance that the project manager follows every contractual requirement that introduces risks into the project activities.

If the risks are not mitigated, there is the possibility of blocking the development of the project. Therefore, each organization must review each requirement in the contract and identify possible risks. A new risk arising for the project leads to the re-estimation of the identified risks and to the management's awareness that each requirement in the contract that introduces risks may influence one or more activities in the project.

Risk Management represents an iterative action to identify, estimate, reduce, accept and mitigate risks in a systematic, proactive, comprehensive and efficient way, taking into account business, technical, quality requirements, deadlines and costs.

3.2 RISK IDENTIFICATION AND ASSESSMENT USING THE FAILURE MODES AND EFFECTS ANALYSIS METHOD (AMDE/FMEA) ADAPTED BY THE AUTHOR FOR AEROSPACE PROJECTS

3.2.1 Stages and activities in Risk Management

The method used for risk estimation is described in the standard

SR EN 16601-80: 2015 - Space project management. Part 80: Risk management[80].

Annex I presents the steps and activities in RM, detailing the content of the step/activity performed.

In order to assess the risks, scoring schemes for severity of consequences and probability of occurrence of risk have been established, as shown in the examples given in Table 3.2 and Table 3.3.

Table 3.2 Example of a scheme for assessing the severity of consequences [76]

Punctaj	Severitate	Severitatea consecințelor: impact asupra (de exemplu) costului
5	Catastrofal	Duce la încheierea proiectului
4	Critic	Creșterea costului proiectului> x %
3	Major	Creșterea costului proiectului> y %
2	Semnificativ	Creșterea costului proiectului> z %
1	Neglijabil	Impact minim sau neglijabil (absent)

Table 3.3 Example of a risk probability assessment scheme[76]

Punctaj	Probabilitate	Probabilitate de aparitie
E	Maximă	Realizare sigură, apare cel puțin o dată în cadrul proiectului
D	Mare	Se va întâmpla frecvent, în 1 din 10 proiecte
C	Medie	Se va întâmpla câteodată, aprox. în 1 din 100 de proiecte
B	Mică	Se va întâmpla rar, aprox. în 1 din 1000 de proiecte
A	Minimă	Nu se va întâmpla aproape niciodată, 1 din 10000 de proiecte sau mai mică

The logical diagram of stages and activities in MR is presented in figure 3.5..

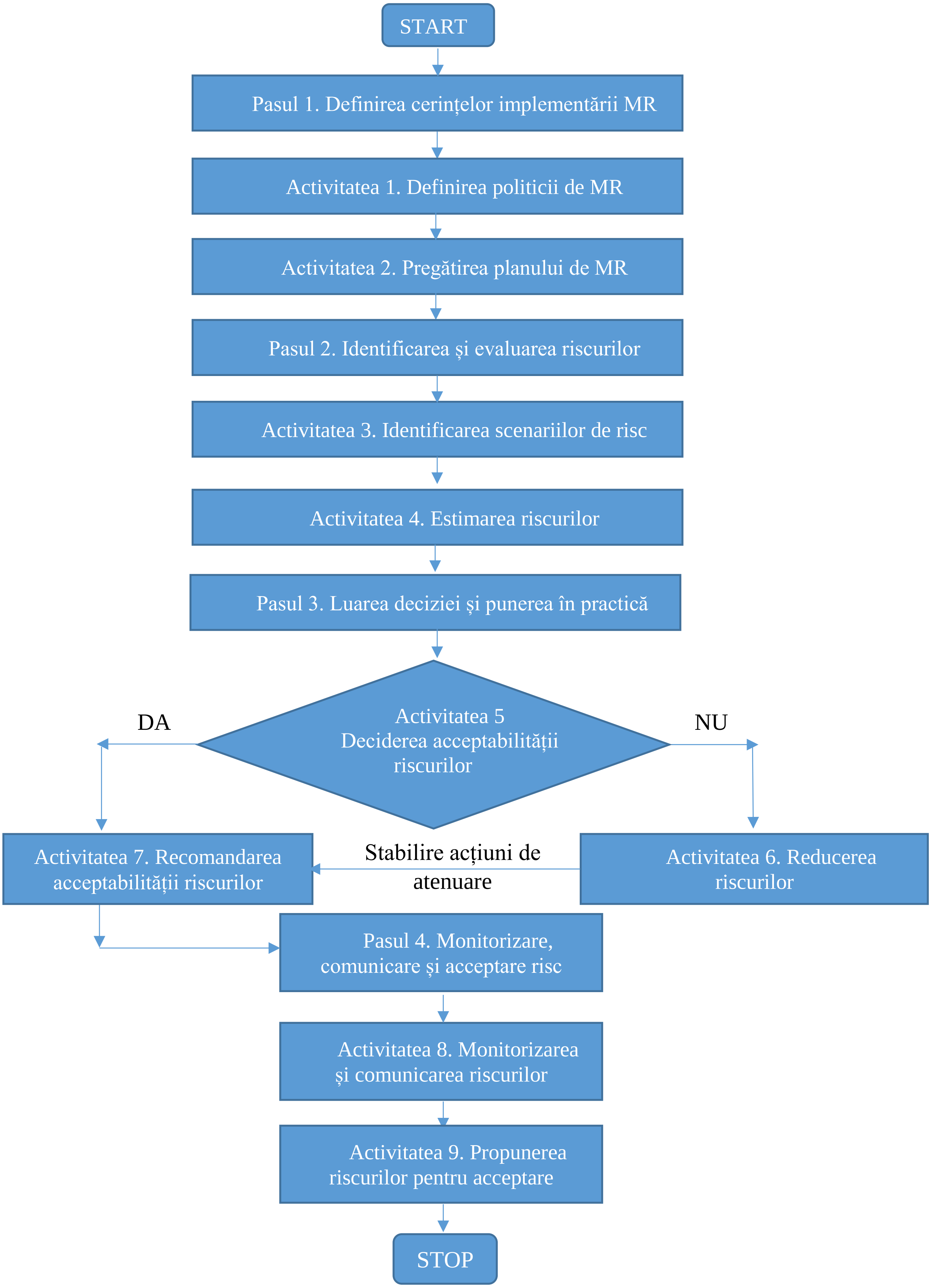


Fig. 3.5. Stages and activities in risk management

Probabilitate

Probabilitate	1	2	3	4	5
E	Scazut	Mediu	Mare	Foarte mare	Foarte mare
D	Scazut	Scazut	Mediu	Mare	Foarte mare
C	Foarte scazut	Scazut	Scazut	Mediu	Mare
B	Foarte scazut	Foarte scazut	Scazut	Scazut	Mediu
A	Foarte scazut	Foarte scazut	Foarte scazut	Foarte scazut	Scazut

1 **2** **3** **4** **5** Severitate

Fig. 3.6 Example of risk indices, their magnitude scheme and numerical quantification [76]

In Figure 3.6 Example of risk indices, their size scheme and numerical quantification [76], the probability of occurrence of an undesirable event is classified into five levels.

Severity is classified as very low, low, medium, high and very high. Numerical values of the indices can be tuned to estimate the relative influence of each stage of probability and severity.

Highlighting the level of risk is done with a colour legend. Thus the colour green represents the very low level, the colour yellow indicates the low and medium levels, and the colour red will represent the high and very high levels.

Table 3.4 details the information presented in Fig. 3.6 Example of risk indices, their size scheme and numerical quantification, showing risk areas, their size, proposed actions in case a certain risk level is recorded.

Table 3.4 Example of assignment of magnitudes for risks and proposed actions for individual risks

Indice de risc	**Mărimea riscului**	**Acțiuni propuse**
E4, E5, D5	**Risc foarte mare**	**Risc inacceptabil:** **-se implementează noi procese pe echipe sau se schimbă proiectul de bază;** **- se semnalează Managementului Proiectului, conform prevederilor din planul de Management al Riscurilor**

E3, D4, C5	**Risc mare**	**Risc inacceptabil:** **-se implementează noi procese pe echipe sau se schimbă proiectul de bază;** **- se semnalează Managementului Proiectului, conform prevederilor din planul de Management al Riscurilor**
E2, D3, C4, B5	**Risc mediu**	**Risc inacceptabil:** **-management agresiv, căutarea unor noi procese pe echipe sau a unui alt proiect de bază;** **- se semnalează Managementului Proiectului, conform prevederilor din planul de Management al Riscurilor**
A5, B4, B3, C3, C2, D1, D2, E1	**Risc mic**	**Risc acceptabil:** **-control și monitorizare** **- se semnalează managementului responsabil cu pachetul de lucru**
C1, B1, A1, B2, **A2, A3, A4**	**Risc foarte mic**	**Risc acceptabil:** **-control și monitorizare** **- se semnalează managementului responsabil cu pachetul de lucru**

The acceptability of the likelihood of occurrence and the severity of the consequences are both project dependent. For example, when a project concerns new research, technological development or management, a high probability of a consequence that will rapidly increase cost may be acceptable.

Table 3.5 Convention regarding the risk probability assessment scheme in the realization of the model

Punctaj	Probabilitate	Convenție pentru model matematic
E	**Maximă**	**5**
D	**Mare**	**4**
C	**Medie**	**3**
B	**Mică**	**2**
A	**Minimă**	**1**

Table 3.5 shows the risk probability assessment scheme in the FMEA mathematical model used in Chapter 4 containing the case studies for the "Project Risk Analysis" section.

3.2.2 Overview

AMDE is a risk analysis technique. Its presentation is done by creating a spreadsheet. To create an AMDE, it starts with a brainstorming session, in which the participants constituted as a risk management team, identify a hierarchical decomposition of the system into its basic elements as illustrated in Figure 3.7. The analysis starts with the elements at the bottom level.

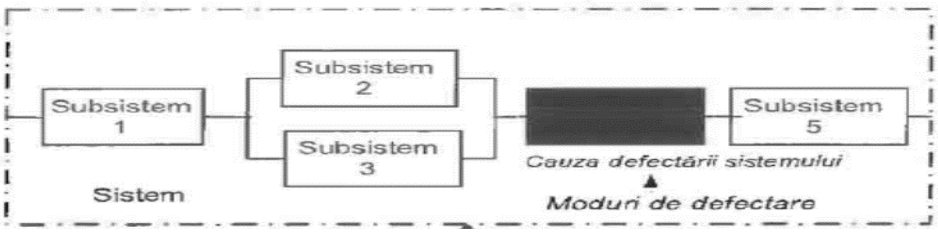


Fig. 3.7 Exemplification of the failure occurring within the studied process [author's contribution after [85]]

An effect of the failure mode at a low level can later become a cause of their chain propagation to a higher level. The analysis is carried out from left to right until the final effect of the fault on the system is identified.

Analysis of failure modes and their effects, system structure, levels of analysis are described in SR EN 60812:2009 - Techniques for system reliability analysis. Procedure for the analysis of failure modes and their effects -AMDE [85] .

FMEA can also be addressed by fuzzy logic process.3.2.3 Analysis of the effects of failure mode-AMDE

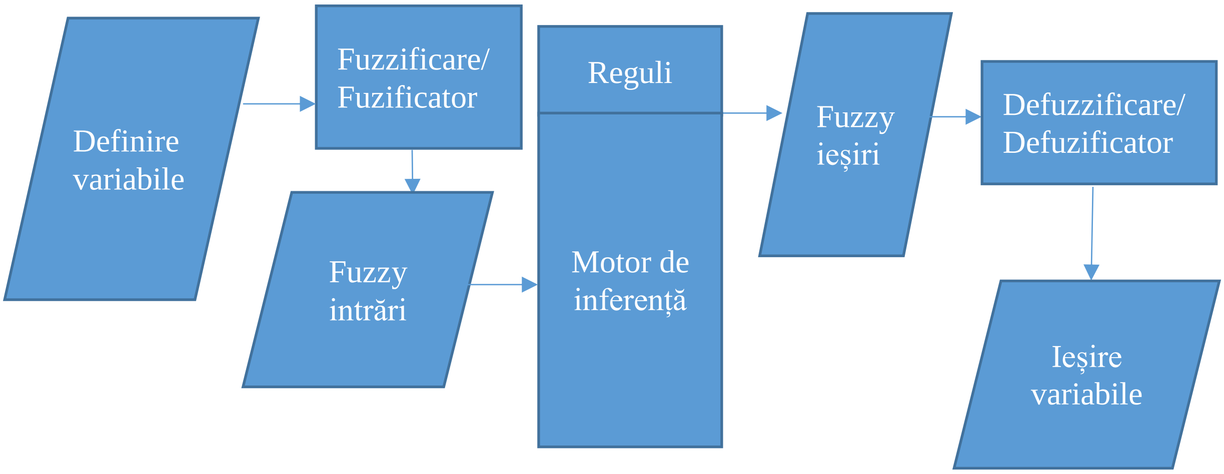


Fig. 3.8 Example of the failure occurring in the studied process [author contribution after [85]].

The fuzzifier is intended to render numerical expressions into fuzzy sets, indispensable for intensifying rules, which in turn have associated linguistic values corresponding fuzzy sets.

The inference engine manages a differentiation of rule sets into fuzzy sets. This is where the rule handling is implemented.

The defuzzifier performs the mutual transformation from fuzzy sets to numeric values.

The algorithm describing the fuzzy logic process has the following steps:

1. Definition of linguistic variables and terms (initialization), i.e. severity, probability, detectability.

2. Construct membership functions (initialization).

3. Constructing the rule base (initialization).

4. Converting crisp input data into fuzzy values using membership functions (fuzzification).

5. Evaluation of the rules in the rule base (inference, i.e. logical operation of passing from one statement to another and in which the last statement is deduced from the first).

6. Combining the results of each rule (inference, i.e. a logical operation of passing from one statement to another, in which the last statement is deduced from the first).

7. Converting the output data into non-fuzzy values (defuzzification).

3.2.4 Analysis of failure mode effects-AMDE

FMEA is the procedure that performs the analysis of the system in order to recognise potential failure modes, their causes and effects on system performance (performance of the sub-assembly, the whole system or a process) [126].

In order to maximise the effectiveness of failure mode removal or mitigation, the analysis is desirable to be performed early in the development cycle.

FMEA recognizes:

- the totality of possible failure modes in any part of the system represents a real failure mode, therefore it has been observed that, a malfunction has occurred, causing the system as a whole to operate incorrectly;

- Failures lead to negative effects on the system;

- Failure mechanisms;

- Ways to avoid faults and/or limit the consequences caused by faults in the system.

One of the methods of quantitative determination of criticality is the Risk Priority Number (RPN).

How to calculate the RPN = Severity of Failure (SEV) x Probability of Failure (OCC) (3.1)

Most often applied to equipment failures where each of these terms can be defined quantitatively and all failure modes have the same consequences.

The risk level is obtained by combining the consequences of a failure mode (severity) with the probability of failure. It is used when the consequences of different failure modes differ and can be applied to equipment systems or processes.

FMEA is the process that performs the system study aiming at the recognition of potential failure modes, their causes and effects on system performance (performance of the sub-assembly, the whole system or a process) [85].

In order to maximise the effectiveness of failure mode removal or mitigation, it is desirable to perform the analysis early in the development cycle.

FMEA recognizes:

- The totality of possible failure modes in any part of the system that represents an actual failure mode. It has been observed that a malfunction has occurred, causing the system as a whole to operate incorrectly;

- Faults lead to negative effects on the system;

- Failure mechanisms;

- Ways to avoid faults and/or limit the consequences caused by faults in the system.

FMEA is applicable throughout the life of the physical system (design, manufacture, operation).

The FMEA process is carried out taking into account the following steps as follows:

1. define the purpose and objectives of the study;
2. the risk management team is assembled;
3. the team understands the system/process that will be the subject of the FMEA;
4. the system/process is divided into components or steps;
5. define the function of each step or component;
6. is identified for each component or step listed:
   - how can each element fail?
   - what mechanisms can produce these failure modes?
   - what would be the effects if failures occur?
   - is the failure non-damaging or does it cause chain damage?
   - how can a fault be detected?
7. identify the provisions required in the design to compensate for the failure;
8. define the attributes of failure severity (S), failure probability (P), detectability (D)

Once vulnerable points are recognised, an estimate of potential outcomes (failures) is made based on the following criteria:

- Severity/severity - how critical is the failure?

- Frequency/frequency of occurrence - how likely is the failure to occur?

- Ease of detection - how easily can the failure be detected?

The author's contribution is that to make a FMEA for aerospace projects she has used for severity assessment - Table 3.2, for probability assessment - Table 3.3, and for detectability - Table 3.6, detailed below

Table 3.6 Example of detection evaluation scheme of detection mode [76]

Punctaj	Detectare	Severitatea consecințelor: impact asupra (de exemplu) costului
5	**Absolut incertă/foarte îndepărtată**	-Probabilitate foarte indepărtată de detectare prin control de proiectare a unei cauze/unui mecanism potential şi a modului de defectare ulterior -Controlui de proiectare nu va putea şi/sau nu va detecta o cauză/un mechanism potențial şi modul de defectare; sau nu există controlul de proiectare
4	**Îndepărtată/ Foarte scăzută**	-Probabilitate îndepărtată de detectare prin control de proiectere a unel cause/unui rnecanism potențial şi a modului de defectare ulterior -Probabiiitate foarte scăzută de detectare prin control de proiectare a unoi cause/unui mecanism potențial şi a modului de defectare ulterior
3	**Scăzută/ Moderată**	-Probabilitate scăzută de detectare prin control de proiectare a unel cauze/mecanism potențial şi a modului de defectare ulterior - Probabilitate moderată de detectare prin control de proiectare a unel cauze/unui mecanism potential şi a modului de defectare ulterior
2	**Ușor ridicată/ridicată**	-probabilitate moderată de detectare prin control de proiectare a unel cauze/unui mecanism potențial şi a rnodului de defectare ulterior -probabilitate ridicată de detectare prin control de proiectare a unei cause/unui mecanism potential şi a modului de defectare ulterior
1	**Foarte ridicată/aproape sigură**	-Probabilitate foarte ridicată dă detectare prin control de proiectare a unei cauze/mecanism potențial şi a modului de defectare ulterior -Controlul de proiectare va detecta foarte probabil o cauză/un mecamism potential şi modul de defectare ulterior.

One of the methods of quantitative determination of criticality is the Risk Priority Number (RPN).

RPN = Failure Severity (S) x Failure Probability (P) x Failure Detectability (D) (3.1)

Most often applied to equipment failures where each of these terms can be defined quantitatively and all failure modes have the same consequences.

The risk level is obtained by combining the consequences of a failure mode (severity) with the probability of failure. It is used when the consequences of different failure modes differ and can be applied to equipment systems or processes.

The Risk Priority Number (RPN) is a semi-quantitative measure of the critical state obtained by multiplying the numbers of the rating scale (in the model proposed by the author for aerospace projects ranging from 1 to 5) corresponding to the consequence of a failure, the probability of a failure and the ability to detect the problem. (A failure is given a higher priority if it is difficult to detect.) This method is often used in quality assurance applications.

Once failure modes and mechanisms are identified, corrective actions can be defined and implemented to mitigate the most significant failure modes.

The system can be reassessed through another FMEA cycle after the actions have been completed.

The output element of the FMEA is a sequence of failure modes, failure mechanisms and consequences of each component or activity of a system or process (containing information about the probability of a failure).

The FMEA output comprises an important hierarchy based on the likelihood of failure of the system, the risk stage resulting from the failure mode or a combination of risk stage and 'detectability' of the failure mode.

The strengths of FMEA are:

- are used in systems where failure may be due to human factors, equipment, system and hardware/software systems and procedures;
- identify component failure modes, causes and effects on the system and present them in an easy to decipher format;
- avoids the need for costly purchase/modification of equipment in service by identifying problems early in the design process;
- identifies individualised failure modes as well as requirements for redundancy or other safety systems;
- provides the output for the completion of monitoring platforms by highlighting key features to be monitored.

FMEA weaknesses are:

- are only used for the determination of individual failure modes, without the determination of combinations of failure modes;
- unless well controlled and properly set up, the studies are time-consuming and costly;
- are difficult to interpret for complex layered systems.

Conclusions on risk analysis method using FMEA

FMEA methodologies are risk assessment tools that allow recognition of hazards related to failure modes, effectiveness of protective barriers and reduction of associated risks.

An FMEA study summarises:

1. Recognition of Failure Modes in the Design or Process phases, before failures occur.
2. Determining the Effects and Severity of these failure modes.
3. Recognising possible Causes and determining correctly, based on probability theory, the occurrence of failure modes.
4. Recognise Existing Controls and their Effectiveness.
5. Quantify and prioritise the Risk associated with Failure Modes.

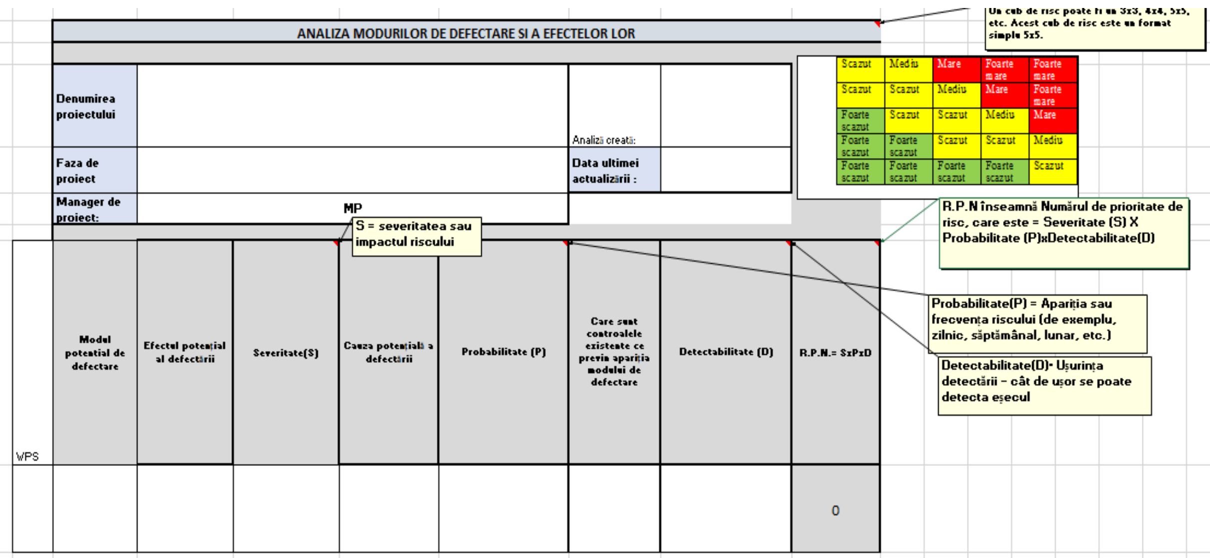


Figure 3.9 Example Analysis of failure modes and their effects FMEA [author contribution].

3.2.5 Table processor and graphical representations

Excel belongs to the category of table processors because of its multitude of functions, simplicity of use, ergonomics, and is successfully used in business, forecasting, project management, economic simulations and statistical analysis, and in routine office activities.

Microsoft Project is a project management software product created, developed and marketed by Microsoft. It is designed to benefit a project manager by enabling them to define a schedule, allocate resources to work tasks, monitor progress, manage budgets and research work tasks. Microsoft Project has become the dominant Project Management software. It is part of the Microsoft Office family.

Primavera is Project Management software for large enterprises. It includes Project Management, scheduling, risk analysis, opportunity management, resource management, collaboration and control capabilities and integrates with other enterprise software such as Oracle ERP and SAP systems. Primavera was launched in 1983 by Primavera Systems Inc. which was acquired by Oracle Corporation in 2008.

Table 3.7 Comparative table on project management software

Tip soft	Licență	Instruire	Continut informații	Observații
Primavera (Oracle)	Necesită licență de operare	Instruire specializată	Managementul proiectelor, programarea, analiza riscurilor, managementul oportunităților, managementul resurselor, capabilități de colaborare și control și se integrează ERP Oracle și SAP	-
VBA Excel	Licență de operare Microsoft Office	Instruire specializată	Managementul proiectelor, programarea, analiza riscurilor, managementul oportunităților, managementul resurselor Dependența de fiabilitatea și performanțele sistemului Skydrive	-
Project 2016	Licență de operare Microsoft Office	Instruire	Planificare resurselor, alocare de resurse, raportare	-
Excel	Licență de operare Microsoft Office	Instruire	Managementul Proiectelor, inițiere, planificare, execuție, control și monitorizare, închiderea proiectului.	Facil de operat

In Table 3.7 the three project management software are analysed by comparison and the specific characteristics of each software are highlighted.

3.2.6 Theoretical contributions to process-based risk assessment

For each process an attempt was made to produce a model illustrating the risk. The slots in each cylinder (process) constitute a possible risk factor. Depending on the process on which risks are identified, the following risk contributions can be identified, illustrated in Figures 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16.

3.3 Sequence and description of the phases of an aerospace project

In an aerospace project the structure detailed in Table 3.8 must be followed

Table 3.8 Project Management Phases [117].]

Phase 1: Initiating the project	**The Global Representation of the project (which includes the preliminary structure of the project) and stakeholders are defined.**
Phase 2: Project planning	**The project initiation meeting is held. The key results of the project objectives are established.** **A project plan is initiated. A risk analysis is carried out.**
Phase 3: Project Execution	**The work described in the plan is carried out. Effectiveness is checked during validation analyses.**
Phase 4: Project Monitoring and Control	**Status and tracking of deliverables on a project developer or Gantt chart.** **A communication plan is drawn up for the entire project. Lessons learned are outlined.**
Phase 5: Closing the project	**The final state is presented. Prepares and manages project closeout.**

4. APPLICATION CONTRIBUTIONS AND CASE STUDIES ON PROJECT MONITORING AND EVALUATION

4.1. TandemAEROdays project 19.20 8th EUROPEAN AERONAUTICS DAYS Bucharest 2019 and Berlin -2020

In order to demonstrate the objectives proposed in chapter 2 of the thesis, we have chosen 2 projects that can be found on the public website of the European Union. the path to this website is presented in [95].

Figure 4.11 EU portal for the TandemAEROdays 19.20 project[113]

Information about the project's progress can be found on the portal of the contracting authority sponsoring the project, described in Figure 4.11, on the event's organising website, www.tandemaerodays19-20.eu.

Although the deliverables of this project are not finalised in a demonstrator or play, the designed template is applicable to any type of project.

The following pages illustrate the phases of the TandemAEROdays19.20 project according to the Table and Graphics Processor designed by the thesis author.

In a Table and Chart Processor, Excel spreadsheets are coupled, which have common data fields, which are transmitted to all spreadsheets once they have been filled in the first sheet.

This allows the information that has been filled in the first spreadsheet to be transmitted to the linked spreadsheets as well. This results in a real-time update of the information.

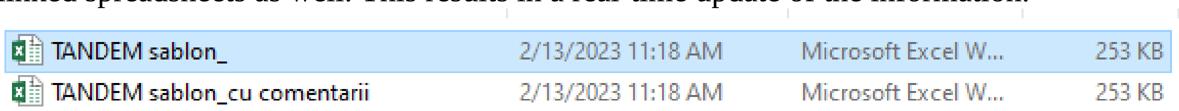


Figure 4.12 Table and graphical representation processor associated with the TandemAEROdays19.20 project [author contribution].

The figure above is a screenshot from the Windows operating system, showing the Excel data file, containing file name, date and time of figure creation, file type, file size.

Opening the file "TANDEM template", the first spreadsheet of the file contains the contents of the phases of a project. By clicking on any of the Phases shown, you activate the spreadsheets containing the records of the called phase.

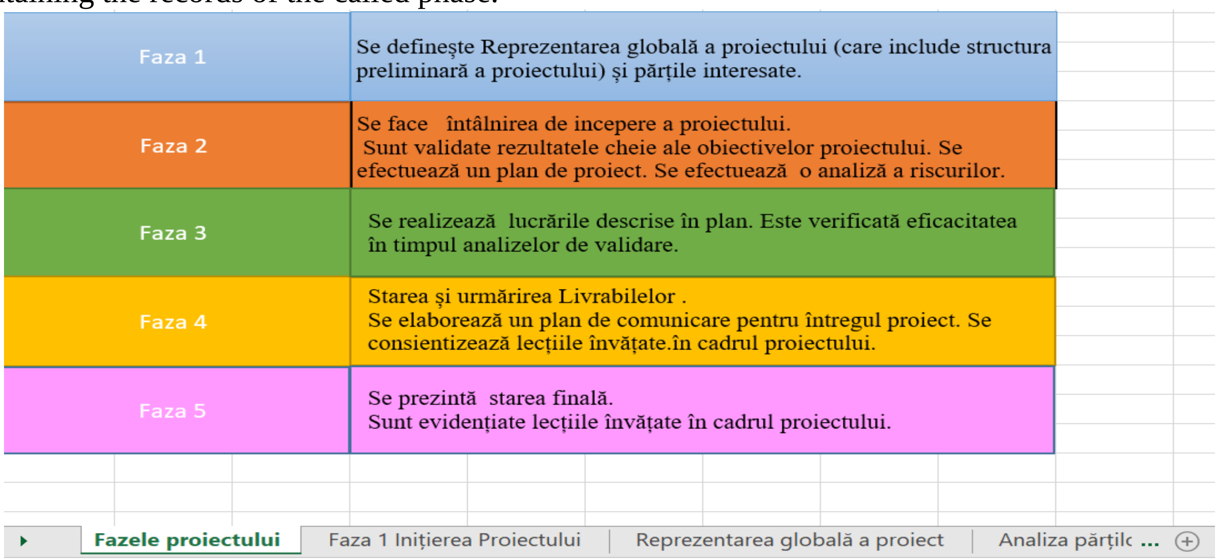


Fig. 4.13 Content of the phases of a project [author contribution].

Figure 4.13 shows the first spreadsheet of the Table and Graph Processor. When the operator calls one of the project phases, the project phase is activated with access to the records of that phase, as described in the footer of Figure 4.13 .

The project phases are as follows:

- Phase 1 Project Initiation
- Overall Project Representation
- Stakeholder analysis
- Statement of Work (SOW)
- Phase 2 Project Planning
- Kick-off meeting
- Deliverables
- Work Breakdown Structure (WBS)
- Project Cost Plan
- Communication plan
- Project risk analysis
- Checklist analysis at a given point
- Phase 3 Project Execution
- List of Continuous Action Items (RAIL)
- Phase 4 Control Project Monitoring
- Traceability sheet Deliverables
- Phase 5 Project closure
- Lessons learnt log

Table 4.1 details the phases of the project with the specific records for each phase, and the number of figures in which they are explained.

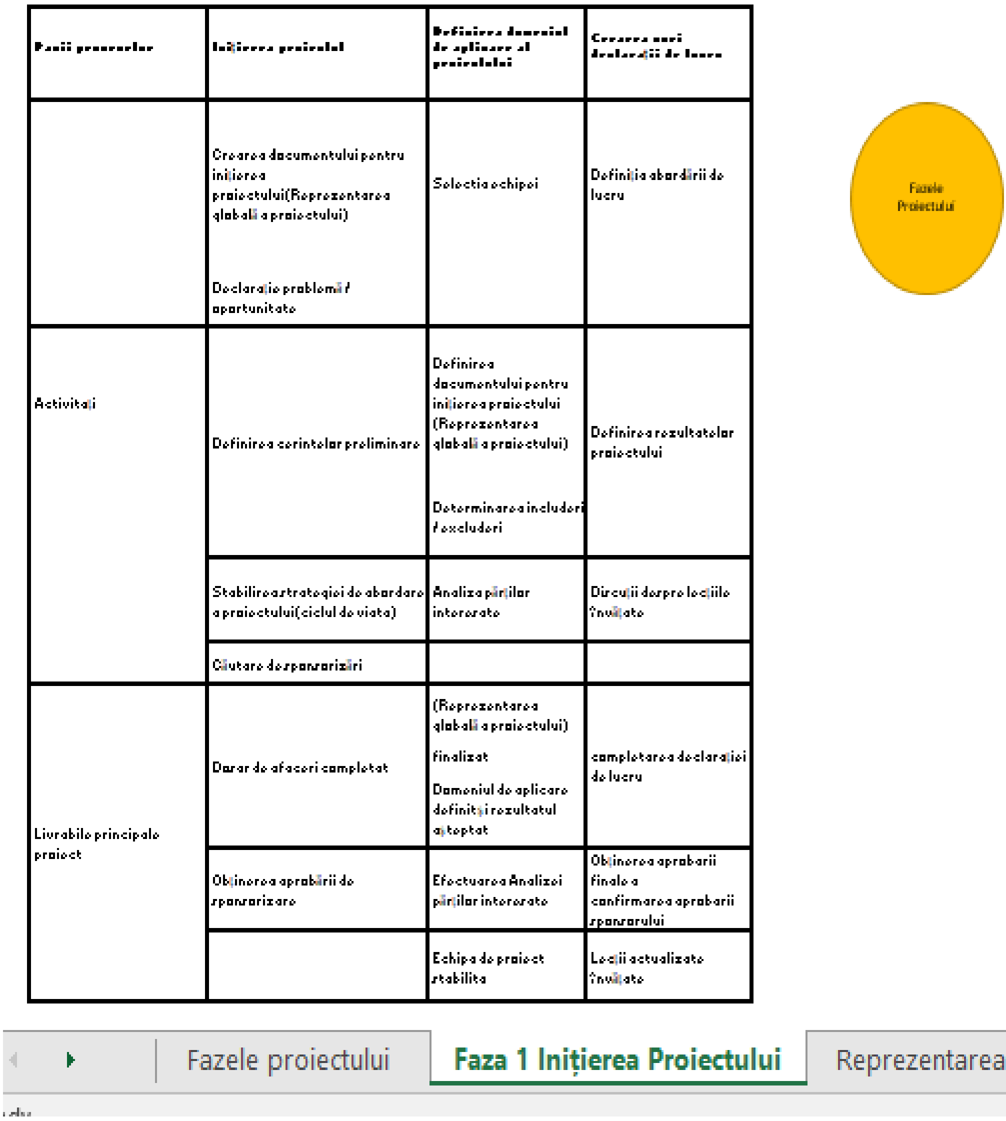
Table 4.1 Project phases and phase-specific records [author contribution].

FAZA	CONȚINUT PROIECT	ÎNREGISTRARE	Explicitare conținut în figura
Faza 1	Inițierea Proiectului	Reprezentarea globală a proiectului	4.15
		Analiza părților interesate	4.16
		Declarație de muncă/Statement of Work (SOW)	4.17
Faza 2	Planificarea Proiectului	Ședința de lansare „Lansarea proiectului”	4.19
		Livrabile	4.20
		Plan de costuri ale proiectului	4.21
		Analiza riscului pe proiect	4.22a,b

		Structura defalcării lucrărilor (WBS)	4.22c
		Desfășurător de proiect GANTT	4.23
		Plan de comunicare	4.24
		Lista de verificare analiză într-un punct dat	4.25
Faza 3	Execuție Proiect	Lista articolelor de acțiune continuă (RAIL)	4.27
Faza 4	Control Monitorizare Proiect	Fișa de trasabilitate Livrabile	4.29
Faza 5	Închiderea Proiectului	Jurnal de lecții învățate	4.31

The table and graphical representation processor with the necessary explanations to fill in the fields, customised for the TandemAEROdays19.20 project, can be found from Figure 4.15 to Figure 4.31.

Fig. 4.14 Phase 1 shows the activities and deliverables of the Project Initiation phase [author contribution].



Pașii procesului	Inițierea proiectului	Definirea domeniului de aplicare al proiectului	Crearea unei declarații de lucru
	Crearea documentului pentru inițierea proiectului(Reprezentarea globală a proiectului) Declarație problemă / oportunitate	Selectia echipei	Definiția abordării de lucru
Activități	Definirea cerintelor preliminare	Definirea documentului pentru inițierea proiectului (Reprezentarea globală a proiectului) Determinarea includeri / excluderi	Definirea rezultatelor proiectului
	Stabilirea strategiei de abordare a proiectului(ciclul de viata)	Analiza părților interesate	Discuții despre lecțiile învățate
	Căutare de sponsorizări		
Livrabile principale proiect	Dosar de afaceri completat	(Reprezentarea globală a proiectului) finalizat Domeniul de aplicare definit și rezultatul așteptat	completarea declarației de lucru
	Obținerea aprobării de sponsorizare	Efectuarea Analizei părților interesate	Obținerea aprobarii finale a confirmarea aprobarii sponsorului
		Echipa de proiect stabilita	Lecții actualizate învățate

Fig. 4.14 Phase 1 Project Initiation [author contribution]

If on the spreadsheet assigned to Phase 1, the "Project Phases" button is clicked, then it will automatically switch to the spreadsheet "Contents of Phases of a Project" which was shown in Figure 4.13.

In Figure 4.14 Phase 1 Project Initiation, information about the process steps, project initiation, project scope, statements of work are contained.

The process steps include activities related to project initiation as well as information about the main project deliverables.

The main deliverables of the project comprise the completed business case consisting of the Overall Representation of the completed project specifying the defined scope and expected outcome.

Obtaining sponsorship approval is based on the Stakeholder Analysis (Fig 4.16), which is the implicit confirmation of sponsor approval, i.e. obtaining final management approval.

The project scope refers to the team selection, documents related to the project initiation are defined - the Overall Project Representation, containing inclusions or exclusions, and the Stakeholder Analysis.

Phase 1 Project Initiation has the first record Global Project Representation.

The Global Project Representation is a statement of the purpose, objectives and participants of a project.

It provides a preliminary delineation of roles and responsibilities, presents the project objectives, identifies key stakeholders and defines the authority of the project manager.

An approved Global Project Representation formally initiates the project and serves as an authority reference for the future of the project.

A project manager together with a team is assigned as early as possible and ideally during the development of the Global Project Representation.

The project should be authorised by someone outside the project e.g. the project sponsor, who has budgetary responsibility.

Instructions:

- Completion of the template is done after discussion with the team members, who have agreed to the agreed functions.

In the field labelled Project the name of the project is filled in, as stated in the contract. The information in this field will be diffused to all spreadsheets of the designed table processor, this field being designed to have the same characteristics in the spreadsheets following the Global Representation spreadsheet, as such the information retrieval will be done automatically.

In point 1 Project description, an overview of what the project entails is given.

In point 2 Scope of the project, specific details are spelled out to ensure a complete and unambiguous understanding of the project, elements that can be presented or excluded are presented.

In point 3 Purpose and justification of the project, the necessary elements of the project are described. Mention of benefits may be included.

In point 4 Project deliverables, the ways and tools with which the project can be measured are mentioned. Looking at key objectives, and phase and gate dates, these are linked to the T0 start time of the project. The rest of the data will be mentioned in the project breakdown structure.

In point 5 Project risks are due to commercial, technological, manufacturing preparation, manufacturing aspects.

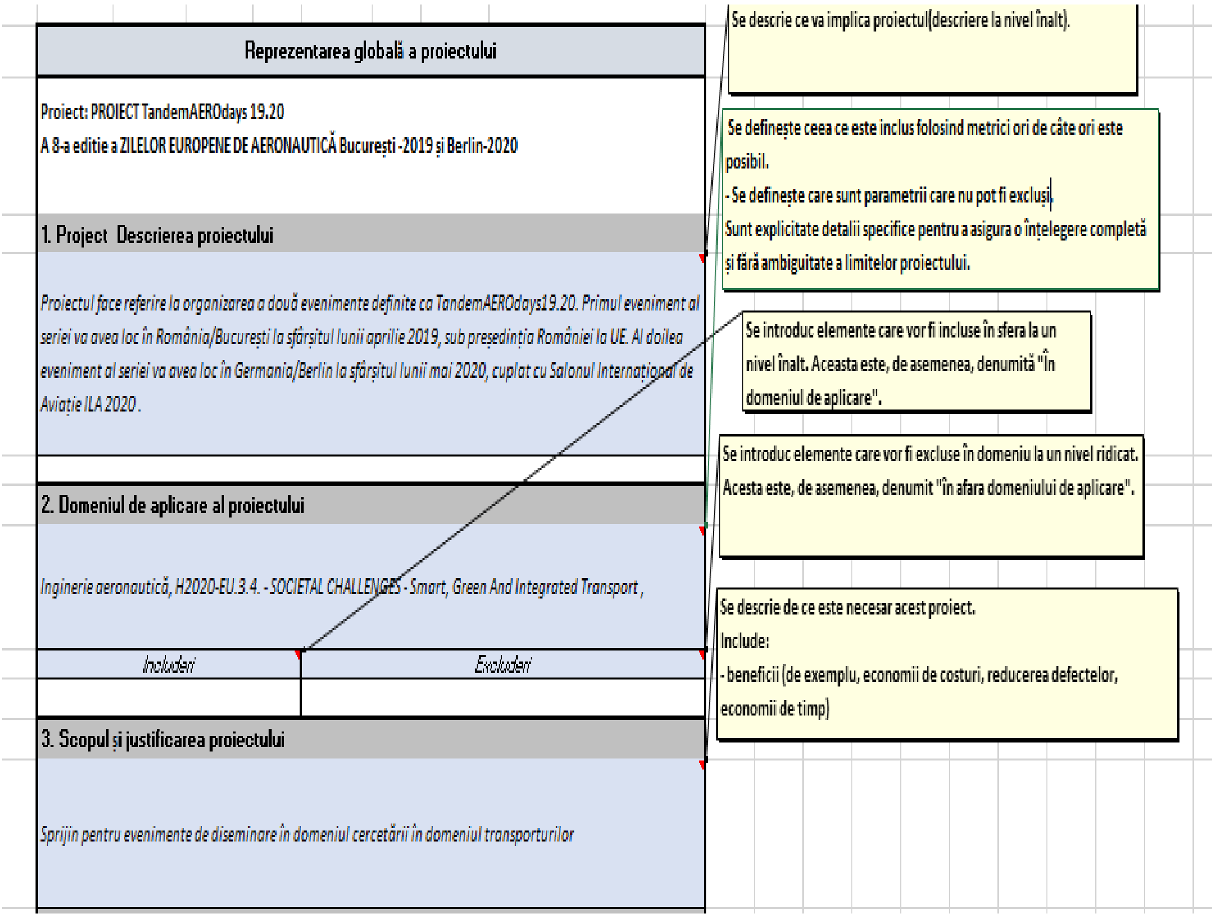


Fig 4.15a Global representation of the TandemAEROdays19.20 project [author contribution]

In the stakeholder analysis in Figure 4.16, the name of the project has been taken, along with the completion of the field with the same name, from the setting made when building the table processor, from the Global Project Representation.

They were identified:

-Stakeholders by their role in the project, C-Coordinator, P-Participant;

-level of involvement (critical, significant, moderate impact, minimal impact, no impact, -) and type of involvement (sponsor, client, supplier, project manager).

The working team is mentioned, with names and functions.

The name of the author of this thesis, MR, can be seen under responsible risk.

The Data Validation option in the Data menu of the EXCEL processor was used to enter the PI role and level of involvement in the table.

Analiza părților interesate			
Proiect: PROIECT TandemAEROdays 19.20 A 8-a editie a ZILELOR EUROPENE DE AERONAUTICĂ București -2019 și Berlin-2020			
Identificați părțile interesate cheie			
Denumire părților interesate	**Rol**	**Nivelul rolului de implicare**	**Tip Implicare**
INCAS	**Coordonator**	**Critic**	Client
DLR	**Participant**	**Critic**	Client
EU	**Coordonator**	**Critic**	Sponsor
BDLI	**Participant**	**Critic**	Client
UEFISCDI	**Participant**	**Critic**	Client
Echipa de lucru			
Nume	*Functie*	*Nume*	*Functie*
1 DC	*PROJECT MANAGER*	2 MR	RESPONSABIL RISC

Părțile interesate pot fi listate după titlu, departament, funcție etc

Se menționează factorii cheie care pot afecta acest proiect, fie prin sprijin direct sau indirect.

Nivelul rolului de implicare este
-Critic
-Semnificativ
-Impact moderat
-Impact minim
-Fara impact

Rol:
C- Coordonator,
P -Participanti,

Se descrie modul în care părțile interesate vor participa pe parcursul derulării proiectului.

Această secțiune poate fi preluată din Reprezentarea globală a proiectului.

Fig 4.16 Stakeholder analysis in TandemAEROdays19.20 [author contribution]

It can be seen in the responsible risk, the mention of the name of the author of this thesis, MR (Manuela Rusu).

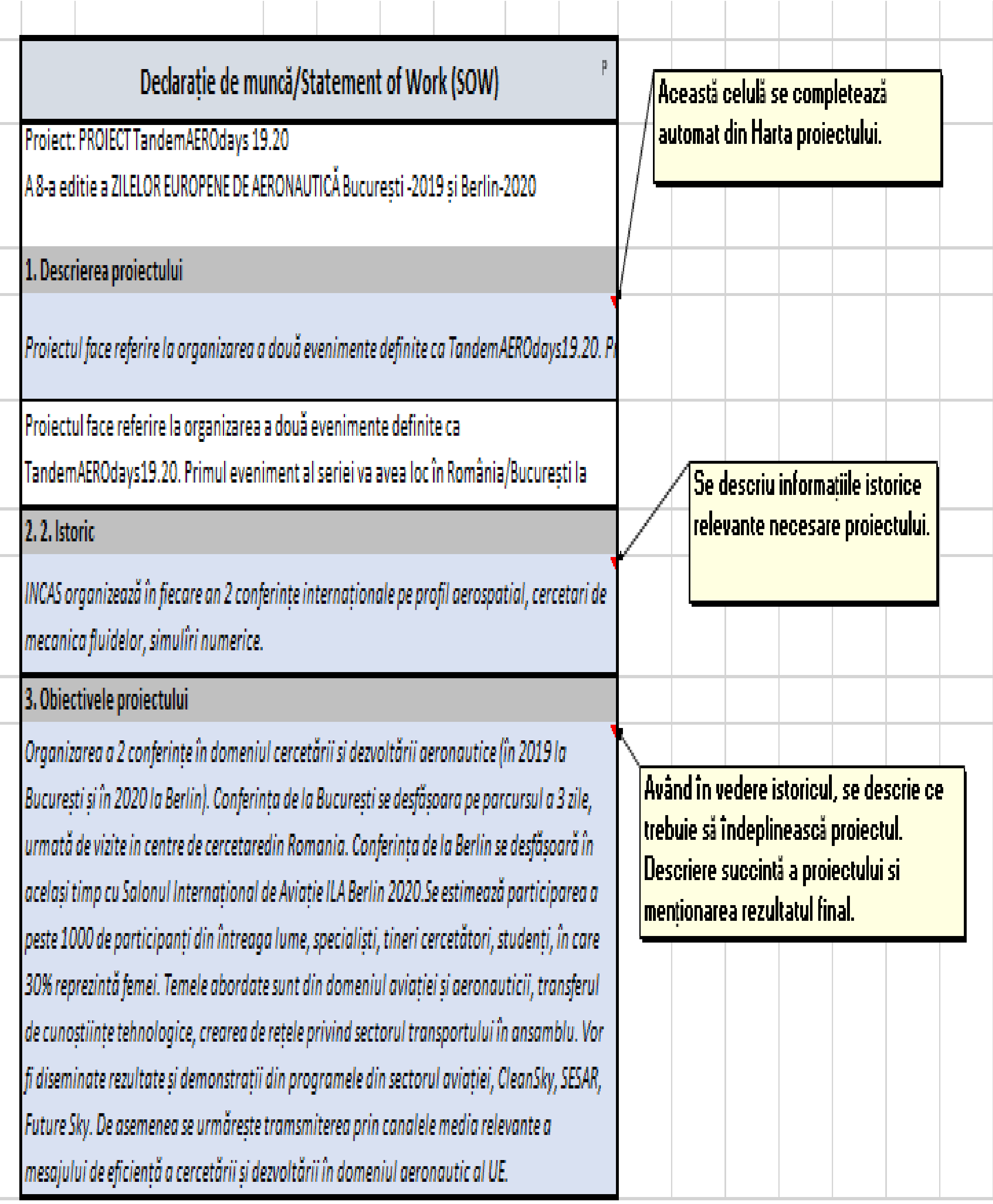
Statement of Work (SOW) is a narrative description of the products, services or results to be delivered by the project.

In Figure 4.17 of the Statement of Work (SOW) the project name and description as well as the project history and objectives are automatically filled in from the Global Project Representation spreadsheet. In point 4 Success Criteria the project objectives are described as they are spelled out in the project framework contract.

In point 5 Working approach, the working assumptions are specified, i.e. validation of the execution of the parts and assembly on a spacecraft (if applicable, depending on the project) as well as the methodology of the project. Under major activities the core activities contributing to the project objectives are described.

Section 6 mentions the Project Deliverables. These are mentioned, the organisation and stakeholder who have responsibility for the deliverables, the acceptance criteria with their approval.

Point 7 refers to the Training Plan required to achieve and implement the objectives.



Declarație de muncă/Statement of Work (SOW)

Proiect: PROIECT TandemAEROdays 19.20

A 8-a editie a ZILELOR EUROPENE DE AERONAUTICĂ București -2019 și Berlin-2020

1. Descrierea proiectului

Proiectul face referire la organizarea a două evenimente definite ca TandemAEROdays19.20. Pr

Proiectul face referire la organizarea a două evenimente definite ca TandemAEROdays19.20. Primul eveniment al seriei va avea loc în România/București la

2. 2. Istoric

INCAS organizează în fiecare an 2 conferințe internaționale pe profil aerospatial, cercetari de mecanica fluidelor, simulări numerice.

3. Obiectivele proiectului

Organizarea a 2 conferințe în domeniul cercetării și dezvoltării aeronautice (în 2019 la București și în 2020 la Berlin). Conferința de la București se desfășoara pe parcursul a 3 zile, urmată de vizite in centre de cercetaredin Romania. Conferința de la Berlin se desfășoară în același timp cu Salonul Internațional de Aviație ILA Berlin 2020.Se estimează participarea a peste 1000 de participanți din întreaga lume, specialiști, tineri cercetători, studenți, în care 30% reprezintă femei. Temele abordate sunt din domeniul aviației și aeronauticii, transferul de cunoștiințe tehnologice, crearea de retele privind sectorul transportului în ansamblu. Vor fi diseminate rezultate și demonstrații din programele din sectorul aviației, CleanSky, SESAR, Future Sky. De asemenea se urmărește tramsmiterea prin canalele media relevante a mesajului de eficiență a cercetării și dezvoltării în domeniul aeronautic al UE.

Fig 4.17a Statement of work/Statement of work [author's contribution]

All information in the records of the first phase of the project is taken from the website [95], and from the portal described in 4.11.

Fig. 4.18 Phase 2 shows the activities and deliverables of the Project Planning phase.

Elements of the activities carried out in this phase are mentioned.

Communication planning is carried out through brainstorming and performs risk assessment as well as risk analysis with mitigation measures.

The project launch uses the Work Breakdown Structure (WBS). The information on the public website [95] only allows a 2-level breakdown, main processes and secondary processes.

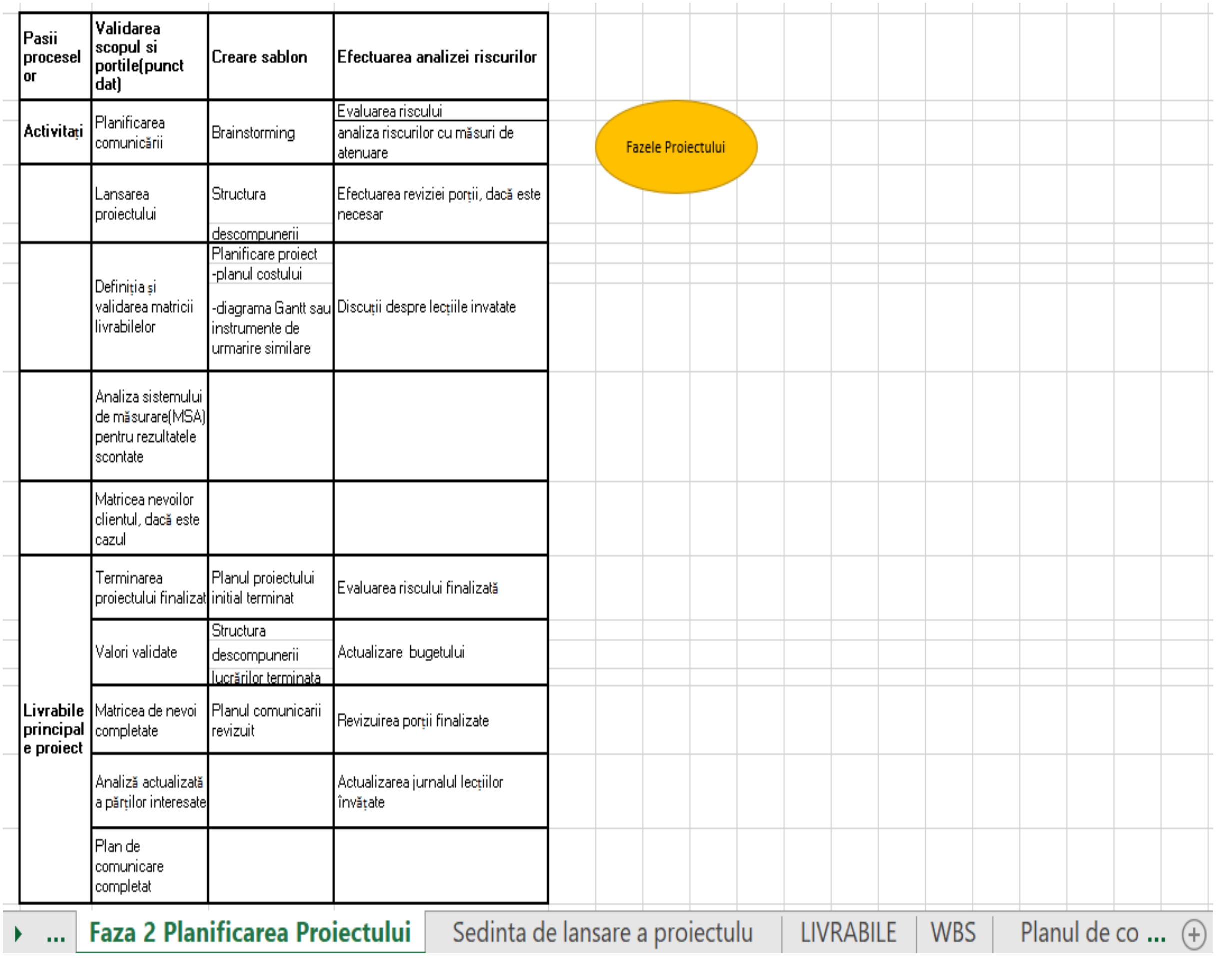
The work of defining and validating the deliverable matrix leads to project planning, cost planning, Gantt project unfolding.

The phase activities also include the analysis of the measurement system for deliverables and the customer needs matrix.

Key project deliverables include:

- Project completion containing the initial completed project plan and completed risk assessment;
- validated values containing the completed Work Breakdown Structure (WBS) followed by budget analysis;
- Completed needs matrix leads to communication plan review followed by gate review.
- Updated IP analysis leads to updated lessons learned log.
- Communication plan completed.

If on the spreadsheet assigned to phase 1, the "Project phases" button is clicked, then it will automatically switch to the spreadsheet "Contents of phases of a project" which has been shown in Figure 4.13.



Pasii proceselor	Validarea scopul si portile(punct dat)	Creare sablon	Efectuarea analizei riscurilor
Activitați	Planificarea comunicării	Brainstorming	Evaluarea riscului analiza riscurilor cu măsuri de atenuare
	Lansarea proiectului	Structura descompunerii	Efectuarea reviziei porții, dacă este necesar
	Definiția și validarea matricii livrabilelor	Planificare proiect -planul costului -diagrama Gantt sau instrumente de urmarire similare	Discuții despre lecțiile invatate
	Analiza sistemului de măsurare(MSA) pentru rezultatele scontate		
	Matricea nevoilor clientul, dacă este cazul		
Livrabile principale proiect	Terminarea proiectului finalizat	Planul proiectului initial terminat	Evaluarea riscului finalizată
	Valori validate	Structura descompunerii lucrărilor terminata	Actualizare bugetului
	Matricea de nevoi completate	Planul comunicarii revizuit	Revizuirea porții finalizate
	Analiză actualizată a părților interesate		Actualizarea jurnalul lecțiilor învățate
	Plan de comunicare completat		

The project kick-off meeting, detailed in Figure 4.19, includes the meeting agenda, task team agreement, roles and responsibilities, mention of the task team code of conduct, decision-making process, conflict management plan (where applicable).

Sedinta de lansare „Lansarea proiectului”					
Agenda întâlnirii					
1	Stabilirea desfasurarii etapei 2		6	Stabiliea Planului de Comunicare	
2	Definirea livrabilelor		7	Realizarea Analizei risc	
3	Stabilirea WBS(Structura defalcării lucrărilor) pentru etapa 2		8	Realizarea Listei de verificare analiza intr-un punct dat	
4	Stabilirea planului de costuri al proiectului TandemAEROdays19.20		9		
5	Realizarea desfășurătorului de proiect cu grafic Gantt		10		
Acordul echipei de lucru					
Roluri și responsabilități					
Rol (C- Coordonator, P -Participanti)					
Nume		*Functie*	*Nume*		*Functie*
1	DC	-	2	MR	-

Managerul de proiect ia în considerare diferitele elemente care trebuie împărtășite cu echipa (de exemplu, politici și proceduri, hartă de proiect).

Figure 4.19 Project launch meeting [author contribution]

It can be seen in the "Roles and Responsibilities" section, the name of the author of this thesis, MR (Manuela Rusu), is mentioned.

The content of the Deliverables spreadsheet in Figure 4.20 is taken from the Global Project Representation, i.e. the fields with the project name (point 2), and from the Statement of Work (SOW) spreadsheet, i.e. the Project Objectives field (point 3) and the Deliverables (point 6).

Deliverable is an expected key result of the project. It is used to help clients, process owners and project/process sponsors know if the project has been successful.

For the proof of validation, the method and the result of the validation are mentioned.

It is supported by the Report demonstrating the consistency of the product/service characteristics with the project.

LIVRABILE
Proiect: PROIECT TandemAEROdays 19.20
1. Descrierea proiectului
Proiect: PROIECT TandemAEROdays 19.20 A 8-a editie a ZILELOR EUROPENE DE AERONAUTICĂ București -2019 și B
3. Obiectivele proiectului
Inginerie aeronautică, H2020-EU.3.4. - SOCIETAL CHALLENGES - Smart, Green And Integrated Transport ,
Proiectul face referire la organizarea a două evenimente definite ca TandemAEROdays19.20. Primul eveniment al seriei va avea loc în România/București la sfârșitul lunii aprilie 2019, sub președinția României la UE. Al doilea eveniment al seriei va avea loc în Germania/Berlin la sfârșitul lunii mai 2020, cuplat cu Salonul Internațional de Aviație ILA 2020.
4. Criterii de succes
Care sunt parametrii măsurabili care vor fi folosiți pentru a determina succesul?
Indeplinirea livrabilelor, impactul media al conferinței, feedback de la participanți

Descriere a ce va presupune proiectul.

Având în vedere contextul istoric, se descrie ce trebuie să realizeze proiectul. Descriere trebuie sa fie scurtă și obiect raportat funcție de rezultatul final.

Având în vedere domeniul de aplicare al proiectului și rezultatele enumerate în Reprezentarea globala a proiectului, se descriu care sunt parametrii criteriilor de succes, pentru ca echipa și sponsorul să știe că ținta a fost atinsă la sfârșitul

Fig 4.20a Deliverable [author contribution]

Proiectul livrabil este un rezultat cheie preconizat al proiectului. Este folosit pentru a ajuta clienții, proprietarii de procese și sponsorii proiectului / procesului să știe dacă proiectul a avut succes.

Se descrie metoda și rezultatul validării.

5. Măsuri	Livrabil #1	Livrabil #2	Livrabil #3	Livrabil #4	Livrabil #5	Livrabil #6
Livrabile principale proiect	D1.3-01 Site-ul web comun operațional constând din videoclipuri, brevete	D1.3-18 Extinderile site-ului web cu publicarea anunțurilor de participare, anunțuri in vederea participării	D3.4-02 Site-ului web realizat de partea romana, inscrierea la conferință, condiții de participare, etc	D4.5-08 Site-ului web realizat de partea germană	D3.1-10 Desfășurarea conferinței românești a Tandem AEROdays19.20	D4.1-28 Desfășurarea conferinței germane a Tandem AEROdays19.20
Dovada validării	Raport realizare livrabil					
Comentarii						
Nu						

Fig 4.20b Deliverable [author contribution]

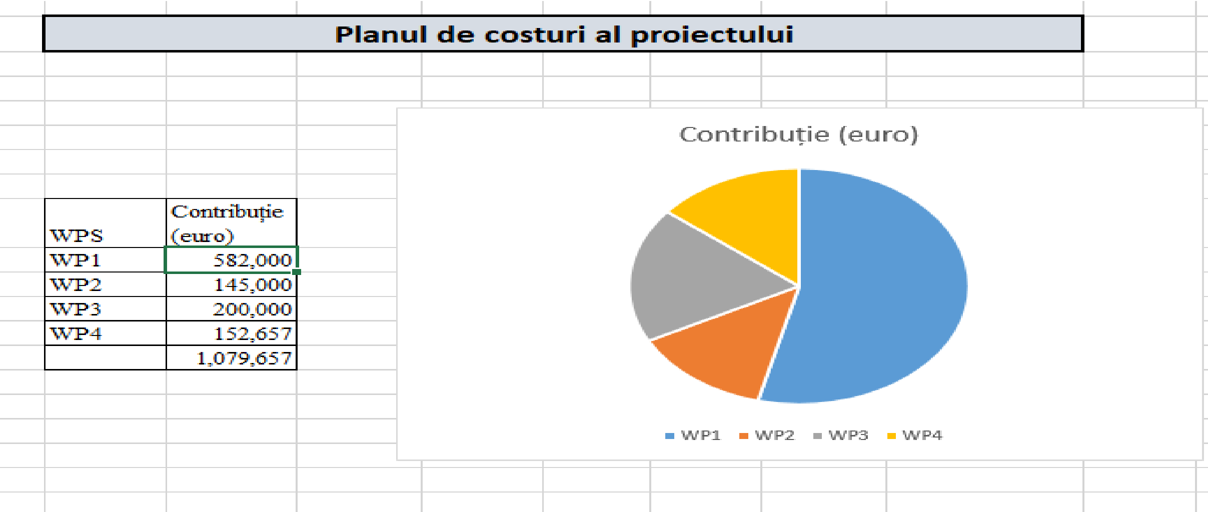


Figure 4.21 Project cost plan [author contribution]

The cost plan of the project has been made on the work packages of the main activities, identified in [95], which materialised in Figure 4.21.

Risk analysis is an analytical technique used to determine within the project, risks or other sources of uncertainty that have a potentially greater impact on project outcomes by correlating variations in project outcomes.

The author's contribution is that for the development of an FMEA for aerospace projects she has used for severity assessment - Table 3.2, for probability assessment - Table 3.3, and for detectability - Table 3.6.

Figure 3.6 shows the combination of severity and likelihood, together with the colour guide (green-very low, yellow-low and medium, red-high and very high). The calculation algorithm in FMEA, is designed as a function of the R.P.N. score, in the table to show the colour assigned to the score:

- green-very low;
- yellow-low and medium;
- red-high and very high.

Figure 4.22 Risk analysis by project, uses the Condittional Formatting function in the Home menu to assign colours according to the R.P.N. score.

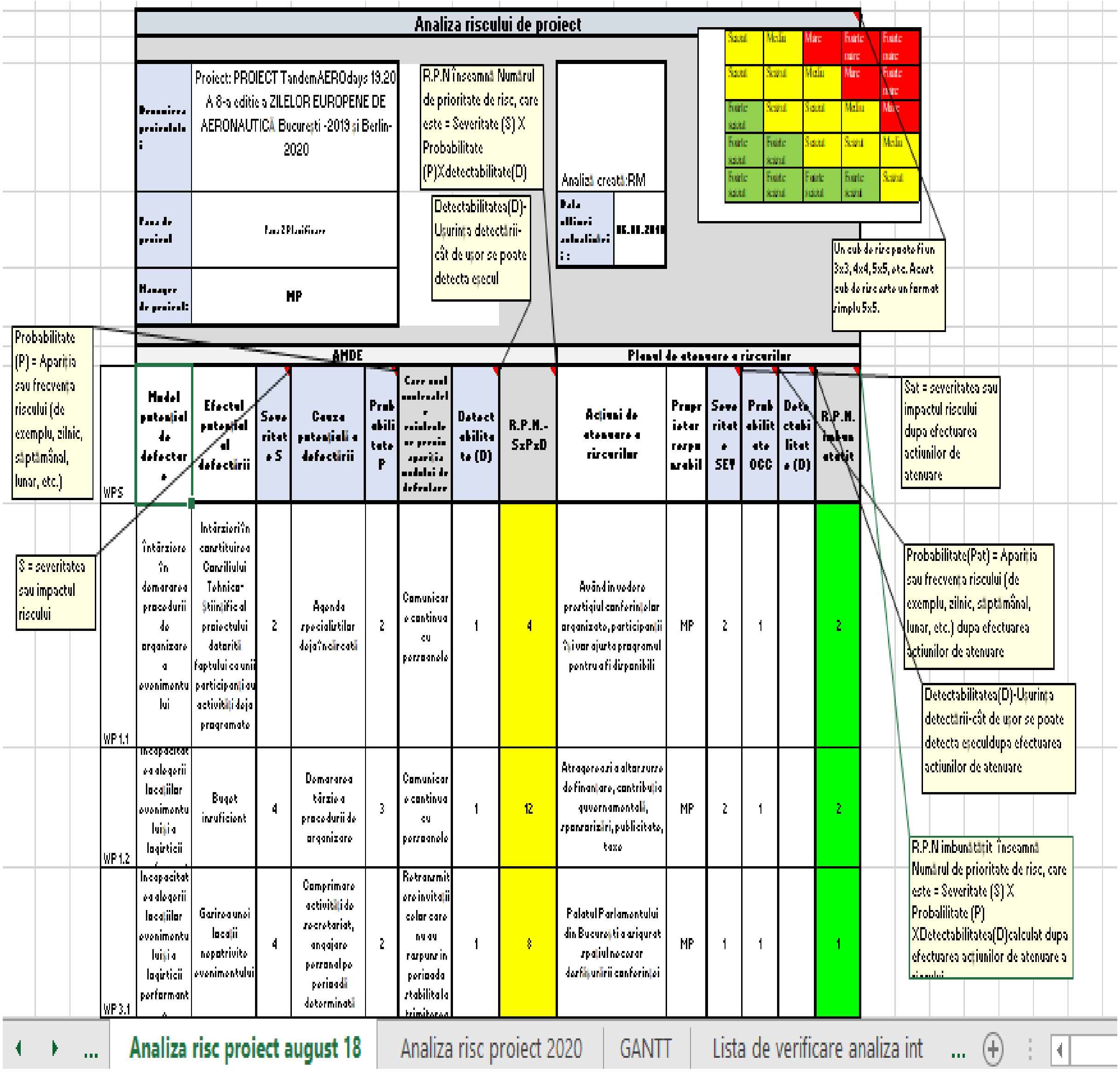


Fig 4.22a Risk analysis on the project before the start of the project [author contribution]

Given that by the time the WP 4 work package was completed, the 2020 COVID pandemic had occurred, with total disruption of non-essential activities for 2 months, then with restricted movement of people between countries, a new risk assessment and mitigation action plan was required.

Analiza riscului de proiect

Denumirea proiectului	Proiect: PROIECT TandemAEROdays 19.20 A 8-a editie a ZILELOR EUROPENE DE AERONAUTICĂ Bucureşti -2019 şi Berlin-2020
Faza de proiect	Faza 2 Planificare
Manager de proiect:	MP

Analiză creată:RM

Data ultimei actualizări:	16.03.2020

Scazut	Mediu	Mare	Foarte mare	Foarte mare
Scazut	Scazut	Mediu	Mare	Foarte mare
Foarte scazut	Scazut	Scazut	Mediu	Mare
Foarte scazut	Foarte scazut	Scazut	Scazut	Mediu
Foarte scazut	Foarte scazut	Foarte scazut	Foarte scazut	Scazut

	AMDE								Planul de atenuare a riscurilor					
WPS	Model potențial de defectare	Efectul potențial al defectării	Severitate S	Cauza potențială a defectării	Probabilitate P	Care sunt controalele existente ce previn apariția modului de defectare	Detectabilitate (D)	R.P.N.= SxPxD	Acțiuni de atenuare a riscurilor	Proprietar responsabil	Severitate S	Probabilitate P	Detectabilitate (D)	R.P.N. imbunatatit
WP 1.	Declanșare pandemiei de coronavirus	Anularea ILA mai 2020, Reprogramare TandemAERO19.20 Berlin	4	Carantina la nivel mondial. Limitarea deplasărilor	4	Imposibilitate a deplasărilor. Trecerea activităților în mediul on-line	1	16	Reprogramare conferinta TandemAERO19.20 Berlin pentru noiebrie 2020 și desfășurarea acesteia in format hibrid (la fata locului si online)	MP	4	1	1	4

Fig 4.22b Risk analysis per project before the start of the project and after the COVID 2020 pandemic [author contribution]

Under the heading "Analysis created: RM" in Figure 4.22, Project Risk Analysis, the name of the author (RM-Rusu Manuela) appears, as evidence of involvement in the risk estimation of the project presented and the design of the table and graphical representation processor.

Work Breakdown Structure (WBS) means a hierarchical breakdown of the total scope of work, to demonstrate the achievement of the project objectives and create the necessary activities, to achieve the deliverables.

For the TandemAERO19.20 project we have a two-level breakdown, the Work Breakdown Structure (WBS), illustrated in Figure 4.22c.

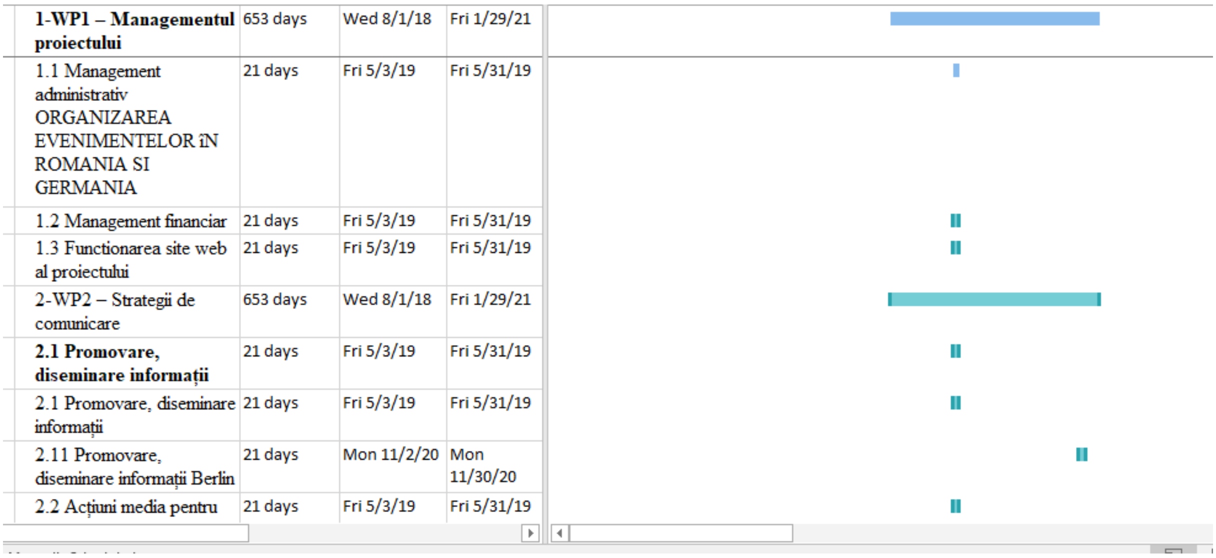
Nume proiect	Procese principale (Nivel 1)	Procese secundare (Nivel 2)
		1.1 Management administrativ ORGANIZAREA EVENIMENTELOR ÎN ROMÂNIA ŞI GERMANIA
		1.2 Management financiar

Fig.4.22c Work breakdown structure (WBS) [author contribution]

The Gantt chart, constitutes for the project used in the example of the template designed by the author, an analysis and planning tool, which allows to manage and organize projects in detail and to track their progress. With the help of this analysis, information about the project start and completion date can be identified.

The project GANTT chart, Figure 4.23, highlighted the activities during the 24 months of the project.

Fig.4.23a GANTT project flowchart [author contribution]



1-WP1 – Managementul proiectului	653 days	Wed 8/1/18	Fri 1/29/21
1.1 Management administrativ ORGANIZAREA EVENIMENTELOR ÎN ROMANIA SI GERMANIA	21 days	Fri 5/3/19	Fri 5/31/19
1.2 Management financiar	21 days	Fri 5/3/19	Fri 5/31/19
1.3 Functionarea site web al proiectului	21 days	Fri 5/3/19	Fri 5/31/19
2-WP2 – Strategii de comunicare	653 days	Wed 8/1/18	Fri 1/29/21
2.1 Promovare, diseminare informații	21 days	Fri 5/3/19	Fri 5/31/19
2.1 Promovare, diseminare informații	21 days	Fri 5/3/19	Fri 5/31/19
2.11 Promovare, diseminare informații Berlin	21 days	Mon 11/2/20	Mon 11/30/20
2.2 Acțiuni media pentru	21 days	Fri 5/3/19	Fri 5/31/19

Fig.4.23b GANTT project flowchart from Project 2016 [author contribution]

The result of the GANTT Project Flowchart produced by the author's designed table and graphical representation processor and by the Project 2016 program are identical, which is a proof of validation of the author's designed template.

A communication plan is managed by the project manager. Fig.4.24 shows a Communication Plan, which can be used to identify key activities and tasks that require communication with stakeholders (both internal and external) and team members.

Plan de comunicare					
	Lista sarcinilor sau activităților proiectului care necesită comunicare	Scop	Responsabil cu comunicarea	Destinatarii	Metodă
Data	17.09.2020	Stadiul desfasurarii activităților de lucru	PM	Parti interesate	mail
1	**1-WP1 – Managementul proiectului**	Realizat	PM	Y, EU	mail
2	1.1 Management administrativ ORGANIZAREA EVENIMENTELOR iN ROMANIA SI GERMANIA	Realizat	PM	Y, EU	mail
3	1.2 Management financiar	Realizat	PM	Y, EU	mail
4	1.3 Functionarea site web al proiectului	Realizat	PM	Y, EU	mail
5	2-WP2 – Strategii de	Realizat	PM	Y, EU	mail
6	**2.1 Promovare, diseminare informații**	Realizat	PM	Y, EU	mail
7	2.1 Promovare, diseminare informații	Realizat	PM	Y, EU	mail
8	2.2 Acțiuni media pentru promovare ROMANIA	Realizat	PM	Y, EU	mail
9	2.3 Acțiuni media pentru promovare GERMANIA	Realizat	PM	Y, EU	mail
10	**3 Pregătirea conferinței București**	Realizat	PM	Y, EU	mail
11	3.1 Management administrativ București	Realizat	PM	Y, EU	mail

Se enumeră metodele (de exemplu, e mail, față în față, telefon) care vor fi utilizate ca parte a comunicării.

Cine trebuie să primească comunicarea?

Este mentionată persoana care face comunicarea (ex. Managerul de proiect, alta persoana din echipă)

... Desfasurator de proiect cu graf | Plan de comunicare | Analiza risc proiect august 18 | Analiza ris ...

Fig.4.24 Communication plan [author contribution]

Figure 4.25 which represents the Analysis Checklist at a given point, highlights the status of the deliverables at a given point in time, i.e. whether the task has not started, is not implemented or is not complete.

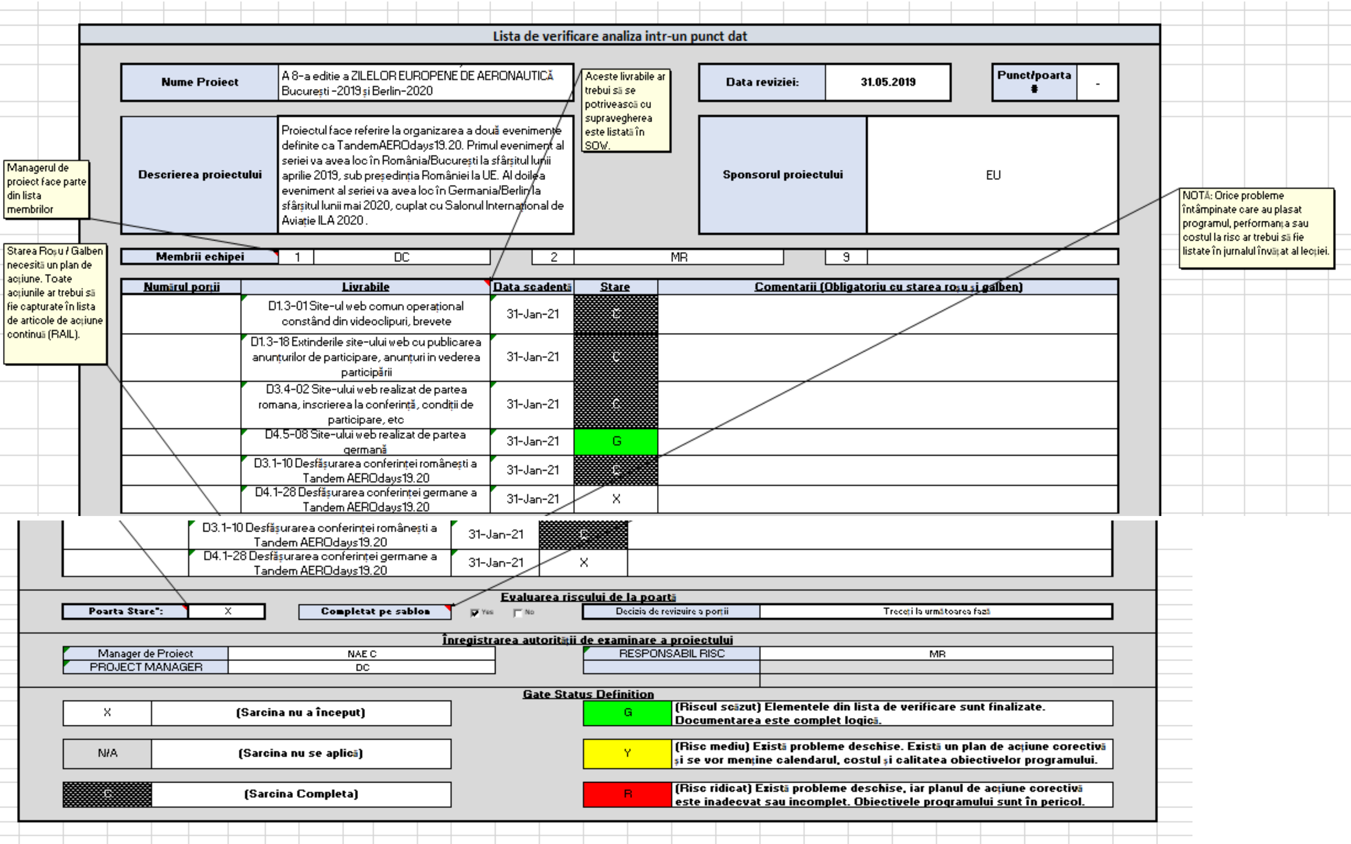


Fig.4.25a, b Analysis checklist at a given point [author contribution]

The Data Validation option in the Data menu of the EXCEL processor was used to enter the information related to the Gate and Deliverable status in the table.

Gate Status had the options:

X-task not started

N/A - task not applicable

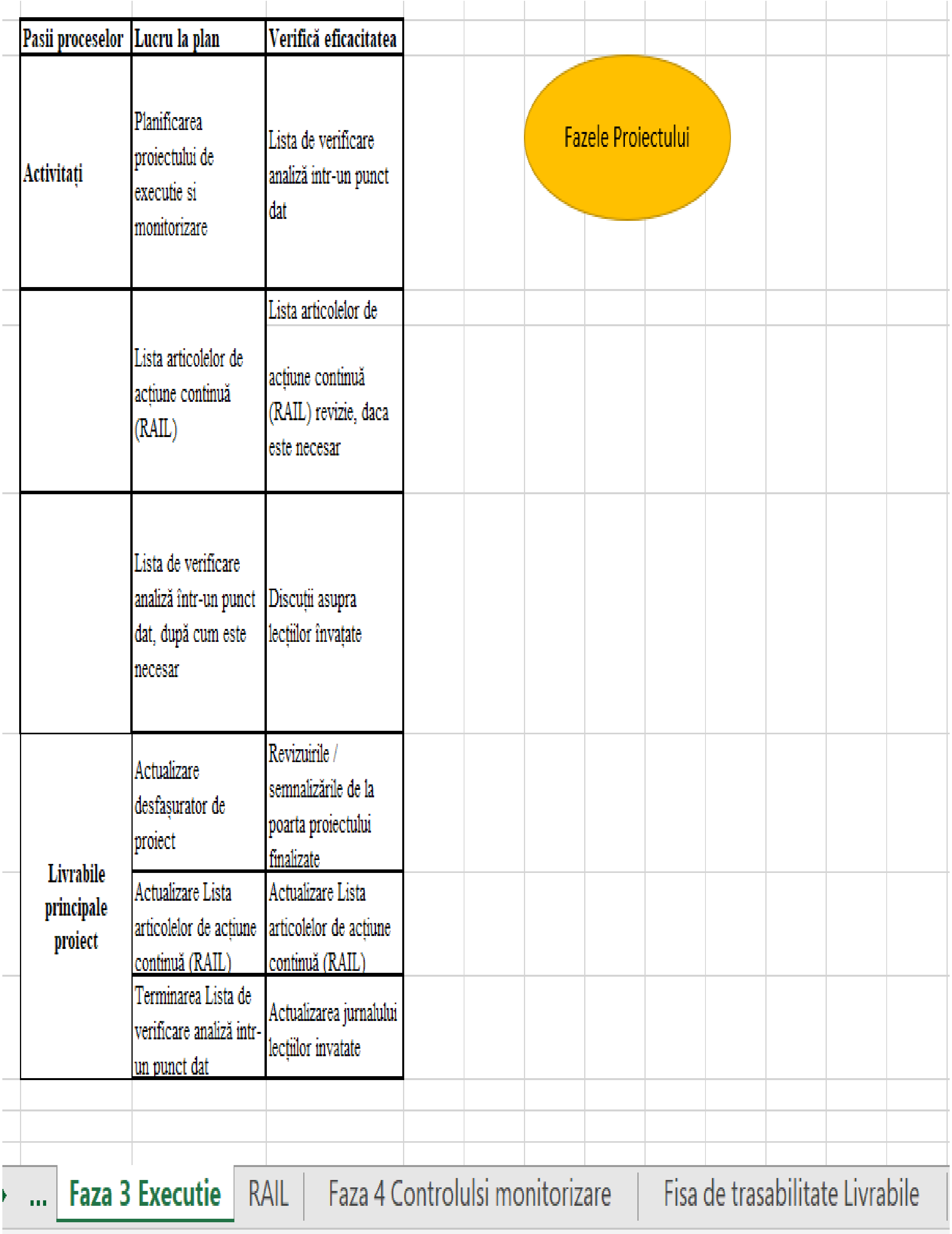
C - task complete

G-(Low risk) Items in the checklist are complete. Documentation is completely logical.

There is no risk to the program.

Y-(Medium risk) There are open issues. There is a corrective action plan and the schedule, cost and quality of program objectives.

R-(High Risk) There are open issues and the corrective action plan is inadequate or incomplete. Programme objectives are at risk.



Pasii proceselor	Lucru la plan	Verifică eficacitatea
Activitaţi	Planificarea proiectului de executie si monitorizare	Lista de verificare analiză intr-un punct dat
	Lista articolelor de acțiune continuă (RAIL)	Lista articolelor de acțiune continuă (RAIL) revizie, daca este necesar
	Lista de verificare analiză într-un punct dat, după cum este necesar	Discuții asupra lecțiilor învațate
Livrabile principale proiect	Actualizare desfaşurator de proiect	Revizuirile / semnalizările de la poarta proiectului finalizate
	Actualizare Lista articolelor de acțiune continuă (RAIL)	Actualizare Lista articolelor de acțiune continuă (RAIL)
	Terminarea Lista de verificare analiză intr-un punct dat	Actualizarea jurnalului lecților invatate

Fig 4.26 Phase 3 Project Execution [author contribution]

Figure 4.26 Phase 3 shows the activities and deliverables of the Project Execution phase. Phase 3 Project Execution activities consist of:

- Project Execution planning and monitoring whose effectiveness is verified by the Analysis Checklist at a given point;

- the list of Continuous Action Items (RAIL);

- Analysis checklist at a given point, as required, which can be verified by discussion of lessons learned.

The main deliverables in the project consist of:

-update of the project deployer, the effectiveness of which is noted in the project gate reviews/signals;

- the list of continuing action items (RAIL);

- completion of the Analysis Checklist at a given point leading to the update of the Lessons Learned Log.

If on the spreadsheet assigned to Phase 1, the "Project Phases" button is clicked, then it will automatically switch to the "Contents of Phases of a Project" spreadsheet that was shown in Figure 4.13.

Figure 4.27 RAIL Continuous Action Items list highlights the status of the activities, the activity start date, due date, number of days overdue and owner.

It also concludes whether the activity is :

- completed;
- in progress;
- pending;
- not started.

Lista articolelor de acțiune continuă (RAIL)

Proiect: PROIECT TandemAERUdays 19.20 A 8-a editie a ZILELOR EUROPENE DE AERONAUTICĂ București -2019 și Berlin-2020	Today's Date	31-Jan-21

						Efectuat
						În desfășurare
						In asteptare
						Nu a început

ID #	Element de acțiune	Data de început	Data scadentă	Proprietar	Observații	Stare
01	Începere proiect, pregatire conferință București, Berlin	Wednesday, August 1, 2018	31-Jan-21	INCAS	-	Efectuat
02	Pregatire conferință București	Monday, September 3, 2018	31-May-19	INCAS	-	Efectuat
03	Demararea managementului administrativ al proiectului București si Berlin	Thursday, October 18, 2018	31-Jan-21	INCAS	-	Efectuat
04	Avans activitate administrativă București, Activități de comunicare	Monday, November 19, 2018	31-May-19	INCAS	-	Efectuat
05	Semnare contracte logistică BUCUREȘTI	Wednesday, December 19, 2018	31-May-19	INCAS	-	Efectuat
06	Evaluare lunara conferință București	Friday, January 18, 2019	31-May-19	INCAS	-	Efectuat
8	Evaluare lunara [illegible]	Monday, February 18, 2019	31-Jan-21	INCAS	-	Efectuat

... | Analiza risc proiect 2020 | GANTT | Lista de verificare analiza int | Faza 3

Fig.4.27 List of continuous action items (RAIL) [author contribution]

Figure 4.28 shows the activities and deliverables of Phase 4 Project Monitoring Control

Fig 4.28 Phase 4 Project Monitoring Control [author contribution]

Phase 4 Project Monitoring Control update includes activities on:
-performing the review of the project portion;
-deliverable traceability sheet;
-monitoring the project schedule chart;
-revision of the Continuous Action Item List (RAIL) ;
-revision of the communication plan;
-discuss lessons learned.
The deliverables related to this phase consist of:
-updating the project plan;
-Update the RAIL;
-completion of the gate review;
-update the deliverables sheet;
-Status communication;
-update lessons learned log.

If on the spreadsheet assigned to phase 1, the "Project Phases" button is clicked, then it will automatically switch to the spreadsheet "Contents of phases of a project" which has been shown in Figure 4.13.

Figure 4.29 The Tracking Sheet is filled in during phase 4 of the Project Monitoring Control and shows the status of the deliverables in this phase, whether they have reached their target or not.

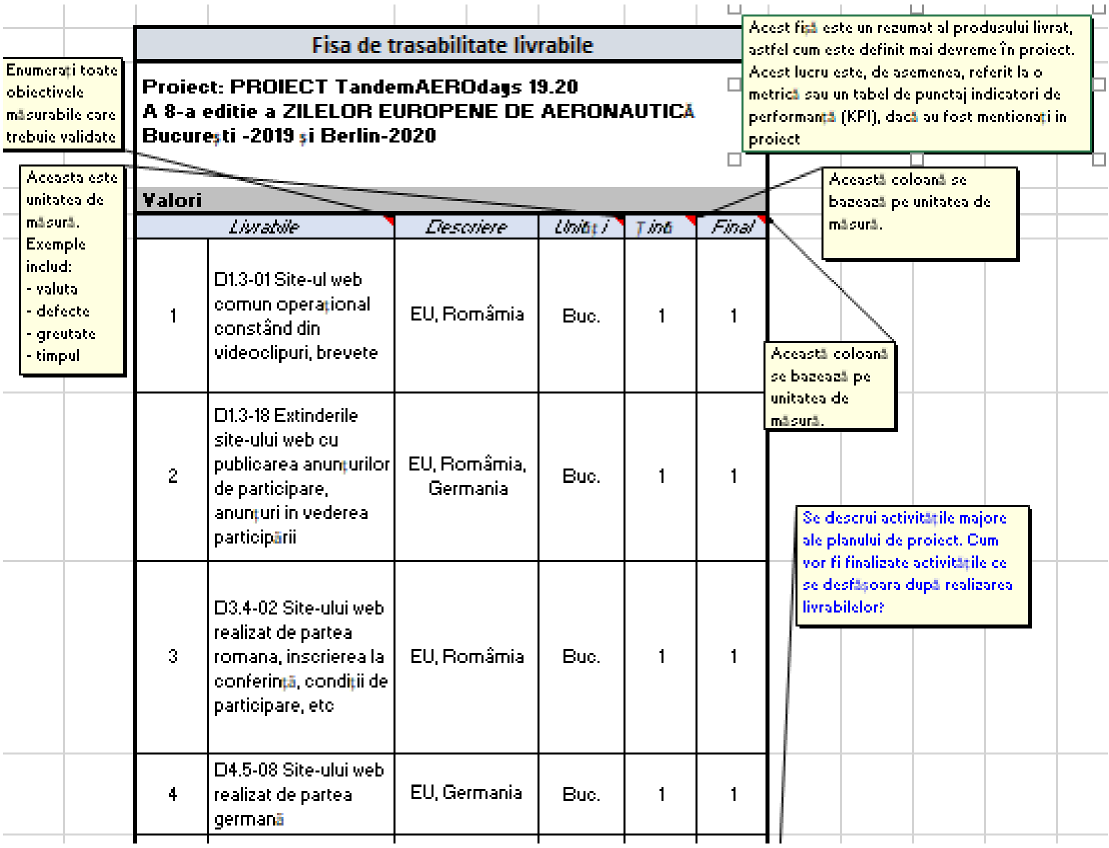
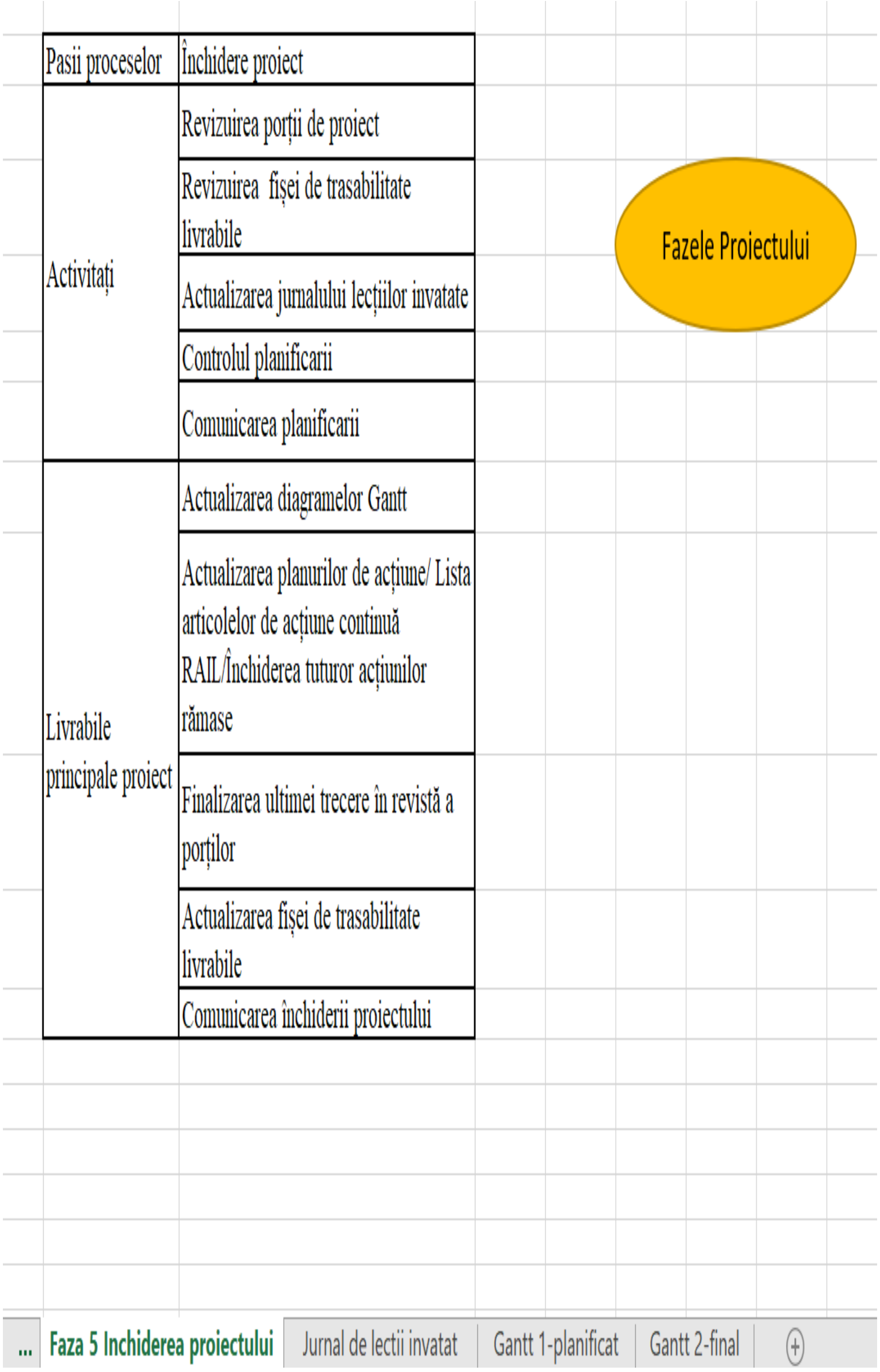


Fig.4.29 Traceability sheet Deliverables [author contribution]

Figure 4.30 Phase 5 shows the activities and deliverables of Phase 5 Project closure



Pasii proceselor	Închidere proiect
Activitați	Revizuirea porții de proiect
	Revizuirea fișei de trasabilitate livrabile
	Actualizarea jurnalului lecțiilor invatate
	Controlul planificarii
	Comunicarea planificarii
Livrabile principale proiect	Actualizarea diagramelor Gantt
	Actualizarea planurilor de acțiune/ Lista articolelor de acțiune continuă RAIL/Închiderea tuturor acțiunilor rămase
	Finalizarea ultimei trecere în revistă a porților
	Actualizarea fișei de trasabilitate livrabile
	Comunicarea închiderii proiectului

Fig 4.30 Phase 5 Project closure [author contribution]

The activities in Phase 5 Project closure include:
-review of the project portion;
-revision of the deliverable tracking sheet;
-updating the lessons learned log;
-control and communication of planning.
The deliverables of this phase refer to :
-updating Gantt charts;

-updating action plans/RAIL (list of action items)/closing all remaining actions;
-Completion of the final gate review;
-Update the deliverable tracking sheet;
-communication of project closure.

If on the spreadsheet assigned to phase 1, the "Project phases" button is clicked, then it will automatically switch to the spreadsheet "Contents of phases of a project" which has been shown in Figure 4.13.

The Lessons Learned Log, shown in Figure 4.31, is used in all project phases. During the course of the project, users can go back to phase 1 and use the information mentioned as lessons learned.

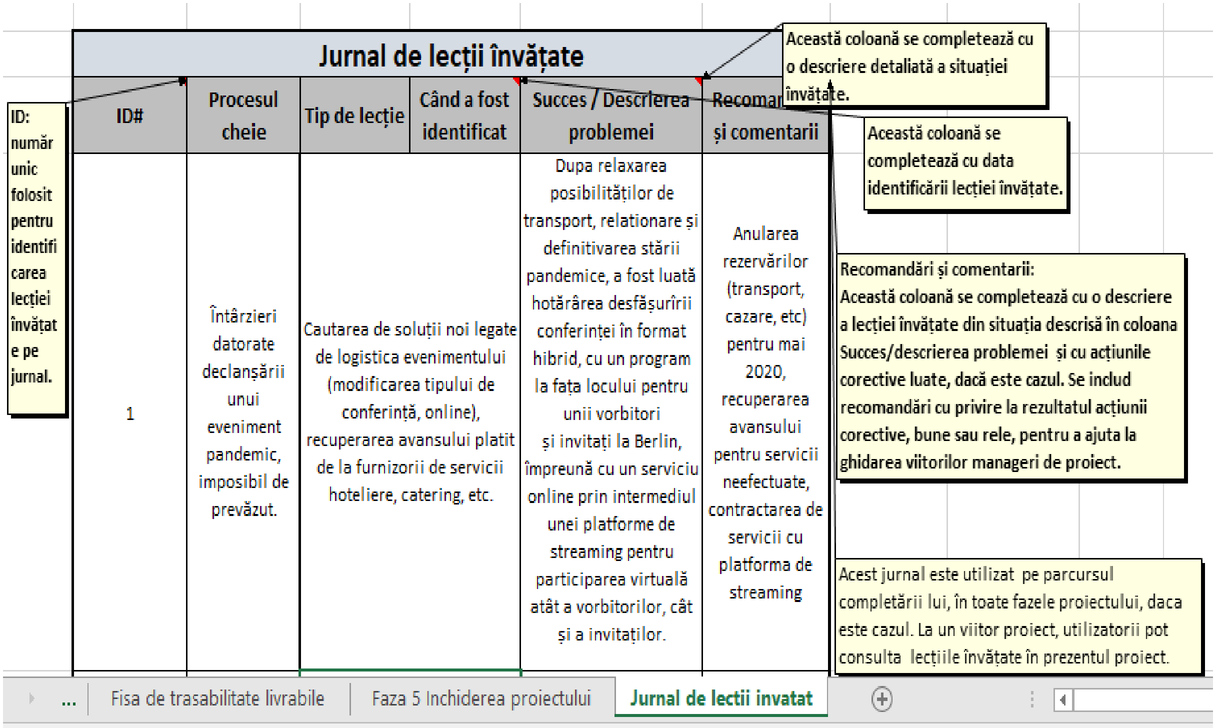


Fig.4.31 Lessons learned diary [author contribution]

Conclusions on the TandemAERO project deployment19.20

My contribution to the TandemAERO19.20 project was the creation of a Table and Graph Processor that correlates the data contained in the spreadsheets and gives the project manager real-time access to the information needed to submit/update the status of a project proposal. We also assessed risk using the FMEA method on the project work packages.

The table and graphical representation processor, once created, has the advantage that depending on the actual situation, it is easily updated/revised, being modular in design.

The maintenance of this product does not pose any problems and it is easy to operate.

The TandemAERO19.20 project contains records according to Table 4.1 Project phases.

4.2 Example AFLoNEXT project

AFLONEXT """2nd Generation Active Wing" – Active Flow- Loads & Noise control on next generation wing"

ID: 604013

From: 1 June 2013 to: 31 August 2018

AFLoNext is a four year EC L2 project with the objective of proving and maturing highly promising flow control technologies for novel aircraft configurations to achieve a quantum leap in improving aircraft's performance and thus reducing the environmental footprint. The pr...

Coordinated in: Germany

Programme: Specific Programme "Cooperation": Transport (including Aeronautics)

Last update: 25 May 2022

Add to my booklet

In Appendix 2 of this thesis, the project "AFLoNEXT" 2nd Generation Active Wing" - Active Flow- Loads & Noise control on next generation wing"/" AFLoNext ""Second Generation Active Wing" - Active Flow- Loads & Noise control on next generation wing", shown in Figure 4.32 can be found

Information in English is available on [89] and [90].

AFLoNext is a four-year project. The project aims to study the maturation and implementation of active flow control and structure-load control technologies to increase aircraft performance and reduce the aerodynamically generated noise footprint. The project consortium consists of 40 European partners from 15 countries. The work has been divided into seven work packages. The information has been taken from [89], [90] and [95].

I.N.C.A.S is participating in the development of two work packages. For these two work packages we analysed the risk contribution already in the project deployment phase, and presented the project deployment on the work packages that were developed in I.N.C.A.S using the template designed by the author and using Project 2016.

Figure 4.33 Work breakdown structure (WBS) made based on public information from [107] and [113] on 2 levels.

Nume proiect	Procese principale (Nivel 1)	Livrabile (Nivel 2)
		Demonstrație simplificată a operațiunii de Control hibrid al fluxului laminar HLFC

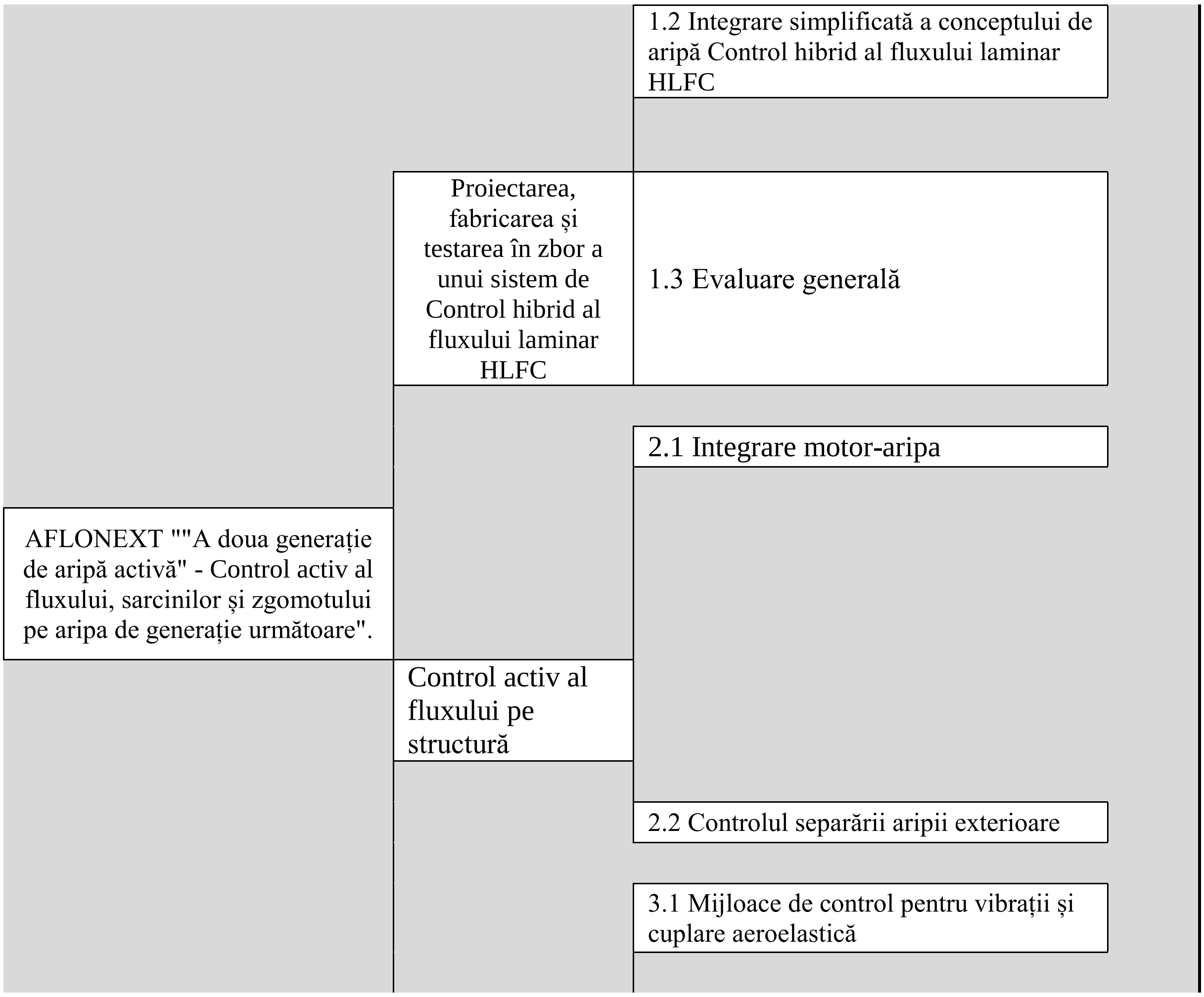


Figure 4.34 and 4.35 shows the Gantt project flowchart for WP package 1.2.3 and 2.2.4 respectively.

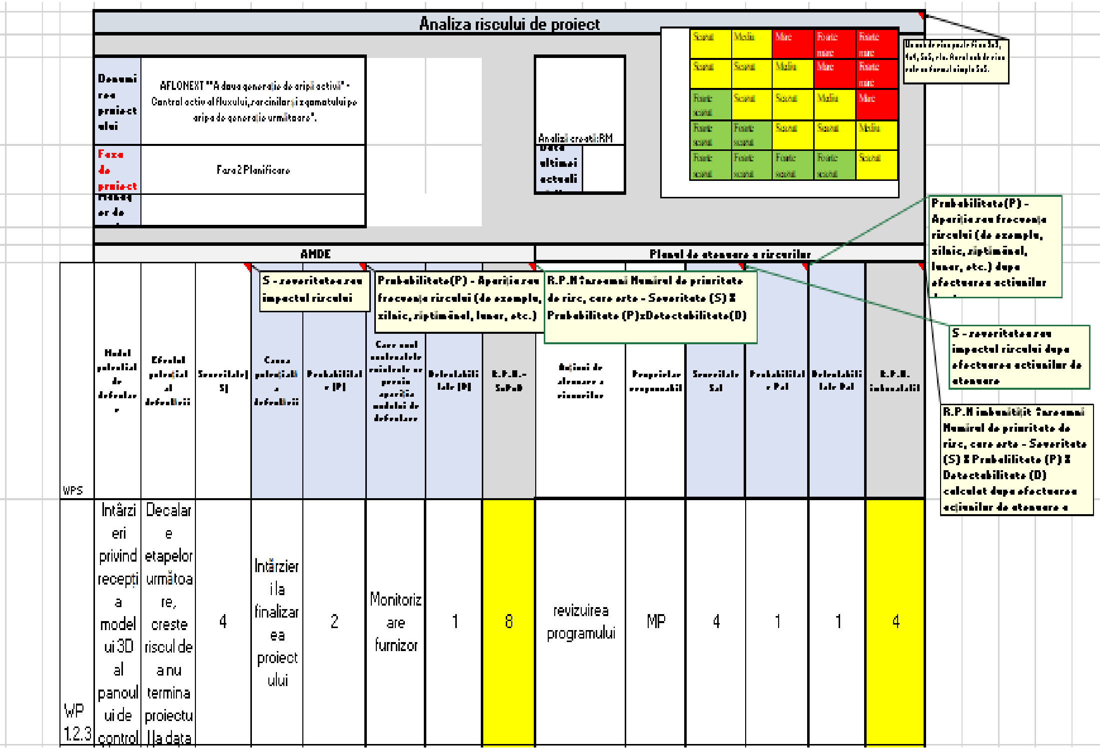


Figure 4.25 shows the risk analysis on the two work packages using the FMEA technique. The risk analysis on the project uses the Condittional Formatting function in the Home menu to assign colours according to the R.P.N. result.

Under the heading "Analysis created: Rusu Manuela - RM" in figure 4.36, Risk analysis on WP 1.2.3 and WP 2.2.4 work packages, the name of the author appears, as evidence of the involvement in the risk estimation of the project presented and the design of the table and graphical representation processor.

4.2.1 Conclusions on the AFLoNext project deployment

The contribution I made to the AFLoNext project was the creation of a Table and Graph Processor that correlates spreadsheet data and gives the project manager real-time access to the information needed to submit/update the status of a project proposal.

The table and graph processor, once created, has the advantage that it can be easily updated/revised according to the actual situation, as it is modular in design.

The author has carried out the risk analysis on the 2 work packages WP 1.2.3 and WP 2.2.4 using the FMEA technique.

4.3 Conclusions on the case studies on project monitoring and evaluation

Through the analysis of the projects developed in 4.1 and 4.2, the author highlighted the functioning of the template created, which consists of a Table and Graph Processor.

The template consisting of a table and graph processor (Excel spreadsheet) has the advantage of easy access and automatic updating.

In sections 4.1 and 4.2, there are mentions in which the author underlines her personal contribution to the risk analysis for the projects mentioned.

This tool does not require any special qualifications, but those of an average user in the field of spreadsheet calculation are sufficient.

In conclusion, the template used for monitoring and evaluating aerospace projects is valuable for organisations wishing to measure their performance accurately and efficiently. In this way, organisations can overcome challenges and improve their business performance.

5. GENERAL CONCLUSIONS REGARDING PERSONAL CONTRIBUTIONS, FUTURE DEVELOPMENTS, AND FUTURE WAYS OF DEVELOPING THE RESEARCH RESULTS

5.1 General conclusions

The present PhD thesis is carried out in line with multiple international scientific concerns in the field of science and technology related to the monitoring and evaluation of applied aerospace projects by implementing an SMCR.

The results of the theoretical and applied research obtained during the development of the present thesis lead to highlight the following findings:

1. Any business, in the present economic context, presents a risk, of greater or lesser magnitude, which must be accepted consciously, in full knowledge of the facts, in relation to the benefits that can be obtained.

2. The risks of each project must be known in advance, identified, analysed and assessed, and solutions sought to mitigate them.

In practice, in relation to risk assessment, there are two situations:

1. Minimising risk (underestimating or ignoring it) can have negative consequences for the project's progress.

2. Overestimation of risk, leading to high costs in project implementation.

It is desirable to involve trained people, knowledgeable in the field and specific techniques, in the risk assessment work.

The way the quality-risk correlation is managed will determine the quality and risk strategies, respectively, in establishing IT methods to measure, analyse and control quality under the conditions of risk and uncertainty.

The results of the theoretical research, the case studies carried out on the 2 applied aerospace projects, allow to highlight the following personal contributions:

1. I have made a presentation of some considerations on quality management, risk management, project management.
2. I have briefly presented the types of risk and their effects on a project/programme.
3. We presented a method for risk estimation based on the Failure Mode and Effects Analysis method - FMEA according to SR EN 60812:2009 System reliability analysis techniques. Failure modes and effects analysis procedure - FMEA.
4. We presented the content of the phases of a project.

5.2 Personal contributions

The contributions made by this thesis were mentioned in Chapter 2.3.

5.2.1 Original theoretical contributions

a). Developments in the theoretical evaluation of aerospace projects.

In Chapter 3.1 we developed a study on the implementation of an SMCR in aerospace research. The concept that each process in an aerospace project brings a risk contribution to the project is mentioned.

It is convenient for the operation of a project that the identified risks are mitigated to avoid blocking the project's progress.

b). Design and development of a specific methodology for the time-bound realisation of project proposals using a template consisting of a table processor and graphical representations (interleaving Excel spreadsheets).

In Chapter 3.3 we have presented the sequence and description of the phases of an aerospace project. The presentation of the elements related to project management has been done in tabular form, leading me to develop a methodology developed with the use of a processor of tables and graphical representations (Excel spreadsheets that interleave). By developing, in each Excel spreadsheet, each phase of the project with the specific record, I created a template consisting of a processor of tables and graphical representations.

c). Risk estimation of a project/activities based on Failure Mode and Effects Analysis (FMEA/AMDE) (case study).

Chapter 3.2 deals with the risk estimation of a project using the Failure Mode and Effects Analysis method (presentation, method description).

5.2.2.Original practical contributions

a) Development of a methodology for the timely submission of scientific research project proposals to a contracting authority;

In order to make them operational with the contracting authority documents and to achieve automatic retrieval of data from the documents in the archive, we created a processor of tables and graphical representations.

b) We developed a template by developing a processor of tables and graphical representations (Excel spreadsheet) for the formulation of proposals for a scientific project.

In an Excel spreadsheet we designed the risk estimation based on FMEA, containing a risk analysis component and a risk mitigation plan.

The template consisting of a table processor and graphical representations (interleaving Excel spreadsheets) allows a project proposal to be produced within a reasonable timeframe according to the requirements of the contracting authority/client.

c). We estimated the risk of a project/activity(ies) based on the Failure Mode Analysis of their effects (FMEA/AMDE), Figures 4.22 for the TandemAEROdays 19.20 project and Figure 4.36 for the AFLoNext project;

d). We monitored and evaluated the phases of an aerospace project;

Using spreadsheets containing records related to each phase of the project, monitor and evaluate each phase of an aerospace project

Table 4.1 contains records specific to each project phase.

e). We have implemented a template consisting of a table processor and graphical representations (Excel spreadsheet) in the evaluation of aerospace projects in the organisation.

Since the use of the template consisting of a table and graph processor does not lead to additional costs, and each record in the template contains information according to [81], [82] or with the requirements of the contracting authorities, the use of the table and graph processor is convenient, since each spreadsheet contains comments on each element of it related to the way of completion, being an aid for a less experienced user, this making the implementation of the template without problems in using the template.

5.3 Future ways of developing research results

From the theoretical findings and case studies carried out in the thesis, the following research directions can be developed in the future:

- Large-scale implementation of integrated quality-risk management with emphasis on planning, control, monitoring, evaluation and continuous improvement;
- Implementation of rapid (snapshot) project evaluation methodology in the organisation. In the first spreadsheet of a project's spreadsheet and graphical representation processor, the information required by the project format is entered and automatically taken over by the downstream spreadsheets, thus making the 5 phases of the project progress;
- Publication as sole author of 2 articles.

[42] **Manuela RUSU,** Quality Management Principles as Illustrated by the Organization of Romanian Inter-War Factories. A Century of Romanian Industrial Tradition in Aeronautics, INCAS BULLETIN, Volume 9, Issue 1/ 2017, pp. 139-153, ISSN 2066 – 8201, DOI: 10.13111/2066-8201.2017.9.1.14.

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- Publication as first author:

[46] **Manuela RUSU**, Ilinca SOARE, Mihail BOȚAN, Alina DRAGOMIRESCU, Constantin MILITARU, FAI First Article Inspection in production activity, prezentată inițial la 7th International Workshop on Numerical Modelling in Aerospace Sciences “NMAS 2019” 15-16 May 2019, Bucharest, Romania, Section 3 – Modelling of structural problems in aerospace airframes, INCAS BULLETIN, Volume 11, Issue 3/ 2019, pp. 209-222, (P) ISSN 2066-8201, (E) ISSN 2247-4528, DOI: 10.13111/2066-8201.2019.11.3.18, https://doi.org/10.13111/2066-8201.2019.11.3.18.

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- Publication as co-author:

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