Politecnico di Torino

Corso di Laurea Magistrale in Ingegneria Gestionale

Analysis and management of operational risk following the implementation of a web based toolset:
the Risk Register applied to a real case

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Premessa

Il principale obbiettivo di questo progetto è stato analizzare il comportamento degli attori presenti in campo industriale nei confronti della gestione del rischio operativo e delle anomalie legate alle attività core dell'impresa, individuando quello che è il ruolo dei fattori umani nella risposta a questo tipo di problematiche.
La decisione di approfondire questo tema è dovuta alla consapevolezza che nella maggior parte dei contesti produttivi (in particolare quelli non rigidamente regolamentati) le imprese ritengono che l'implementazione di opportune strategie di gestione del rischio ed ottimizzazione dei processi comporti un ingiustificato dispendio di tempo e risorse rinviandone l'implementazione od escludendola dai progetti futuri, sottovalutandone gli effetti benefici di medio e lungo periodo.
La letteratura, come spesso accade, è ricca di nozioni utili alla definizione di strategie di miglioramento generalmente applicabili ma si presenta priva di contenuti specifici quando si rende necessario scendere ad un livello più profondo e specifico.

Per i motivi suddetti è stato intrapreso questo progetto con l'obbiettivo di verificare se e come l'utilizzo di strumenti specifici possa generare una risposta al rischio più efficace ed un concomitante incremento della resa operativa delle attività core dell'impresa. Lo svolgimento di questa indagine è stato reso possibile grazie alla collaborazione offerta dalla spin-off company del Trinity College Dublin, *Tosca Human Factors Solutions LTD.,* presso cui ho avuto il piacere di condurre un periodo di ricerca della durata di sei mesi, in cui ho svolto un'indagine approfondita sull'efficacia dei software nella gestione del rischio in contesti come l'industria aeroportuale e, marginalmente, quella mineraria.
In concomitanza con la ricerca operativa è stato realizzato uno studio sulla sostenibilità del business proposto da Tosca Solutions, i cui risultati sono stati presentati e premiati presso la "*EIT Business Idea Competition"* svoltasi a Budapest nel Novembre 2017, la competizione periodicamente organizzata dall' Istituto Europeo per l'Innovazione e la Tecnologia con l'obbiettivo di identificare business promettenti nei diversi settori scientifici e tecnologici.

I risultati elaborati in questi mesi ci hanno quindi permesso di dimostrare come opportuni strumenti per la gestione delle performance, a complemento delle strategie di livello più alto dettagliate dalla letteratura, possano generare risultati migliori in termini di gestione del rischio, prevenzione delle anomalie e ottimizzazione dei processi, determinando una migliore resa operativa (ed economica) delle attività core dell'impresa.

Nei seguenti capitoli, dopo un'iniziale presentazione dei risultati fondamentali raccolti nella letteratura del Project Management e del ruolo che i Fattori Umani rivestono all'interno degli ambienti industriali, si procederà con l'introdurre gli

strumenti oggetto dello studio, approfondendo gli aspetti più tecnici ed analizzando in maniera sia qualitativa che quantitativa i risultati ottenuti dalle diverse applicazioni pratiche. Infine sarà presentata in maniera completa e dettagliata l'analisi della sostenibilità del business con particolare attenzione al mercato di riferimento, al contesto competitivo e strategico ed agli scenari futuri.

Si tenga presente che tutti i dati di natura sperimentale di seguito presentati sono il frutto esclusivo della ricerca inerente le applicazioni pratiche effettuate da Tosca Solutions Ltd. ed elaborate con gli strumenti matematici più opportuni.

Assumption

The main purpose of this project is to analyze the behavior of companies present in the industrial context towards the management of operational risk and anomalies related to the core activities of the company, identifying the role of human factors in the response to this type of issues.
The decision to analyze this issue is due to the awareness that in most production contexts (especially those not strictly regulated), companies believe that the implementation of appropriate risk management strategies and optimization of processes involves an unjustified waste of time and resources by postponing the implementation or excluding it from future projects, underestimating its medium and long-term benefits.
Literature, as often happens, is full of notions useful for the definition of strategies of improvement generally applicable but does not contain specific contents when it becomes necessary to go down to a deeper and more specific level.

For the aforementioned reasons, this project was undertaken with the aim of verifying if and how the use of specific tools can generate a more effective risk response and a concomitant increase in the operational performance of the company's core activities.
This survey was made possible thanks to the collaboration offered by a spin-off company of Trinity College Dublin, *Tosca Human Factors Solutions LTD*., where I conducted a research period of six months in which I carried out an investigation in depth on the effectiveness of software in risk management in contexts such as the airport industry and, marginally, mining.
Concurrently with the operational research, a study on the sustainability of the business proposed by Tosca Solutions was carried out, the results of which were presented and awarded at the *"EIT Business Idea Competition"* held in Budapest in November 2017, the competition periodically organized by the European Institute of Innovation and Technology with the aim of identifying promising businesses in various scientific and technological sectors.

The results obtained in these months allowed us to demonstrate how appropriate performance management tools, together with the highest level strategies detailed in the literature, can generate better results in terms of risk management, anomaly prevention and process optimization determining a better operational (and economic) yield of the company's core activities.

In the following chapters, after an initial presentation of the fundamental results gathered in the Project Management literature and the role that Human Factors play within the industrial environments, we will proceed with the introduction of the analyzed tools, deepening the technical aspects and analyzing in qualitative and quantitative way the results obtained from the various practical applications. Finally, the analysis of the sustainability of the business will be presented in a complete and

detailed way, with particular attention to the reference market, the competitive and strategic context and future scenarios.

It should be noted that all the experimental data presented below are the exclusive result of research concerning the real applications made by Tosca Solutions Ltd. and elaborated with the most appropriate mathematical tools.

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Introduction

1 Introduction

1.1 Risk Management

In recent years, companies have begun to get closer to the concept of risk, particularly as a result of the awareness that a prudent risk management can prevent direct and indirect damages to the company's business, generating, for example budget savings, a reduction in time to market and a quicker response to market needs. Although many studies have already been carried out concerning the issues of risk, the authors have not yet been able to give a univocal definition: the problem underlying this lack lies in the wide range of risks that can be identified and analyzed and this, in part, justifies the inability to reach a concise and complete definition. Many activities are in fact subjected to one or more risks: operational risk, financial risk, insurance risk are just a few examples but here we will focus exclusively on operational risk, that is the risk of suffering losses due to inadequacy or failure of procedures, human resources and systems, or from external events and we will attempt to carry out extensive analysis for a better understanding of the following parts of this project.

A recurrent definition of risk is that given by the British Standard Institute (1991) defining risk as *"a combination of the probability of occurrence of a defined hazard and the magnitude of the consequences of the occurrence"* which implies that the risk is characterized by two fundamental elements: the probability of occurrence of an event and the negative impact it could generate. Another recurring definition is given by the Project Management Institute which defines the risk as "*an uncertain event or condition that, would have a positive or negative effect on the project objectives"* also underlining the uncertain nature of the risk and the consequences connected to it. Beyond the definition of risk let us now analyze what are the "phases" of risk.

Risk management takes place at two separate times:

1) *Risk Assessment*, which is composed of two sub-moments

   a) *Identification*
   b) *Quantification*

2) *Risk Response,* also composed of two moments

   c) *Response development*
   d) *Response control*

1.1.1 Risk assessment

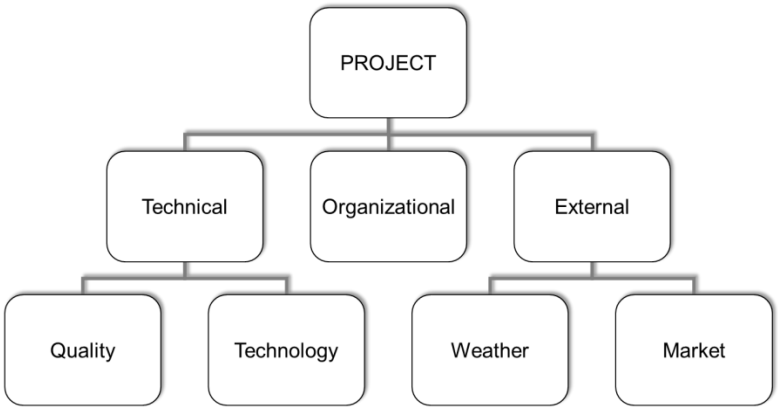
The purpose of the risk assessment is to obtain a qualitative and quantitative assessment of the risks deriving from the performance of the company activities; this allows us to have a clear awareness of the risks associated with individual business processes and to assign them a level of priority that allows us, where possible, to take the necessary countermeasures able to mitigate the probability of occurrence and the effects on the company business.

In order to identify a risk *(a)* it is important to have a clear understanding of the characteristics of the products and processes that the company carries out, the organizational structure of the company and the responsibilities of individuals. After that, one of the possible approaches is to carry out interviews with project managers or risk analysts, thus creating a list of the main risks that, according to their experience and the type of project, can characterize the processes underway: this type of tool is very flexible and easy to apply, but is limited to knowledge about the past experience and is not able to identify new potential risks, providing only a descriptive assessment.
Another technique often used to identify a risk is the *"what-if"* analysis. This involves having to ask a series of questions such as *"what would happen if ...?"* in order to identify potentially dangerous situations and extract their effects. This methodology has two different approaches:

- The *bottom up* approach: we start from the causes up to arrive, progressively, to the consequences;
- The *top down* approach: we start from an unwanted consequence and go back to the primary cause that created it.

One of the most used tools in companies is the Risk Breakdown Structure, it allows to classify risks in such a way as to identify the hierarchies and, then, the cause-effect connections. The RBS is a very useful tool because it acts in a *"forward"* way, proceeding from the causes to the effects (the RBS should be used in conjunction with the above "what if" analysis methods
to determine potential sources of risk).

Below is an example of Risk Breakdown Structure.



Example of a Risk Breakdown Structure

After identifying the risks, an analysis must be carried out that is able to quantify *(b)* the impact of the risk and the expected effects. A useful tool to do this is the *Risks-Activities matrix*, a matrix that sees on the lines the risks identified and on the columns the activities characterizing the production process. A full box "ij" indicates that activity "j" is characterized by the "i" risk, while an empty intersection indicates that the activity is not characterized by that risk.

		Activities			
		A1	A2	A3	A4
Risks	R1			X	
	R2		X		
	R3	X	X		
	R4			X	X

Risks-Activities matrix

Alternatively, we can use the mentioned matrix to quantify the risk, that is, to dimension its scope and assign a priority to each risk[1]. A common quantification of risk is given by the following formula:

$$Q = P(En) * I(R)$$

where:

- $P(En)$ is the probability that the risk R will materialize on the basis of the identified risk elements;

[1] It should be noted that the quantification of risk is a very important moment for risk management, since by assigning priority to risk, we calculate the budget necessary for risk reduction interventions. Underestimating the risk we may not have sufficient budget for an effective and complete risk mitigation.

- $I(R)$ is the effect of damage (magnitude) due to the materialization of the risk R.

The combination of $P(En)$ and $I(R)$ produces Q which indicate the exposure value to the En events from the concretization of the risk.

Risks	Activities			
	A1	A2	A3	A4
R1			Q_{13}	
R2		Q_{22}		
R3	Q_{31}	Q_{32}		
R4			Q_{43}	Q_{44}

Risk-Activity matrix with risk quantification

There are three approaches to quantify the risk exposure elements: qualitative, semi - qualitative and quantitative.

The qualitative approach makes use of a scale of levels with semantic differential, for example:

$P(En)$: Very low, Low, Medium, High, Very high;
$I(R)$: Negligible, Marginal, Medium, Critical, Catastrophic;

The semi-qualitative approach associates a corresponding number with each nominal evaluation:

PROBABILITY

Very high	High	Medium	Low	Very low
5	4	3	2	1

IMPACT

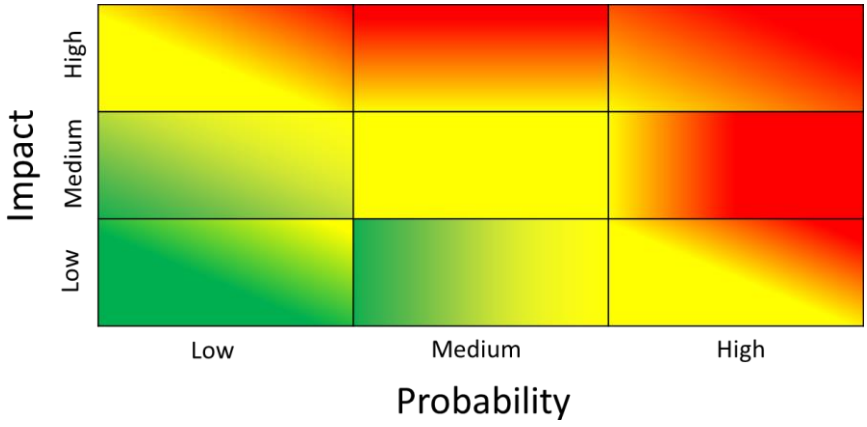
Catastrophic	Critical	Medium	Marginal	Negligible
5	4	3	2	1

Quantitative quantification is based exclusively on the use of numbers. The probability of occurrence is indicated with a percentage and it is sometimes possible to calculate the probability distribution of occurrence of the event. The impact of the event is measured in relation to the various project parameters (e.g. cost, time or level of performance).

1.1.2 Risk response

In this phase the project manager's goal is the implementation of corrective actions in order to mitigate, where possible, the risk. During the response development phase *(c)* it is impossible and inexpensive to consider all threats and risks (eg: external risks are often not controllable). In this moment the main goal is to identify high-risk situations and try to minimize the threat and, in order to compare the risks identified in the risk assessment phase, we construct a *risk plan*. A risk plan is a diagram where we find the intensity of the impact in the event that the risk should materialize and the probability of relative occurrence.

Below is an example of a risk plan:



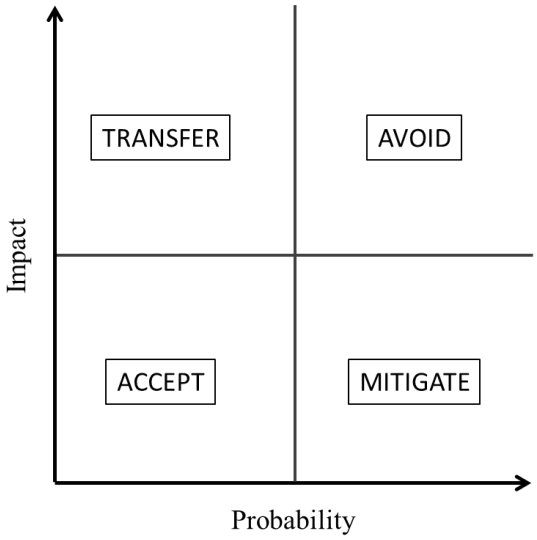
Risk Plan example

Risk response strategies depend on the area of the chart where our risk is located and they may be drawn in four directions: *avoid, transfer, mitigate,* and *accept* risk.
We proceed with the description of the mentioned strategies one by one:

- *Avoid:* red areas require that the risk be avoided. Avoiding risk is the most practical way to reduce risk but it is not always possible. This requires changing the goals of the project, reducing the constraints or considering alternative solutions.
- *Transfer:* yellow area characterized by a high impact and a low-medium probability requires transfer of the risk (in particular the financial risk). This can be done by stipulating specific insurance or by transferring the risk on sub-contractors.
- *Mitigate:* yellow area characterized by a low impact and a medium-high probability requires to mitigate the risks, ie to put in place appropriate countermeasures to minimize the causes and the negative effects.
- *Accept:* green areas. When the probability of occurrence and the magnitude of the impact can be considered low, the risk can be accepted, without forgetting to put in place appropriate risk monitoring plans that are able to detect when

the extent of the risk (operational or financial) is no longer negligible. Furthermore, it may be useful to establish which countermeasures should be put into practice and the actors involved. Finally it is always advisable to keep emergency funds in order to provide an adequate response.

A summary of the strategies just proposed is as follows:



Overview of the different risk response strategies

The risk control phase *(d)* provides for the verification of the evolution of risk after the countermeasures adopted. The main goal is to assess the adequacy of the interventions carried out in order to confirm their validity or to start a review phase of the risk management system. This phase ends with the realization of specific documentation and with the update of the risk plan.

In conclusion risk is a management variable that cannot be eliminated and always brings with it more or less important impacts on the life of the company. Proper risk management is critical to the success of any project, so it is important to address the risk in a methodical way, as described above. Unfortunately, it is not possible and not cost-effective to eliminate all possible sources of risk, but a careful preventive analysis can help to identify the first steps to be taken. In relation to this it is good to remember that a company is made up of tools, processes but also people. People are responsible for the success or failure of a project and it is important that corporate management takes time to build a safe environment in which to work by always involving the "resources" in planning strategies for achieving company goals.
As human resources, people bring with them a wealth of knowledge, skills, attitudes, routines and relationships that should not be overlooked; this set of factors takes the name of *"Human Factors"* and assumes a fundamental importance in the management of risk in the company.

1.2 The Human Factors

The "*Human Factors*" is the discipline that deals with the human factor in order to study the ways in which an individual acts in his working environment, with the objective of increasing the levels of operations security. According to the International Civil Aviation Organization (ICAO) definition: "The *Human Factors* studies people performing their duties, their inclusion in the physical and interpersonal work environment, their relationship with tools and procedures. The aim of this research is to pursue safety and efficiency". In recent years, the human factors has become increasingly important to the point where many international organizations conduct constant conferences and refresher courses on these topics. The issue of human factors is greatly important in environments where human behavior can lead to more or less uncontrolled consequences or cause adverse effects on human safety. Specifically, the need for the study of the human factor comes from a simple finding: industrial history teaches us that humans are the source of the errors that cause most of the incidents.

Human Factors became particularly important in the commercial aeronautical industry where companies realized that human error, rather than mechanical failure, is the basis of many accidents and aircraft accidents.
A human error can be intentional or unintentional: unintentional errors include errors in your action, opinion, or judgment caused by poor reasoning, carelessness or insufficient knowledge. If someone knowingly or intentionally chooses to do something wrong, it is an intentional error, which means that one has deviated from safe practices, procedures, standards or regulations. Lack of communication is an example of unintentional errors: it is a key human factor that can lead to dangerous consequences: a common scenario is a lack of communication during a shift change in a maintenance operation. A partially completed job is transferred from the technician finishing his workday to the technician coming on duty. Many steps in a maintenance procedure are not able to be seen or verified once completed due to the installation of components hiding the work. Obviously, no steps in the procedure can be omitted and any defects or problems must be communicated to the incoming operator to guarantee a correct completion of the work. The lack of communication at this juncture could be crucial for the proper functioning of the instrumentation.
Another crucial situation that we can cite is a lack of knowledge: during an aircraft maintenance phase a lack of knowledge can have catastrophic results. Differences in technology from aircraft to aircraft and updates to technology and procedures on a single aircraft also make it challenging to have the knowledge required to perform airworthy maintenance. All maintenance operations must be performed according to specified standards in approved instructions. These instructions are based on knowledge gained from the engineering and operation of the aircraft equipment. Technicians must be sure to use the latest applicable data and follow each step of the procedure as outlined. They must also be aware that differences exist in the design and maintenance procedures on different aircrafts. It is important for technicians to

get training on different types of aircraft. A lack of teamwork may also contribute to errors in aircraft maintenance: team can win or lose depending on how well everyone in the organization works together toward a common objective. A lack of teamwork makes all jobs more difficult and, in maintenance, could result in a miscommunication that affects the airworthiness of the aircraft.
Finally think about the stress: physiological stressors include poor physical condition, not eating enough, working in dark, lack of sleep and conflicting shift schedule. Everyone handles stress differently and particular situations can bring about different degrees of difficulty for different people. The mentioned factors make the aviation industry one of the most stressful environment to work on and represent one of the main reasons of accidents.

The aeronautics industry is not the only one where Human Factors play a key role in managing operational risks: looking at the industry that, today, have the highest rates of accidents and deaths we find the mining industry. In spite of recent increases in safety provision the mining industry can still be considered a high-risk environment: it is one of the most high-risk professions worldwide and its accident rates are very high when compared to other sectors[2]. Geologists, designers, mining engineers, supervisors, they are the main figures working in the modern mining industry, but the category most exposed to accidents is workers.
The dangers associated with this work can result from several factors: inadequate and technologically obsolete machinery, poor security standards and incomplete controls, bad environmental conditions and many others. This mix contributes to creating very risky working conditions, not infrequently fatal. An aggregate picture of accidents and deaths in the mine is not easily accessible (statistics are often incomplete because of obsolete regulations and the proliferation of abusive mines). In the last years the major mining companies have progressively adopted security and prevention measures, guaranteeing better pay conditions too but the same cannot be said for small and medium-sized companies. The role of skilled personnel and the limited number of them in the global mining industry growth cycle is also a challenge that brings Human Factors to the forefront of the key operational issues that the industry needs to enhance (Bassan et al, 2011[3]); another key role for Human Factors in mining is increasing work performance, productivity and finding an easy way to guarantee corporate compliance.

In the just described contexts we perceive the need of a complex management system of all the main factors and activities that, on a daily basis, manage the entire life cycle of a project, flexible, modular and able to provide crucial information about the trend

[2] Patterson, Jessica, 2009 "HUMAN ERROR IN MINING: A MULTIVARIABLE ANALYSIS OF MINING ACCIDENTS/INCIDENTS IN QUEENSLAND, AUSTRALIA AND THE UNITED STATES OF AMERICA USING THE HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM FRAMEWORK" (2009). Dissertation presented to the Graduate School of Clemson University.
[3] Bassan J., Srinivasan V., Tang A., 2011 The Augmented Mine Worker – Applications of Augmented Reality in Mining. SECOND INTERNATIONAL FUTURE MINING CONFERENCE /SYDNEY, NSW, 22 - 23 NOVEMBER 2011

of business processes. From this point of view, information technology has given great impetus to the creation of tools useful for an increasingly efficient processes management in highly regulated environments. The described situations are complex and they are composed by a group of physical, mechanical and logistical complementary activities: information technology will drive continuing improvements in terms of efficiency, reduction of costs and health and safety.

1.3 Information Technology and Risk Management: the *Risk Register*

According to *Air Transport IT Trends Insights 2017* airports around the world invested 33 billion dollars in Information Technology in 2017 in the development of technologies and tools for logistics flow management, boarding, check in, flight status, sensory and security. The same is happening in the mining industry, where there is a need for assimilating the advances in information and communication technologies into mining operations for technological up gradation; in this case, the first applications of information technology in the mining industry date back several years. The first successful applications were those for monitoring and controlling performance; only in recent years applications have been implemented to improve the safety of operators.

With the advent of information technology and a growing sense of risk management, tools have been created that enable the Project Manager to monitor and manage a project processes, identifying potential risks, mode of occurrence and, where appropriate, solutions: we are talking about the *Risk Register*.
The Risk Register consists of a set of specific areas that can be combined to offer a one stop shop for project managers to address the issue of monitoring and reviewing operational safety and quality on core tasks for the business, all this in real time. This tool enables users to have a list of all tasks and assets, identify the critical activities, risk assess. Subsequently, the tool provides parameters to coordinate the execution and completion of effective plans and strategies to mitigate the issues (until the problems are eliminated) in which the employees are involved.

Risk management must be a constant, continuous and cyclical process: the risk manager has the task of identifying and classifying the risk, finding the necessary countermeasures, verifying that the risk is reduced and restarting from scratch (cyclical process). To respond adequately to a risk, the Risk Manager may need to involve experts in identifying hazardous processes, identifying actions that can be taken to reduce the likelihood of occurrence and impact if the risk occurs. The Risk Register is a tool that can put all these elements together and, once inputs are set up, work autonomously by anticipating dangerous situations depending on the structure of business processes.

Company

2 Company

2.1 About *Tosca Solutions Ltd.*

Tosca (*Total Operations Management for Safety Critical Activities)* Human Factors Solutions Ltd. is a *Trinity College Dublin* spin-out campus company registered in Ireland in May 2016. The company was set up to develop and distribute risk management tools customized specifically to the needs of highly regulated environments. Tosca provides various solutions to optimize core operations for safety critical activities initially focusing on airport operations, providing real time performance data.
Tosca platform is a web application to monitor performance data on every flight and for every activity, it provides digital shift handovers and daily sign off checks for key operations, including ground handling. This delivers higher integration of task support and risk management capacity for people on the ground, it also allows task assignment and *KPI* monitoring for management; the data collected offers data analytics and real time auditing for airports, on human and technical performance metrics.

The general market category for Tosca Solutions' products and services is the *"Safety Services"*: this market segment includes engineering and consulting services, software as a service and software for purchase[4]. By January 2017, Tosca had a live reference client for their software, a regional airport, *Airport d'Abruzzo* in Pescara, Italy. Airport d'Abruzzo initially used the software in 2016 on a trial basis and found it "*positively changed the way they operated"*. Airport d'Abruzzo are currently paying Tosca to provide them with solutions around check lists for ground handling staff operations. The feedback from this trial site are very positive with results showing a 50% reduction in the number of hours spent in paper processing, a 30% decrease in operational issues, better planning and issue resolution as well as providing greater clarity in '*who does what*' at the site.

Tosca Solutions can deliver a robust, tested technology for digitized shift handovers, real time task allocation and performance monitoring, including risk modeling for main tasks, processes and procedures leading to increased accuracy and efficiency. In September 2017 Tosca Solutions started a technology transfer with the aim of adapting the tool developed for aviation (TRL 9) to the mining industry, a completely new domain (the starting point is therefore estimated to be a TRL 6).
The web-based application is proven to reduce safety risks, mitigates the number of accidents and substantially reduces operational delays. It will provide better support

[4] According to Frost & Sullivan analysis in the last year the Safety Services Market grew up to total worldwide earned revenue of $5.24 billion and the majority of this revenue growth was in Western Europe.

for staff and provide a competitive edge over use of resources and optimization of core operations for safety critical activity (higher productivity and total safety management). Tosca Solutions aims to address the market needs highlighted during our interviews with key mining industry stakeholders. The results of the trial application supported by *EIT RawMaterials*[5] funding will be shared with the others organizations. The main advantages provided for the industrial and research partner of the platform are (1) reduction in avoidable incidents and lessons learnt to be shared across various organizations, (2) reduction in required budging for corrective actions across the company (due to centralized identification of common causes), (3) optimized and efficient workflow management for risk data analysis and data collation and (4) reduced insurance costs.

2.2 Lead promoters and corporate structure

Maria Chiara Leva – *Managing Director & Lead Promoter*

Maria Chiara Leva is a Lecturer in Safety Management in the School of Food Science and Environmental Health in *Dublin Institute of Technology*. She is also a visiting Research Fellow in the Centre for Innovative Human systems in *Trinity College Dublin*. Her area of Expertise is Human Factors and Safety Management Systems. Chiara holds a PhD in Human factors conferred by the *Polytechnic of Milano* Department of Industrial Engineering. Her PhD focused on Human and Organizational factors in Safety Critical System in Transport Sector. She is the current chair of The Irish Ergonomics Society and has been working in Ergonomics and Risk Assessment as a consultant since 2008.

Fabio Mattei – *Chief Technology Officer & Promoter*

Fabio Mattei is the lead software developer in the Centre for Innovative Human Systems in TCD. Fabio holds a degree in Software Engineering from *University of Bologna,* Italy. He has extensive experience with objects oriented languages such as Java, Ruby, Python. He's involved with designing layouts and in the optimisation of informative systems and he has have experience mainly with MySql and PostSQL. He has worked for years in web development with HTML language and some of the most spread XML dialects, the .NET area of Microsoft for the implementation of web services and web applications in C#. Before joining TCD Fabio worked as a software developer consultant for four years.

[5] EIT (*European Institute of Innovation and Technology)* Raw Materials was designated as an EIT Knowledge and Innovation Community (KIC) by the EIT Governing Board on 09 December 2014. Its mission is to boost the competitiveness, growth and attractiveness of the European raw materials industry via radical innovation and entrepreneurship.

Maria Chiara and Fabio are also the only unpaid employees and Directors of the Company. Maria Chiara is responsible for the H&S technical development aspects as well as the commercial areas of the business including marketing, sales and business development and Fabio is responsible for the platform maintenance and development.

Tom Shearer - *IC Aviation Ltd*

Tom Shearer has agreed to come on board a consultant in business development for a six month period commencing September 2017. Tom is one of Europe's foremost experts on route development and airline negotiations. He spent 8 years as a Ryanair executive and has represented a multitude of airports, governments and regions in relation to air transport development. He is currently a Director of IC Aviation's which provide advisory services to the Aviation sector.

Andrea Frittella - *It Consultant / Developer*

Involved as external consultant. Andrea has more than 15 years of IT development experience and has been working with Tosca on developing the web application trial for Sodexo. He has extensive experience in designing and realizing web projects for small and medium sized enterprises. The language of choice is PHP and CakePHP framework. For frontend development he is expert in Bootstrap, jQuery and ExtJs for small CRM.

Yilmar Builes - *Risk Analyst*

Yilmar holds a first class honors Msc Degree in Chemical Engineering and has worked previously as a research assistant at Centre for Innovative human system TCD where he developed his thesis during the TOSCA project on the Diageo case study. He is currently working part time as a risk analyst for Tosca solutions mainly on the Sodexo trial and on the mining industry plan.

A breakdown of the current shareholders of the Company, number of shares issued, % shareholding and cash investment to date are as follows:

Name of member	Number of shares	% Shareholding	Cash investment
Maria Chiara Leva	65.000	55,2%	€ 0
Fabio Mattei	35.000	29,7%	€ 0
Trinity College Dublin	5.264	4,5%	€ 0
National Digital Research Centre Ltd.	1.064	0,9%	€ 5.000
Enterprise Ireland (Trance 1)	5.596	4,7%	€ 25.000
Enterprise Ireland (Trance 2)	5.891	5,0%	€ 25.000
Total	**117.815**	**100%**	**€ 55.000**

All shares are Ordinary Shares, the nominal value is €0.001.

Software

3 Software

3.1 Risk Register

Tosca Solutions' risk register is a web based toolset that provides an overview of all main risks associated to a company operations: this tool is characterized by a set of specific areas (called "modules") that can be combined to offer a customized solution to managers, supervisors and operators. The main goal of our risk register is to provide a simple and effective risk management system, allowing organizations to make correct analysis of tasks and assets and, in the same time, creating a cycle of never-ending self-improvement in order to be sure to give a good value to the organization and to guarantee them the achieving of **ISO 45001, ISO 9001** or **ISO 14001**.

3.1.1 Dashboard

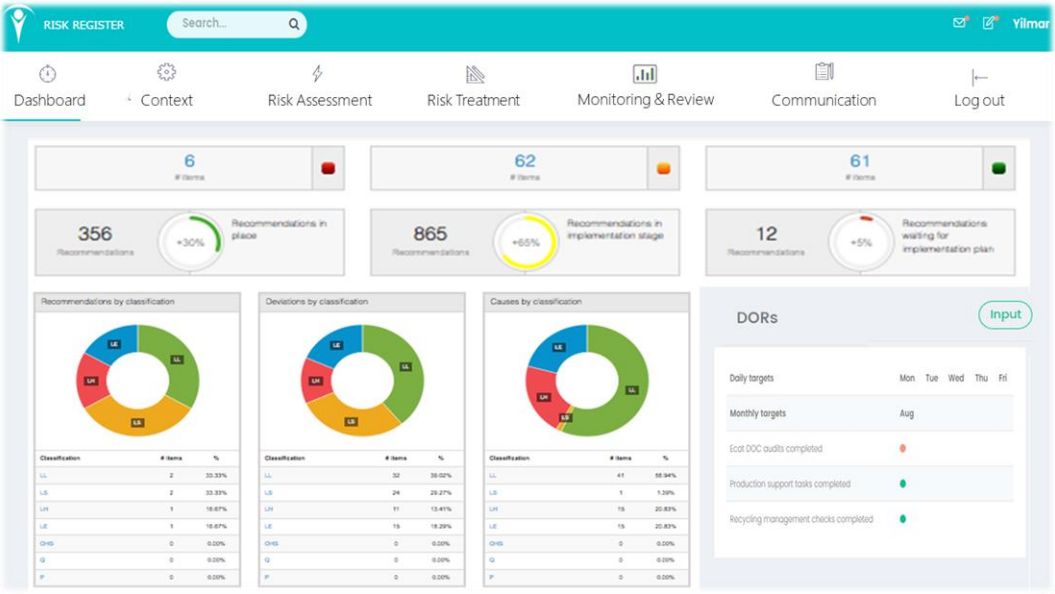


Fig. 1 - Dashboard module

The *"Dashboard"* module is the form that appears when the information system is opened. It is designed in such a way as to present a summary of the most relevant information of the system and to provide a quick overview of the main KPIs of interest to the company. This module is totally customizable[6] according to the needs of the company and may contain any type of numerical or graphical information: usually in this form it is advisable to present a macro analysis of the processes, how many of these are in time, delayed or stopped due to unforeseen events, without going

[6] The customization of the modules takes place mainly during the job order, a possible modification of the modules must be agreed with the manufacturer.

into details of which processes are involved or the reasons that have slowed or blocked them (for more details there are specific modules). The possibility to introduce graphs and to signal different events with different colors makes the dashboard a powerful tool to manage a large amount of data and quickly identify anomalies from the first minutes of the day. Just like the dashboard of a car, this module allows you to get real-time information about company performances with the possibility to receive alerts, recommendations and to visualize any deviations from the pre-established targets. It is always possible to look for specific items on the page and check inter-company communications in real time.

3.1.2 Context

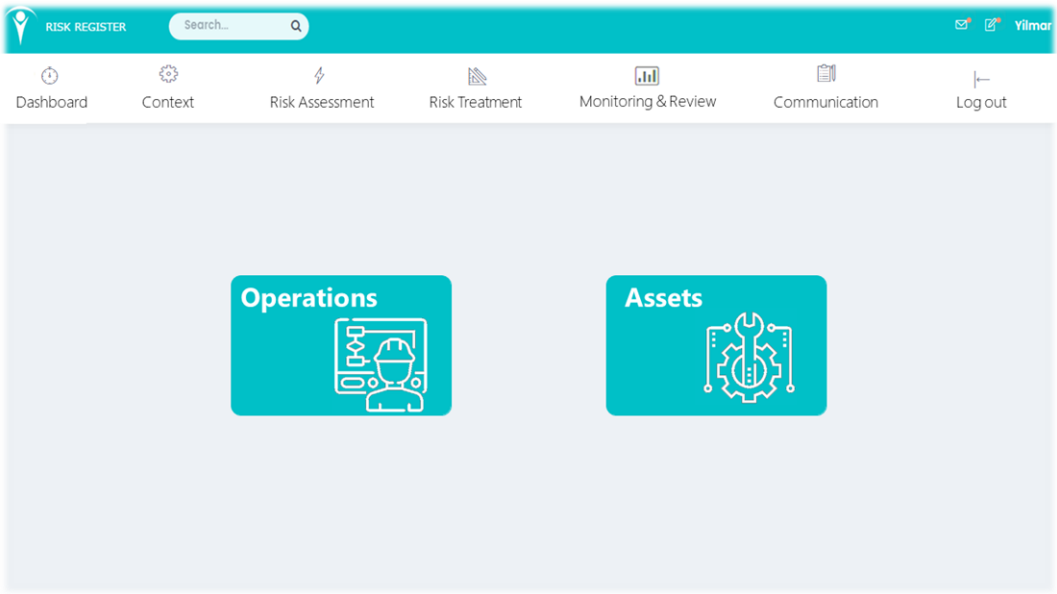


Fig. 2 - Context module

Inside the *Context* module the system offers us the possibility to choose between two sub-modules:

Operations

The Operations sub module allows the User a greater understanding of their operational tasks to be carried out during a daily work and raising awareness of the dangers to which the whole organization is involved. One of the main goals is to have a clear idea of the activities performed and to keep the staff involved updated, such as, to notify them about the most dangerous procedures and their recommendations to avoid issues.

Assets

The Assets sub module has the function of keeping a register of equipment and machinery required to perform operations. The main purpose is to have a clear understanding of the risk associated with assets an organization owns and keep the staff informed of all these details.

3.1.3 Risk assessment

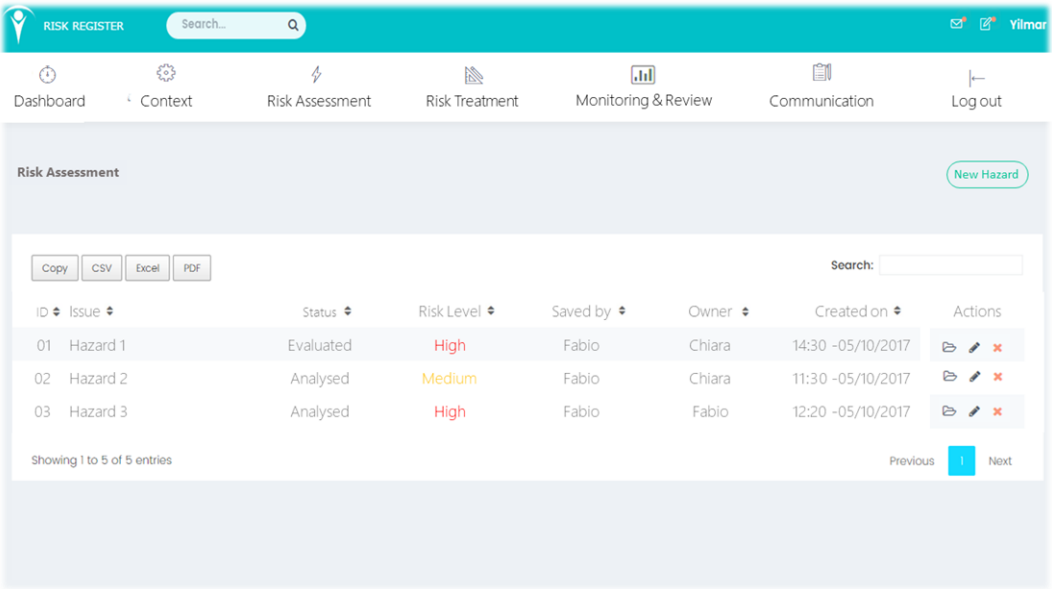


Fig. 3 - Risk assessment module

This module allows the User a complete identification, analysis and risk evaluation. The initial overview allows us to get a picture about the status of all identified hazards specifying:

- the type of *issue*: in such a way as to distinguish the various types of danger and allow the user a rapid identification;
- the *status*: in order to understand at what point of the risk management process we are (for example if the hazard has just been identified and waiting to be evaluated or if we have already carried out a quantification of the risk, see *"Risk Assessment"* chapter 1.1.1);
- the *level of risk*: allows us to prioritize the hazard;
- the actors involved, specifying from whom the new item was introduced and who will be in charge of operational management;
- the date of creation of the item.

The buttons *"Copy", "CVS", "Excel"* and *"PDF"* allow the user to copy the content of the form or to export it in pdf, excel, etc.

The *"New Hazard"* bottom allows the User to add a new hazard.

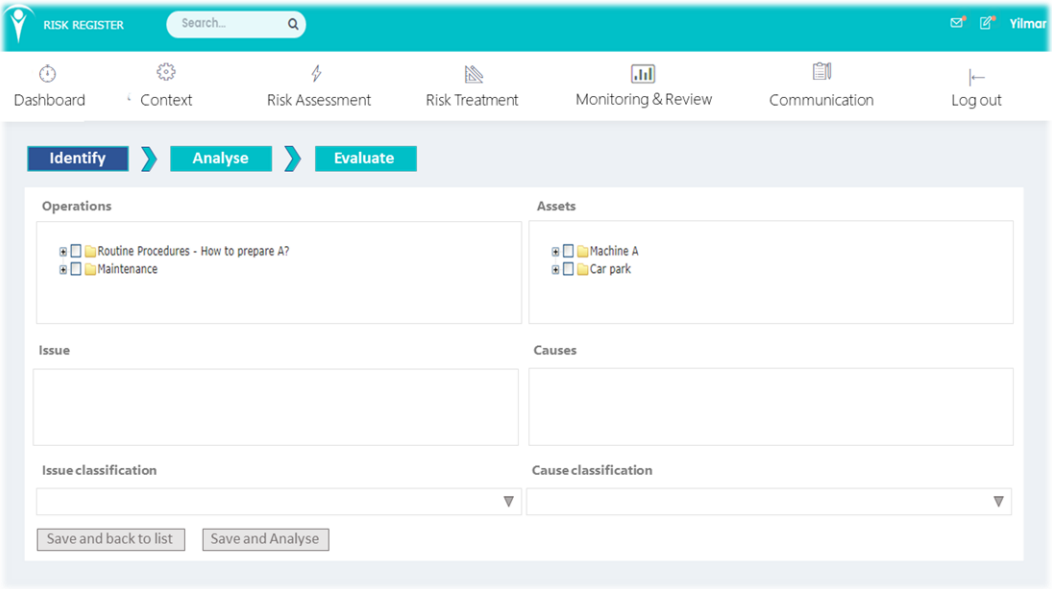


Fig. 3.1 - Risk Assessment, Identify

This form allows us to add a new one hazard describing the main features, analyzing causes and, where possible, classifying it within categories already known to the system (the categories are contained in appropriate drop down menus). The same hazards can also be included in specific categories of *operations* and *assets*.
Once the new hazard is introduced, the user can save updates and go back to the list of hazards or save and proceed with hazard analysis: let's see this second option.

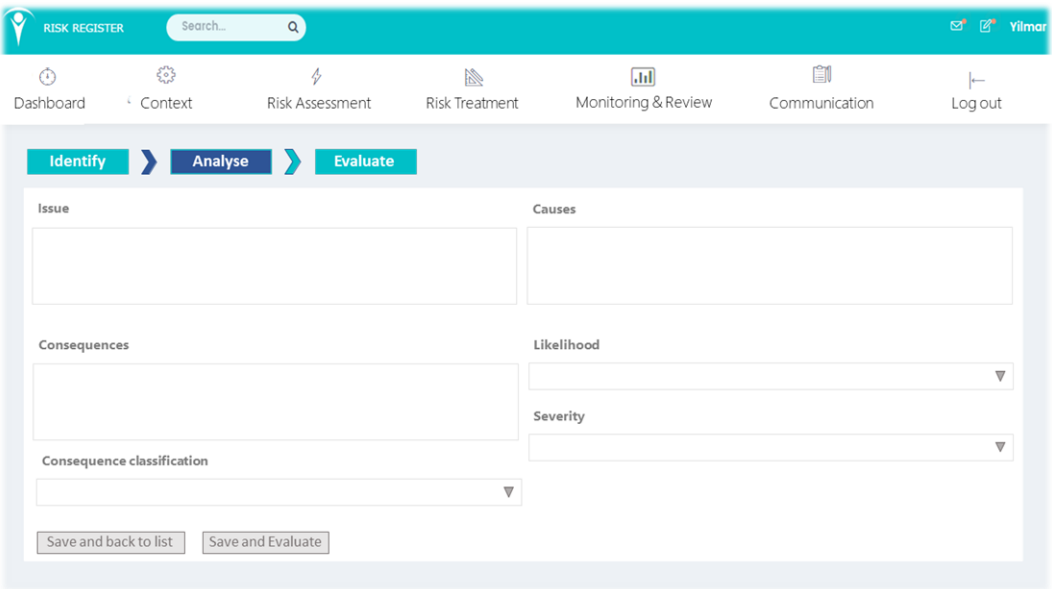


Fig. 3.2 - Risk Assessment, Analyse

In the form *Analyse,* the *Issue* and *Causes* boxes will contain the same information entered in the boxes *Issue* and *Causes* in the form *Identify*, in this way the user can easily complete the form without having to go back to the form *Identify* to find the entered information.
In this form it is also possible to report the possible consequences of the identified risk, classify it and identify probabilities of occurrence and severity (see *"Risk Response"* chapter 1.1.2). Also in this case it is possible to save the changes and go back to the list of hazards or proceed with the *"Evaluate"* form.

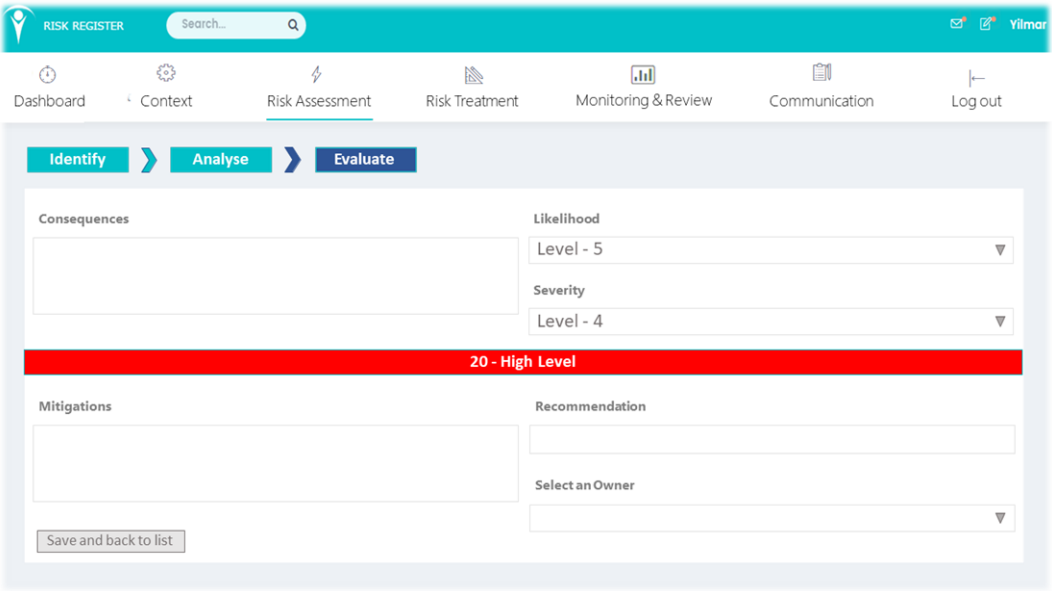


Fig. 3.3 - Risk Assessment, Evaluate

In the form *"Evaluate"* are reported all the info already entered previously in the form *"Analyse"*, but now the system gives us a quantification of both numerical and nominal risk with specific colors. In this form the user will be able to list specific actions from which to mitigate risk, insert special recommendations and select the owner responsible for risk mitigation actions in the appropriate drop-down menus.

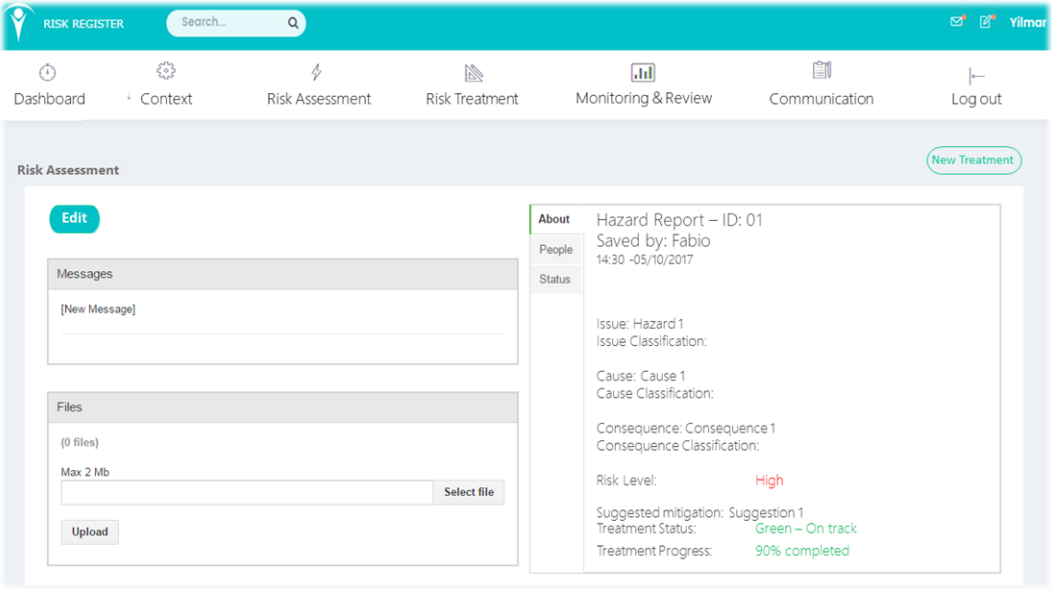


Fig. 3.4 - Risk Assessment, Overview

Finally, just click on one of the hazards indicated in the first form of the risk assessment module (see previous figure) to always get the complete information list related to the selected hazard, make changes, attach messages and useful files.

3.1.4 Risk treatment

The Risk Register offers techniques to plan and execute a correct risk treatment, this would ensure a better risk manage in a more comprehensive manner and to ensure compliance with internal and legal requirements.

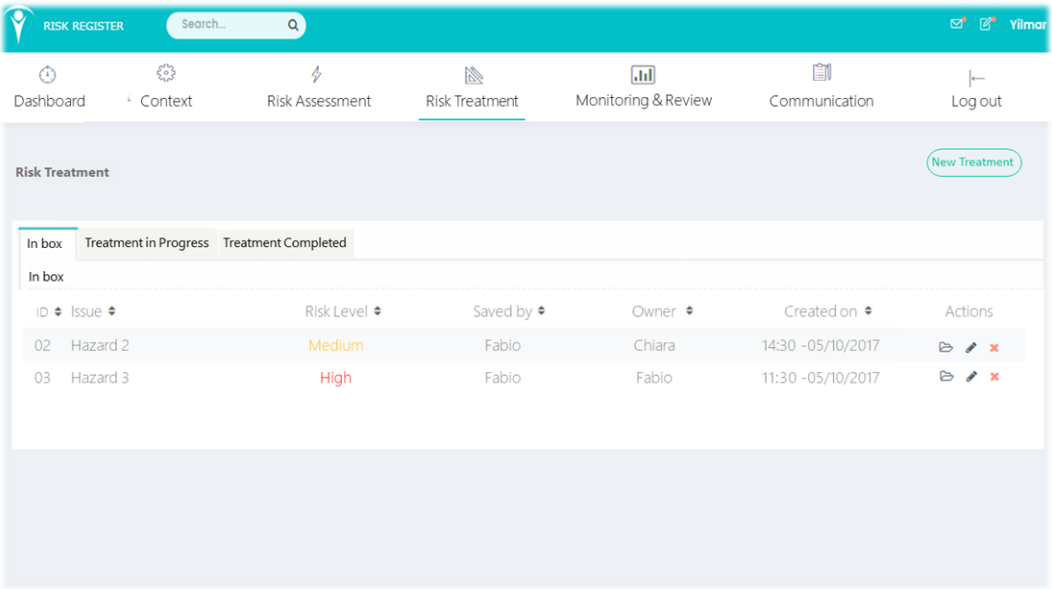


Fig. 4.1 - Risk Treatment, In box

In the *"In Box"* form we find the treatments requested through the *Manager* or *Supervisor* profile, describing the type of hazard, the level of risk, owners involved and the creation date.

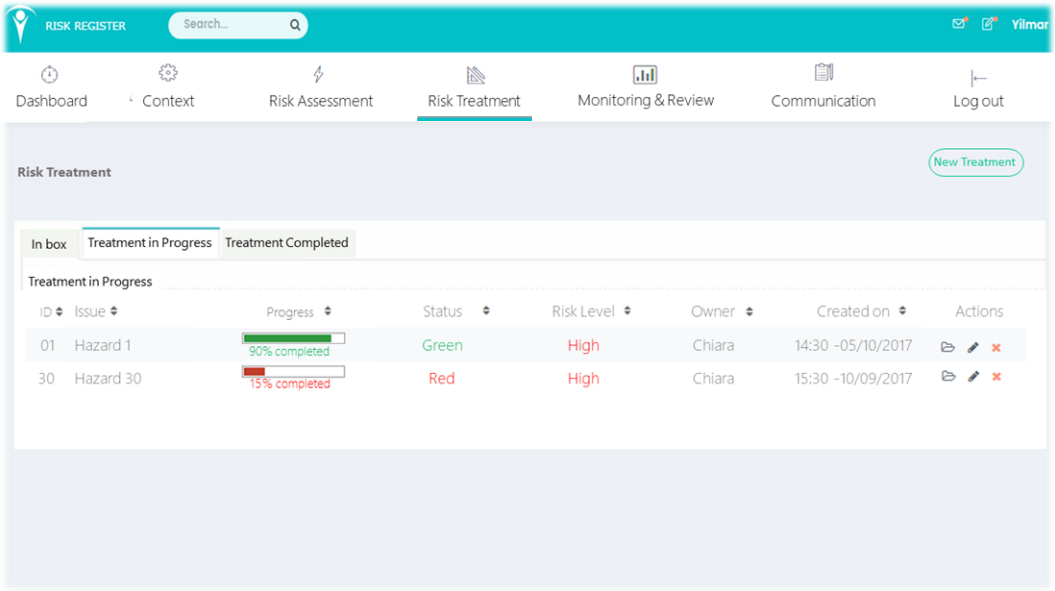


Fig 4.2 - Risk Treatment, Treatment in Progress

In the *"Treatment in Progress"* form we can find treatments in the execution phase indicating the percentage of progress, the status (ie if the activity proceeds well and without any unforeseen events the status will show the word "green", if the delays have occurred the word "yellow" will appear, if the activity is blocked the status will "red"), risk level and the owner involved.

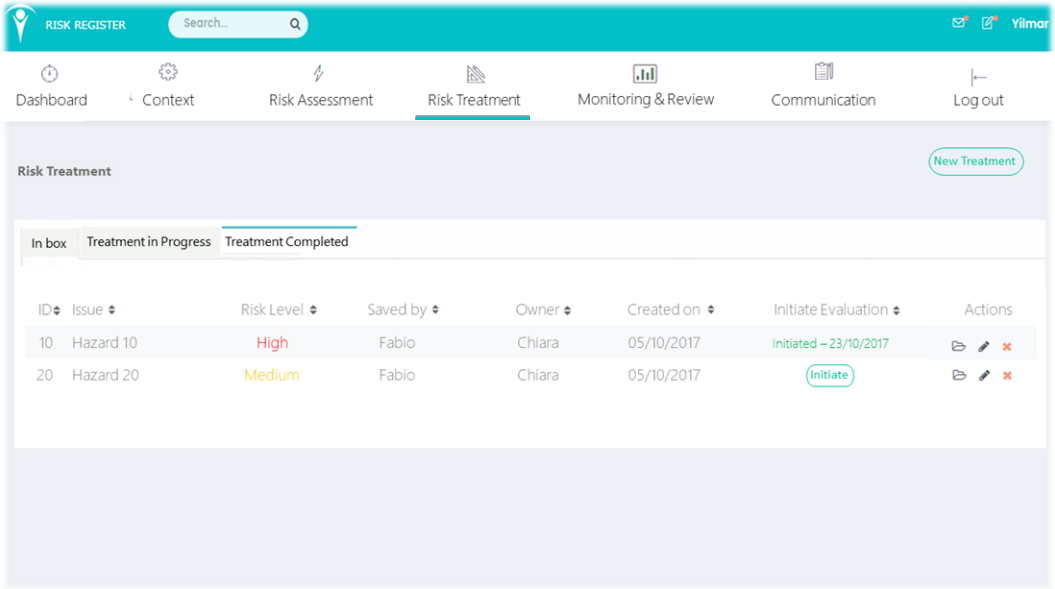


Fig. 4.3 - Risk treatment, Treatment Completed

In the *"Treatment Completed"* form the treatments already completed are indicated, and which ones are in the evaluation phase (in order to assess whether the countermeasures adopted were effective in the risk response, see below "Evaluation" form). Each treatment brings with it all the necessary details including tasks to be performed, which of these have already been completed, and overall progress.

3.1.5 Monitoring & review

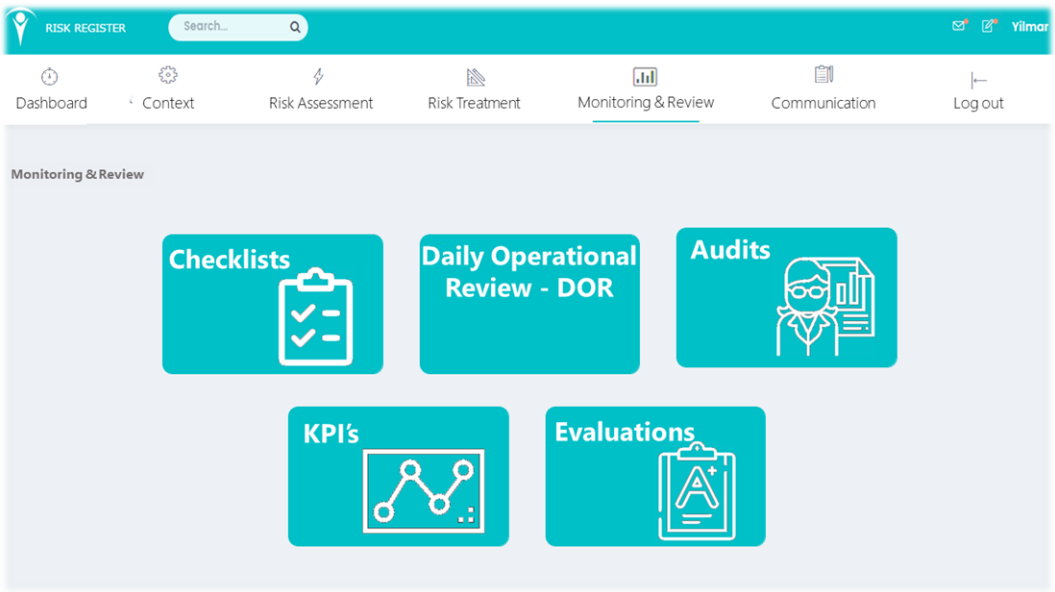


Fig. 5 - Monitoring & Review module

The monitoring and review process is intended to be a continuous process throughout the whole risk assessment process feeding into each of the previously discussed phases. At the same time, this module is a key element in fostering a safer and more efficient work environment.

Check lists

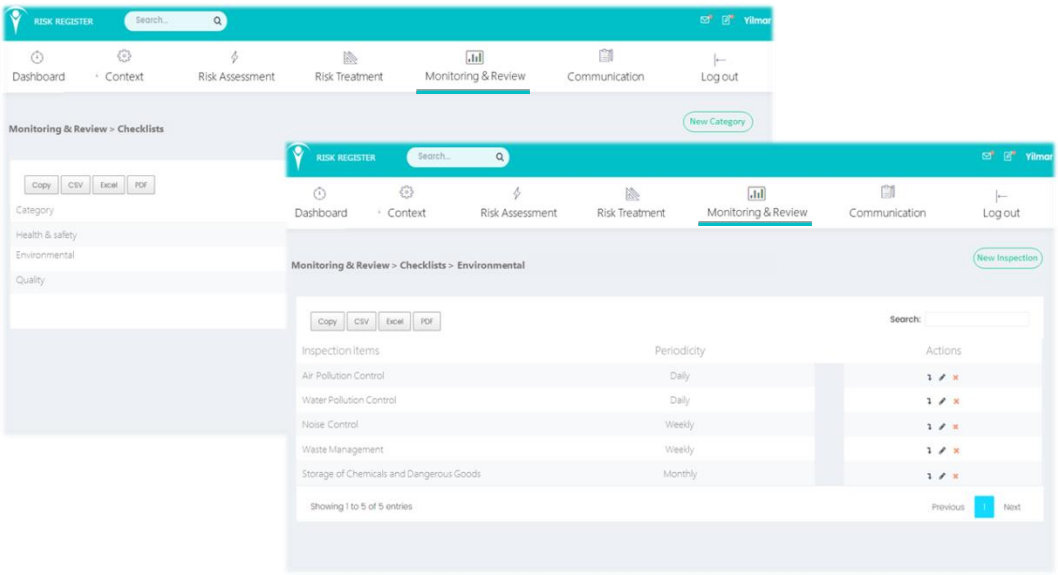


Fig. 5.1 - Monitoring & Review, Checklists

The electronic checklist provides a better planning and coordination during the internal inspections scheduled for the company, to guarantee internal and legal compliances, helping to reduce the excessive cognitive workload and to share the information in real time.

Daily Operational Review

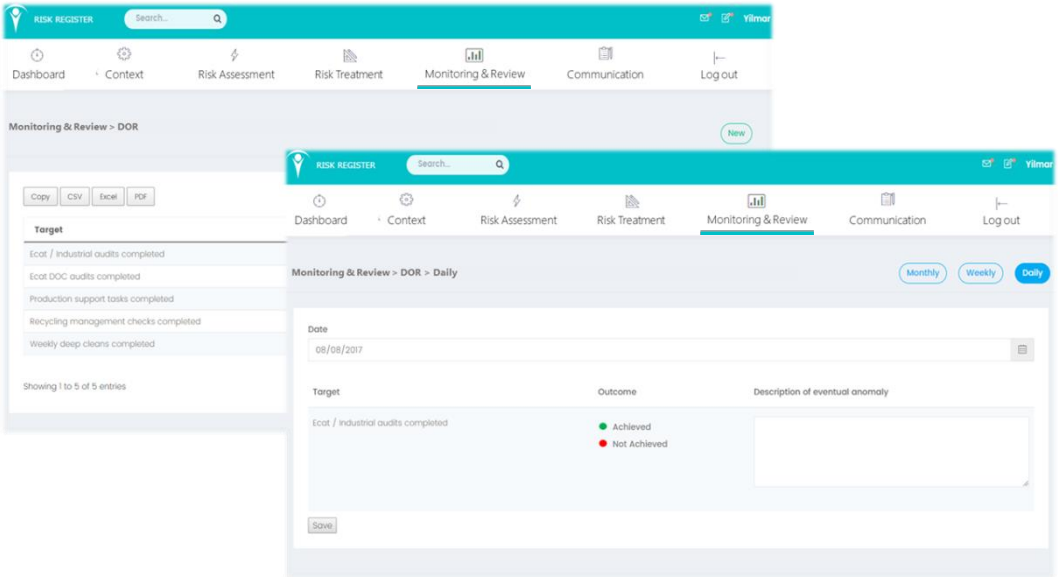


Fig. 5.2 - Monitoring & Review, Daily Operational Review

This form provides an overview of the main activities of the plant (even here with the possibility of reporting any anomalies) and allows to review staff performances and ensures that controls are effective and efficient in both design and operations.

Key Performance Indicators

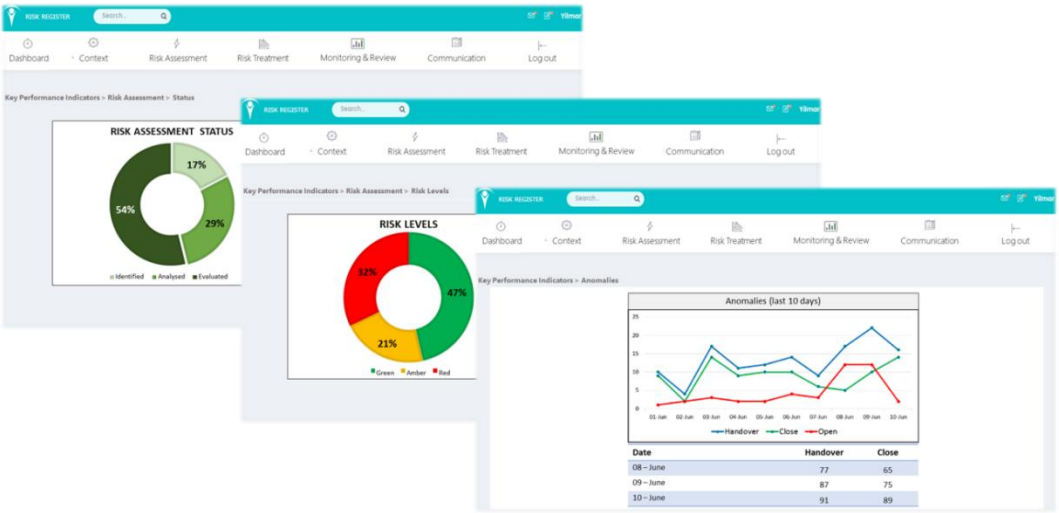


Fig. 5.3 - Monitoring & Review, Key Performance Indicators

This form offers the possibility to Managers and Supervisors to monitor continuously and simply the performances of the company thanks to an effective system of charts of different types, obtaining useful information to improve the risk management system and daily operations. This section also allows you to analyse and learn lessons from events, changes, trends, successes and failures.

Evaluation

This module plays a fundamental role in the risk management system: the user can now evaluate the outcome of the risk treatment implemented for each hazard (see chapter 3.1.4 *"Risk treatment"*) and finally understand if the countermeasures applied have produced the desired goals or the procedures must be reviewed.

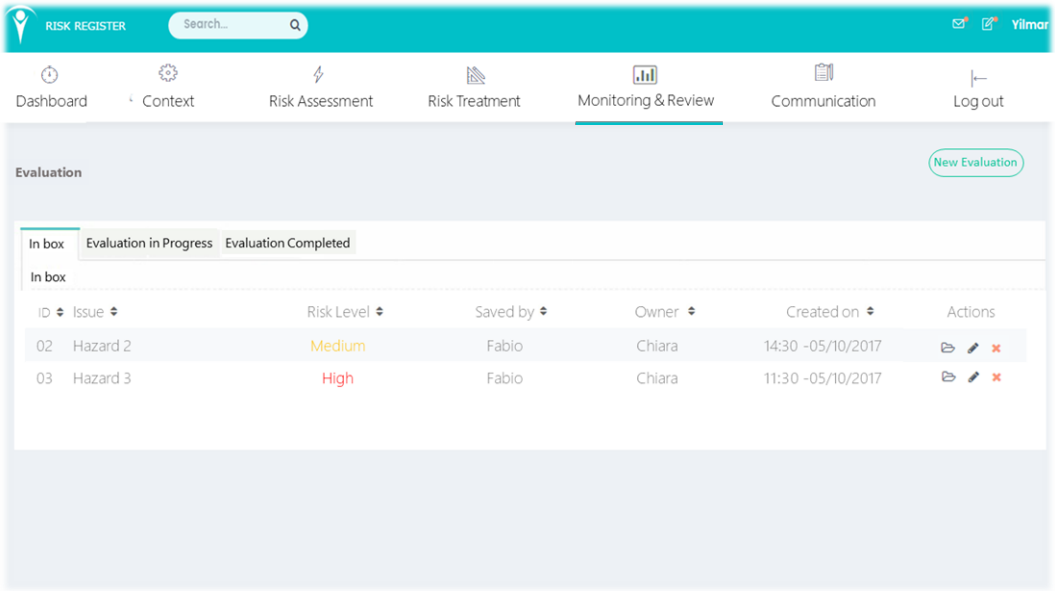


Fig. 5.4 - Monitoring & Review, Evaluation (In box)

Within the form *"In Box"* we can see the risks previously identified in the *"Risk Treatment"* module, tab *"In Box"*, with the relevant salient information (risk level, actors involved, creation date).

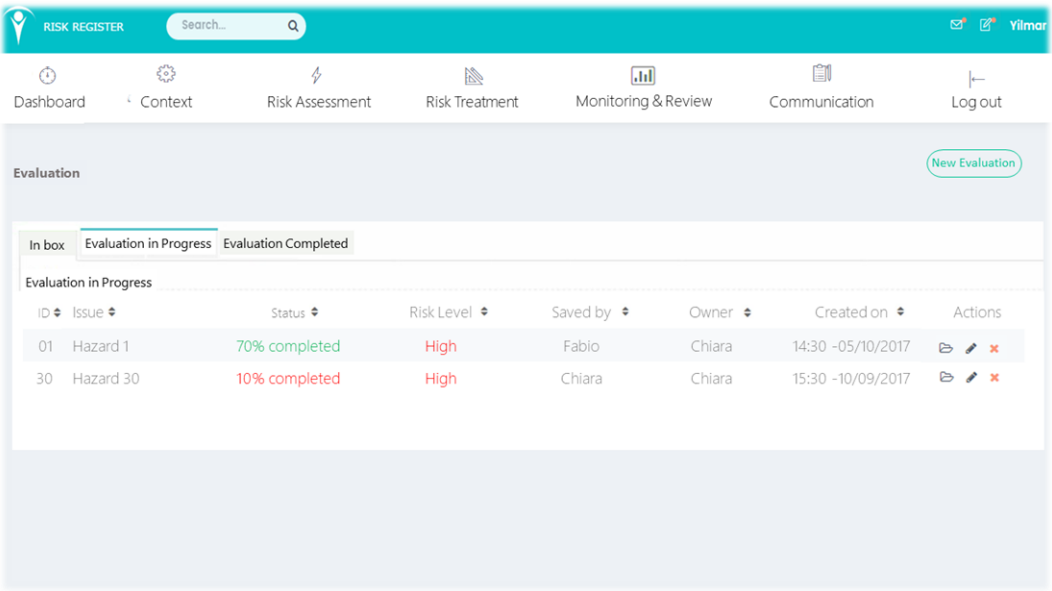


Fig. 5.5 - Monitoring & Review, Evaluation (Evaluation in progress)

Within the form *"Evaluation in Progress"* are listed which risks already treated are under evaluation. The dashboard shows not only the list of risks during the evaluation phase, but also the percentage of progress (appropriately highlighted with different color), the starting level of the risk, the actors involved and the creation date.

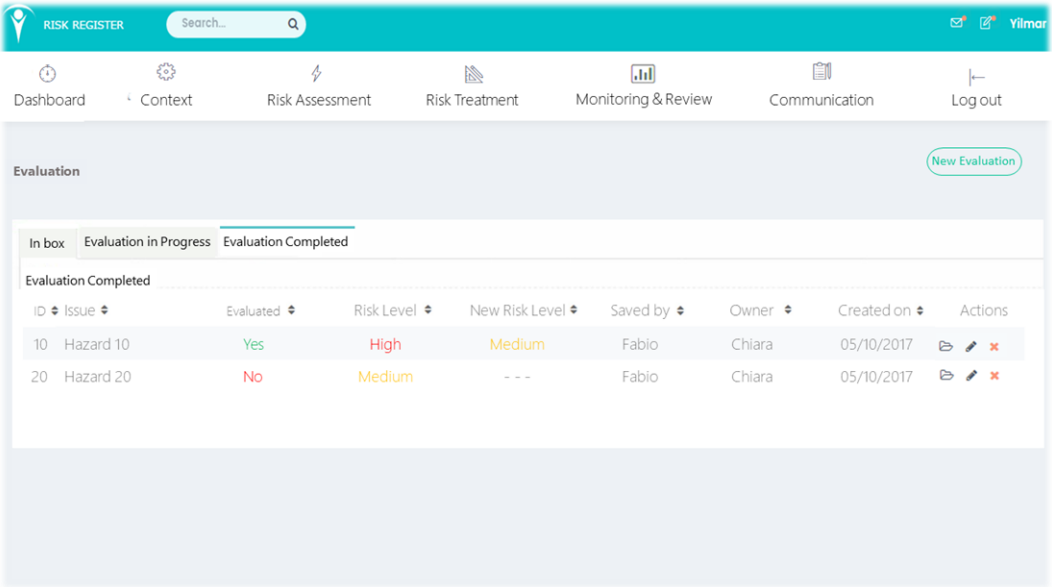


Fig. 5.6 - Monitoring & Review, Evaluation (Evaluation completed)

Within the form *"Evaluation Completed"* we can see what are the risks already completed and which are being completed, their first level of risk and their new level of risk (appropriately highlighted with different colors), which are the interesting actors and the creation date.

3.1.6 Communication & consultation

The reliable communication is crucial and the first safeguard to safety and shift handover is highly relevant. This module offers the possibility to access two macro areas: let's see them together.

Anomalies

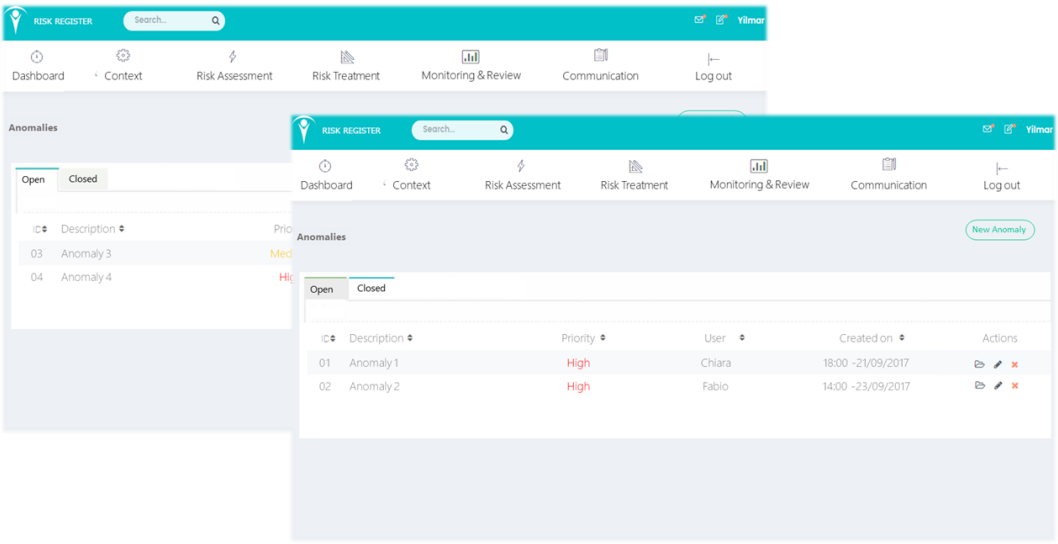


Fig. 6.1 – Communication, Anomalies

The submodule anomalies has two different tabs. By clicking on the "Open" tab we can see the anomalies in the analysis phase, ie the anomalies already identified that we are trying to reduce or eliminate altogether. The module has the same structure as the previous modules: each anomaly is identified by an identification code, a description, a priority level, one or more managers and the creation date. At the top right there is a "New Anomaly" button which allows the user to insert new anomalies. By clicking instead on the tab "Closed", we can go and review the anomalies already neutralized with the relative levels of risk and responsibility.

The anomalies report is an easy and quick reporting system implemented by Tosca Solutions to improve the communication between different individuals. The anomaly is reported by a worker and the Manager/Supervisor will have the chance to evaluate the best option to fix the problem.

Shift Handover

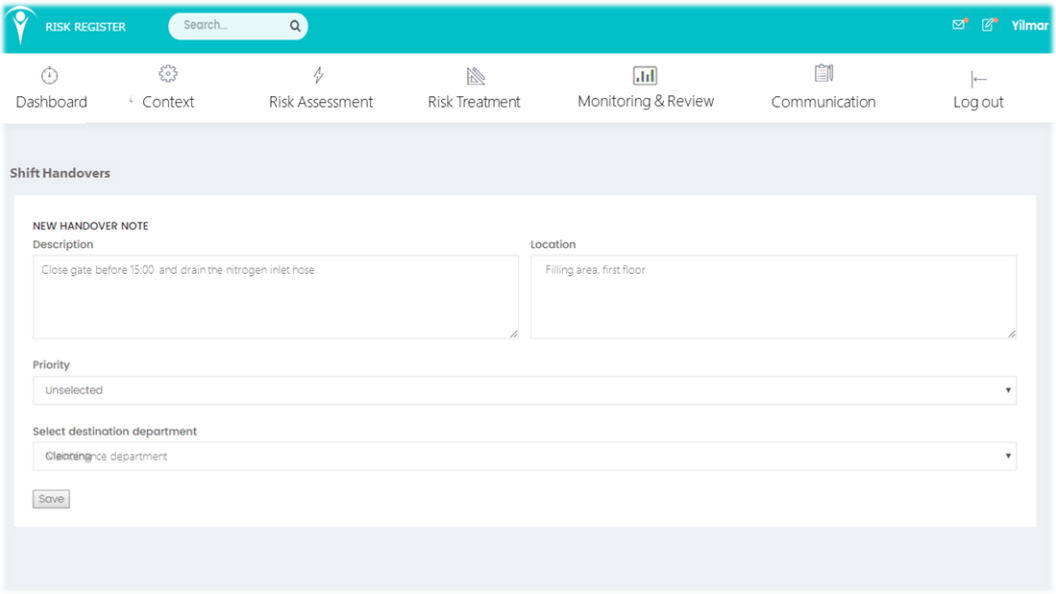


Fig. 6.2 – Communication, Shift Handover

This section is designed to reduce communication problems by providing complete and accurate information that helps reduce anomalies and human issues, increasing staff involvement, planning and monitoring to make rapid intervention.
It is possible to introduce notes relating to the new tasks to be performed, places or area concerned, priority level and the office in charge which will receive the notification and proceed with the required actions, after which it can be sent software, feedback on the tasks requested.

Case study

Abruzzo International Airport

4 Case study: Abruzzo International Airport

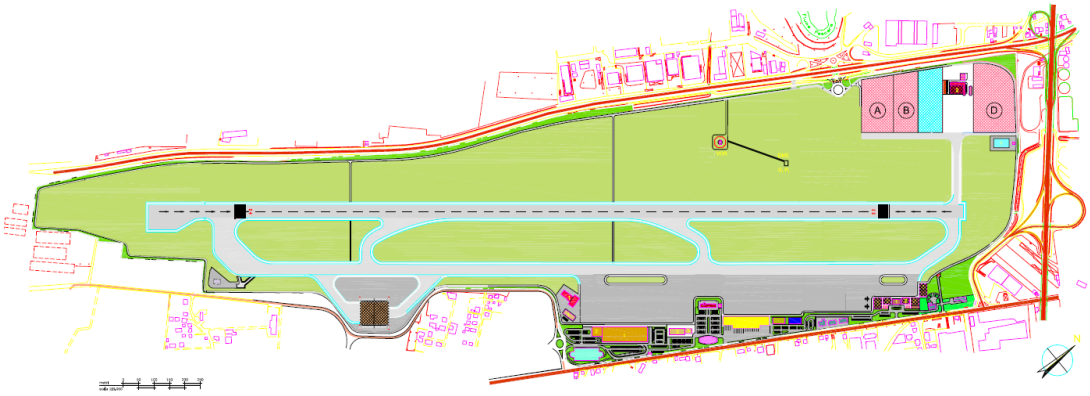
The Abruzzo International Airport is an airport located near Pescara, Italy, open to civilian traffic since 1996. It has seen a steady increase in the number of transit passengers over the years, mainly due to a growth in low-cost airlines and flights. Every year it hosts about 600,000 passengers and almost 9,000 aircraft connecting the city of Pescara and the entire region with many Italian and European destinations.
Today the airport is managed by SAGA, an acronym for "*Società Abruzzese Gestione Aeroporto"* (established in 1981 in order to manage the Abruzzo airport), which since 2008 has held a thirty-year concession under a special agreement stipulated with the National Civil Aviation Authority (ENAC) which regulates the assignment of airport grounds. The great development of the Abruzzo airport of the last years (which from 114,000 passengers in 2000 passed to over 600,000 in 2015), is substantially due to the low cost phenomenon that has affected all of Europe and most Italian airports, also positively involving the Abruzzo airport. A good part of this growth can be attributed to the low cost Irish airline company *Ryanair*, one of the main European low cost airlines, which has connected the Pescara airport with several European destinations for over 15 years, including London, Frankfurt, Bruxelles, Budapest and Barcelona.

The Abruzzo airport has 5 gates of boarding (3 departures and 2 arrivals), with functional and service areas for passenger in the pre-shipment area, photovoltaic system on the roof, air conditioning systems, water treatment plant, sterile areas, border police, first aid and meeting rooms. The area of the airport reserved for passengers is about 8000 square meters, it can accommodate up to a maximum of 1.000.000 passengers and contains a total of 17 commercial areas plus bars and atms; it includes 750 car parks, 24 airplanes parks and 2 conveyor belts.
The Abruzzo airport has a single two-lane track (*22/04*), normally for runways *04* is used, while *22* for landings. The distances declared are as follows[7]:

Identification	TORA (m)	TODA (m)	ASDA (m)	LDA (m)
4	2418	2418	2418	2313
22	2418	2418	2418	2330

Technical data of the Pescara Airport

[7] Abruzzoairport.com/Dati_tecnici_dell_Aeroporto



Plan of the Pescara Airport

4.1 Ground Operations and Human Workload

In the aviation with the term *"Ground Operations"* is meant the set of operations carried out on the ground related to the management of procedures such as boarding of passengers to baggage, the pre-departure checks, the maintenance and refueling; operations of this type must be carried out quickly and reliably due to the limited time available, requires qualified personnel and, normally, generates heavy workload due to the high number of tasks covered in a short time. In particular, the shift towards automation has changed the nature of the operators' work, moving it from physical work to mental work and problem solving.
Work spikes and long work shifts can affect mental processing capacity reducing performance: an excessive cognitive workload is generated when the satisfactory performance of a task demands from the operator more resources than are available at any given time[8]. The assignment of additional tasks to a worker is one of the main reasons for the worker's failure, the use of executive control systems thus becomes essential to ensure the success of several simultaneous activities.

A web application can support these phases, in particular by generating electronic checklists that prevent you from leaving pending or uninitiated tasks and creating a more efficient work environment. The digitization of daily electronic checklist and support systems for the shift handover which list the operations of the "turnaround" to be performed for each aircraft, and other maintenance activities required for equipment and/or infrastructure (e.g. runway inspections) was a platform able to provide the opportunity to collect real time performance and reporting on day to day anomalies and issues that was not available before. The tool is being used by *Abruzzo International Airport* and in this case study we collected feedbacks from front line personnel and management on what were the perceived impacts the tool had on performance.

[8] Meyer, D., & Kieras, D. A Computational Theory of Executive Cognitive Processes and Multiple-Task Performance: Part 1. Basic Mechanism. Psychology Review, 104, 3–65 (1997)

4.2 Electronic checklist and shift handover: their role for task support & workload management

The US National Transportation Safety Board recommends the use of checklist to carry out highly proceduralized work such as proper maintenance of the aircraft. However, the improper use of these tools can bring danger consequences, even lethal.[9]

It should be emphasized that the checklists were already present at the airport of Abruzzo, but from a preliminary study it was noted that many were the weak points of these instruments. The most significant shortcomings included the inability to mark skipped or pending activities and the lack of a support tool in the transition between different checklists. All these obstacles have been mitigated through the implementation of the "Monitoring & Review" module and the "Checklist" submodule (see Chapter 3.1.5).
Electronic checklists offer numerous advantages: they guarantee faster execution of tasks, provide external memory support for tasks that are pending or omitted and detect the current status of each task: this can guarantee the correct completion of multiple tasks concurrent. The functions contained also ensure faster handling of information in the transition from one procedure to another or in sub-procedures without losing track of the procedures yet to be completed. The electronic checklist system is designed to reduce four types of common errors found in traditional paper checklists:

1. avoid forgetting fundamental tasks or leaving them incomplete;
2. distractions or interruptions during every day work are unavoidable, an electronic checklist can minimize the problem, supporting the resumption of work after any interruption / distraction;
3. share information in real time with the competent offices, asking for support if necessary;
4. calculate KPIs and offer daily data analysis.

Just as the electronic checklists play an important role to guarantee the proper performance of the tasks connected with aircraft turnaround, in the same way electronic shift handovers are an important factor for non-recurrent tasks, safety critical activities such as runway inspections and coordination between operators at various level (passengers handling operators and ramp operators with airport duty manager).
The importance of proper shift handovers is often discovered in accident analysis where improper communications and assignment transfer occurred between shifts. In 2005 for instance Texas City submitted the final investigation report about the fatal

[9] National Transportation Safety Board. (1988). Aircraft accident report, NTSB/AAR-88/05. Washington, DC. Retrieved 2 February 2017, from https://www.ntsb.gov/investigations/AccidentReports/Pages/AAR8805.aspx

Isomerization Unit Explosion in its city; the report explicitly mentions poor shift handover as a key root cause of the accident.[10]
NASA demonstrated in a study how the design weaknesses of the traditional checklist and the improper human interactions associated with it can reduce the effectiveness of procedures, especially in complex socio technical systems where the role of the human is key. The same study also points out that merely improving the engineering design and the procedural sequence of the checklist will not eliminate the problem.[11]

4.3 The implementation

The design and customization of the tool has seen the involvement of the staff in order to receive a more precise description of the work environments, the activities carried out and ensure the design choices that incorporate the needs of workers allowing them to take control of the knowledge necessary and greater understanding of the risk of their daily activities.
The information system developed in this case study aimed to support the management of processes and to face new challenges such as the growth of passenger traffic and, consequently, increase the effectiveness of the personnel: this has led to the development of a new integrated platform through which operators at all levels can fulfill all the required tasks and share information in real time. To start the process, a model was built that allows the identification of data to be transferred from paper format to electronic check lists. The paper check lists did not contain basic information such as anomalies found, shifts and names of the operators: the electronic checklists were created to cope with this type of shortcomings. The current checklists contain not only the names of the actors involved, but also possible anomalies that may occur during operations and the levels of associated risk (the proactive risk assessment is required by the ICAO guidelines[12]), also contain performance monitoring, reporting, support of activities, documentation and evaluation of procedures.
To guarantee a proper shift handover design, a mock-up was built to single out all the data that needed to be migrated from the paper format of the checklists used by Ramp and Operations for each flight into an electronic format. The checklist was structured around the subtask performed for Ramp and Handling operations identified during the process mapping exercise. The system has been built as a management system and it is configured as a Web Application. The application is connected to the existing

[10] British Petroleum, Fatal Accident Investigation report – Isomerization Unit Explosion Final Report –Texas City, Texas, USA (2005)
[11] Degani, A., & Wiener, E. L. The Human Factors of Flight-Deck Checklists: The Normal Checklist (NASA contractor report 177549). Moffett Field, CA: NASA Ames Research Center (1990)
[12] ICAO. (2009). Safety Management Manual (SMM) Doc 9859 AN/474. Retrieved 31 January 2017, from http://www.icao.int/safety/SafetyManagement/Documents/Doc.9859.3rd%20Edition.alltext.en.pdf

company's databases and can show all required data using an interface protected by password.[13]

Before the tool was implemented, it was found that the airport's activities were strongly conflicted with each other, in particular all personnel found that within a work shift or within the individual tasks responsibilities were never exactly defined. 70% of people interviewed proposed a use of shift planning around each flight which was the method used for short-term periods of significant traffic growth due to special events; it was also proposed to allow automatic collection of data for ground handling task performance for every turnaround (already manually collected with the *Trip File* associated to each flight) and around 80% of people interviewed said that there wasn't a clear form of performance appraisal and they would have liked to have one.

The first action performed was to create electronic checklists that were able to identify the activities and the actors involved, assigning clear responsibilities and timing, so that all the processes involved in the ground handling activities could be totally monitored.

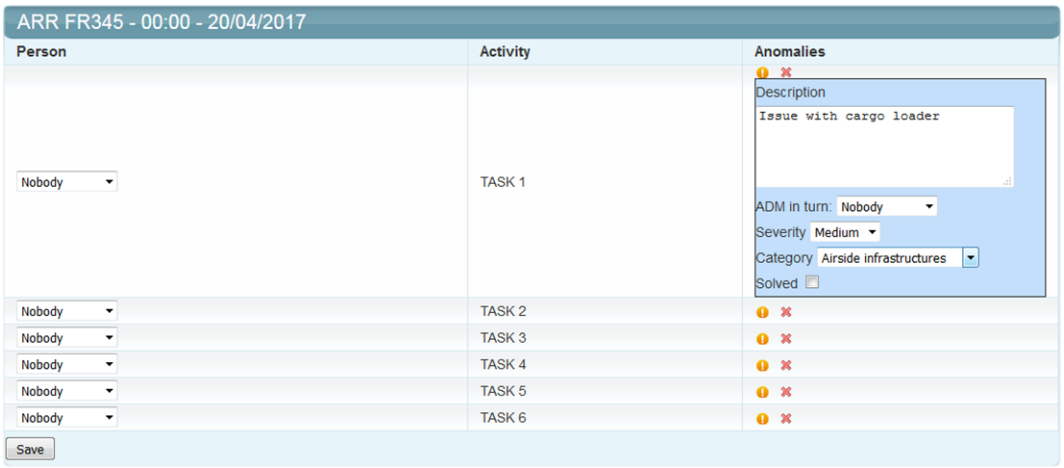


Fig. 1 – Example of an electronic checklist

Figure 1 shows an electronic checklist of flight ARR FR345 of 00.00 of the day 20 April 2017, an incoming flight: the checklist requires you to select the name of the operator responsible for the action to be performed, the task, possible anomalies, severity and impact on quality, safety, health, environment, etc. The tool has been installed on 3 workstations, two in the Airport Duty Manager (ADM) office, located in front of the aircraft parking apron and one in the ramp station, also located in front of the apron, the turnaround display is user friendly and easy to handle which allows users to enter information in a short time and share it instantly.

[13] Leva, M.C., Naghdali F., Balfe, N., Gerbec, M. and Demichela M. Remote Risk Assessment: A Case Study using SCOPE Software. CHEMICAL ENGINEERING TRANSACTIONS, ISSUE N 43. (2015)

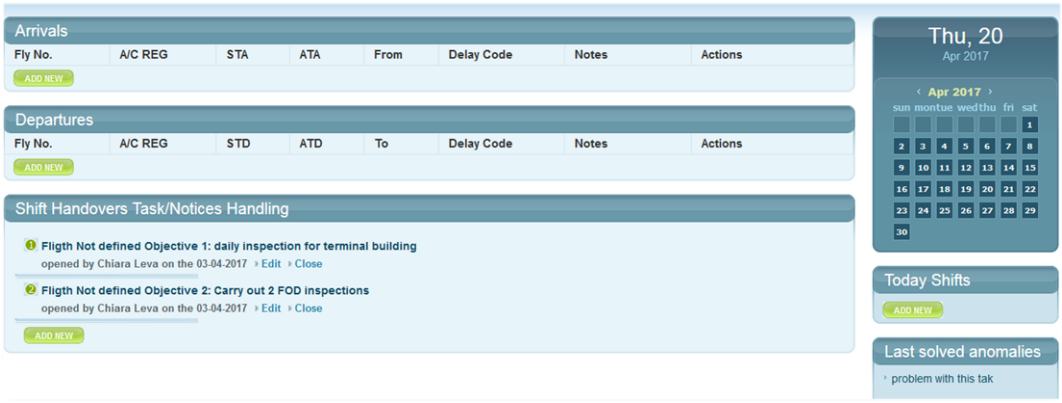


Fig. 2 – Example of dashboard

Figure 2 shows the dashboard with all flights arriving and departing every day (the data are automatically loaded thanks to the possibility to interface the tool with the main management software of the plant), several elements have been grouped together a single box called *"Actions"* for each flight. The other elements make possible to insert checklists (with all operations and operators involved in the flight), to add cases of passengers with reduced mobility or who need assistance, to include loading instructions and to insert any anomalies. Finally the main screen also shows the activities derived from handovers (shift handovers). The reporting around those activities is completed by the airport-duty-managers. He/she may also report problems even when they have already been investigated and resolved. Any abnormality reported remains in the system, even if it has been resolved, and they are analyzed and discussed during scheduled during management review meetings.

One of the main advantages identified in this tool is to provide a real picture of the processes routines operations available in a shift relative to their history. As this data can be used to show a precursor of workload based on the task performed by the resource available in each shift by cumulating the turnaround and routine tasks with the non-recurrent tasks performed during each shift. It was also used to identify latent risks and potential anomalies in the procedures, equipment, training and the human factor component, deviations which otherwise would have never been highlighted as well as providing a lever on the monitoring of key performance in the context of business management for long-term strategies. This leads to improved efficiency and avoids substantial costs that may arise from possible accident scenarios. It can also highlight if there are potential correlations between certain type of issues and different workload levels.

4.4 Anomalies

4.4.1 Dataset

In September 2017, approximately a year after the first implementation of the Risk Register, we built a dataset through the information related to the anomalies identified thanks to the use of the software. This was made possible thanks to the *"Anomalies"* sub-module, included in the *"Communication and consultation*" module of the current risk register. This form, as witnessed by the analysts of Pescara Airport, today plays a crucial role in handling management and it became an essential tool during the inspections by the airline companies, ENAC and the internal meetings of the Management Review Board, which analyzes the most frequent critical issues extrapolated from the Risk Register and seeks solutions to eliminate or reduce these criticalities.

Just in the first 10 months of activity it has been possible to identify more than 600 previously unknown anomalies in airport activities, characterized by more or less variable levels of risk and responsibility that would have led to important consequences if they were not identified in time (delays, excessive costs, accidents, accidents).

As widely described above, most of the problems that can occur inside an airport (including runway and landing) are due to human factors and the risk register tool has proved to be a valuable tool to monitor and mitigate the anomalies within the core activities of the airport. The risk register is not only useful to signal the presence of an anomaly or to build a list of actions to perform but is able to provide guidelines to coordinate the execution and completion of plans and effective strategies to mitigate problems in which employees are involved.

Thanks to the set of information gathered from the *"Anomalies"* sub-module it was sufficient to use a few Excel tables to identify which anomalies had already been identified in previous years (often reported in paper format or even reported vocally) and which, instead, they had never been identified before. The result was shocking. Of the entire number of anomalies identified in almost 10 months of activity at full capacity, 615 were the anomalies that have always been part of the daily life of the airport in question, but they are never exactly indivudated and eliminated. To make the reader aware of the seriousness of the pre-existing situation, we will list below some of the anomalies reported by the software which, we recall, do not appear on any previous official document/report of the Pescara airport (anomalies that analysts did not officially known).

To make the reader aware of the seriousness of the pre-existing situation, we will list below some of the anomalies reported by the software which, we recall, do not appear

on any previous official document / report of the Pescara Airport (ie anomalies not officially recognized). After that we will proceed to categorize all the anomalies in such a way as to identify the appropriate countermeasures necessary to limit the consequences.

N°	Anomaly	Flight	Description	Category
606	Failed baggage delivery	ARR FR 5016 CRL 19:55 04/09/2017	One or more baggage has not been returned to its owner, has been lost or has been returned late	*Health & Safety*
35	Broken wheelchair ramp	ARR AZ 1243 LIN 15:05 06/07/2017	The *"x"* ramp for boarding reduced mobility passengers is broken	*Health & Safety*
157	Communication interrupted	DEP FR 983 STN 22:00 15/10/2017	Communication between operators was interrupted due to a failure in the communication network	*Health & Safety*
352	Missing announcement of boarding	DEP FR 4036 BGY 06:30 08/10/2017	The start of boarding operations has not been announced to airport speakers	*Quality*
421	Lack of stairs for passenger descent	ARR FR 4015 BGY 23:20 26/07/2017	The ramp for the descent was missing due to the absence of an operator assigned to the descent of the passengers	*Quality*
79	Lack of drinking water on the plane	ARR FR 4015 BGY 23:20 01/07/2017	Reserves of drinking water not refilled	*Customer care*
41	Toilet service not performed	ARR AZ 1689 FCO 23:00 10/01/2017	Due to an equipment failure it was not possible to proceed with the cleaning and sanitation of the toilets	*Quality / Customer care*
121	Information displays off	-	Information monitors were turned off due to a failure	*Terminal infrastructure*
591	Presence of scratches under the tailgate	ARR FR 4015 BGY 21:50 01/05/2017	The presence of scratches could signal the happened impact of a ramp against the tailgate	*Environmental*
322	Lack of baggage on board	DEP FR 983 STN 10:10 24/03/2017	The baggage on board was more than expected	*Security*
450	Refueling too early	ARR FR 982 STN 21:20 02/06/2017	Refueling started when the disabled passenger was still on the plane	*Health & Safety*

Tab. 4.1 - Example of anomalies classification

The examples shown above is useful to make the reader understand the structure of the dataset realized over the months and how the anomalies can be categorized. Thus, for example, the lack of the announcement that the flight boarding operations (no. *352*) falls into the *"Quality"* category because this lack generates a worse airport experience for the passenger, while it does not lead to any risk in terms of health and safety. On the contrary, starting the refueling operations when one or more passengers are still on board (no. *450*) involves serious risks in terms of safety for operators and passengers.

Assigning each anomaly to a category is a fundamental phase and requires great attention: in fact, each category includes precautionary measures and precise risk response protocols that are not, of course, common to all the categories. It is essential to clarify that the countermeasures implemented to combat certain categories of risks may be totally useless if applied to a different category: it is obvious at this point that understanding an anomaly $'i'$ in a category $'J'$ not only entails the risk of non-neutralization but also the risk that it will recur when you think it has already been eliminated (and therefore forgotten).
From the examples above we have seen how, in this specific case, there are risks to *health*, that is, those that most affect the physical and biological aspect of operators who perform tasks where exposure is required, *safety* risks, personal or of other kind, and *transversal* and *organizational* risks, or risks that depend on the so-called "business dynamics", that is, on the whole of the working relationships, interpersonal and organizational approaches that are created in the airport context.

With these clarifications, we will not dwell further on how to insert an anomaly within the right category (that is the task of the risk analyst), but we will proceed with the analysis of the 615 anomalies that were identified in the 10 months following the software implementation and we will verify if the same anomalies have been neutralized (or not).

4.4.2 Anomaly analysis

Before proceeding with the numerical analysis of the anomalies, it is opportune to indicate all the categories in which the anomalies have been understood and to describe their meaning:

- *Health & Safety:* identifies problems that may affect the safety of passengers and operators who are preparing to perform their duties in places such as the runway, near the aircraft, on board the aircraft or at the gates; these anomalies may include, for example, particular aircraft conditions (damage), refuelling or incorrect fuel supply, drinking water operations, incorrect or missing maintenance etc.

- *Quality:* this kind of anomaly, in general, does not generate a risk for the health of passengers and / or operators but affects their experience at the airport; technical problems with the baggage belt, a delay in passenger boarding or document control, the in-perfect clean-up of the aircraft or an inadequate updating of the information display generate a negative judgment with respect to the service in the passenger.
- *Airside infrastructure:* in this case they are anomalies registered in the external infrastructures or leading to the runway (for example a departure room); among the many anomalies that may occur in this situation we can mention a lack of inspection of the track, a ramp that is not working or not accessible or the temporary lack of tools for transporting disabled people.
- *Customer care:* identifies anomalies in the services made available to the passenger, for example the failure to print a travel document or the lack of sound announcements.
- *Security:* reports issues related to the safety of passengers, baggage and cargo at the airport during, for example, passenger boarding operations, reconciliation of baggage with the operational office, etc.
- *Terminal infrastructure:* this category includes general anomalies inside the terminal.
- *Economical* and *Environmental:* it identifies problems different from those described above such as a failure to remove a ramp, problems with toilet services, failure to clean the holds, failure to inspect the aircraft, etc.

Given these premises should be kept in mind (but we will not go further) how the boundaries of these categories can sometimes be very thin, so that an anomaly that has been included in the category *Health & Safety* could easily be included in the *Security* category: in this case the experience and the competence of the risk analyst plays a fundamental role in the decision of the precautions to be taken.

Now, let's proceed with the anomalies classification:

Category	Anomalies found	Resolved anomalies	Unresolved anomalies
Health and safety	308	289	19
Quality	134	133	1
Airside infrastructures	16	14	2
Customer care	71	70	1
Terminal infrastructures	48	48	0
Economical	21	21	0
Security	12	12	0
Environmental	5	5	0
Total	615	592	23

Tab. 4.2 – Anomalies classification

As we can see the largest number of anomalies found are belonging to the categories *Health & Safety* and *Quality* and then all the others, within the dataset obtained we

have also introduced the severity level of the anomalies that are identified, that is the level of risk and urgency that the anomalies entail. Thus, for example, the failure of a vacuum cleaner (No. *54*) is characterized by a low severity level and a dent on a hatchback (No. *140*) is instead characterized by a medium level severity. On the contrary, the lack of antifreeze liquid to be sprayed on the wings of the plane (No. *258*) leads to an obviously high level of severity; the same can be said of 3 passengers departed without a valid identity document (No. *290*) or a failed positioning of a ramp for the disabled (No. *456*).

The previous examples have served to make the reader understand what the lines of demarcation are between the levels of low, medium and high severity. It should be noted that when there was uncertainty about the severity level to associate, it was always preferred to associate a higher severity level in order to be in a more cautious position.

Now, let's proceed with the severity classification:

Risk Level		
High	Medium	Low
232	236	145

Tab. 4.3 – Risk Level

From the classification we have found that over 75% of the identified situations are characterized by a medium-high level of severity and it is astonishing how these anomalies have never been recognized; on the other hand, in the past, serious problems were not missed at the Pescara airport in the past few years.

16th November 2014 - Due to a failure on the runway at a small private aircraft, Ryanair Fr 09364 from Barcelona was diverted to Ancona: the pilots, after several minutes in flight, in agreement with the control tower, had to make a stop at the airport of Ancona because of the delay with which the small aircraft on the runway was moved. The private plane was secured by SAGA employees. The Ryanair flight arrived in Abruzzo around 2 hours in late.[14]

9th May 2015 - At the airport the ceiling of the Police offices occurred. Saga immediately started to analyze what happened and to identify the technical reasons that led to the event. Nothing to do, therefore, with aspects related to the maintenance that is regularly carried out by the company according to a plan that is partly implemented even with the use of trained internal personnel.

[14] http://www.abruzzoweb.it/contenuti/problemi-per-aereo-privato-disagi-ad-aeroporto-pescara/557901-4/

Winter 2016/17 - Due to bad weather, there were numerous delays in scheduled flights, mainly due to logistical problems and related to the antifreeze liquid to be applied on the wings of the aircraft.

Thanks to the functionalities implemented in the "*Anomalies*" submodule (see chapter 3.1.6) we are able to keep track of the anomalies faced and closed, of the relative risks (severity) and of the responsible operators. In this context, analyzing the neutralized anomalies and the relative severity we realized the following table:

Resolved risks level		
High	Medium	Low
227	220	143

Tab. 4.4 – Resolved risk level

As we can see, the effective identification of anomalies involves an equally effective response:

- about 98% of the high-severity anomalies were neutralized;
- more than 93% of medium-severity anomalies were neutralized;
- almost 99% of the anomalies with reduced severity were neutralized;

At this point some considerations are necessary.

The use of the *Communication* module (and the related sub-module *Anomalies*) allowed not only the identification of over 600 anomalies never officially announced previously, but also a categorization in terms of severity and attribution of responsibility (this factor was a reason to initial resistances by some operators). Anyway, the software has proved statistically effective in neutralizing almost all anomalies with a high and moderate severity, slightly less effective in the case of medium severity anomalies.
At this point it is important to understand why the software has not been able to correct the anomalies of medium severity (93%) as with the other two categories (98% and 99%). Analyzing one by one the anomalies with medium severity we found that they were all characterized by a denominator: let's see some examples.

- *No. 60: ramp not positioned due to lack of a driver;*
- *No. 123: luggage loaded only after first providing AZ1242 flight assistance;*
- *No. 126: baggage returned after flight departure FR 983 due to concomitant arrival with flight Alitalia;*
- *No. 203: all the operators are busy. As a result, the baggage loading phase is delayed;*
- *No. 232: cleaning inside the aircraft not carried out due to lack of operators;*
- *No. 394: insertion of a checklist not made despite solicitation;*
- *No. 416: operational messaging not received;*

- *No. 433: reduced mobility passenger disembarkation was difficult as it was carried out with only 2 operators;*
- *No. 471: passenger disembarkation made by GSI operator for lack of staff SAGA engaged with arrival AZ;*
- *No. 553: delivery last cart time 22:30. Departure flight with 27 minutes delay time 22:52;*
- *No. 585: lack of staff and consequent delay in opening the check in.*

An attentive reader notices that, in all the examples just seen (all characterized by a medium level of severity), there is always one single element in common: the lack of operators. To verify that it was not a coincidence we discussed it with some airport analysts and these were their words:

"In general, the most frequent anomalies occurred is due to the lack of personnel assigned to ramps and infrastructures. The main consequences are often: delays in assistance to passengers with reduced mobility, delays in departure of aircraft, lack of information due to the lack of updating of the information displays (all anomalies that we have classified with medium severity!).
Thanks to the tool a large number of anomalies never recognized, rarely vocally reported or written on paper have been identified and resolved. However, there are limits that the software cannot overcome due to anomalies deriving from the lack of personnel that, at the moment, represents the great problem of our airport."

What emerges from the statistical evidence has therefore been widely confirmed by airport staff, most of the medium level anomalies are due to a lack of personnel. If on the one hand, then, this type of anomalies has not been completely eliminated (about 7%), on the other it must be emphasized that as many as 236 anomalies never previously identified were finally recognized and formalized, in addition to the fact that 93% of anomalies eliminated remains however a highly satisfactory percentage (considering the starting conditions).
The content of this conclusion is highly significant and encouraging because it highlights a fundamental concept: the software, although in conditions of insufficient staff, was able to generate routines that "optimize" the resources used.
A second result from this investigation is that the tool is finally able to identify precise responsibilities: it is known that the existence of *tacit routine* in the organization often constitutes a reason for non-compliance, a claim for merit and no assumption of responsibilities. We do not want to say that routines are harmful and to be eliminated, on the contrary, routines are part of the organization's unregistered knowledge and competence and allow processes to be improved through so-called *learning by doing*, but in highly regulated contexts the ability to recognize responsibilities, both in merit and in guilt, is of vital importance (as we will see later, this was a reason for an initial refusal by some staff members and enthusiasm of others).

In any case, the tool allows to identify the owner of a specific task and the period of responsibility: for illustrative purposes we will show the results related to the responsibilities generated by the *"Anomalies"* submodule, for obvious reasons the names of the operators have been replaced by the wording *Operator ' i '* .

User	Technical interventions
Operator 1	49
Operator 2	9
Operator 3	109
Operator 4	9
Operator 5	58
Operator 6	113
Operator 7	24
Operator 8	11
Operator 9	10
Operator 10	1
Operator 11	17
Operator 12	9
Operator 13	8
Operator 14	102
Operator 15	2
Operator 16	3
Operator 17	2

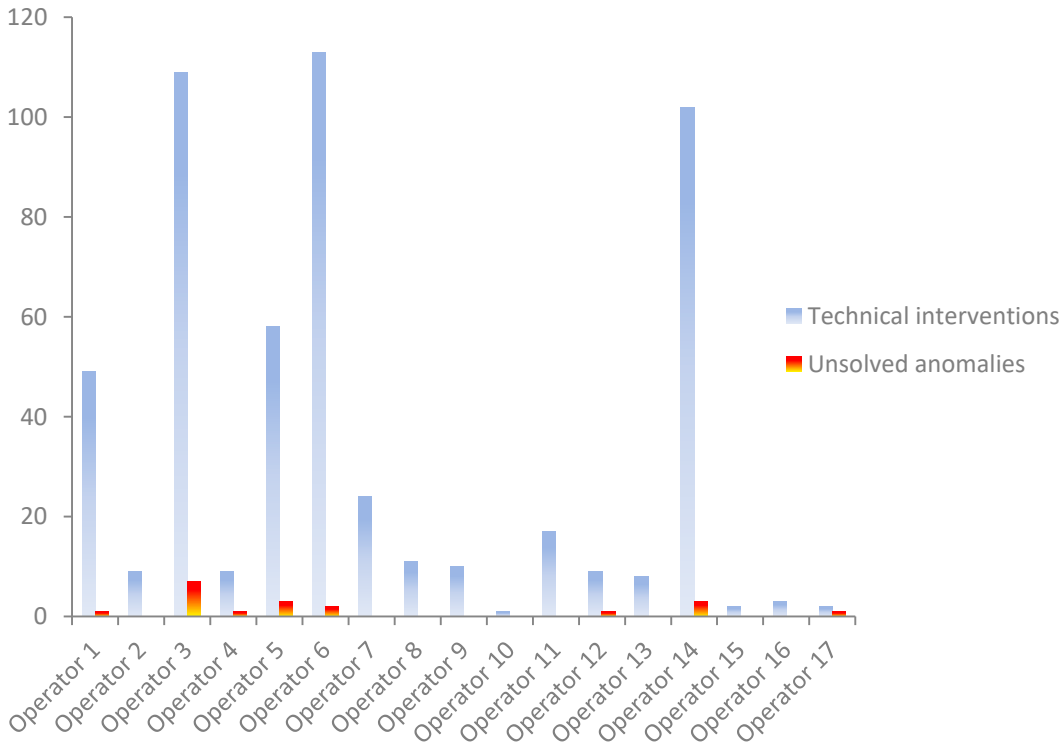
Tab. 4.5 – Interventions per operator

As you can see, operators 3, 6 and 14 are the operators that have been most affected by the number of technical interventions, then we find operators number *1*, *5* and *7* and then all the others. Beyond the role played, the position occupied these data allow us to understand which operators have identified the anomaly and which have personally dealt with resolving it and whether they have actually managed to do so.
Proceeding with our analysis we obtained:

User	Technical interventions	Solved anomalies	Unsolved anomalies
Operator 1	49	48	1
Operator 2	9	9	0
Operator 3	109	102	7
Operator 4	9	8	1
Operator 5	58	55	3
Operator 6	113	111	2
Operator 7	24	24	0
Operator 8	11	11	0
Operator 9	10	10	0
Operator 10	1	1	0
Operator 11	17	17	0
Operator 12	9	8	1
Operator 13	8	8	0
Operator 14	102	99	3
Operator 15	2	2	0
Operator 16	3	3	0
Operator 17	2	1	1

Tab. 4.6 – Interventions per operator (bis)

In order to a better visualization, see the following graph:



Interventions per operator

The chart allows us to better visualize the results obtained and it is possible to make some considerations: as previously noted, operators *1*, *3*, *5*, *6* and *14* are those who are more involved in the neutralization of anomalies (together they have had to deal

with more than 80% of the anomalies that have arisen in this period of time). The possibility of obtaining this data is a powerful tool for the airport management to monitor the performance of individual operators and reward their commitment. Operators *6* and *3* identified and tried to neutralize *113* and *109* anomalies, respectively; operator *6* managed to neutralize over 98% of the anomalies faced, operator *3* just under 94% (an excellent result for both!). In contrast, the most "lazy" operators in this period were number *10*, *15*, *16* and *17* with just 8 interventions in total on the same time horizon.
Obviously it is not our job to judge the work of the staff, but just make clear to the reader how this tool is very powerful that in addition to allowing better risk management and anomalies at the airport may have some use in the implementation of mechanisms "rewarding".

As demonstrated by the great effectiveness of the tool lies largely in the "*Communication & consultation"* module: as will be shown later through the study of the risk register market, the Tosca Solutions' tool puts a large part of its competitive advantage on a better management of information flows with respect to competitive products, in a market that is not yet perfectly structured and homogeneous.
As already described in the previous paragraph the 615 anomalies found in about 10 months since the implementation of the software were rarely found before and when this happened the information was transmitted via voice or were transcribed on cards that today we do not have track (hence the impossibility of constructing a greater comparison between anomaly management before and after software implementation).

Furthermore, it is necessary to underline that for greater effectiveness the *"Anomalies"* submodule must be used together with the submodule *"Shift handovers"*: this last section is designed to optimize information flows by providing timely and complete data that help reduce anomalies and increasing the involvement of all the staff in the planning and monitoring phases in order to guarantee a timely intervention in case of need. The combined use of the two modules mentioned above ensured, through a system of sending messages, reception of notifications in real time, feedback and other greater neutralization of anomalies and a reduction of response times, all this will be analyzed in the next paragraph.

4.4.3 Control charts

On the basis of the provisions of the Prime Ministerial Decree of November 30th 1998, each airport operator is required to draw up an Airport Services Chart in order to provide the passenger an overview of the main services offered by the airport and to improve the quality of the services offered by the infrastructure.
In general the factors that are held in strict consideration in carrying out of the control charts are the following[15]:

- Travel security;
- Personal and financial security;
- Cleaning and hygiene conditions;
- Comfort at the airport;
- Additional services;
- Services for passengers with reduced mobility;
- Public information services;
- Relational and behavioural aspects;
- Counter / access services;
- Modal integration - effective airport city connections.

Before showing the results of the survey carried out in recent months it is good to make some general clarifications regarding the operation of the airport.

The European Union has adopted specific safety rules that limit the amount of certain substances that can be carried through and beyond the airport security checkpoints. The new rules are subject to all passengers departing from the European Union airports, including national flights, whatever their destination. This means that every passenger will be subject to a check of the baggage in order to identify items that cannot be carried by plane (for example dangerous substances, liquids, etc.) and is the only responsible person for their baggage, presentation times at check-in and security checks.

Furthermore, all airports must provide support structures for visual and motor impairment (lifts, toilets for the disabled, parking, tools that facilitate the boarding and disembarkation of passengers with reduced mobility and precise reception points). Generally, in order to receive a timely and effective service, people with reduced mobility or their carers can request an assistance service tailored to their needs by notifying their arrival time at the airport and the flight they intend to take in time (possibly also indicating return flight). People with reduced mobility are boarded before the other passengers and disembarked last (unless otherwise provided by the

[15] Services Chart 2017, S.A.G.A.

companies aerial) and the airport is fully responsible for assistance through qualified personnel and dedicated vehicles until boarding / disembarkation has occurred.[16]

In these months, part of the work carried out, was aimed at collecting as much information as possible in order to establish if and how the software of Tosca Solution has generated improvements in the quality of the processes and services offered within the infrastructure. Thanks to the collaboration of the staff of the Airport of Pescara we could gather enough data to carry out a complete analysis of the main dynamics and activities on which the implementation of the software was going to impact and, considering that the implementation of the Risk Register at the Pescara Airport constitutes the first real application of the software, the results (which we will present below in an analytical way using quality charts) can be considered very encouraging.

[16] IATA (International Air Transport Association) Regulations. European Regulation 1107/2006 dated july 5th 2006. Enac circular Gen-02, july 8th 2008.

1. Delivery time of the first baggage

The first situation analyzed concerns the delivery times of the first baggage: this timing may depend on a number of factors as the baggage is unloaded from the aircraft at the same time as the passengers descend from the plane and are transported to areas designated for unloading and checking, after which they are sent via a special conveyor belt to the withdrawal point. The period between the descent of passengers from the aircraft and the arrival of the baggage on the delivery belt should be as short as possible because, in addition to offering a better experience to the passenger, it may occur that the passenger has to make a transit and then go to the next boarding in the shortest time possible. Obviously, the worst situation is that in which a baggage is lost.

With the data available we calculated that the number of moved baggage in 2016 was 185575 with an average 102 baggage per trip, while in 2017 it was 217750 with an average of 120 luggage per trip. In this case the most appropriate tool was the *Shewhart Control Chart for individual measurements* (and moving range).

2016

Below we see the data collected from the sampling of 100 individual measurements:

Sample	Delivery time (s)	Moving range	Sample	Delivery time (s)	Moving range
1	621		51	798	40
2	705	84	52	606	192
3	689	16	53	562	44
4	589	100	54	709	147
5	587	2	55	690	19
6	625	38	56	737	47
7	736	111	57	793	56
8	558	178	58	517	276
9	587	29	59	762	245
10	526	61	60	590	172
11	720	194	61	559	31
12	514	206	62	635	76
13	503	11	63	641	6
14	803	300	64	541	100
15	630	173	65	568	27
16	554	76	66	568	0
17	570	16	67	809	241
18	690	120	68	540	269
19	630	60	69	827	287
20	512	118	70	628	199

21	571	59	71	806	178
22	818	247	72	816	10
23	498	320	73	576	240
24	550	52	74	859	283
25	601	51	75	773	86
26	511	90	76	582	191
27	669	158	77	855	273
28	602	67	78	613	242
29	662	60	79	619	6
30	518	144	80	866	247
31	535	17	81	718	148
32	565	30	82	604	114
33	641	76	83	773	169
34	504	137	84	610	163
35	832	328	85	638	28
36	737	95	86	611	27
37	722	15	87	612	1
38	831	109	88	785	173
39	692	139	89	836	51
40	833	141	90	642	194
41	648	185	91	544	98
42	731	83	92	506	38
43	543	188	93	838	332
44	797	254	94	588	250
45	855	58	95	733	145
46	633	222	96	767	34
47	628	5	97	645	122
48	516	112	98	735	90
49	822	306	99	633	102
50	838	16	100	503	130

From the analysis of the samples (n=1), on average, in 2016 the first baggage was characterized by a waiting time of 660 seconds or 11 minutes.
The average moving range (124 seconds) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 825\ s$$

Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 495\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

2017

Below we see the data collected from the sampling of 100 individual measurements:

Sample	Delivery time (s)	Moving range	Sample	Delivery time (s)	Moving range
101	513	10	151	590	62
102	540	27	152	685	95
103	661	121	153	534	151
104	631	30	154	678	144
105	590	41	155	639	39
106	577	13	156	653	14
107	685	108	157	667	14
108	563	122	158	592	75
109	550	13	159	510	82
110	690	140	160	556	46
111	679	11	161	521	35
112	507	172	162	632	111
113	593	86	163	673	41
114	699	106	164	518	155
115	688	11	165	549	31
116	670	18	166	624	75
117	661	9	167	538	86
118	520	141	168	510	28
119	612	92	169	646	136
120	669	57	170	539	107
121	567	102	171	537	2
122	599	32	172	506	31
123	536	63	173	643	137
124	690	154	174	675	32
125	602	88	175	653	22
126	581	21	176	599	54
127	611	30	177	633	34
128	519	92	178	567	66
129	511	8	179	622	55

130	667	156	180	506	116
131	524	143	181	679	173
132	587	63	182	634	45
133	500	87	183	524	110
134	596	96	184	532	8
135	563	33	185	664	132
136	660	97	186	613	51
137	569	91	187	596	17
138	548	21	188	697	101
139	585	37	189	666	31
140	499	86	190	680	14
141	588	89	191	699	19
142	587	1	192	616	83
143	622	35	193	521	95
144	663	41	194	499	22
145	661	2	195	587	88
146	626	35	196	575	12
147	573	53	197	610	35
148	683	110	198	683	73
149	615	68	199	664	19
150	528	87	200	536	128

From the analysis of the samples (n=1), on average, in 2017 the first baggage was characterized by a waiting time of 600 seconds or 10 minutes.
The average moving range (67 seconds) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 689\ s$$

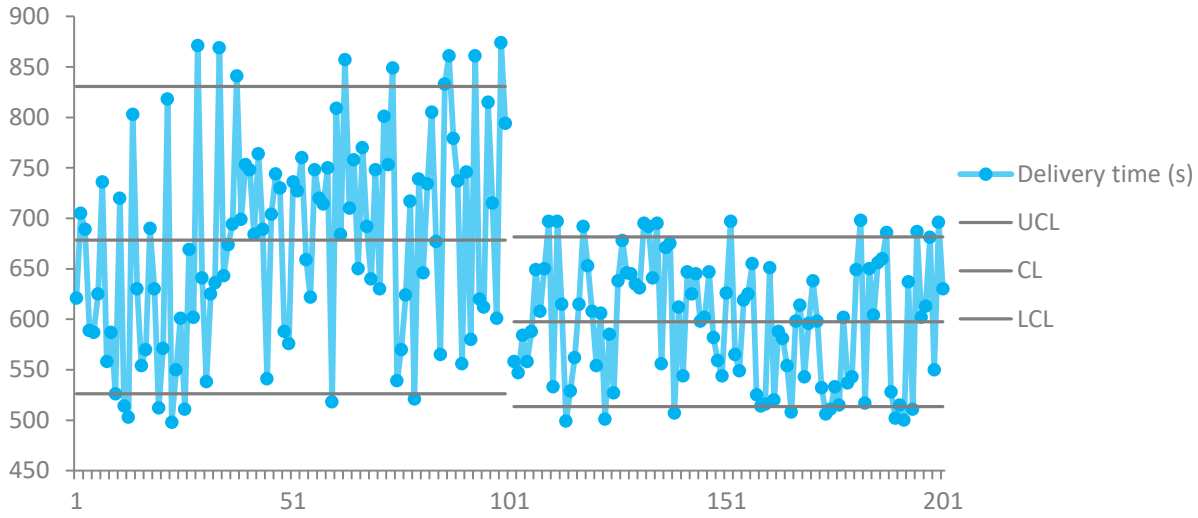
Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 511\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

Plotting the previously obtained data, the following graph is obtained:



Control chart for delivery time for the first baggage

As we can see, the average waiting time for the delivery of the first luggage in 2016 is about 11 minutes, but the worrying figure is that it reaches even higher peaks reaching about 14 minutes waiting times. A further concern comes from the high variability of the samples and the excessive jumps of the curve in 2016 (remember that the sampling is done completely random and applies to national and international flights).

One of the main aims of the implementation of the new system was to reduce both the average wait and the variability in order to guarantee a process of redelivering luggage to passengers and realign the related activities connected.
We immediately notice that, starting from hundredth sample onwards the number of "out-of-control" has decreased and that, if before the implementation of the risk register the oscillations had an amplitude increasing over time, immediately after implementation the oscillations are reduced starting from the 101st sample and presents a most under control situation.

The reduction of the delivery time of a baggage, as well as providing a better passenger experience, also entails the possibility of anticipating numerous other related activities. It must be kept in mind that an airport, as well as a port or a train station, consists of a network of key activities that influence each other. So, in this case, a reduction in the delivery time of the baggage offers the possibility to anticipate the delivery of the luggage of the next flight, proceed with the maintenance and cleaning of the conveyor belts, anticipate airport police checks, avoid the accumulation of queues of people, reduce the risk of loss of luggage, etc.

2. Waiting time for security checks

Once the check-in has been completed before going to the embarkation, it is necessary to carry out the security checks at the designated checkpoints. In this area passengers are obliged to show their boarding pass (electronic or paper) which will be checked electronically or manually by airport personnel: in these stations there are metal detectors and other equipment to support operators in the control of travelers.
Passenger control phases can take many minutes, in particular in crowded situations and / or peak times. It is important for passengers to present themselves to the controls in a prepared manner facilitating the control of airport operators. On the other hand, the staff, in addition to verifying that passengers can embark safely, must make the control activities as quick as possible in order to avoid the formation of long queues and overcrowding situations.

2016

Sample	Average wait	Moving Range	Sample	Average wait	Moving Range
1	410		51	188	17
2	340	70	52	406	218
3	182	158	53	370	36
4	270	88	54	375	5
5	182	88	55	322	53
6	489	307	56	441	119
7	546	57	57	250	191
8	181	365	58	492	242
9	178	3	59	538	46
10	437	259	60	413	125
11	167	270	61	389	24
12	210	43	62	314	75
13	456	246	63	351	37
14	323	133	64	369	18
15	419	96	65	229	140
16	328	91	66	496	267
17	401	73	67	401	95
18	273	128	68	270	131
19	223	50	69	306	36
20	255	32	70	419	113
21	360	105	71	166	253
22	267	93	72	476	310
23	329	62	73	180	296
24	351	22	74	243	63
25	350	1	75	408	165
26	400	50	76	371	37
27	308	92	77	467	96

28	464	156	78	184	283
29	314	150	79	279	95
30	446	132	80	321	42
31	351	95	81	423	102
32	480	129	82	422	1
33	303	177	83	449	27
34	419	116	84	227	222
35	434	15	85	226	1
36	436	2	86	314	88
37	311	125	87	378	64
38	256	55	88	505	127
39	182	74	89	286	219
40	398	216	90	471	185
41	347	51	91	474	3
42	210	137	92	486	12
43	220	10	93	320	166
44	226	6	94	243	77
45	471	245	95	545	302
46	330	141	96	389	156
47	494	164	97	336	53
48	255	239	98	529	193
49	391	136	99	207	322
50	205	186	100	491	284

Sampling is here characterized by single measurements and uses the moving range.
In 2016, Pescara Airport carried out 100 individual samplings with an average duration of the checks wait of 374 s.
The average moving range (117 seconds) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 477\ s$$

Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 270\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;

$d_2 = 1{,}128.$

2017

Sample	Average wait	Moving Range	Sample	Average wait	Moving Range
101	403	88	151	528	16
102	260	143	152	231	297
103	527	267	153	416	185
104	503	24	154	516	100
105	298	205	155	472	44
106	339	41	156	525	53
107	216	123	157	208	317
108	401	185	158	538	330
109	197	204	159	420	118
110	490	293	160	410	10
111	391	99	161	212	198
112	300	91	162	447	235
113	322	22	163	235	212
114	471	149	164	520	285
115	460	11	165	204	316
116	508	48	166	177	27
117	493	15	167	202	25
118	196	297	168	415	213
119	527	331	169	384	31
120	474	53	170	460	76
121	517	43	171	201	259
122	219	298	172	297	96
123	540	321	173	271	26
124	500	40	174	232	39
125	414	86	175	172	60
126	446	32	176	384	212
127	322	124	177	388	4
128	254	68	178	446	58
129	253	1	179	253	193
130	435	182	180	441	188
131	350	85	181	400	41
132	353	3	182	496	96
133	407	54	183	250	246
134	396	11	184	280	30
135	532	136	185	484	204
136	392	140	186	298	186
137	538	146	187	402	104
138	378	160	188	457	55

139	179	199	189	435	22
140	218	39	190	226	209
141	380	162	191	427	201
142	221	159	192	259	168
143	338	117	193	474	215
144	194	144	194	331	143
145	483	289	195	265	66
146	201	282	196	468	203
147	171	30	197	220	248
148	312	141	198	288	68
149	340	28	199	531	243
150	512	172	200	213	318

In 2017, contrary to what was hoped for, the average wait for safety checks was slightly raised (about one minute), the sampling was carried out in a completely random way and as in the previous case the USL and LSL were calculated. The new moving range is about 137 s.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 678\ s$$

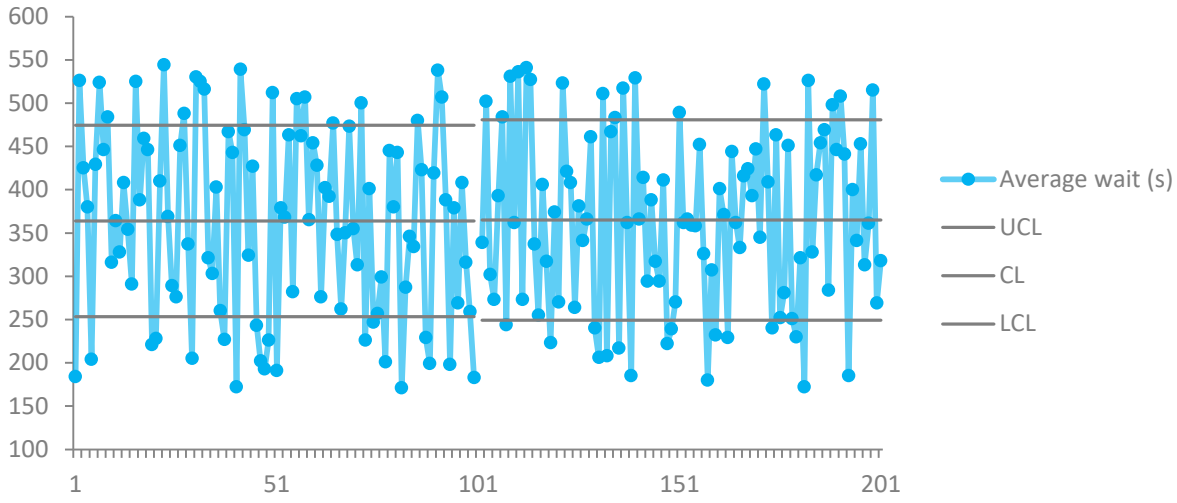
Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 151\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

Putting together the previously obtained data, the following graph is obtained:



Waiting time for security checks

It is worth making some considerations about the results obtained: as you can see, the distance between the control limits is increased rather than reduced as we hoped. Moreover, the number of "jumps" of the curve (larger and more numerous in 2017) highlights a particular situation to which particular attention must be paid. With the information available it is difficult to identify the specific and contingent causes that have generated such jumps and a higher number of out of control. In order to give an exhaustive explanation, however, we went on to assess what changes, in the last year, could have generated such a deterioration.

Among the most relevant causes in this regard, it should be noted that in 2017 there was a +16.7% compared to the previous year of the total number of passengers in transit (reaching the historic maximum for the airport of Pescara) with obvious consequent increase in attendance at the checkpoints.

Considering this we can be satisfied with the result obtained because we have reason to believe that in the absence of the implementation, the average waiting time would probably be further dilated generating a problematic overcrowding to be managed for an airport that, for the first time in its history, reaches a similar peak of passengers.

Ultimately, however, it is expected that 2017 may represent a "frictional" period and that waiting times for controls may be reduced even further starting in the two-year period 2018/19.

3. Time of disembarkation for passengers with reduced mobility

At the airport, passengers with disabilities and passengers with reduced mobility can take advantage of many important services, under the responsibility of airport managers, who should allow their stays and transits without particular constraints.
Pescara Airport has disability, visual and motor support structures including elevators for vertical movements, toilets for the disabled people, parking near the airport, tools to facilitate the boarding and disembarkation of passengers from aircraft and call points. Generally it is advisable for passengers with reduced mobility or for accompanying persons to make an assistance request to the airline company already during the flight booking phase and within 48 hours of departure.

Among the indicators related to passengers with reduced mobility analyzed in this project we have chosen to evaluate the waiting time on board for the landing after the land of the last passenger (in this chapter) and the waiting time to receive assistance once notified its presence at the airport (in the next chapter).

2016

Sample	Average wait	Moving range	Sample	Average wait	Moving range
1	22		51	24	5
2	22	0	52	23	1
3	19	4	53	19	4
4	16	2	54	21	2
5	19	2	55	23	2
6	22	3	56	21	2
7	18	4	57	22	1
8	23	5	58	20	2
9	22	1	59	19	1
10	21	1	60	18	1
11	20	1	61	22	4
12	17	3	62	19	3
13	22	5	63	18	1
14	21	1	64	16	2
15	23	2	65	24	8
16	19	5	66	21	3
17	20	1	67	20	1
18	18	2	68	19	1
19	24	6	69	24	5
20	19	5	70	23	1
21	21	2	71	17	6
22	17	4	72	17	0
23	18	1	73	20	3

24	19	1	74	20	0
25	19	1	75	20	0
26	18	2	76	22	2
27	20	2	77	17	5
28	20	0	78	19	2
29	21	1	79	19	0
30	22	1	80	23	4
31	23	1	81	16	7
32	21	2	82	18	2
33	22	1	83	20	2
34	18	4	84	20	0
35	20	2	85	21	1
36	17	3	86	22	1
37	22	5	87	17	5
38	16	6	88	20	3
39	23	7	89	16	4
40	19	4	90	16	0
41	19	0	91	16	0
42	23	4	92	24	8
43	16	7	93	23	1
44	22	6	94	18	5
45	18	4	95	20	2
46	21	3	96	16	4
47	24	3	97	18	2
48	19	5	98	21	3
49	18	1	99	16	5
50	19	1	100	16	0

Also in this case sampling was performed with single measurements and moving range.
The average wait for passengers with reduced mobility after the last passenger's disembarkation has been calculated to be approximately 20 minutes (19,8) in 2016.
The moving range (2,66 minutes) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 22{,}2\ min$$

Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 17{,}5\ min$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

2017

Sample	Average wait	Moving range	Sample	Average wait	Moving range
101	12		151	9	2
102	7	5	152	14	5
103	9	2	153	9	5
104	10	1	154	14	5
105	10	0	155	10	4
106	12	2	156	11	1
107	14	2	157	9	2
108	7	7	158	12	3
109	7	0	159	11	1
110	13	6	160	12	1
111	12	1	161	11	1
112	13	1	162	13	2
113	7	6	163	12	1
114	10	3	164	10	2
115	10	0	165	11	1
116	8	2	166	10	1
117	12	4	167	14	4
118	11	1	168	13	1
119	13	2	169	13	0
120	8	5	170	14	1
121	14	6	171	7	7
122	12	2	172	7	0
123	13	1	173	10	3
124	12	1	174	9	1
125	10	2	175	11	2
126	11	1	176	12	1
127	14	3	177	10	2
128	8	6	178	14	4
129	8	0	179	11	3
130	11	3	180	7	4
131	8	3	181	11	4
132	12	4	182	9	2
133	9	3	183	7	2

134	14	5	184	11	4
135	8	6	185	12	1
136	10	2	186	9	3
137	14	4	187	12	3
138	12	2	188	7	5
139	13	1	189	10	3
140	11	2	190	11	1
141	7	4	191	9	2
142	9	2	192	8	1
143	13	4	193	11	3
144	12	1	194	14	3
145	12	0	195	14	0
146	11	1	196	11	3
147	13	2	197	13	2
148	10	3	198	10	3
149	11	1	199	8	2
150	11	0	200	14	6

In 2017 sampling provided 100 others samples (single measurements) with the calculation of the respective moving ranges.
The average wait for passengers with reduced mobility has been calculated to be approximately 10 minutes and half in 2017.
The moving range (2,52 minutes) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 13{,}0\ min$$

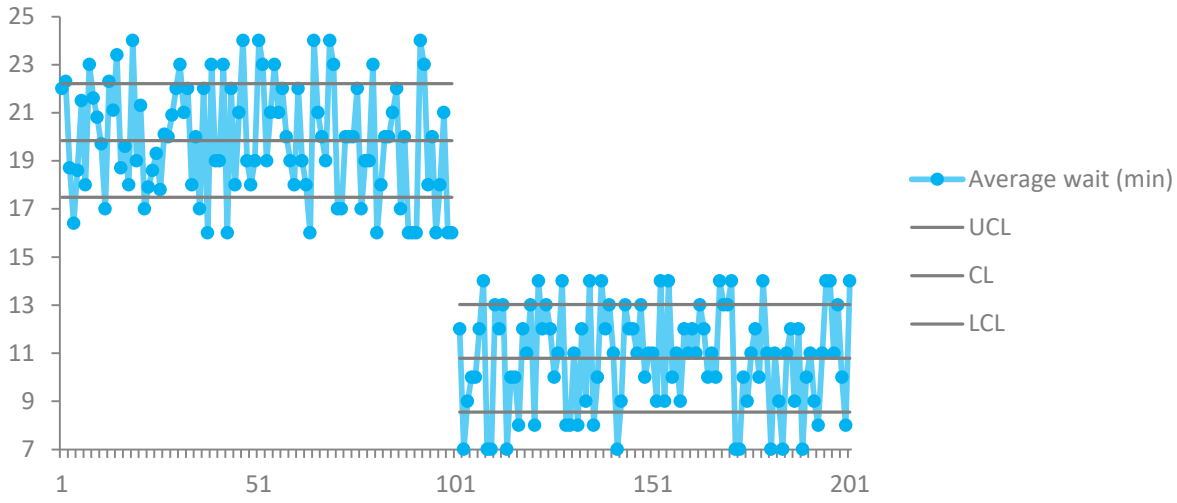
Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 8{,}6\ min$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

Putting together the previously obtained data, the following graph is obtained:



Disembarkation time for passengers with reduced mobility

As can be seen before the implementation of the software, the variability of the disembarkation times of the passengers is particularly high and has wide fluctuations between reasonable disembarkation times and long periods of time. It should be noted that these fluctuations, in addition to the natural variability of landing activities and singular and contingent reasons, are also due to the different degrees of disability of the passenger. From the comparison between the two graphs we can see that if in the first year the curve shows a high variability with significant jumps along the entire distribution, in the second year the average wait is reduced significantly (almost halving), accompanied by a moderate reduction in the variability of the process.

It is worth explaining the meaning of the variability of these graphs: it is normal that the operations involving passengers with reduced mobility may require very different timing as each passenger is characterized by a different disability, which implies dutifully measures, tools and procedures very different which can lead to very different landing times. A more "rigid" trend of these curves could have generated in the reader the doubt that the data were not entirely real.

4. Waiting time to receive assistance once passenger with reduced mobility has notified its presence in the airport

In compliance with the EC regulation - No.1107 / 2006 the airport operator provides assistance to disabled passengers and passengers with reduced mobility. The EC Regulation gives airport management companies responsibility for assistance services at European airports and standardizes their level of service (assistance is totally free for disabled passengers and reduced mobility).

Among the many services offered to the disabled passenger there is also the possibility to receive assistance from the moment you leave your vehicle in the reserved areas of the airport until you board to the aircraft.

2016

Sample	Average wait	Moving range	Sample	Average wait	Moving range
			38	25	3
1	22		39	22	3
2	26	4	40	19	3
3	20	6	41	19	0
4	19	1	42	22	3
5	25	6	43	24	2
6	17	8	44	20	4
7	24	7	45	20	0
8	18	6	46	14	6
9	25	7	47	14	0
10	18	7	48	21	7
11	17	1	49	21	0
12	16	1	50	14	7
13	21	5	51	17	3
14	14	7	52	24	7
15	20	6	53	24	0
16	25	5	54	14	10
17	23	2	55	26	12
18	24	1	56	23	3
19	19	5	57	18	5
20	16	3	58	14	4
21	26	10	59	21	7
22	25	1	60	24	3
23	19	6	61	24	0
24	20	1	62	26	2
25	22	2	63	23	3
26	22	0	64	15	8
27	14	8	65	15	0

28	24	10	66	20	5
29	20	4	67	25	5
30	19	1	68	26	1
31	22	3	69	26	0
32	21	1	70	21	5
33	15	6	71	25	4
34	21	6	72	15	10
35	16	5	73	19	4
36	26	10	74	26	7
37	21	5	75	14	12

Also in this case sampling was performed with single measurements and moving range.
The average wait for passengers with reduced mobility in a waiting area has been calculated to be approximately 20 minutes.
The moving range (4.43 minutes) has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 24{,}3\ min$$

Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 16{,}5\ min$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

2017

Sample	Average wait	Moving range	Sample	Average wait	Moving range
76	16				
77	15	1	114	17	1
78	14	1	115	15	2
79	18	4	116	15	0
80	15	3	117	12	3
81	14	1	118	15	3
82	16	2	119	13	2
83	15	1	120	15	2
84	14	1	121	15	0
85	14	0	122	14	1
86	14	0	123	15	1
87	18	4	124	17	2
88	17	1	125	16	1
89	16	1	126	13	3
90	17	1	127	17	4
91	16	1	128	16	1
92	17	1	129	18	2
93	14	3	130	12	6
94	15	1	131	18	6
95	15	0	132	17	1
96	18	3	133	18	1
97	14	4	134	17	1
98	16	2	135	16	1
99	13	3	136	18	2
100	12	1	137	16	2
101	13	1	138	18	2
102	16	3	139	16	2
103	12	4	140	14	2
104	14	2	141	14	0
105	12	2	142	13	1
106	16	4	143	18	5
107	17	1	144	15	3
108	15	2	145	16	1
109	15	0	146	17	1
110	18	3	147	12	5
111	12	6	148	12	0
112	16	4	149	14	2
113	16	0	150	14	0

From the data analyzed in 2017 we can see how the waiting times have clearly decreased since the first sampling and that the oscillations are drastically reduced with the continuation of the sampling. The average waiting time in the second year is reduced by 5 minutes (from 20 to 15 minutes) while the moving range has been reduced to about 2 minutes compared to 4.43 in the previous case (an indication that even the variability of the process is clearly reduced).
The moving range was calculated not only to evaluate the variability of the process, but also to identify the lines of UCL and LCL.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 17{,}0\ min$$

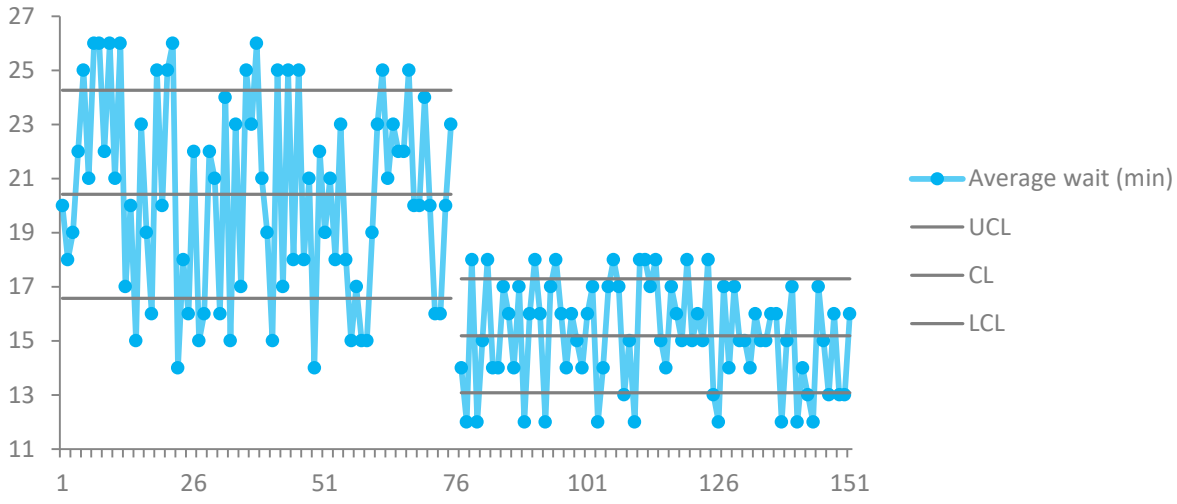
Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 13{,}5\ min$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

Plotting the data obtained:



Waiting time to receive assistance

In this graph we can see that the trend in the first year was highly variable. Since sampling is done randomly, there are probably no reasons to tie a point in the curve with the next one: this implies that the high variability of 2016 can be traced back to

reasons such as disorganization, delays and lack of coordination. Part of these delays can however be traced back to the variable flows of passengers in transit: during our analysis it was noticed that in all the circumstances in which the waiting of the disabled passenger has exceeded 24 minutes (approximately the Upper Control Limit) they were days and times of peak for departures and arrivals. As we see in the second year, the aim was to reduce this variability and the average wait of every disabled passenger.

The curve shows a drastic reduction in average waiting time and the mobile range already in the first year of implementation. The number of out of control has not changed as we expected, the reasons are probably attributable to what previously described: the points of the curve are unrelated to each other and suffer from singular and contingent factors (for example, the arrival point of the passenger disabled, transit passenger flows, timetables, personnel available, etc.). However, it should be emphasized that coordination and communication flows have greatly improved thanks to the implementation of the Risk Register and this has led to a reduction in waiting times of 5 minutes in just one year.

5. Waiting time from B.O. on board for the landing of the first passenger

Once the landing procedures have been completed, passengers are usually asked to wait a few minutes before they can pick up their personal belongings and get off the plane: this is because in addition to the usual protocol to be carried out once the plane has reached the area for the descent of the passengers it requires that the operators and vehicles in charge are ready for the aircraft and perform, in safety, the usual procedures in order to allow a safe disembarkation of the passengers.
Sometimes these procedures can take longer than usual as it is necessary to bring vehicles, ramps and tools closer to the aircraft to allow the descent even to passengers with disabilities. The timeliness of communications and the coordination between managers and track operators play a fundamental role in these phases. It is easy to understand how certain circumstances (such as the contemporaneousness of take-offs and landings and the limitation of instruments and track personnel) can lead to a not always effective coordination.
In optimizing time and resources instruments such as the Risk Register play a fundamental role and we will see an example of this applied to waiting times on board before the passengers they can get off.

2016

Sample	Waiting	Moving range	Sample	Waiting	Moving range
1	116		41	109	0
2	120	4	42	112	3
3	110	10	43	122	10
4	99	11	44	100	22
5	125	26	45	107	7
6	121	4	46	109	2
7	151	30	47	113	4
8	124	27	48	124	11
9	136	12	49	102	22
10	128	8	50	100	2
11	119	9	51	124	24
12	140	21	52	114	10
13	158	18	53	105	9
14	134	24	54	129	24
15	101	33	55	121	8
16	116	15	56	138	17
17	144	28	57	121	17
18	122	22	58	109	12
19	122	0	59	104	5
20	114	8	60	103	1

21	103	11	61	121	18
22	108	5	62	100	21
23	110	2	63	136	36
24	111	1	64	136	0
25	140	29	65	121	15
26	119	21	66	132	11
27	144	25	67	120	12
28	125	19	68	112	8
29	118	7	69	116	4
30	155	37	70	113	3
31	111	44	71	138	25
32	125	14	72	129	9
33	109	16	73	100	29
34	126	17	74	144	44
35	108	18	75	98	46
36	130	22	76	136	38
37	125	5	77	108	28
38	120	5	78	110	2
39	109	11	79	129	19
40	109	0	80	116	13

Also in this case sampling was performed with a single measurements and moving range. The average wait for passengers in board of the aircraft has been calculated to be approximately 2 minutes.
The moving range was just 15 seconds and it has been calculated to obtain the Upper Control Limit and the Lower Control Limit.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 133\ s$$

Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 106\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

In this case it should be emphasized that waiting times on board the aircraft were not particularly high (for the same reason, reducing this indicator represented the biggest challenge for the Tosca Solution Risk Register).
In any case, the sampling carried out in 2016 (80 single measurements and mobile range) showed that the initial data were already acceptable, albeit with some large fluctuations. As mentioned previously, these jumps can depend on many factors: lack of coordination, delay in communications, distances from the parking positions of vehicles suitable for the descent of passengers and the adverse weather conditions that imply a lower speed in the phases of approaching the aircraft for the vehicles of support for the descent of passengers.
However, since this was a particularly low average duration we wanted to go down to a further level of precision to understand if, even in already good starting conditions, the Risk Register could have reduced on-board waiting times. For this reason the sensitivity of the measurements has been deliberately converted from minutes to seconds (as can be seen from the measurement scale of the following graph). Improving this aspect, albeit (as already mentioned) it starts from an acceptable situation, plays a key role for passengers in transit, ie those passengers who have to get on a subsequent flight from the same airport, contributing to improve their airport experience.

2017

Sample	Waiting	Moving range	Sample	Waiting	Moving range
81	108		121	134	24
82	113	5	122	135	1
83	138	25	123	137	2
84	128	10	124	116	21
85	113	15	125	115	1
86	131	18	126	138	23
87	127	4	127	129	9
88	131	4	128	139	10
89	116	15	129	130	9
90	111	5	130	135	5
91	126	15	131	128	7
92	117	9	132	122	6
93	119	2	133	134	12
94	112	7	134	116	18
95	131	19	135	117	1
96	109	22	136	129	12
97	109	0	137	110	19
98	116	7	138	132	22
99	124	8	139	123	9
100	125	1	140	130	7

101	133	8	141	126	4
102	122	11	142	134	8
103	111	11	143	109	25
104	135	24	144	119	10
105	108	27	145	126	7
106	113	5	146	125	1
107	113	0	147	112	13
108	131	18	148	126	14
109	113	18	149	122	4
110	113	0	150	138	16
111	121	8	151	127	11
112	112	9	152	117	10
113	129	17	153	133	16
114	137	8	154	138	5
115	116	21	155	134	4
116	120	4	156	120	14
117	127	7	157	109	11
118	115	12	158	115	6
119	118	3	159	108	7
120	110	8	160	125	17

In 2017, sampling was carried out in 80 different situations. The average waiting time for the landing of the first passenger was also 2 minutes in this case, but for the reasons specified above we fell to a better sensitivity level: we evaluated the number of seconds for the first passenger's disembarkation (and not just minutes).
In this way we calculated that the average duration for disembarkation the first passenger was 3 seconds bigger than the previous year and with a moving range of less than 4 seconds compared to 2016.

The moving range was calculated not only to evaluate the variability of the process (lower than the previous year), but also to identify the lines of UCL and LCL.

Upper Control Limit:

$$UCL = x + L\frac{MR}{d_2} = 132\ s$$

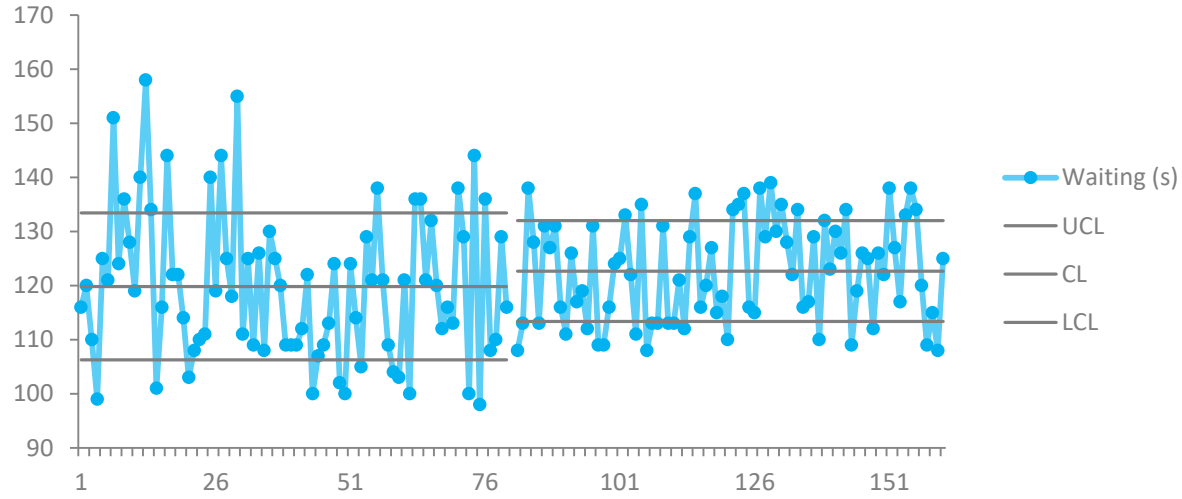
Lower Control Limit:

$$LCL = x - L\frac{MR}{d_2} = 113\ s$$

where:

x is the mean;
L is the distance of the control limits from the center line;
MR is the moving range;
$d_2 = 1{,}128$.

Plotting the date on the graph:



Waiting time from B.O. on board for the landing

Although we cannot deduce any particular improvements from the graph, it should be noted that the variability of the whole process have been moderately reduced since the implementation of the software even if, from the result of this sampling, the number of out of control does not seem to have been reduced. The results to be analyzed in this case are therefore two: the reduction of variability and the fact that the number of out of control has remained constant.
Although the reduction of the variability when the starting data (2016) were absolutely acceptable, further margins for improvement were noted after the implementation of the software. This was not obvious in the implementation phase, since the reorganization of the staff and communications could easily generate frictional delays due to the reorganization of the routines that, as is known, constitute the tacit know-how of every organizational context.
This allows us to conclude that, even if there were some inertia for organizational change, this has been largely offset by the effectiveness of the new protocols suggested by the software. It goes without saying that there are limits that it is impossible to reduce further (for example it is impossible that a ramp can reach a plane in the farthest track in bad weather conditions in less than 2 minutes), for this reason we can be satisfied with the results achieved.

6. Conclusion

In conclusion, we consider it useful to present some reflections about the implementation of the software in the computer systems of the Pescara Airport.

At an early stage, software implementation has suffered some inertia: it is well known that changes at the organizational level take time to create new routines that can make an organization work well. However, a part of the operators was enthusiastic about the change because they felt involved and important because the use of the tool, with the signature of the activities performed and the highlighting of any anomalies, offered them the possibility of expression and visibility also towards the management. On the other hand, the remaining part showed, at least in an initial phase, hostility and mistrust as if the instrument had been a weapon of the management to monitor them and consequently "punish" them for possible errors. However, through various workshops with the collaboration of Trinity College and with a change in the Safety Policy the mistrust has been overcome and everyone has enthusiastically accepted the new tool. This period lasted approximately 6 months.

To date, the tool is still compiled manually by the operators and analysts have let us know that, given the enthusiasm with which they use the software and the idea of continuing to use it for a long time, it would be convenient for them to implement the possibility to communicate the airport management software with the risk register in such a way as to reduce the time (this obviously requires a study).

The most frequent anomalies identified through the use of the software concern both the lack of personnel and anomalies to ramp vehicles or infrastructures and concern mostly: delays in the assistance to disabled passengers, delays in the departure of aircraft and lack of information due information systems malfunction. Thanks to the tool many anomalies reported and related to the ramp vehicles, infrastructures have been resolved. The problem of anomalies deriving from the lack of personnel remains and these have not yet been resolved.

Communication was the strong point of this software. The communication time between departments, between offices and between managers and track operators has considerably reduced with all the advantages that this entails within an airport.

Finally, from the testimonies gathered at the airport, analysts and operators have told us that the risk register has become for them a fundamental tool for the certification of the Handling and the monitoring of the turnaround processes is a very powerful tool during the inspections by the airline companies, ENAC and the internal meetings of the Management Review Board, which analyzes the most frequent critical issues extrapolated from the Risk Register and seeks solutions to eliminate or reduce these criticalities.

Business Plan

Finalist at EIT Business Idea Competition
Budapest, 7th November 2017

TOSCA HUMAN FACTORS SOLUTIONS LTD.

EIT Business Idea Competition

7th November 2017, Budapest

5 Business Plan

5.1 Executive Summary

Tosca Human Factors Solutions Limited is a Trinity College Dublin spin-out campus Company registered in Ireland in May 2016. The company was set up to develop and distribute risk management tools customized specifically to the needs of highly regulated environments. Tosca provides various solutions to optimize core operations for safety critical activities initially focusing on Airport Operations providing real time performance data:

- Tosca platform is a web application to monitor performance data on every flight and for every activity;
- it provides digital shift handovers and daily sign off checks for key operations, including ground handling;
- this delivers higher integration of task support and risk management capacity for people on the ground;
- it also allows task assignment and KPI monitoring for management;
- the data collected offers data analytics and real time auditing for airports, on human and technical performance metrics.

After a test phase, Tosca converted Pescara Airport into a paying customer where it achieved impressive results, positively changing the way in which it operates. Feedback from this project is very positive with results showing a 50% reduction in the number of hours of paperwork processing and a 30% reduction in operational problems, better planning and resolution of issues as well as greater clarity in " who does what " to the site.
In order to verify the sustainability of the business, a study of the market, business opportunities, the competitive environment and financial forecasts were carried out. The results were encouraging and, joining the operational effectiveness of the tool, push the management of Tosca Solutions to continue with the path taken.
The main customer segment identified to which Tosca Solutions should address is that of the airport industry. At present, the safety services industry, although it appears highly fragmented, seems to offer better returns especially to small businesses which, at least for the time being, do not have to face large barriers to entry.

The monetary needs requested at this time amount to approximately € 85.000 needed to start a second project after the one carried out at Pescara. The financial projections achieved in recent months have allowed us to build the following income statement:

	2018	2019	2020	2021	2022
Taxable Revenues	€ 789.905	€ 1.694.608	€ 3.465.852	€ 5.153.158	€ 5.576.090
Not Taxable Revenues	€ 0	€ 0	€ 0	€ 0	€ 0
REVENUES	€ 789.905	€ 1.694.608	€ 3.465.852	€ 5.153.158	€ 5.576.090
Costs and Expenses	-€ 447.220	-€ 587.380	-€ 727.540	-€ 770.740	-€ 830.500
EBITDA	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Depreciations & Amortizations	€ 0	€ 0	€ 0	€ 0	€ 0
EBIT	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Interests	€ 0	€ 0	€ 0	€ 0	€ 0
EARNINGS BEFORE TAXES	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Taxes	-€ 42.836	-€ 138.404	-€ 342.289	-€ 547.802	-€ 593.199
NET EARNINGS	€ 299.849	€ 968.825	€ 2.396.023	€ 3.834.616	€ 4.152.391

Tab. 1 - Income statement

From the perspective income statement it is possible to note that there are no years of loss making: this is motivated by the fact that we have proposed to sell 6 projects from the first year (reasonable conclusion as Tosca Solutions is currently discussing 6 contracts with airports of Dublin, Berne, Athens, Naples, Cork and Nuremberg) and this demonstrates the sustainability of the hypothesized business model.

The request for funding and the relatively high IRR (see below) are natural consequences of the assumptions made at the base of the proposed business model and the market opportunities currently present, moreover considering a rate of profit distribution equal to 30% of the maximum dividend of the year the Net Present Value rises to approximately € 590.000.

5.2 Value Proposition

The research carried out in recent months showed convincingly that despite in the recent years we have witnessed a strong openness to risk management issues and many tools have been created to plan and mitigate risks in critical safety activities, they are not yet widely used today. The two main factors in the lack of adoption are:

- these methods and tools are difficult to use (sometimes even for experts) and it's impossible to integrate them with pre-existing management software;
- many companies believe that these software are useless or can have a potentially negative impact on the overall economics of a project.

Tosca Solution's goal is to provide a tool that can assist small, medium and large companies in the creation, planning and management of safety critical activities, also in highly regulated industries.

Tosca's Risk Register is a web application capable of reporting events and anomalies in real time, ensuring constant monitoring of business processes and a faster and more effective information delivery to competent offices; all of this is served by a cloud storage service that prevents the loss of information and makes them accessible anywhere, which plays a fundamental role in inspections and internal management meetings. This tool also allows a quick calculation of the most interesting KPIs for the company and the creation of different profiles (*Manager, Supervisor* and *Operator*) allowing different actions in relation to the role and the responsibility degree covered. Moreover, Tosca's Risk Register is an easy-to-use software for non-experts and people without a specialist education or extensive training and it can be able to integrate with existing planning methods and management software. Finally it produces a positive overall economic impact on the project by including efficiency and economic considerations in the planning, design and risk mitigations for Safety Critical Activities.

In September 2017 Tosca Solutions started a technology transfer with the aim of adapting the tool developed for aviation (TRL 9) to the mining industry, a completely new domain (the starting point is therefore estimated to be a TRL 6).

5.3 Company and corporate structure

TOSCA *(Total Operations Management for Safety Critical Activities)* Human Factors Solutions LTD. is a spin out Company of *Trinity College* Campus registered in Ireland in May 2016. The company was created to develop and distribute operational risk management tools in highly regulated industries. Tosca offers various solutions to optimize the core operations of client companies, from assigning activities to monitoring process KPIs. Assisted by an Enterprise Ireland commercialization fund which invested €50,000 over 18 months, Tosca's approach is proven to reduce safety risks, mitigates the number of accidents and substantially reduces operational delays: it provides better support for staff and offers a competitive edge and the ability to grow without additional staff.

From January 2017, Tosca has a new reference customer for the Abruzzo International Airport in Pescara, Italy. Pescara Airport used the software for the first time in 2016 and immediately found that *"it has positively changed the way we operate"*. The Abruzzo Airport is currently paying Tosca to receive customized solutions and consultations. Among the main results achieved we have:

- 50% reduction in the number of hours of processing papers;
- 30% reduction of operational problems;
- better planning and resolution of problems;
- clear assignment of responsibilities.

Maria Chiara Leva – Managing Director & Lead Promoter

Maria Chiara Leva is a Lecturer in Safety Management in *the School of Food Science and Environmental Health* in *Dublin Institute of Technology*. She is also a visiting Research Fellow in the *Centre for Innovative Human systems* in *Trinity College Dublin*. Her area of expertise is Human Factors and Safety Management Systems. Chiara holds a PhD in Human Factors conferred by the Polytechnic of Milano Department of Industrial Engineering. Her PhD focused on Human and Organizational factors in Safety Critical System in Transport Sector. She is the current chair of The Irish Ergonomics Society and has been working in Ergonomics and Risk Assessment as a consultant since 2008.

Fabio Mattei – Chief Technology Officer & Promoter

Fabio Mattei is the lead software developer in the *Centre for Innovative Human Systems* in *TCD*. Fabio holds a degree in Software Engineering from *University of Bologna* Italy. He has extensive experience with objects oriented languages such as Java, Ruby, Python. He's involved with designing layouts and in the optimisation of informative systems and he has experience mainly with MySQL

and PostSQL. He has worked for years in web development with HTML language and some of the most spread XML dialects, the .NET area of Microsoft for the implementation of web services and web applications in C# before joining TCD Fabio worked as a Software developer consultant for four years.

Tom Shearer, IC Aviation Ltd

Tom Shearer has agreed to come on board a consultant in business development for a six month period commencing September 2017. Tom is one of Europe's foremost experts on route development and airline negotiations. He spent 8 years as a Ryanair executive and has represented a multitude of airports, governments and regions in relation to air transport development. He is currently a Director of IC Aviation's which provide advisory services to the Aviation sector.

Andrea Frittella, It Consultant / Developer

Involved as external consultant. Andrea has more than 15 years of IT development experience and has been working with Tosca on developing the web application trial for Sodexo. He has extensive experience in designing and realizing web projects for small and medium sized enterprises. The language of choice is PHP and CakePHP framework. For frontend development he is expert in Bootstrap, jQuery and ExtJs for small CRM.

Yilmar Builes, Risk Analyst

Yilmar holds a first class honors Msc Degree in Chemical Engineering and has worked previously as a research assistant at Centre for Innovative Human System TCD where he developed his thesis during the Tosca Project about the Diageo case study. He is currently working part time as a risk analyst for Tosca Solutions mainly on the Sodexo trial and on the mining industry plan.

The board of directors consists of Maria Chiara Leva and Fabio Mattei. It is envisioned as the company grows from a consulting services to a product based company, the board of directors will be supplemented with appropriate appointments. The current Chairperson of the board is Maria Chiara Leva. Tosca Solutions Ltd. are actively looking for a new Chairperson of the board to support the vision to deliver on a Tosca Solutions product and scaling the company.

5.3.1 Advisors

- Sebastiano Toffaletti Secretary of *PIN-SME - The Pan European ICT & e-Business Network for SMEs;*
- Darina Heavey - Strategic Advisor;
- John Paul Comer - Retail Product Manager *AXA MPS Financial Limited;*
- Tom Shearer - Commercial Sales Agent, *IC Aviation;*
- Alan Ryan - Legal Advisor;
- Giovanni Uguccioni - Unit Manager for *Oil and Gas HSE consultancy* in D'Appolonia;
- *Paul Walker Limited*, Financial Advisor;
- Gerry Reynolds - Business consultant;
- Pietro Soldini founder of *Londinium Investment Services and Regulated Markets.*

5.3.2 Company shares

A breakdown of the current shareholders of the Company, number of shares issued, % shareholding and cash investment to date are as follows:

Name of member	Number of shares	% Shareholding	Cash investment
Maria Chiara Leva	65.000	55,2%	€ 0
Fabio Mattei	35.000	29,7%	€ 0
Trinity College Dublin	5.264	4,5%	€ 0
National Digital Research Centre Ltd.	1.064	0,9%	€ 5.000
Enterprise Ireland (Trance 1)	5.596	4,7%	€ 25.000
Enterprise Ireland (Trance 2)	5.891	5,0%	€ 25.000
Total	**117.815**	**100%**	**€ 55.000**

Tab. 2 - Company shares

5.4 Market Analysis

5.4.1 Macro Analysis

The general market category for Tosca Solutions' products and services is the "*Safety Services"*. This market appears to be highly fragmented today, particularly in the geographical origin of Tosca Soution's products, and therefore suppliers tend to be relatively small. According to a *Plimsoll Publishing Ltd*[17]*.'* report, median gross profit margin for large safety consultancies in the UK was 34.2% while small safety consultancies in the same market showed a median gross profit margin of 76.4% for the most recent year. The ten-year trend data for gross profit margin contained in the same report showed that these margins had remained essentially unchanged over the last 10 years. Plimsoll Publishing Ltd. also found that smaller companies similarly outperform larger companies in pre-tax profit, with smaller companies averaging 28.4% and larger companies averaging 6.5%. This indicates that small consultancies not only compete effectively in this market but thrive in it and this, together with the reduced barriers to entry due to a fragmented market, are an excellent opportunity for new small businesses.

A report by *Transparency Market Research* predicts the global safety service market will reach a valuation of US$ 4,3 billion by 2025. The majority of this revenue growth will be seen in Western Europe. While not growing as fast as the Asian region, the Western European region already generates the largest proportion of global safety services revenue and is expected to increase its share of global revenue over the same time period. In this context, consulting firms often collaborate with software companies (exploiting their reputation) which are able to provide ever-more advanced software solutions. By vertically integrating with established safe services providers and making their complementary services, companies entering the market are able to accelerate their growth and increase the range of services they are able to offer.

Tosca Solutions believes that the tool created is unique among the companies already present in the sector but, despite this, there is always the possibility of imitation once they have entered the market. Given the high fragmentation of the market and the relatively small size of the competitors we believe that, at least for the time being, the risk is low (it will still require some form of protection). The Tosca Solutions' offer is by definition broad and generally applicable while that of competitors is often specific and not very flexible.
Furthermore, since it is a software company, Tosca Solutions will have the possibility to extend the offer and revenues beyond simple advice.

[17] Plimsoll Publishing Limited is a company founded in 1987 that carries out financial analysis of the performance of businesses and competitors for 30 years, analyzing the individual performance of companies together with key trends and developments in the industry.

In order to better understand the context in which Tosca Solutions operates we considered appropriate to carry out a *SWOT* analysis to identify what are the factors that make the sector and what are the innovative dynamics of the moment.

Strengths

Among the strengths that we find in the project of Tosca Solution we have identified first of all the development of a valid tool in which we believe. The experience at the Pescara airport was particularly encouraging (so much so that the same customer decided, after a trial period, to buy the product and ask for the implementation of new modules useful for core activities). The management of the Airport believes it cannot do without software and that it has become of vital importance for the monitoring of activities and for the collection of data and inspections by the various airlines, by the ENAC and for meetings inside the board.

Another strong point, in some ways the most important, is that the Tosca Solutions team has strong expertise in IT and H&S. The entire staff of Tosca Solution is highly skilled and has ten years experience in IT consulting.

Weaknesses

Among the weaknesses of the organization we find the lack of internal commercial skills (the organization does not yet have a sales force suitable for the market it is facing) and the lack of medium / long term funding. Moreover, the fact that the product is still in the early stages of development (albeit with a first pilot project that has given very encouraging results) and the lack of brand awareness are factors that can represent an obstacle to the development of this new business.

Opportunities

The opportunities derive first of all from the good awareness that can derive from the Pescara experiment which continues to provide increasingly positive feedback on the product and the strong interest in vertical integration by other companies. Furthermore, as previously mentioned, the sector is still highly fragmented and this constitutes an opportunity as it implies an advantage as *"First Mover*".

Threats

Among the external conditions that could cause damage to the project we find the reduced number of customers in the airport industry currently accessible and the long waiting times in the customization of the software (at least until there will be appropriate economies of scale).

Despite the difficulties with which a business such as Tosca Solution can grow in a context like the one just described, there is a strong evidence of how the tool is generating very satisfactory results despite being at its first real application with the Airport d'Abruzzo. The tool was provided for trial in 2016 and, given the results obtained, the Abruzzo airport was converted into a paying customer.

The results of the study have unequivocally highlighted that the tool has positively changed the way the airport staff works by generating:

- a 50% reduction in the number of hours spent in card processing;
- 30% reduction in operational problems;
- greater clarity in "who does what";
- greater speed in processing critical information promptly;
- better distribution of workload;
- reduction of telephone calls;
- more planning for ordinary and extraordinary events.

5.4.2 Micro Analysis

The reference market to which Tosca Solutions initially looked is the Airport industry: as was also shown in the case study at Pescara Airport, the number of passengers in transit, also thanks to the phenomenon of low cost flights, has increased significantly in the last decade and is expected to even double in the next twenty years. This will lead the airports to encounter a number of new problems, mostly related to the management of passenger flows.
The numbers below show the consequences of the changes taking place:

- by 2030, many world airports will reach saturation points (including Athens, Vienna, Warsaw, Vienna and Barcelona). With current infrastructure this could result in delays and accidents that will affect 50% of all passenger and freight flights;
- the International Air Transport Association (IATA) already reports 27,000 accidents on the runway every year - one for every 1,000 departures worldwide;
- approximately 243,000 people are injured each year (9 passengers out of 1,000 departures) and the cost of these accidents is about US $ 10 billion / year;
- 70% of all flight delays are caused by problems on the ground, not in the air;
- from the extensive collection of testimonials, we have found that further improvements of ground handling services are needed to address persistent problems with efficiency and quality (reliability, resilience, safety and security, environment);
- ground handling is a labor-intensive industry (labor costs 65% -80% of costs). High quality and well trained staff is essential to maintain the safety and quality of ground services.

in this first phase, Tosca plans to look at the regional airports or smaller international airports in order to establish its brand in the industry. The reasons for this choice are

different, first of all new European regulations are in place concerning international and regional airports (also engaged in international traffic). Moreover, smaller regional airports believe that a digitized solution is now necessary (larger airports are for now excluded from the target).
According to *Flight Global Aviation Consultancy* there are 1983 travellers transport airports globally which include both regional and international airports, 30% of which are located in Europe.

Total Addressable Market (Global Airport Market*)		
Size (Passengers per Year)	**Total Airports (Number)**	**Identified Airports (Number)**
10-50k	257	257
50-100k	152	152
100-500k	573	573
500-1M	253	253
1M-2M	243	243
2M-5M	212	212
5M-10M	114	-
10M-25M	107	-
>25M	72	-
Total	1983	1690
** This represents total available verifiable data compiled by Flight Global, aviation consultancy*		

Tab. 3 - Total addressable reference market

As previously mentioned in this first phase of the project, Tosca Solutions has excluded the largest airports from its target customers, accepting to supply its product to the airports with a number of passengers in transit not exceeding 5 million, TAM is therefore reduced to 1690 airports (remember that the airport of Pescara receives an average of 600,000 passengers in transit each year) for a total value of approximately €28 million.

Based on our market research we can reasonably assess that the portion of TAM potentially reachable through our channels is no more than a 30%, ie, referring to the network of contacts born from the activity of *Trinity College*, the associated research groups, *Enterprise Ireland* and the *European Institute of Innovation & Technology (EIT)* our Served Available Market is just over 500 airports.

As a precautionary measure, we have reasonably set the target market at 20% of this last portion: our Target Market is almost 100 airports distributed as follows:

Size (Pax/Yr)	Airports
10-50k	16
50-100k	7
100-500k	37
500-1M	12
1M-2M	14
2M-5M	14
5M-10M	0
10M-25M	0
TOTAL	**100**

Tab. 4 - Target market

As an example below we report the number of potential airports that the *EIT* network has allowed us to access in the last year for the countries of Greece, Italy and Ireland.

Size (Pax/Yr)	Airports (Number)
10-50k	13
50-100k	4
100-500k	18
500-1M	6
1M-2M	6
2M-5M	6
5M-10M	0
10M-25M	0
>25M	0
TOTAL	**53**

Tab. 5 - Target market for Greece, Italy and Ireland

5.5 Competitive context analysis

As already mentioned above the safety services market is highly fragmented and therefore suppliers tend to be relatively small; nevertheless the investigations carried out by *Plimsoll Publishing Ltd.* showed that in the last 10 years, just small companies have realized median gross profit margin far superior to the largest companies in the same industry allowing them not only to survive, but also to get interesting returns and customer trust.

The strong performance of small businesses in the market and the low entry barriers represent an excellent opportunity for new startups. The surveys carried out in recent months have confirmed the full confidence of the market in Tosca's solutions, considering the unique methods and tools among companies already in the industry.

The risk of imitation is low due to the fragmented market structure and the relatively small size of the competitors, however, after the actual market entry, Tosca Solution believes to patent the software in order to avoid imitations when the market faces its phase of greater expansion. Tosca believes to exploit the broad and generally applicable offer of its proposal as a source of competitive advantage as opposed to most companies offering industry-specific solutions or processes.

5.5.1 Five Forces Analysis – New entrants

According to the above, the *"Safety Services"* market is very attractive for smaller companies which, given the difficulty of entering the market autonomously, have developed the tendency to choose some preferential routes through integration or merger with companies already active on the market (exploiting the reputation of the incumbent for faster penetration of its brand within the market), resulting in lower production costs and expansion towards new markets. Risk mitigation, access to technological resources and regulatory requirements also encourage many entrants to opt for "*white labeling*" strategies or to enter into joint ventures to reduce initial capital requirements and leverage economies of scale and/or of learning.

Access to distribution channels is not, at least in the first phase, an issue too important since in most cases the same company is in the process of customizing and installing the software and possibly with subsequent training of the operators, but it would be appropriate to create a sales force within the company, the lack of which could penalize the company in terms of timing. Access to human capital and skills together with the proper organization of a team plays a key role in entering a relatively young and expanding marketplace.

The threat from newcomers is assessed as moderate.

An image of the situation just described is shown below:

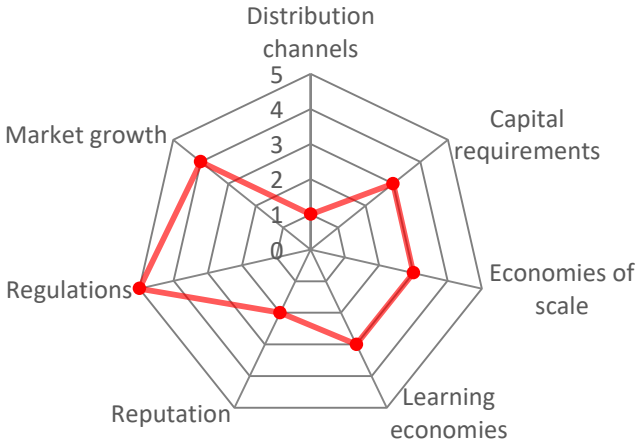


Fig. 1 - New entrants

5.5.2 Five Forces Analysis – Degree of rivalry

The high fragmentation of the market, the specificity of existing products, and the small size of most incumbents make the competitive environment unaggressive to new entrants (at the moment). Product flexibility along with the ability to adapt to the most different contexts allows us to benefit from a huge competitive advantage that for the time being the major competitors have not demonstrated; in addition, the centrality of scale and learning economies favors consolidation through mergers and acquisitions, especially in highly fragmented contexts, resulting in players' reduction and size increase.

Exit barriers do not appear too high, as the main resources are not highly specific and can therefore be reused or sold in other contexts (ie switching costs are not huge). In this situation, players are strongly motivated to remain in the industry even where conditions become more difficult, and rivalry should increase.

The industry is not subjected to significant cyclicality and is not strongly affected by macroeconomic conditions, on the contrary it is a growing market that sees its maximum expansion phase in the present and in the next five years.

Overall, rivalry is assessed as moderate.
An image of the situation just described is shown below:

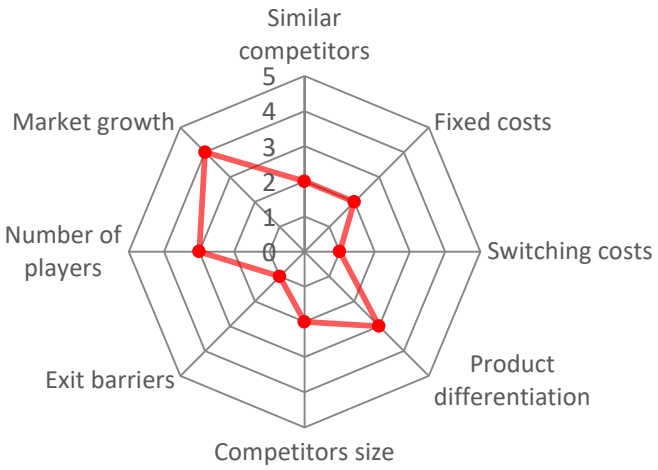


Fig. 2 - Degree of rivalry

5.5.3 Five Forces Analysis – Threat of substitutes

The amount of solutions proposed in this market is certainly high but it is known that, when there is not a *"dominant design"*, the degree of innovation is certainly high but not all companies invest in the same direction and consequently the development efforts do not "add up". Inevitably, this entails a lack of confidence on the part of customers who still do not see a valid product and the demand remains low. In this context the software of the principals competitors appear very specific and customized for singular contexts, not very flexible and difficult to readapt.
Tosca solution believes that its offer is broad and generally applicable, also believes that being firstly a software company has the ability to extend its offer beyond "just" consultancy.

The threat of substitutes is assessed as weak, but may increase in the future.
An image of the situation just described is shown below:

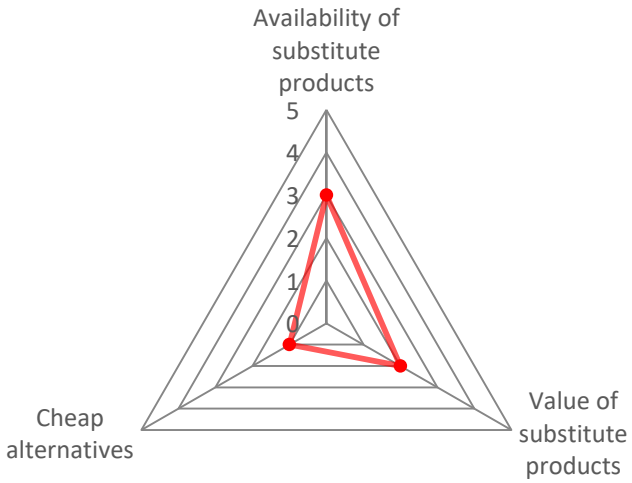


Fig. 3 - Threats of substitutes

5.5.4 Five Forces Analysis – Buyer power

Buyers can represent many industries but mainly include airports, mining companies, pharmaceutical companies and facility management: the importance and necessity of these products for buyers influence their presence on the market but, despite the above mentioned industries represent some of the most regulated environments, buyers are typically large companies with good willingness to pay which means they can negotiate long-term contracts and strengthen their bargaining power (especially where they work with non-highly specialized processes and switching costs are low). On the other hand, if the processes are specific and require a high degree of customization, the use of long-term contracts can impose non-negligible switching costs that reduce their bargaining power.

Overall, buyer power is assessed as moderate.
An image of the situation just described is shown below:

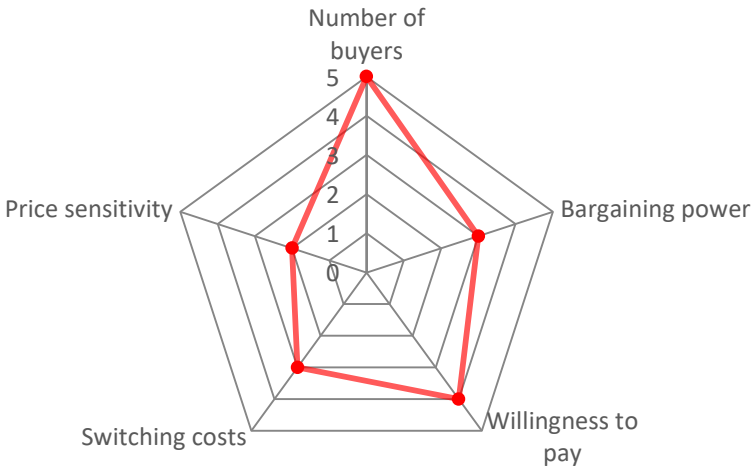


Fig. 4 - Buyer power

5.5.5 Five Forces Analysis – Supplier power

As previously discussed, the power of suppliers does not seem to be, in a first approximation, particularly strong and present. This is because the only resources we need in this (and the next) phase are the skills of the development team and managers. In technical terms, on the other hand, the necessary inputs are fundamentally standardized and can be acquired at reduced costs by any supplier.

Ultimately we believe that suppliers' power is weak.
An image of the situation just described is shown below:

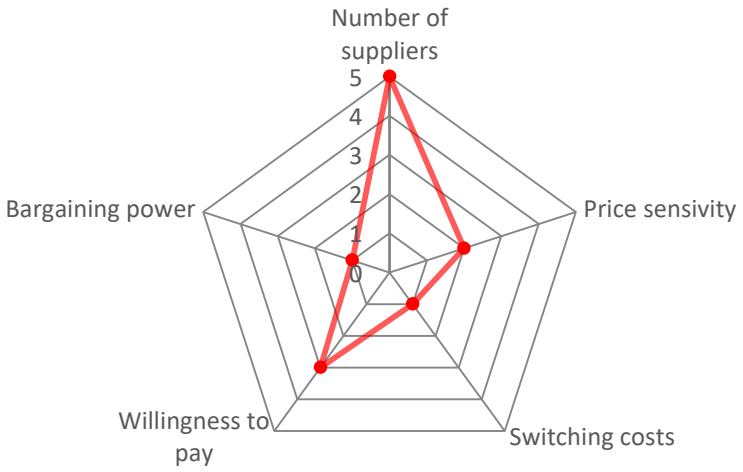


Fig. 5 - Supplier power

Now let's proceed with the evaluation of the competitive environment and in particular which competitors Tosca Solutions deals with in the safety services market. The main competitor products within the Airport market are as follows:

5.5.6 Competitors analysis

1. Opscom Systems

Opscom Systems is located at the Bodø Airport in the northern part of Norway. The company, founded in 2003, has created tools and operational-management systems for the aeronautical industry, boasting over 35 sites in which it is present in locations such as Scandinavia, Iceland, Greenland and the Czech Republic, as well as Luton airport in London. Given the type of product and the geographic location we believe that it represents one of the main competitors of Tosca Solutions.

Given its 15-year experience in the sector, *Opscom System* enjoys a brand recognition within the entire sector, offering a complete solution including both safety and compliance management functions (ICAO regulations, ICAO recommendations, EASA-Ops, EC 139/2014 (ADR) or any range of ISO / IOASA standards).
Furthermore, the greater traction within the Aviation sector including government sourced and the Ministry of Defense engagements should not be forgotten. On the other hand, it must be considered that the *Ospcom System* product does not have a specific module for checklists like the Tosca Solutions' risk register that allows a better planning and coordination of activities and better management of workloads.
Note that, at the moment, the *Opscom System* tool does not offer a notification feedback system such as that of Tosca Solution, ie a system that is able to provide bridges and communications between offices in real time (this implies that from a notification of anomaly does not match any feedback regarding the neutralization of the anomaly), instead this represents one of the strong points of the risk register of Tosca Solutions, with related responsibilities, timing and severity levels.
Another point to the detriment of the system in question is that it has not yet been conceived a register of operational risks, that is a dataset able to collect all the anomalies and risks that have been reported over time: in Tosca this represents instead one of the most valid points of the whole project.
The Analysts at the airport of Pescara underlined how this constitutes one of the most important and most frequently used tools above all in the phases of inspections by the airline companies, ENAC and the internal meetings of the Management Review Board, which analyzes the most frequent critical issues extrapolated from the Risk Register and seeks solutions to eliminate or reduce these criticalities.

2. AeroAscent

AeroAscent is based in Sydney, Australia. TrackerAIRSIDE™ is their main product, an innovative app that can be used by any mobile platform (mobile, tablet, computer) that allows you to acquire all the data related to the operations carried out by the operators within the airport perimeter to ensure greater safety and a more effective accident management. The application is able to organize and manage maintenance operations (with specific module) and operations in general. AeroAscent is operative since 2015 and has listed 5 regional airports, all located in Australia.

Among the highlights of this product we find the dashboard first of all. The *Dashboard* is a fundamental tool in the management of core activities because it allows you to create a dashboard of little detailed but summary information that can offer a satisfactory description of the status of the activities: normally it is designed in such a way as to present a summary of the most relevant information of the system and to provide a quick overview of the main KPIs of interest to the company. Actually we can assume that *AeroAscent* Dashboard has a more effective structure than that offered by Tosca Solutions and a more accurate data monitoring. Currently, despite *AeroAscent* is a new company, it appears ahead of Tosca Solutions in terms of trials with regional airports.
On the other hand, despite having specific modules for maintenance, it does not have a checklist with embedded reporting system on ground operations neither an anomaly correction module. Also in this case Tosca Solutions proves stronger in the case of feedback and communication (*AeroAscent* like *Opscom* does not have specific functionalities that allow to notify if and when the anomalies have been resolved) and on the construction of a database of risks / anomalies.

3. Others

The competitors seen above are the competitors (for industries of interest and sizes) closest to Tosca Solutions, but there are other companies who have implemented software for risk management and activities in the perimeter area to those of reference.
The first of all is **Effective Software**, it has created a totally customizable tool able to generate reports for accidents / injuries of operators (*Effective's Incident module*) which offers instant communication via email with system administrators, but not to the whole system. The tool incorporates reports for investigations in order to save time in data collection, is able to calculate the KPIs of interest for the company, track statistics on the work of staff, carry out risk assessments (but without assigning a level of risk), make use of a mobile app and synchronize the data obtained through a cloud platform.

Another similar software is **Integrum**: it is a tool that does not offer the possibility to customize modules, neither the instantaneous communication between the offices but it is able to make a qualitative risk assessment (the calculation of the KPI's is not foreseen).Operator activities are not tracked, but you can still use the tool on a mobile device. Finally, cloud data collection is guaranteed and the use is also possible offline.
OPTIAL™ offers a limited customization of the modules and the calculation of the KPIs, but does not allow an instant communication with *"notification"* like the risk register of Tosca Solutions. There is a specific module for incident management and investigation, it is able to track employee actions and carry out a risk assessment. With this tool it is not possible to create risk ratings, instead it is possible to use the mobile version and the GPS to locate the operators. Data synchronization is guaranteed through a cloud system.

As has been widely demonstrated by the comparison with the main competitors, the competitive advantage of the Tosca solutions Risk Register is based on some particular aspects such as:

- unique features on the market not provided by any of its main competitors;
- checklist with built-in reporting system;
- corrective actions suggested by the system;
- pre and post anomaly analysis;
- real-time audit of the main operations of the airport;
- reduction of the time spent in processing disjointed information based on paper;
- reduction of avoidable accidents;
- efficiency in finding resources and following action plans;
- reduction of corrective actions through functions (two for the centralized identification of common causes);
- optimized and efficient workflow management for risk data analysis.

5.6 Marketing/Sales strategy

In the last year Tosca Solutions has successfully implemented its software within the operating systems of Abruzzo Airport, a regional airport located in Pescara, Italy, with over 600,000 passengers in transit each year.
The software was implemented in the Summer of 2016 and took about 6 months to be able to run at full capacity, also due to an initial distrust by some members of the airport staff (distrust disaffected thanks to a series of training workshops that made the staff understand the true value of the tool). The enthusiasm of airport analysts meant that the software was bought in 2017 (Abruzzo airport has been converted into a paying customer). The feedback from the experimentation was particularly positive and, from the analysis carried out in recent months, we point out:

- a 50% reduction in the number of hours spent in card processing;
- a 30% decrease in operational problems;
- greater clarity in "who does what";
- critical information is dealt with promptly;
- increased efficiency;
- more planning on assigning workload;
- reduction of telephone calls;
- more planning for ordinary and extraordinary events.

In January 2017, Enterprise Ireland worked alongside Tosca Solutions management, ensuring that the results obtained at the Pescara airport were not random. After this recommendation, Tosca Solutions, through a network of personal and professional contacts, is committed to providing solutions also to the following regional airports:

- Dublin Airport;
- Cork Airport;
- Naples Airport;
- Bern Airport;
- Nuremberg Airport;
- Athens Airport.

The aforementioned airports have found it useful to have a tool similar to that of Tosca Solutions as tools for collecting data and identifying anomalies (unfortunately most European regional airports are owned by local authorities, which is notoriously slow to make decisions).
As has been specified in the comparison with competitors, Tosca Solutions does not yet have an official sales force or specific distribution channels. In recent months we have discussed with potential partners / suppliers in the airport industry: *IC Aviation* (that provides consultancy services to the aviation industry) could be one of these.
From a meeting November 2017 with Tom Shearer (November 2017), the director of IC Aviation, we have been reassured that there is an aviation market for Tosca's

software in the Nordic regions (Ireland, United Kingdom, Norway, Sweden, Finland, Estonia, Germany and Iceland).

5.6.1 Opportunities (Airport Market)

One of the strategies envisaged for entering in the Safety Services market is the so-called "*White-label strategy"*: as already described in the analysis of the Five Porter Forces, many small companies wishing to enter this market decide to create a "White Label" product and allow rebranding by incumbent companies on the market and with a considerable market share. In this industry it is a common tendency not to directly produce a product but to buy it through subcontracting contracts (this guarantees the supplier a quicker entry into the market but requires that the characteristics of the product are in line with the requirements of the largest company).
We have commenced early stage discussions with the following organizations in relation to white labeling opportunities within the Airline industry:

- SITA (Headquartered in Switzerland, SITA is a multinational information technology company providing IT and telecommunication services to the air transport industry and has revenue in excess of $1.6 Billion);
- Arup Aviation (Part of the International Arup Engineering Group, Arup Aviation provide advisory and IT solutions into the Aviation sector);
- Adecs Airinfra (Based in the Netherlands, Adecs Airinfra offers over 15 years of experience in consultancy and IT-solutions to help airports with their development and improve airport efficiency. Their international client base includes airports, governments and airlines).

5.6.2 Opportunities (Other Markets)

In the last 8 months together with the management of Tosca Solutions we have evaluated the possibility of a transfer of the technology developed for the airport industries in other sectors, in particular facility management and the mining industry. Here are the results of our research.

1. Facility Management

Tosca Software can be used to build a database to map out and risk assess all the main procedures/operations of a building management company and revise them in a collaborative manner with front line staff in accordance with ICAO SMS requirements.

Tosca are currently engaged in a paid trial with *Sodexo* who are one of the world largest food services and facility management companies. Tosca are commencing trials on two of their Irish sites Sodexo Ely Lily and Sodexo Diageo to provide a tailored risk management solution into their catering division to enhance operational and safety excellence on site'. The general Facility Manager of these sites are very happy with the Tosca service and will provide testimonials.
Within the broader facility management industry, we provided a demo of the solution and requested feedback from the COO of Billfinger (Apleona), Ireland to determine if there is an opportunity within the broad facility management sector for deployment of Tosca solutions. We have intentions to meet with other companies within this sector.
The findings from our engagements was as follows:

- That the FM sector in general are very open to using technology and software to make work more efficient.
- There is no one system out there (with the exception of Oracle / SAP) can provide all requirements. These Tier 1 systems are cost prohibiting which leads to a lot of competition for software solution operating within the sector.[18]

2. Mining industry

Technology transfer to the mining industry has played a very central role in the research carried out in recent months (and the subject of my internship at Tosca Solutions) and deserves a more in-depth discussion.

The mining industry can still be considered a high-risk environment, as even considering recent increases in safety provision, it still remains one of the most high-risk professions worldwide and its accident rates are very high when compared to other industries (Patterson 2009)[19].
The role of skilled personnel and the reducing number of them in the global mining industry growth cycle is also a challenge that brings Human Factors to the forefront of the key operational issues the industry needs to enhance (Bassan et al, 20112). The other key role for Human Factors solutions in mining is increasing work performance, productivity, and an easy way to guarantee corporate compliance. Improvements related to how the operators are supported in their task can lead to more than 5 per cent gain in minerals industry process control efficiency (Thwaites, 2008)[20].

[18] TOSCA HUMAN FACTORS SOLUTIONS LIMITED BUSINESS PLAN, Darina Heavey, August 2017
[19] Patterson, Jessica, 2009 "HUMAN ERROR IN MINING: A MULTIVARIABLE ANALYSIS OF MINING ACCIDENTS/INCIDENTS IN QUEENSLAND, AUSTRALIA AND THE UNITED STATES OF AMERICA USING THE HUMAN FACTORS ANALYSIS AND CLASSIFICATION SYSTEM FRAMEWORK" (2009). Dissertation presented to the Graduate School of Clemson University.
[20] Thwaites, P. 2008. "Process control in metallurgical plants: Towards operational performance excellence." Plenary talk at the Automining 2008: International Congress in Automation in Mine Industry, Santiago, Chile.

The need to support human performance in safety critical tasks for mining is focused on the following key requirements:

- Focus on key operations that are core and safety critical;
- Reducing avoidable incidents;
- Support optimised and efficient workflow management for risk data analysis and data collation;
- Support a participative risk monitoring and assessment plan across multiple locations worldwide;
- Support data analytics capacity on key performance indicators worldwide with a low cost IT solutions.

Similarly the metal recycling industry is also on the forefront of Health and Safety concern as the UK HSE reports waste treatment and raw material a sector breaking workplace injury records in 2014, as its workers doubled the injury risk of building workers for that year (HSE 2014)[21].

The reporting of daily issue is a powerful base for data analytics and performance appraisal that can also feed into revised operational risk assessment and improvement plans. The Risk Assessment module allows to collect reported issue and correlate them to possible safety critical scenarios leading to updating risk and performance assessment for safety critical Operations. This will allow small and big organizations required to be highly reliable to build a predictive risk register linked to actual company activities and tasks, updatable with the use of observational data. This in turn will provide much more robust procedures and troubleshooting knowledge for the operators to make the organization resilient on actual practical ground.

According to "*Istituto superiore per la protezione e la ricerca ambientale*", in Europe there are approximately 30,000 active quarries, mines and mining facilities. Extraction actions and recovery are particularly important as they have a leading role in production world of construction minerals and industrial minerals (57% feldspar (22% only) from Italy), 36% kaolin, 19% bentonite and 15% gypsum), our continent is heavily dependent on extra continental suppliers / competitors regarding metals. You think that China is the first producer at world of Antimonio, Pond, Manganese, Molybdenum, Rare Earth, German, Zinc, Titanium, Vanadium and is also the world's leading importer of Aluminum, Chrome, Cobalt, Copper, Ferrous Minerals, Nickel. But, above all, China is never part of the first four exporting countries of minerals to world. This shows how much the European economy is fragile and how geology plays a fundamental role for ours development and the revival of the economy. Moreover, 70% of the manufacturing industry Europe uses directly mining raw materials worth € 1324 billion and with employing 30 million workers.

[21] Edwards R. 2014. "The fatal dangers of working in the recycling industry". Spring-summer 2014/Environmental Health and Safety Manager

In this context, operational risk management software is used everywhere to optimize mining activities, define the entire production cycle, predict all realistic scenarios (with a "what-if" logic too) and process all raw data.

A company interested in trialling the transferability of Tosca' solutions on their operations is Codelco. Codelco is a Chilean state owned copper mining company consisting in research, exploration, acquisition and development departments. Currently the largest copper producing company in the world (produced 1.83 million tonnes of copper in 2016), in addition to being one of the world's largest molybdenum and rhenium producers, Codelco has structured a solid and modern management system to ensure compliance with all standards required, supported by an IT tool that has met a main requirement, specifically a software available in telecommunication devices such as mobile phones and tablets that can be manipulated by managers, supervisors and workers to report major failures during daily operations. However, they have acknowledged that this current system has some shortcomings once they have discovered the existence of the Operational Risk Register modules created by Tosca.
Tosca also discussed a trial application with ENAMI, a state company with the mission is to promote small and medium size private sector mining in Chile. ENAMI's assets include one smelter, five processing plants, purchasing agencies, and a network of technical support and technology transference facilities, focused on some 2.000 small size private sector producers of copper and precious metals. Enami is implementing strict policies of integral management, being a determining factor for its sustainable development, services with high standards of Quality, and protection of the health and safety of all its workers, employees and those who visit its facilities. Following an initial analysis, Tosca is in the position to offer a solution to increase productivity in the foundry plant in continuous operation (three shifts), where a large variety of mining products is processed.

The contents of this research (and the results obtained in the airport industry) were presented in November 2017 at *Business Idea Competition* in Budapest at the a committee of *European Institute of Innovation and Technology* (EIT) experts: the project was one of the 10 finalists of the competition and received a cash award.
For more information refer to the "*Codelco and Enami cases study*" appendix.

5.6.3 Pricing

As we said in the previous chapters, Tosca Solutions realized only one real project (Pescara Airport) and is working to tighten new commercial agreements inside and outside the airport industry: at this point it is necessary to establish a sales price of their products and services.
Given that the pricing of these services is still being defined, we have tried to estimate some reasonable price swings that we can discuss in this business plan.
These prices have taken into account numerous factors, among which the most important are:

- sustained costs;
- characteristics of the sector;
- characteristics of the product / service offered;
- prices of competitors;
- willingness to pay potential customers.

Before proceeding to a more detailed analysis it is necessary to examine some important aspects of the product strongly influenced by the price. First of all the risk register is not a standardized product, but as widely described it is a product made up of several modules, customized, which can contain more or less information and functionality depending on the needs of the customer.
For example, a small airport with no more than 130.000 passengers a year may feel that it does not need all the modules that the Risk Register is composed of, but only for example, *"Context", "Risk Assessment"* and *"Risk Treatment"* modules, sufficient for a more effective organization of activities and a quicker response to risks. A small airport consisting of relatively small and close offices could thus decide to avoid buying / implementing the "*Communication & consultation"* module and even postpone the implementation of *"Monitoring & review"* at a different time.
A larger airport (800.000 – 1.000.000 passengers) with greater flows of passengers, cargo and baggage, with areas and offices spread out even kilometers away, more checkpoints, police stations and a greater number of shopping centers requires necessarily tools for effective communication between the various stations: this implies that the use of the *"Communication & consultation"* module becomes of fundamental importance (together with that of *"Monitoring & review"*).

The variability of the modules is not the only one to bring price differences, but we must also take into account who and how many are using the software; in fact, the Tosca Solutions Risk Register was designed for three types of users: *Operator profile, Manager profile* and *Supervisor profile.*

In principle we can establish that the customization required for the identified airports will be as follows:

Size (Pax/Yr)	Airports	Package
0-100k	23	Basic
100-500k	37	Silver
500k-5M	40	Gold

Tab. 6 - Packages

The planned packages contain respectively:

Basic:

1. *Context;*
2. *Risk Assessment;*
3. *Risk Treatment;*

Silver:

1. *Context;*
2. *Risk Assessment;*
3. *Risk Treatment;*
4. *Monitoring & Review;*

Gold:

1. *Context*
2. *Risk Assessment*
3. *Risk Treatment*
4. *Monitoring & Review*
5. *Communication & Consultation*

The estimated price for individual packages is shown in the table below:

Size (Pax/Yr)	Airports	Package	Price	Value
0-100k	23	Basic	€ 899,00	€ 248.124,00
100-500k	37	Silver	€ 1.399,00	€ 621.156,00
500k-5M	40	Gold	€ 1.799,00	€ 863.520,00

Tab. 7 - Package prices and values

Together with the software implementation, a number of workshops not yet defined for the training of operators is foreseen. Although in this case the cost of the initial training is still to be defined we can assume an average value for each of the three categories identified (the final cost will depend on the number of operators, managers and supervisors who will take part in the training).
In general, it is estimated that the users to be trained in contexts with less than 100.000 passengers are 30, for airports with a number of passengers between 100.000 and 500.000 will be 40 and for higher numbers of passengers (maximum up to 5 million) users must be at least 100.
The training days will be, respectively, 5, 10 and 20.

For the training of operators the estimated costs can be seen in the table below:

Size (Pax/Yr)	Airports	Package	Training days	Training income	Value
0-100k	23	Basic	5	€ 5.600,00	€ 128.800,00
100-500k	37	Silver	10	€ 8.000,00	€ 296.000,00
500k-5M	40	Gold	20	€ 16.000,00	€ 640.000,00

Tab. 8 - Training value

Also the customization of the software is obviously the responsibility of the client:

Size (Pax/Yr)	Airports	Package	Customization income	Value
0-100k	23	Basic	€ 6.000,00	€ 138.000,00
100-500k	37	Silver	€ 12.000,00	€ 444.000,00
500k-5M	40	Gold	€ 24.000,00	€ 960.000,00

Tab. 9 - Customization value

In addition to the above, it should be noted that once the product has been customized, the client may request further consultancy and / or training sessions in order to ensure perfect performance satisfaction.
The cost of consultancy and training is shown below:

Size (Pax/Yr)	Airports	Package	Consultancy (€/day)	Training (€/day)
0-100k	23	Basic	€ 800,00	€ 800,00
100-500k	37	Silver	€ 1.200,00	€ 1.600,00
500k-5M	40	Gold	€ 2.400,00	€ 2.800,00

Tab. 10 - Consultancy & training

It is specified that further customizations and remote assistance have a variable cost.
Every year there will therefore be a value of:

Size (Pax/Yr)	Airports	Package	Total Value (€/Year)
0-100k	23	Basic	€ 534.124,00
100-500k	37	Silver	€ 1.394.756,00
500k-5M	40	Gold	€ 2.525.920,00

Tab. 11 - Total value

in the hypothesis that additional consultations and training take place once a month the total value deriving from the cost of using the software plus customization, training and availability is around € 4.5 million per year.

5.7 Research and development

As described in detail in chapter 3, the current version of Tosca Solution's Risk Register consists of 6 macro modules (*Dashboard, Context, Risk Assessment, Risk Treatment, Monitoring & Review, Communication and Consultation*) with numerous sub modules and additional functions. Although this solution has now been accurately validated for a wide range of users and contexts it is conceivable that in the short/ medium term it is necessary to apply modifications to the tool or to build specific modules for specific needs.
At the moment, the management is planning to implement 3 new elements within the tool:

1. *Dynamic event tree:* the new version is expected to integrate a process simulator to avoid failures, this element will be realized with a logical-probabilistic model in combination with a phenomenological model. Furthermore, this module will better support decision making in contexts such as risk prevention, maintenance, design changes, etc;

2. *Incident / Accident Reports:* this module (already present in competitor products) will allow the organization to access details of incidents occurring in the reference perimeter and / or collect important information to understand if the causes of the incident have been resolved in order to avoid the occurrence of new ones accidents;

3. *Financial module:* this module (already in the planning phase) will allow the organization to maintain a register related to the income and expenses related to the secondary services offered by the company (for example in the case of the Berne airports managers have specifically asked us to create a module that take account of revenues from car parking services).

Definitely the long terms objectives of the business are as follows:

- Digitize shift handover and core support on turnaround and real time operations for 20% of European regional Airports within 4 years.
- Penetrate at least two other market verticals using the technology, such as catering, mining & logistics.

5.8 Financial analysis

Through the analysis and the results that have been obtained from the work previously done, we present the following economic-financial analysis over a 5 year time horizon, in line with the identified business model: then the period considered in this analysis is the five-year period January 2018 - January 2023.
We have set specific prices for each segment and every product package, as well as for additional services such as consultancy, training and customization.
This information is available below:

Package	Fee	Training	Customization	Consultancy	Training
Basic	€ 899,00	€ 5.600,00	€ 6.000,00	€ 800,00	€ 800,00
Silver	€ 1.399,00	€ 8.000,00	€ 12.000,00	€ 1.200,00	€ 1.600,00
Gold	€ 1.799,00	€ 16.000,00	€ 24.000,00	€ 2.400,00	€ 2.800,00

Tab. 12 - Consultancy, training and customization prices

Let's now examine the costs of the service starting from software costs.

Package	Software cost	Customization cost	Consultancy cost	Training cost
Basic	€ 660,00	€ 4.500,00	€ 650,00	€ 650,00
Silver	€ 960,00	€ 9.000,00	€ 950,00	€ 1.200,00
Gold	€ 1.560,00	€ 18.000,00	€ 1.700,00	€ 1.950,00

Tab. 13 - Consultancy, training and customization cost

For software costs the purely technical costs for software development were considered (the values obtained are mostly estimates and have been suggested by the company's technical staff).
"Cost of customization" contains the cost of initial personalization of the modules, with all the specific functions requested by the customer. For obvious reasons the cost depends on which package must be implemented and therefore on the quantity of modules that must be customized.
“Consultancy cost” and “Training cost” are the costs of the resources involved in carrying out the requested service.

Assuming a starting training session and a monthly consulting session (1 day) we will have:

Package	Total cost
Basic	€ 13.610,00
Silver	€ 22.560,00
Gold	€ 41.910,00

Tab. 14 – Total cost

The prices and costs shown are considered inclusive of VAT (23%), the payment of VAT is bi-monthly and must be paid before the 19th day of the month following the expiration of the period.
The tax rate is set at 12.5%.

Below are the market volumes and the estimates made in the market analysis.

From the analysis of the market we have identified a Total Addressable Market value of approximately 1700 airports, of which we reasonably thought we could reach about 30%: the Served Addressable Market therefore assumes a value equal to 500 airports and the relative Penetrated Market has been calculated with 20% for the SAM and is therefore equal to about 100 European airports for passengers transport (50% of these airports belong to the countries Greece, Italy and Ireland).
Of this Penetrated Market about 60% of the airports have a number of passengers in transit less than or equal to half a million passengers, the remaining reach up to 5 million. At the turn of these two categories we can find Pescara Airport.
On average it was considered that the users to be trained in contexts with less than 100.000 passengers are 30, for airports with a number of passengers between 100.000 and 500.000 will be 40 and for higher numbers of passengers (maximum up to 5 million) users must be at least 100.

All the numbers mentioned above have been calculated with precautionary logic.

Since it is impossible to foresee to reach the volumes described above without first providing a coherent staff, we have tried to hypothesize what and how many professionals the company needs today. Today there are two main priorities: building an internal sales force and creating a team of IT professionals able to develop the software and to meet the needs of future customers.
With this in mind, we expect that the sales force today requires at least 2 new sales manager in addition to the already present external sales consultants: these two people must preferably have a degree in economics, marketing or management engineering and have at least 2-3 years experience in sales in highly technological contexts.
Furthermore, the IT team should be enriched with at least 2 new IT programmers (preferably with experience of at least 5 years).
To date, the company already has an accountant but could benefit from a person who takes care of international relations considering the breadth of the market involved.
Finally, the presence of at least one other risk analyst will be required to support the already existing team. Salaries and severance pay will be decided later.

5.8.1 Financial projections

To make the financial projections we have considered a period of time equal to 5 years starting from January 2018. The currency used is Euro and has been fixed a rate $Euro\ /\ US\ Dollar$ equal to 1,2321 constant for the next 5 years ($USD/EUR = 0{,}8116$) and the tax rate is set at 12.5%.
Capital contribution supplied at the start amounted to € 55.000 distributed as follows:

1. 2 rounds of € 25.000 from *Enterprise Ireland;*
2. € 5.000 from *European Institute of Innovation & Technology (EIT);*

which we can presume paid in January 2018.
The Trinity College, while retaining a small share of the company, did not make any cash payments to the company and there is no debt with the banks.

Through the calculated market volumes and considering a weighted average price compared to the data seen in the previous paragraph we will have a price equal to 1445€. Note that the prices set at the start are generally lower than the industry average, this was done to attract greater demand in the initial stages of the business and allow a more rapid penetration of the market. Subsequently we forecast a growth in prices of 5% per year.
This will result in an increase in average prices as follows:

Period description	Year	Price	Growth
1st year	2018	1.445,00 €	0%
2nd year	2019	1.517,25 €	5%
3rd year	2020	1.593,11 €	5%
4th year	2021	1.672,77 €	5%
5th year	2022	1.756,41 €	5%

Tab. 15 – Prices growth

The licensing of the use of the software involves the following monthly revenues:

Period description	Year	Price	Revenue
1st year	2018	1.445,00 €	9.031 €
2nd year	2019	1.517,25 €	22.759 €
3rd year	2020	1.593,11 €	71.690 €
4th year	2021	1.672,77 €	117.094 €
5th year	2022	1.756,41 €	175.641 €

Tab. 16 – Fee Revenues

The revenues described above are those deriving from the monthly fee that the client companies must pay to Tosca Solutions for the use of the software. But remember that companies must support other payments (customization, training and

consultancy). The total revenues expected in the 5 years thanks to these activities (the additional training is excluded) are the following:

Training	Customization	Consultancy
€ 1.064.800,00	€ 1.542.000,00	€ 9.528.000,00

Tab. 17 – Training, Consultancy and Customization total revenues

which, for convenience will be considered equally distributed over the 5 years (obviously not true as market penetration will be gradual).

Among the operating costs we include:

- Office rental;
- Other office fixed expenses:
- Insurance and wages:
- Professional, legal and marketing services;
- Meal / Subsistence;
- IP and Web Site maintenance;
- Recruiting;
- Travel;
- Software licenses.

Once all the above data have been included in our financial model, taking into account the training sessions and supplementary advice, any new investments, potential variable costs and an appropriate dividend policy, we have obtained the cash flow statement and the income statement of the company.

	2018	2019	2020	2021	2022
Taxable Revenues	€ 789.905	€ 1.694.608	€ 3.465.852	€ 5.153.158	€ 5.576.090
Not Taxable Revenues	€ 0	€ 0	€ 0	€ 0	€ 0
REVENUES	€ 789.905	€ 1.694.608	€ 3.465.852	€ 5.153.158	€ 5.576.090
Costs and Expenses	-€ 447.220	-€ 587.380	-€ 727.540	-€ 770.740	-€ 830.500
EBITDA	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Depreciations & Amortizations	€ 0	€ 0	€ 0	€ 0	€ 0
EBIT	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Interests	€ 0	€ 0	€ 0	€ 0	€ 0
EARNINGS BEFORE TAXES	€ 342.685	€ 1.107.228	€ 2.738.312	€ 4.382.418	€ 4.745.590
Taxes	-€ 42.836	-€ 138.404	-€ 342.289	-€ 547.802	-€ 593.199
NET EARNINGS	€ 299.849	€ 968.825	€ 2.396.023	€ 3.834.616	€ 4.152.391

Tab. 18 – Income statement

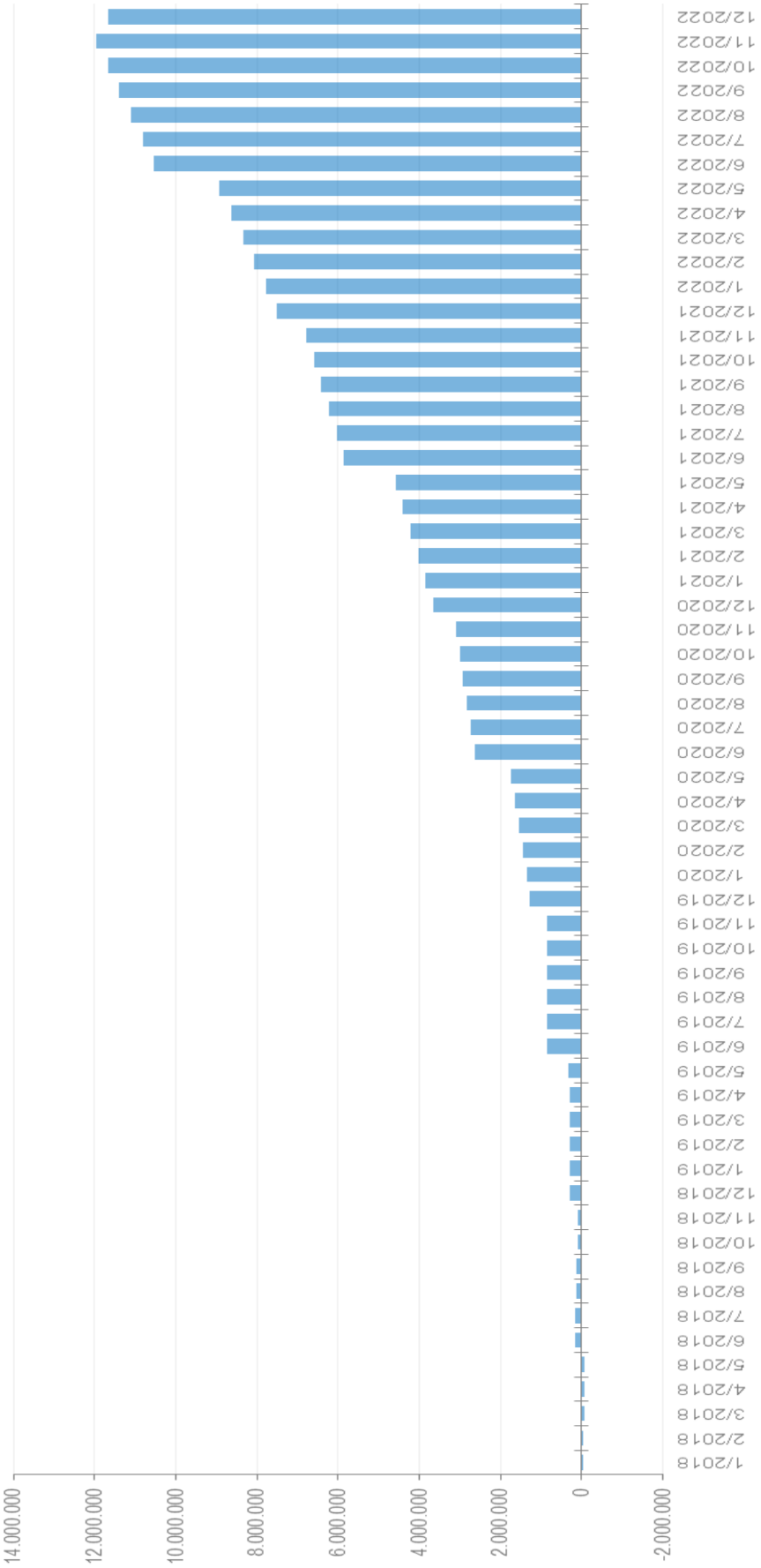
From the perspective income statement it is possible to note that there are no years of loss making: this is motivated by the fact that we have proposed to sell 6 projects from the first year (reasonable conclusion as Tosca Solutions is currently discussing 6 contracts with airports of Dublin, Berne, Athens, Naples, Cork and Nuremberg) and this demonstrates the sustainability of the hypothesized business model.

The internal rate of return (IRR) is calculated as equal to 89% and the other returns are:

	2018	2019	2020	2021	2022
RETURN ON EQUITY (ROE)	89%	76%	67%	53%	37%
RETURN ON INVESTMENT (RO	89%	76%	67%	53%	37%

Tab. 19 – ROE, ROI

Below we see the graph related to cash flows: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12.000.000
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From the summary cash flow statement, it is possible to note a negative cash flow in the first year, exactly starting from January 2018 up to May 2018, where the lowest negativity peak is equal to -83,516 € (the negative peak is relatively low); the cumulative value of the cash flows becomes positive in June 2018, where the first sale of the license occurs plus the completion of training and customization of the tool.
Ultimately, today Tosca Solutions needs around € 85,000 to cover this lack and undertake the first implementation project at the first airport. The request for funding and the relatively high IRR are natural consequences of the assumptions made at the base of the proposed business model and the market opportunities currently present, moreover considering a rate of profit distribution equal to 30% of the maximum dividend of the year the Net Present Value rises to approximately € 590.000.

To date, Tosca Solutions is looking for new resources and new staff to kick off the aforementioned projects: to do so it is participating in numerous business competitions throughout Europe. Recently, EIT has granted Tosca Solutions a sum of € 5,000 to spend exclusively on journeys in search of new customers for Europe, which are attracting many new customers and potential partners starting from the markets of Italy, Ireland and Greece.
I started my work at Tosca Solutions in September 2017 to create a business plan that could take part in business competitions like other ideas. Thanks to the support of the entire Tosca Solutions team and that of external consultants, I conducted the research in a relatively short period of time considering the complexity of the market to which the company looks.
The conclusion of my research indicates that there is an expanding market for Tosca Solutions' Risk Register and that this is certainly one of the best quality products available on the market at the moment: Tosca Solutions software is an excellent data collection tool that can be used to identify anomalies and trends over time and useful to prevent problems in the future and support improved efficiency.
The results obtained at the Pescara airport have been impressive and the company hopes to start a new project within a few months and respect the deadlines obtained in the business plan just shown.

At the moment one of the quickest solutions to favor a rapid integration into the market seems to be to exploit a "*white label*" strategy and their solutions can be appealing to the incumbents of the safety services market.
Furthermore, the possibility of exploring other industries such as mining or facility management, has been evaluated, but the airport industry is undoubtedly the one in which Tosca Solutions has made the most progress and for this reason Tosca should continue to aggressively pursue the talks he has already taken.

Conclusions

Conclusions

At the end of this project it is opportune to carry out some considerations about the results obtained during our analysis.
As has been demonstrated in the analysis dedicated to the management and neutralization of risks and, then, in the assessment of the quality of services offered to passengers, the Risk Register is an effective tool in detecting anomalies that may compromise the quality and safety of operating activities, strictly respecting the modern Risk Management regulatory protocols.

Risk management should represent a continuous and cyclical process: the risk manager must be able to identify and classify possible sources of risk, generate the necessary countermeasures, verify that the anomalies have been neutralized and, if not, reiterate; the Risk Register helps managers in each of these phases providing for dangerous situations based on the structure of the company processes. Moreover, as has been amply demonstrated in the case study *"Abruzzo International Airport*", the Risk Register is configured as a valid tool for the improvement of the real quality of the processes and consequently with an increase in the perceived quality of all the stakeholders.
From these and many others elements springs the awareness that companies should not look at this kind of instruments with fear or mistrust but should embrace the opportunity to achieve a "qualitative leap" in many of the crucial aspects of the business that they have to support.

The validity of the technical aspects is further enhanced by looking at the Safety Services market: although still highly fragmented (a condition due to the current absence of a dominant design), the projections show that the market has just entered its expansion phase, but appears already characterized by high rates of innovation. In this context Tosca Solutions plays the card of the "*First Mover*" in a market with high potential and begins to enjoy a modest notoriety from the insiders, thanks to the network of contacts created through the mediation with the European Institute for Innovation and Technology (EIT).
On the other hand, the company must be ready to “ride the wave” of expansion and not be caught unprepared, a condition that would dissolve the discrete competitive advantage it currently enjoys: this will require investments in assets in the short or medium term (protection forms of intellectual property included) but first of all new figures able to find hidden opportunities and latent needs to create value in a quickly growing market.

Finally, although the search for potential customers in the airport industry enjoys a great advancement, Tosca Solutions' management is advised not to limit its search to the same market, but to explore new horizons that can offer further income opportunities, exploiting their skills and declining them in the most appropriate

directions. Although today the Tosca Solutions' market promises high returns for smaller businesses, it is known that these kind of environments (IT) are in fact highly variable and can bring to a strong competition within a very few years.

Conclusioni

Al termine di questo progetto è opportuno svolgere alcune considerazioni in merito all'insieme dei risultati ottenuti nel corso dell'indagine svolta.
Com'è stato dimostrato prima, in maniera qualitativa, nell'analisi dedicata alla gestione e neutralizzazione dei rischi e poi, in maniera quantitativa, nella valutazione della qualità dei servizi offerti al passeggero, il Risk Register rappresenta uno strumento efficace nel rilevare anomalie che possano compromettere la qualità e la sicurezza delle attività operative, rispettando pedissequamente i moderni protocolli normativi del Risk Management.

La gestione del rischio dovrebbe rappresentare un processo continuo e ciclico: il risk manager deve essere in grado di identificare e classificare possibili fonti di rischio, generare le contromisure necessarie, verificare che le anomalie siano state neutralizzate ed, in caso contrario, reiterare; il Risk Register accompagna il manager in ognuna di queste fasi prevedendo situazioni pericolose in base alla composizione dei processi aziendali. Inoltre, com'è stato ampiamente dimostrato nel caso studio *"Abruzzo International Airport",* il Risk Register si configura come un valido strumento per il miglioramento della qualità effettiva dei processi e di conseguenza con un incremento della qualità percepita da parte di tutti gli stakeholder.
Da questi elementi e da molti altri scaturisce la consapevolezza che le imprese non dovrebbero guardare a questa tipologia di strumenti con timore o diffidenza ma dovrebbero invece abbracciare l'opportunità di realizzare un "salto di qualità" in molti degli aspetti cruciali del business che sono chiamate a sostenere.

La validità degli aspetti tecnici si arricchisce di ulteriore valore guardando al mercato dei *Safety Services*: seppur ancora altamente frammentato (condizione dovuta all'attuale assenza di un design dominante) le proiezioni dimostrano che il mercato è entrato da poco della sua fase di espansione ma appare già caratterizzato da elevati tassi di innovazione. In questo contesto Tosca Solutions gioca la carta del *"First Mover"* in un mercato ad elevato potenziale e comincia a godere di un modesto riconoscimento da parte degli addetti ai lavori, anche grazie alla rete di contatti nata attraverso la mediazione con l' Istituto Europeo per l'Innovazione e la Tecnologia (EIT).
D'altra parte l'impresa dovrà essere pronta a cavalcare l'onda dell'espansione e non farsi trovare impreparata, condizione che farebbe dissolvere il discreto vantaggio competitivo di cui gode attualmente: ciò richiederà degli investimenti in asset nel breve-medio periodo (forme di protezione della proprietà intellettuale comprese) ma soprattutto di nuove figure in grado di cogliere opportunità nascoste e bisogni latenti per creare valore in un mercato in piena crescita.

Infine, sebbene la ricerca di potenziali clienti nel settore aeroportuale gode di un avanzamento indiscutibile si suggerisce al management di Tosca Solutions di non limitare il proprio raggio d'azione al medesimo mercato, bensì di esplorare nuovi orizzonti che possano offrire ulteriori opportunità di reddito, facendo leva sulle proprie competenze e declinandole nelle direzioni più opportune. Sebbene oggi il mercato di Tosca Solutions prometta rendimenti elevati per i business più piccoli è noto come ambienti di questo tipo (IT) siano infatti altamente volubili e possano rendere la competizione feroce nel giro di pochissimi anni.

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Appendix

Codelco and Enami's cases study

Codelco-Chile (Cobre de Chile National Corporation) is Chile's state-owned mining company that uses and exploits the copper deposits nationalized on July 11, 1971. Due to the size of its installations and the volume of production it is considered one of the largest mining companies in the world.
Codelco created a solid and modern management system to ensure compliance with all required standards, supported by an IT tool that meets the main needs. Software available in telecommunication devices such as mobile phones and tablets that can be manipulated by managers, supervisors and workers to report the main problems during normal daily operations. However, the current system has some shortcomings, the most important of all, and the lack of effective feedback following a signaling. In fact, despite the fact that the software in use has gained more involvement from the entire organization, the system does not offer the option of monitoring and follow-up, ie all the messages are included in the software but the staff is not aware of what will happen (for example, if the problem is resolved, if an environment is again agable, if the maintenance is over). Also, the reported problems are not classified according to their priority / severity, resulting in little clarity and confusion. Inspections are performed correctly but there are no verifications and operators believe that the management cycle is not completed, and in some cases the information has been lost.
Lastly, the staff had serious problems with the use of computer systems and would like a more "friendly" system and interface, and staff must spend part of their day manually entering data into the system.
Codelco believes that Tosca's risk register is able to cope with the failures that its software has been unable to do, providing more information before and after the intervention, reducing the degree of uncertainty and management time.

Enami is a state-owned company that promotes the small and medium sized private mining industry in Chile, providing incentives to improve metallurgical engineering and financial services.
In order to fulfill its mission, ENAMI's activities include five processing plants and a technical support network and technology transfer facilities that focus on about 2,000 small private copper producers and precious metals.
Enami is implementing solid management policies that are a key factor in its sustainable development, services with high standards of quality and the protection of health and safety of all its employees, workers and those who visit its facilities.
From an initial analysis it was found that Tosca could be able to provide a solution that can increase productivity in plants with high volumes and mineral varieties (nominal processing capacity of 340,000 tons per year of material).

Ringraziamenti

Con questo progetto si conclude ufficialmente il mio percorso universitario e ritengo doveroso volgere un ringraziamento speciale a tutti coloro che hanno contribuito, in un modo o nell'altro, al raggiungimento di questo atteso traguardo.

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Dario

Marzo 2018