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Cost-benefit risk analysis modeling for corporate compliance: evidence from Italy obtained through investment and industry 4.0 tax credit data analysis

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Abstract

Modern industrial systems are typically characterised by their multiple elements (technological, communicational, physical, etc.). These elements are interconnected and structured in such a way as to make them "immune" to, or only marginally affected by, any harmful events. On the basis of this assertion, the traditional bimodal definition (which only considers functional and failure states) is inadequate for understanding the behaviour of complex systems. It is in this context that the concept of resilience has caught on in both the academic and corporate fields because it is capable of taking into account all the ways a system may behave following a harmful event, from the so-called "reaction and absorption" of shocks, to recovery and adaptation of the system to new operating conditions. In a previous paper (Ventura in Eur Bus Law Rev 34(2):239–268, 2023) introduced a model set within a wider system of corporate compliance management drawn up in accordance with the NIST and ISO international standards. This model is based on the joint use of Erik Hollnagel's Functional Resonance Analysis Method (FRAM) and Saaty's Analytic Hierarchy Process (AHP). After defining its properties, from a purely methodological viewpoint, the proposed model was then applied to a very common case study in the Italian industrial context: the acquisition of a plant with features making it eligible for tax credit both for Investments in the South and for Industry 4.0. This paper sets out to go further by evaluating the validity of this model also from a cost-benefit analysis point of view. The three possible situations will be analysed (without any risk assessment, risk assessment using the FRAM method, risk assessment using the FRAM/AHP method), establishing which of the three is most useful for corporate management.

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1 Introduction

Cost-benefit analysis is probably the most comprehensive method of economic evaluation available. By offering a formal explanation of the subject and exploring the theoretical foundations of certain methods that have come to be recognized as global decision-making instruments, it advances knowledge. The aim of cost-benefit analysis is to offer a standardized process for assessing choices in light of their effects. Although it may seem to be the most obvious and practical course of action, this is by no means the only one. It is evident that cost-benefit analysis encompasses a vast area. It provides precise standards for assessing government choices in a wide range of areas, including licensing private ventures, public goods provision, food rationing, trade, and income programs. Industry 4.0 promotes decentralized production and therefore cost models are needed to capture the costs of products and jobs within the production network. Corporate compliance systems are becoming ever more widespread in organisations of all shapes and sizes, whatever their degree of complexity (Arcuri et al. 2022; Belmonte et al. 2011; Dinh et al. 2012; Haimes 2009). Systems designed to guarantee compliance with specific rules and regulations are gaining ever growing attention on the Italian industrial scene. The underlying deterministic and probabilistic methodologies' apparent shortcomings in comprehending the behaviour of complex systems served as the impetus for the creation of the Functional Resonance Analysis Method (FRAM). Aligned with the tenets of Resilience Engineering, the FRAM has undergone gradual scientific development and growing implementation in industrial settings, with purportedly fruitful outcomes, in recent times. The scientific background of FRAM was briefly described in the Prologue of the FRAM book (Hollnagel 2012). More focused development of FRAM began around 2000 and led to the first description of the method in 2004 (Patriarca et al. 2020). More generally, as a method, FRAM is used to produce a representation of how work is carried out (Patriarca et al. 2020). FRAM is based on the concept of resilience engineering, in order to provide a practical approach to describe and analyze failures in complex sociotechnical systems (Nieto-Morote and Ruz-Vila 2011; Hollnagel 2012). The Functional Resonance Analysis Method (FRAM) can be a useful tool for dealing with systems that tend to focus on the nature of daily activities rather than the previously defined structure or the nature of failures (Hollnagel et al. 2014). Due to its inherent features, FRAM can only supply certain guidelines or instructions for the improvement of resilience in emergency response systems (Aguilera et al. 2016; Bergström et al. 2015; De Carvalho 2011). In particular, it is necessary to reduce, as much as possible, the individuality that derives from multiple experts interacting simultaneously in the various phases of analysis of the system in question so as to avoid the risk of any barriers supporting risk mitigation being set exclusively by individual and personal choices (Buikstra et al. 2020; De Carvalho 2011; Hollnagel et al. 2006; Rosa et al. 2015). In particular, Rosa et al. (2015), in their study, suggest using FRAM in occupational risk assessment for the construction industry in compliance with green building laws. This study also makes a contribution to the field by using the analytic hierarchy process (AHP) to improve FRAM. Specifically, AHP reduces subjectivity in determining potential feature variability and upstream-downstream coupling, while maintaining key features and techniques of the current method. Alboghobeish and Shirali (2022) identify emerging risks in reservoir construction and prioritize them using the analytical hierarchy process (AHP) method. The functional resonance analysis method (FRAM) was used to evaluate potential variability and determine barriers to damping it. Tierra-Arévalo et al. (2023) review five studies using FRAM and AHP in the construction industry. The study confirms the compatibility of FRAM with other tools, but suggests that a combination of FRAM and AHP could be complicated if the decision-makers do not have adequate skills. Ventura (2023) introduced a hybrid model, associating FRAM with another analysis method that helps the parties to identify the risks deriving from the variability of the functions and therefore to establish priorities in combating the identified failures. In particular, a FRAM/AHP model was used. The application of a combined AHP and FRAM methodology supplied an adequate objective criterion for a subjective choice of the output variability of the FRAM functions, in terms of time and precision. The risk assessment model proposed, from a purely methodological viewpoint, takes two approaches: that of the ISO 31000:2018 and the one proposed by the NIST Special Publication 800-30 Revision 1 from September 2012 entitled "Guide for Conducting Risk Assessment".

In our work we have introduced a new point of view related to the methodology proposed by Ventura (2023) to study the effects produced by the use of the tax credit for investments in the South and the tax credit for Industry 4.0, in particular for manufacturing companies in Italy. From the study of a literature on the topic—as far as we know—there are no contributions that have applied the hybrid methodology to our case study. The measures are significant for the Italian industrial landscape as they enable investment to be combined with other forms of State aid and "de minimis" aid, improving the business's net financial position through tax offset mechanisms.

2 FRAM/AHP hybrid model as a decision support system for evaluating risk assesment: a new point of view

The FRAM/AHP methodology identifies 3 steps necessary in order to carry out an effective risk assessment with respect to the expected objectives. The first level is the one on which the Risk Assessment strategy, guidance and policy are determined. The second level of analysis is the one on which the process model in question is determined. In this model, the team has the task of defining the management flows of the process, identifying problems linked to existing ties between the functions and the resilience/protection capacities required following specific shocks. On the third level, the information level, assessment activities provided for by the system will be completed.By applying the combined approach of NIST Publication 800-39 with that of NIST 800-37 (Risk Management Framework), it can be stated that the Risk Analysis activity proposed in the model will follow the steps described in Fig. 1.

Saaty et al. (2012) propose a fundamental scale of values, presented in the Table 1, which represents the intensity of each evaluation. The effectiveness of this scale has been validated not only by various people in numerous applications, but also through the theoretical justification of which scale should be used when faced with homogenous elements.

Saaty et al. (2012) conclude that, taking this table into account, it is necessary to construct a square matrix with these numbers and their reciprocals where an element "*i*" (a decision) has one of the above-mentioned non-negative numbers assigned to it when it is compared with the element (a decision) "*j*", then "*j*" has the reciprocal value when compared with "*i*". In other words, the decisional elements can be represented by an ordinary square matrix "*M*", the elements of which can be compared in pairs, where the element a_{ij} of this matrix represents the

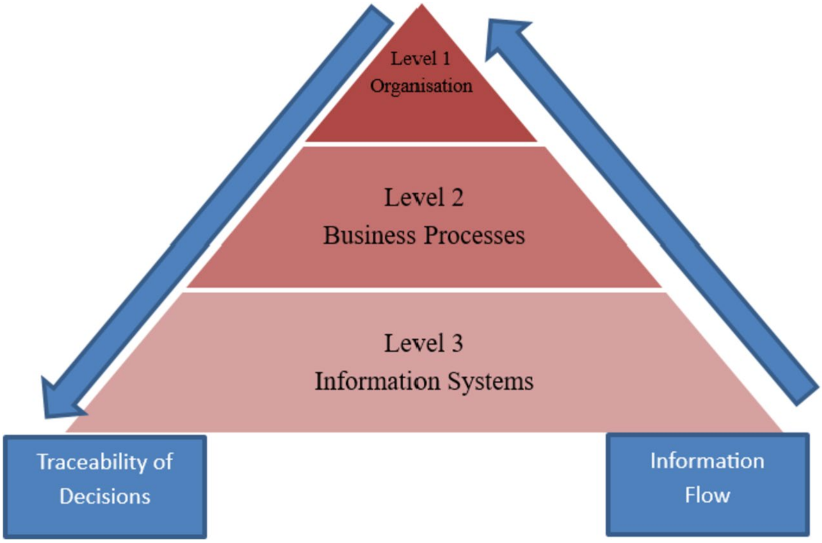

Fig. 1 Risk management hierarchy (*Source:* NIST)

Table 1 Evaluation scale proposed by Saaty (2008) (Our own elaboration)

Intensity	Explanation
1	Given two activities, both contribute equally to the aim
3	Given two activities, experience and judgement demonstrate a slight preference for one over the other
5	Given two activities, experience and judgement demonstrate a moderate preference for one over the other
7	Given two activities, experience and judgement demonstrate a strong preference for one over the other
9	Given two activities, experience and judgement demonstrate that one activity is without doubt preferable to the other
2, 4, 6, 8	Intermediate values

comparison value between the decisional criteria of row "*i*" and column "*j*", as illustrated in Table 1.

$$M = \begin{pmatrix} 1 & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ \frac{1}{a_{1n}} & \cdots & 1 \end{pmatrix}$$

The element a_{ij} will be equal to 1 ($a_{ij} = 1$), if "*i*" is equal to "*j*", meaning that it is the same factor with respect to itself, which corresponds to the value 1. Thus, the main diagonal of this square matrix, in which the elements with $i = j$ are always present, will always have numerical values equal to 1, since no relationship of priority or dominance exists between strictly equal elements. Moreover, the element a_{ij} will be the inverse of the element a_{ij}, that is $a_{ji} = a_{ij} - 1$, which characterises this opposition relationship and corroborates the inverse mathematical relationship. According to Saaty (2008), the next step in the method is defining comparison weights between the elements of the square matrix "*M*", calculating the partial results of the set A within each criterion $vi(Aj), j = 1, ..., n$, called impact value of the alternative "*j*" with respect to the alternative "*i*". These results represent the numerical values of the subjective opinions given by the experts to each equilibrium between the alternative decisions relating to the weights. These results are normalised by the equation:

$$\sum_{i=1}^{n} v_i\left(A_j\right) = 1 \quad with\, j = 1,,,n$$

Where *n* is the number of alternatives or elements compared. Each part of this sum consists of:

$$v_j(A_{j)} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad with\, j = 1,,,n$$

This means that the vector of the priorities of the alternative "*i*", in relation to the criterion of importance factor, is defined by the following equation:

$$v_k = \left(A_i\right) = \sum_{j=1}^{n} \frac{v_j(A_i)}{n} \quad with\ i = 1, \dots ., n$$

Therefore, having a square matrix "*M*" to determine the weights of importance of each factor of the matrix, it is necessary to calculate the sum of each factor and of each element a_{ij} of each column. Thus, it is necessary to construct another matrix "*MRW*", where each of its elements a_{ij} will be the relative weight of each of the elements of the left-hand column, with respect to each of the elements of the upper row. To this end, it is necessary to divide each of the elements a_{ij} of the matrix "*M*" by the value obtained from the sum of the elements of each column. In this matrix "MRW", the simple weighted average of the elements a_{ij} of each row will give as its result the relative weight RW of each of the elements of the matrix "*M*". In order to validate and guarantee the validity of these considerations and calculations, the AHP methodology provides for coherence analysis of all the data processed. Since the matrix "*M*" is a reciprocal matrix, if all the value decisions made by the experts were adequate, it would be possible to verify, a_{ij} that:

$$a_{ij} \times a_{jk} = a_{ik} \quad \forall i, j, k$$

Thus, according to this protocol, the matrix "*M*" would be coherent (Gomes et al. 2004). Having n as the number of elements, λ_{max} as the autovector of "*M*" and "*w*" as the priority vector. If the opinions expressed by the experts are coherent,

$$\lambda_{max} = n \quad and \quad a_{ij} = \frac{w_i}{w_j}$$

However, considering that there is almost always some incoherence, this incoherence can be measured assuming that the closer the value λ_{max} is to *n*, the greater the coherence of opinions. Saaty (2008) demonstrated that for a matrix "*M*", such as the one presented above, it is necessary to find a vector that satisfies the equation $A_w = \lambda_{max} x$ "*w*", and to obtain the autovector of this equation it is necessary to calculate:

Table 2 Random consistency index (R.I.) *Source*: Saaty et al. (2012)

N	1	2	3	4	5	6	7	8	9	10
Random consistency index (R.I.)	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

$$\lambda_{max} = \frac{1}{n}\sum_{I=1}^{N} v_i \frac{[A_w]_i}{w_j}$$

It is important to note that marginal variations in a_{ij} imply marginal variations in λ_{max}, where the deviation of the autovector with respect to n (order number of the matrix) is considered a measure of consistency. Thus, it is possible to affirm that λ_{max} allows us to evaluate the proximity of the scale developed by Saaty (1993) with the scale of relations and quotients that would be used if the matrix "*M*" were totally coherent. This can be done by using a coherence index (CI). According to Saaty's Theorem 1 (1993), "*M*" is consistent if, and only if, $\lambda_{max} \geq n$. That is, if the matrix "*M*" is consistent, then when we calculate the entity of the disturbance of the matrix "*M*" using the relation

$$CI = \frac{(\lambda_{max} - n)}{(n-1)}$$

the CI will have a value below 0.1 (Saaty et al. 2012). Considering these questions relating to the consistency of matrix data, Saaty proposes calculating a Coherence Relation (CR), obtained using the equation,

$$CR = \frac{CI}{RI}$$

where CI corresponds to the coherence index calculated using the above-mentioned equation (Gomes et al. 2004). The element RI is a casual coherence index, calculated for square matrices of the n order by the Oak Ridge National Laboratory-USA. presented in Table 2 (Saaty et al. 2012).

The greater the CR, the greater the incoherence. When $n = 1$ or 2, the CR is null; when $n = 3$, the CR must be lower than 0.05 and when $n = 4$, the CR must be lower than 0.08. In general, an acceptable inconsistency for $n > 4$ is the CR below or equal to 0.10. if it is not below 0.10, it is necessary to examine the problem and revise the judgments. The AHP provides for a coherence index for a whole hierarchy. An inconsistency of 10% or less means that the adjustment is negligible with respect to the effective values of the autovector items (Saaty et al. 2012).

3 Investment and industry 4.0 tax credit

We are going to study the effects produced by benefiting from Tax Credit for Investments in the South and Tax Credit for Industry 4.0 for manufacturing businesses, considering the focused case studies involving in this paper. The measures in question are of great interest for the Italian industrial landscape because, unlike other kinds of financial benefits, they allow for the concurrence of the investment with other forms of State aid and with so-called “de minimis” aid.[1] Consequently, the financial offset linked to the investment and obtainable by benefitting from two state aids allows the business in question to improve its net financial position through mechanisms offsetting tax credits and liabilities provided for by the current tax régime. The first type of benefit that will be analysed is the so-called Investments in the South Tax Credit. This is a measure originally adopted as part of the Finance Law in 2016 and reconfirmed repeatedly in annual Budget Laws. For tax year 2023, the law allows businesses situated in the regions of Campania, Puglia, Basilicata, Calabria, Sicily, Molise, Sardinia to benefit from Investments in the South Tax Credit in the event that they decide to purchase capital goods to be used within their production process. For the tax year 2023, the level of aid foreseen by the law varies from 25 to 45% depending on the type of business applying for the benefit. Necessary conditions for gaining access to the benefit are that:

1. the capital goods in question must be new and never used previously;
2. the capital goods in question must be delivered/tested by 31.12.2023;
3. the capital goods in question must be essential for the business’s activity;
4. the capital goods in question must be purchased in order to start up a new production site or to enlarge an existing one.

The use of tax credit requires those interested to complete a series of formal steps in order to profit from the benefit. First and foremost, the businesses interested must make an application to the tax authorities using the appropriate form (Form CIM 17), to be forwarded online using the system provided by the latter. On the form the business must indicate the data relating to the eligible investments and to the tax credit which it is requesting authorisation to use, describing the type of intervention that will be carried out. After the online application has been forwarded, the business is sent a receipt showing that the tax authorities have received it. Following receipt of the application the tax authorities carry out a preliminary examination of the data. This activity may result in the application being accepted or refused or further information may be requested if, from examination of the documentation, doubts arise requiring clarification. Once the preliminary examination phase is completed, the tax authorities send the taxpayer the relevant authorisation (or refusal) by means of a notification provided to the taxpayer in their Personal Account Area on the Italian Tax Authority website. The use of tax credit for offset is possible from the day following receipt of the notification authorising said use. A necessary condition for use of the tax credit is the demonstrable delivery and testing of the capital goods in question. As mentioned above, one of the most evident advantages of tax credit investments lies in their cumulativeness with de minimis aids and with other state aids regarding the same costs. All of this must respect the condition that the cumulation does not exceed the costs borne. For this reason, the tax credit in question is cumulative with tax credits provided for in the Industry 4.0 Transition Plan. The second type of tax credit under consideration is the

[1] So-called ‘de minimis’ aid is a particular kind of benefit granted to a single business in a determined time period with the aim of improving the net financial position of the beneficiary through a transfer of public resources. Unlike other sources of financing, they are exempt from notification to the European Commission as per article 108, paragraph 3, of the Treaty on the Functioning of the European Union. The types of aid available are small-scale transfers of state resources or economic benefits of a direct or indirect nature. Examples of de minimis state aid are direct grants, tax breaks, loans at favourable interest rates. A necessary condition for the state supplying such aid is that this must not in any way affect the normal functioning of the market.

so-called Industry 4.0 Tax Credit. The statutory source for this benefit is Italian Law 232 of 2016, which deals with the Industry 4.0 Digital Transition Plan, and which provides for two possible benefits for businesses:

- a tax credit for the purchase of capital goods not included in schedules A & B of the above-mentioned law and qualified as "Industry 4.0"
- a tax credit for the purchase of capital goods included in schedules A & B of the above-mentioned law and qualified as "Industry 4.0".

There is a notable difference between the two instruments. Indeed, while the former type of benefit has a tax credit of 6% with a maximum level of costs allowed equal to 2 million Euros, for the latter type, the level of the benefit varies depending on when the transition project was started up. Indeed, analysing the scenario applicable under the current law, the Budget Law 2023 provided for new investments made from 1st January 2023 receiving a preferential rate varying between 20% and 5% depending on the value of the investment made. For investments registered before 31 December 2022, in other words investments for which a binding purchase order has been made and a down payment of at least 20% of the order made, the beneficial rate varies between 40% and 10%, depending on the value of the investment and provided that it terminates by 30 September 2023. As happens for the Investments in the South Tax Credit, the Industry 4.0 Tax Credit can only be used by offsetting tax liabilities utilising form F24. Unlike the Investments in the South Tax Credit, the Industry 4.0 Tax Credit can be used in three annual instalments, starting from the year in which the goods were interconnected. The interconnection, subject to a series of compulsory and optional requirements expressly provided for in the law, must be certified by an appropriate survey report issued by a qualified figure. This survey is not compulsory for investments below € 300,000, for which the certification can be made by means of a declaration signed by the legal representative of the business.

4 Cost-benefit analysis

The model proposed allowed it to be demonstrated how the integration of two systems of analysis such as FRAM and AHP permits the organisation to obtain positive results in terms of project performance. However, the analysis cannot be complete if the solidity of the model is not verified also from an economic-financial point of view. The cost-benefit analysis provided for the following scenarios:

1. Scenario in which the team does not carry out any risk assessment;
2. Scenario in which the team uses only the FRAM method to carry out risk assessment;
3. Scenario in which the team uses both the FRAM and AHP methods to carry out risk assessment.

The objective is to verify whether, given the natural increase in costs tied to the dedicated use of team resources, there is a real decrease in the risk of suffering penalties from the tax authorities. The perceived risk is calculated thus:

Perceived Risk = (Cost of operation in question · Risk of error)/(Cost of operation without risk assessment)

Table 3 Table summarising project data

Year of project start and completion	2022
Overall project value	100,000.00 €
Investments in the South tax credit rate	35%
Industry 4.0 tax credit rate	40%
Source of financing for project	Own sources

Table 4 Table summarising hourly cost per team member

Role	GLI	Annual hours	Hourly cost
DS	71,645.13 €	1720	41.65 €
CE	37,828.94 €	1720	21.99 €
P4.0	39,779.74 €	1720	23.13 €
ICT	56,801.07 €	1720	33.02 €
PM	51,261.88 €	1720	29.80 €

Table 5 Table summarising calculation of an organisation's perceived risk

	Calculation of perceived risk
Formal assessments carried out 2021	156,507
Formal assessments of tax credits 2021	9811
Incidence of tax credit assessments	6.27%
Percentage of final judgments in favour of tax authorities	76.60%
Perceived risk of committing errors	4.80%

A further development of the third scenario is also considered in which the team members decide to dedicate further resources to brainstorming activities associated with the project. This scenario serves to demonstrate up to what point it is possible to lower perceived risk profitably for the business. Economic analysis is based on a series of initial assumptions regarding the project which are summarised in the Table 3:

The second aspect examined is the hourly cost associated with the individual functions dedicated to the project. The calculation is based on the value of the Gross Labour Income (GLI), determined on the basis of collective national work contracts, and considering middle/high salary grades. Assuming an annual total of 1,720 h' work, the hourly cost is determined as the relationship between GLI and annual hours worked. The result is shown in Table 4:

The final element to determine is the perceived risk of the organisation committing errors. The determination of this factor begins by looking at the data contained in the Performance Report for 2021 published by the Italian tax authority Agenzia delle Entrate. In the year in question, the tax authorities carried out 156,507 checks of which 9,811 were linked to tax credits (6.27% of the total). The report also reveals that, in the year in question, the percentage of final rulings by tax judges in favour of penalties issued by the tax authorities to taxpayers subjected to audit accounted for 76.60% of cases. Thus, let's suppose, that the perceived risk of being assessed by and suffering a penalty from the tax authorities following assessment is equal to the product of the two above-mentioned

Table 6 Scenario 1: Table of labour cost linked to the project team

Role	Hourly Cost	Time dedicated in hours	Project Cost
DS	41.65 €	12	499.85 €
CE	21.99 €	20	439.87 €
P4.0	23.13 €	20	462.56 €
ICT	33.02 €	35	1,155.84 €
PM	29.80 €	50	1,490.17 €
	TOTAL	137	4.048.28 €

Table 7 Scenario 1: sources/uses statement

Sources		Uses	
Description	Value	Description	Value
Own sources	104,048.28 €	Project	100,000.00 €
		Team cost	4,048.28 €
Total	104,048.28 €	Total	104,048.28 €

percentages (6.27% and 76.60%), that is to say 4.80%. Table 5 summarises the relevant data:

In the cases examined, the action carried out by the tax authorities is different. Indeed, in the former case, the authorities perform an "ordinary" assessment of the taxpayer with resulting legal dispute, while in the latter two cases the taxpayer undertakes a form of collaboration, using the voluntary correction tool, which allows for the remedy of any errors committed. Given this premise, we will now analyse the various scenarios.

4.1 Scenario without any risk assessment

The first case study foresees that the team goes ahead with the project without making any assessment of the risks linked to carrying out the individual phases of said project. The standard scenario being evaluated is that in which the team implements the plan dedicating itself simply to carrying out the operational activities linked to the project. An estimate of the time dedicated by each member to development of the programme is summarised in Table 6.

Based on the above, the company draws up the Sources/Uses statement summarizing the costs linked to the project and the related sources of financing (see Table 7).

Considering that the current legislation provides for the possibility of offsetting tax debts, using the F24 form, the Tax Credit for Investments in the South in a single plant and the Tax Credit for Industry 4.0 in three identical plants, the company can offset its credits as the table shown in Table 8.

Consequently, the "real" Sources/Uses statement provides for a lower outlay than the one foreseen by the project (see Table 9).

Let us now suppose that the business undergoes a tax assessment and that its defence is considered ineffective during the legal dispute with the tax authorities. In this scenario, taking into account the sum of penalties and interest applied, the business will have to repay to the tax authorities the sums it unduly offset, including penalties and interest (see Tables 10 and 11).

Table 8 Schedule for use of tax credit

Tax credit offset using F24	
2022	35,000.00 €
2022	13,333.33 €
2023	13,333.33 €
2024	13,333.33 €
TOTAL	75,000.00 €

Table 9 Scenario:1 sources/uses schedule with tax credit offset

Sources		Uses	
Description	Value	Description	Value
Own sources	29,048.28 €	Project	100,000.00 €
Tax credit used	75,000.00 €	Team cost	4048.28 €
Total	104,048.28 €	Total	104,048.28 €

Table 10 Scenario 1: Table summarising Penalties and Interest (*Source*: Italian Tax Authority

Undue offset of non-existent credit	
Penalties (percentage on credit considered)	100%
Interest	1.25%

Table 11 Recovery of sums unduly offset including penalties and interest

	Tax credit offset using F24	Penalties	Interest
2022	35,000.00 €	70,000.00 €	39.00 €
2022	13,333.33 €	26,666.67 €	14.86 €
2023	13,333.33 €	26,666.67 €	14.86 €
2024	13,333.33 €	26,666.67 €	14.86 €
TOTAL	75,000.00 €	150,000.00 €	83.57 €

Table 12 Scenario: 1 sources/uses schedule following assessment by tax authorities

Sources		Uses	
Description	Value	Description	Value
Own sources	254,131.86 €	Project	100,000.00 €
		Team cost	4,048.28 €
		Penalties	150,083.57 €
Total	254,131.86 €	Total	254,131.86 €

In the light of the above, the updated Sources/Uses schedule with linked penalties to be paid to the tax authorities shows a real cost for the business of € 254,131.86 compared to the original € 104,048.28 (see Table 12).

Table 13 Scenario 2: Table of labour cost linked to project team

Role	Hourly cost	Time dedicated in hours	Project cost
DS	41.65 €	10	416.54 €
CE	21.99 €	32	703.79 €
P4.0	23.13 €	28	647.58 €
ICT	33.02 €	55	1,816.31 €
PM	29.80 €	75	2,235.26 €
	Total	200	5819.48 €

Table 14 Scenario 2: sources/uses schedule

Sources		Uses	
Description	Value	Description	Value
Own sources	105,819.48 €	Project	100,000.00 €
		Team cost	5,819.48 €
Total	105,819.48 €	Total	105,819.48 €

Table 15 Scenario:2 sources/uses schedule with tax credit offset

Sources		Uses	
Description	Value	Description	Value
Own sources	30,819.48 €	Project	100,000.00 €
Tax credit used	75,000.00 €	Team cost	5,819.48 €
Total	105,819.48 €	Total	105,819.48 €

4.2 Scenario 2: risk assessment by using the FRAM model

Now, let us consider the scenario in which the team decides to use a risk analysis model based only on the FRAM model. In this scenario, the number of hours dedicated to the project by the team increases as a result of the necessary brainstorming activities to carry out the project.

Leaving the unit costs the same, the total team cost is €5,819.48 as described in Table 13.

The Sources/Uses statement will therefore be the one represented in Table 14.

Taking into account the offset schedule as shown in Table 14, the effective Sources/Uses schedule will allow for an outlay by the business of € 30,819.48 rather than € 29,048.28 as previously (see Table 15).

The presence of risk assessment activity based on the FRAM model allows the business to study specific problems that may arise during implementation of the project and which, therefore, can be resolved in advance. Let's suppose, for example, that in 2023 an error in tax credit offset is noted and the team decides to use the voluntary correction procedure, which allows for application of a lower rate for the calculation of penalties than in the previous scenario. Taking into account the fact that the voluntary rectification occurs more than 90 days later, we will have the summary table—in Table 16-of the

Table 16 Scenario 2: recovery of sums unduly offset including penalties and interest

	TAX CREDIT OFF-SET USING F24	PENALTIES	INTEREST
2022	35,000.00 €	45,500.00 €	39.00 €
2022	13,333.33 €	17,333.33 €	14.86 €
2023	13,333.33 €	– €	– €
2024	13,333.33 €	– €	– €
Total	75,000.00 €	62,833.33 €	53.86 €

Table 17 Scenario:2 sources/uses schedule following voluntary correction

Sources		Uses	
Description	Value	Description	Value
Own sources	142,040.00 €	Project	100,000.00 €
Tax credit used	26,666.67 €	Team cost	5819.48 €
		Penalties	62,887.19 €
Total	168,706.67 €	Total	168,706.67 €

penalties and interest unduly paid to be recovered. Please note that the 2023 and 2024 credits will be used correctly thanks to the voluntary correction carried out.

Therefore, the actual Sources/Uses program will be the one shown in Table 17.

What emerges from this analysis is that the mere implementation of FRAM as an analysis model brings about a considerable increase in costs, above all because the control mechanism is activated late due to the incorrect expectation of adequate countermeasures to protect the various “critical” phases of the project. However, the perceived risk of committing errors is significantly reduced, from 4.80% a 3.19%. This result demonstrates how the FRAM model, thanks to its graphic capacities, makes the project flow clear, allowing the team to be more assured in carrying out their activities. On the downside, the strong subjectivity, unsubstantiated by further elaboration to make the analysis more “aseptic” with respect to personal opinions, shows its harmful effects on the operating result, as seen in the post-project Sources/Uses schedule.

4.3 Scenario involving risk assessment using the FRAM/AHP model

The third scenario provides for full implementation by the team of a model that uses the AHP method alongside FRAM. Given the presence of this additional analysis step, the team’s work will require further elaborations and, thus, more time dedicated to the project. All this will obviously be translated into higher project costs (see Table 18).

The planning of the Sources/Uses will therefore be as described in Table 19.

The analysis capacity provided by the AHP method allows the team to build adequate barriers protecting the critical phases. Consequently, it will be much easier to uncover specific failures during the project and correct them quickly. This speed of action is also “rewarded” by the tax authorities, who provide for special “favourable” rates to be applied to penalties inflicted for undue offsetting that is corrected in a short time period. In particular, corrections carried out within 90 days are subject to a penalty rate of 15%. Thus, simulating an immediate correction by the team for the tax credit offset in 2022 and considering that there will be no problems in offsetting later credit in 2023 and 2024, the cost of the

Table 18 Scenario 3: table of labour costs linked to project team

Role	Hourly cost	Time dedicated in hours	Project cost
DS	41.65 €	21	874.74 €
CE	21.99 €	52	1,143.67 €
P4.0	23.13 €	44	1,017.62 €
ICT	33.02 €	106	3,500.53 €
PM	29.80 €	102	3,039.95 €
	Total	325	9576.50 €

Table 19 Scenario 3: sources/uses schedule

Sources		Uses	
Description	Value	Description	Value
Own sources	34,576.50 €	Project	100,000.00 €
Tax credit used	75,000.00 €	Team cost	9576.50 €
Total	109,576.50 €	Total	109,576.50 €

Table 20 Scenario 3: recovery of sums unduly offset including penalties and interest

	Tax credit offset using F24	Penalties	Interest
2022	35,000.00 €	40,250.00 €	39.00 €
2022	13,333.33 €	15,333.33 €	14.86 €
2023	13,333.33 €	– €	– €
2024	13,333.33 €	– €	– €
Total	75,000.00 €	55,583.33 €	53.86 €

Table 21 Scenario:3 sources/uses schedule following voluntary correction

Sources		Uses	
Description	Value	Description	Value
Own sources	138,547.02 €	Project	100,000.00 €
Tax credit used	26,666.67 €	Penalties	55,637.19 €
Total	165,213.69 €	Total	165,213.69 €

penalties will be € 55,637.19 rather than € 62,887.19 as previously foreseen in the event of implementing only the FRAM model (see Table 20).

Moreover, the real post-project Sources/Uses schedule shows a real cost to be borne by the business of € 138,547.02 rather than € 142,040 as expected in the previous scenario (see Table 21).

The improvement in financial results described above does not translate, however, into a significant improvement in perceived risk, which is reduced from 3.19% to 3.12%, obtained using a FRAM/AHP risk assessment. The underlying reason for this result is fundamentally linked to the fact that the AHP, given how it was used in this model, serves to elaborate the analyses previously made using the FRAM model, enhancing only certain elements.

Fig. 2 Comparison between own sources used to implement the project

5 Results

The economic analysis undertaken has shown the validity of the proposed assessment model. Considering that, in a soft financing project, the parameters that describe the effectiveness of the operation can be expressed in terms of lower levels of resources originating from own sources deployed by the organisation to carry out the project, the validity of the assessment mechanism will be evaluated by taking into account not only said variable, but also:

- The perceived risk trend with respect to the possibility of ending up as the "losing party" in the event of assessment by the tax authorities;
- Amount of tax credit unduly offset in F24 by the organisation.

As regards the first point, Fig. 2 shows how the application of a risk analysis model composed at least of the FRAM model is certainly beneficial for an organisation approaching a soft financing project. Indeed, the use of own sources, expressed as the sum of machinery costs and costs linked to undue offsetting of tax credit in F24, is drastically reduced if compared to the scenario in which no model is used and the scenario in which only the FRAM model is used as a Risk Analysis tool.

This data, however, should not mislead careful readers. Indeed, joint implementation of a FRAM/AHP model, compared to a model that uses only FRAM, not only reduces the perceived risk of the organisation ending up as the "losing party" in the event of final judgment relating to a tax assessment, but also the value of the unduly used tax credit by the business in F24. Figures 3 and 4 explain this aspect.

Indeed, reading the data in combination, it can be seen how the capacity to better notice problems underlying management of the "Time" and "Precision" variables within the FRAM allows the organisation to adopt countermeasures that respond more quickly

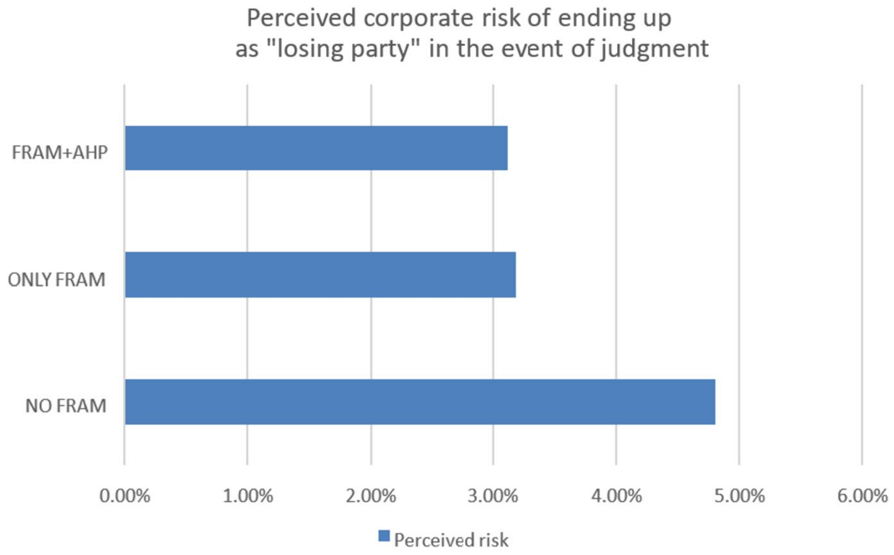

Fig. 3 Comparison of perceived risk in the event of losing at judgment

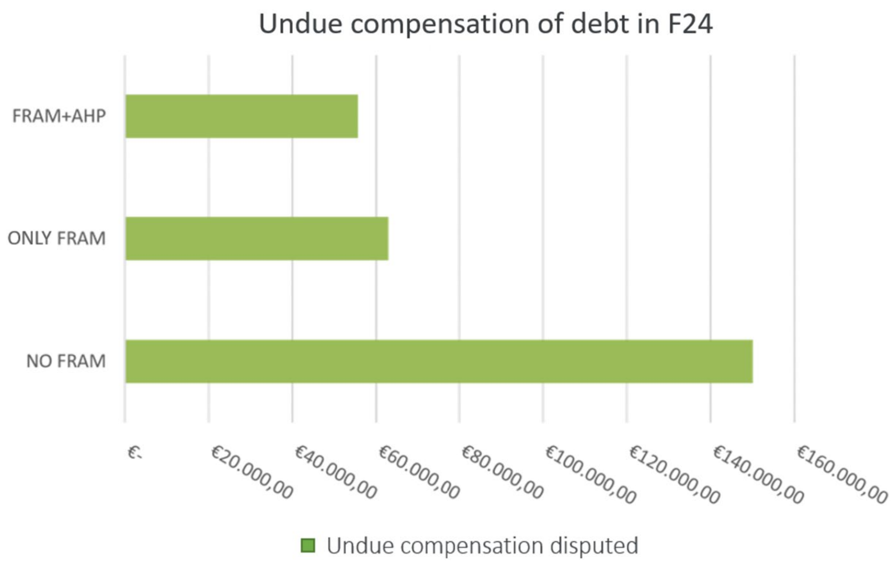

Fig. 4 Comparison of unduly offset tax credit in F24

to any problems that arise. This affirmation derives first and foremost from the fact that the FRAM/AHP model, compared to the model based only on FRAM, allows a reduction in the amount of tax credit that could be used mistakenly, either because it is used "too soon" or is accompanied by documentation that has been prepared not so precisely. Moreover, even the perceived risk of being considered the "losing party" in the event of a legal

Table 22 Table of labour costs linked to the project team

Role	Hourly cost	Time dedicated in hours	Project cost
DS	41.65 €	42	1749.47 €
CE	21.99 €	94	2067.40 €
P4.0	23.13 €	78	1803.96 €
ICT	33.02 €	148	4887.53 €
PM	29.80 €	152	4530.12 €
	Total	514	15,038.49 €

Table 23 Sources/uses schedule

Sources		Uses	
Description	Value	Description	Value
Own sources	40,038.49 €	Project	100,000.00 €
Tax credit used	75,000.00 €	Team cost	15,038.49 €
Total	115,038.49 €	Total	115,038.49 €

Table 24 Post-project sources/uses schedule

Sources		Uses	
Description	Value	Description	Value
Own sources	144,009.01 €	Project	100,000.00 €
Tax credit used	26,666.67 €	Team cost	15,038.49 €
		Penalties	55,637.19 €
Total	170,675.68 €	Total	170,675.68 €

dispute is reduced, precisely because of the greater perceived quality of the risk assessment carried out and, thus, of the capacity of the countermeasures adopted to avoid failures. Therefore, from the evidence, it may be thought, at first, sight that the implementation of a risk assessment model based on the joint use of FRAM and AHP could always be the most cost-efficient. This is not the case, and the following scenario demonstrates this. Indeed, if we assume that the team dedicates a large amount of time to creating the project and to the relative risk assessment, the following project cost is reached, leading to a new Sources/Uses schedule being drawn up (see Tables 22 and 23).

Taking into account the fact that the company can always voluntarily correct any errors using the sprint procedure for 2022, we arrive at the post-project Sources/Uses program described in Table 24.

It thus clearly emerges that the sum of own sources that the business will have to allocate is equal to € 144,009.01 rather than € 138,547.02. Perceived risk does not even improve; indeed, a slight worsening can be seen as it moves from 3.19% to the current 3.22%. This result is summarized in Fig. 5.

The trend shown by the curve illustrates how, as team costs for carrying out risk assessment increase, the perceived risk of the organisation committing errors in the correct application of the model, once a minimum is reached, will tend to gradually increase. The trend illustrated is justified by the fact that this tendency, widely expected, is confirmed by

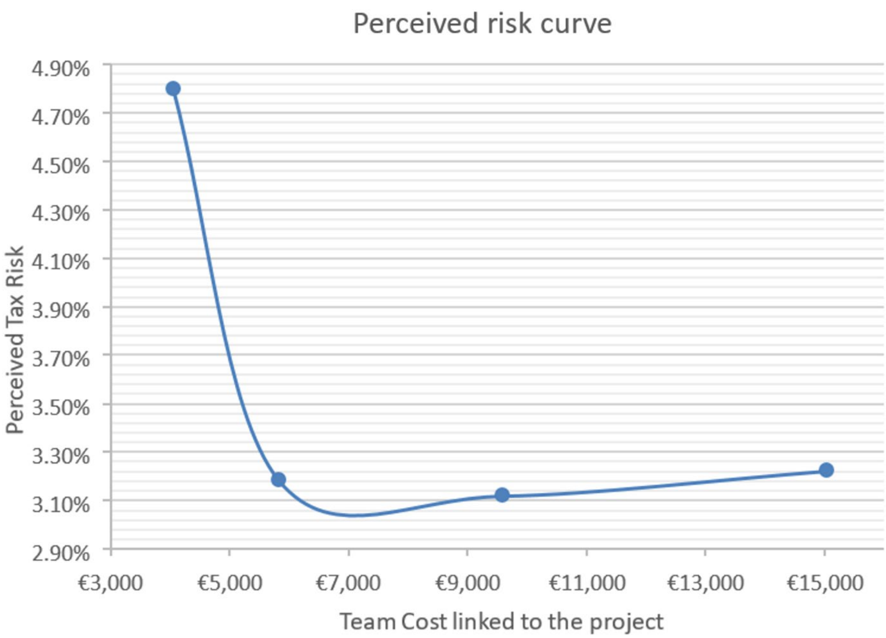

Fig. 5 Perceived risk curve

numerical analysis, which demonstrates how a cost variation does not necessarily bring about an improvement in perceived risk and, thus, of the team's capacity to introduce further mechanisms to protect the system in question. Thus, the organisation will have to take into due consideration how many resources to effectively allocate to the project, bearing in mind that people are not dedicated exclusively to the project but also to other "ordinary" activities essential for the operation of the business.

6 Conclusions

The study introduces a model based on Erik Hollnagel's functional resonance analysis method (FRAM) and Saaty's analytical hierarchy process (AHP) to understand the resilience of modern industrial systems. The model was applied to a common case study in Italy, assessing its validity through cost-benefit analysis, identifying three scenarios for business management: scenario without risk assessment, FRAM method risk assessment, and combined AHP models.The objective was to determine whether increased costs due to resource use reduce tax penalties. We have shown that implementing the FRAM model increases costs due to delayed control mechanisms and incorrect expectations of countermeasures. However, it reduces the perceived risk of errors from 4.80 to 3.19%. We also noticed that financial results improved by applying the FRAM/AHP model but did not significantly reduce perceived risk; this is because the FRAM/AHP risk assessment only improved some elements, resulting in a reduction from 3.19 to 3.12%. However, the analysis revealed that implementing the joint use of FRAM and AHP may not always be the most cost-effective solution, as demonstrated in a scenario where prolonged engagement in risk assessment brings about a new project cost. Qualitative analysis shows that increasing team costs for risk assessment leads to a gradual increase in the perceived risk of errors in the correct application of a model, while numerical analysis confirms this trend, indicating that the change in costs it does not necessarily improve perceived risk or the team's ability to protect the system.

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