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Management and Analysis of Organizational Risks with Mosler and Mixed Quantitative Methodologies, Using IT

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Abstract: The word and implication of "risk" has always been immersed in activity human and organizational work. Since the early 1990s, risk management has taken a real boom and importance because, once the risk is identified, preventive actions can be accomplished to mitigate its consequences. Recognizing the risks early allows to devised strategies to reduce impact at the organizational level.

The present article proposes the development and implementation of an Information System that facilitates the identification and evaluation of the risks, in order to achieve a lower degree of uncertainty in the fulfillment of objectives. This tool allows the evaluation and identification of risks in order to correct them in advance and benefit the decision making in organizations. Nowadays there are several alternative operational risk methodologies like: T Fine Method or Mixed Quantitative, HACCP Method, Greneter Method, Gustav Pur Method, Eric Method, Frame Method, Magerit Method, and Mosler Method.

The developed tool combines both Mosler Methodology and Quantitative Mixed methodology to identify levels of risk, regardless of size or business activity.

Key words: risk, computer system; control; analysis; Mosler; quantitative mixed

JEL codes: C88, C89

1. Introduction

Identifying and managing risks in a timely manner allows organizations to anticipate, understand, measure and assess risks for efficient decision-making. The present work of technological development promotes the systematization of the process through a Web Information system, which allows to measure the magnitude of risk, control and inform the user at any time.

In order to use information technologies, the aim is to speed up the process of analysis and identification of the type of risk, ensuring the collection and accuracy of the information entered by each of the organizations, decreasing data loss and facilitating access over the Internet.

2. Literature Review

The following refers to the theory and concepts that will support the present technological development.

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2.1 Background

In 1730 Abraham de Moivre proposes the structure of the normal probability distribution and the concept of standard deviation (Haro, 2005).

The normal curve represents the way many variables are distributed, some of its characteristics are described as follows:

- The main, mediana and mode are all of the same value.
- The curve is symmetrical around its midpoint, implying that the left and right halves of the curve are mirror images.
- The tails of the curve get closer and closer to the X-axis. but never touch it, meaning the curve is asymptotic (Figure 1).

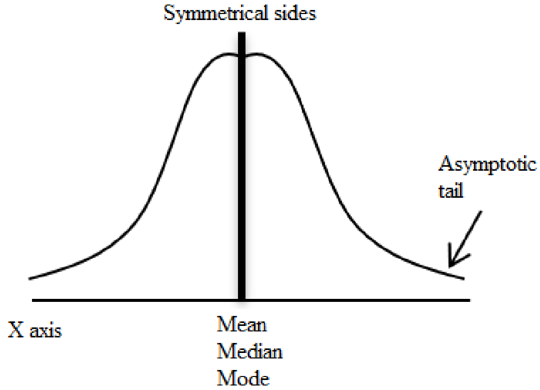

Figure 1 Normal Curve

Source: Salkind, 1999

In 1738 Daniel Bernoulli defined a systematic decision-making process, based on probabilities, which gave rise to the theory of operations research games.

In 1959, Harry Markowitz developed portfolio theory, proposing the concept of covariance and correlation; to the extent that they have negatively correlated assets among themselves, the market risk of a portfolio of assets decreases.

Harry Markowitz's pioneering work sets an important standard in risk management, with his work Portfolio Selection, published in the journal Journals of Finance in 1952; it was about an investment portfolio using statistical tools, which allowed to minimize risks and optimize returns of the instruments that make up an investment portfolio (Markowitz, 1952).

In 1994, the JP Morgan US bank proposed a technical paper called Riskmetrics, the concept of risk value as a model for quantitatively measuring the market risks in financial instruments or portfolios with various types of instruments. With this proposal, concepts of statistics of the seventeenth century are incorporated, modern risk management at the threshold of the 21st century is conceived as the adoption of a more proactive approach, which transforms the way risks are measured and monitored. Today there is a better definition of risks, new standards in the quantitative measurement of them (Haro, 2005).

2.2 Concept of Risk

According to Montero Moreno, a risk is defined as vulnerability to potential harm or damage that can affect individuals, organizations or entities (Moreno, 2016). Evokes the possibility of a mishap or damage, but also as verb defines the risk, dare, supposes the choice with uncertainty, hence its etymology that comes from the Latin *riscare*, which means to dare or to walk on the path of danger (Alfonso De Lara Haro, 2013, p. 13).

From another perspective, authors as White (1974), Varnes (1984), Cardona (1993), Aneas (2000) and Díaz (2004) perceive the risk quantitatively, aimed at estimating costs due to the expected losses from the occurrence of a natural or human-induced phenomenon.

2.3 Mosler Model

Within the operational risk measurement methodologies, the Mosler method has a solid foundation, the purpose is to make the information obtained easy to manipulate in order to manage operational risk and thus it allows the calculation of the class and dimension of the risk.

Identification, analysis and evaluation of factors that may influence the manifestation and materialization of a risk.

The operational risk cycle consists of the following phases:

- Identification: signaling of factors that affect the operational performance of the company.
- Quantification: measurement of key factors.
- Mitigation: implementation of measures to correct deviations from the operational process.
- Monitoring: involves monitoring of mitigation measures for operational risk reduction (figure 2).

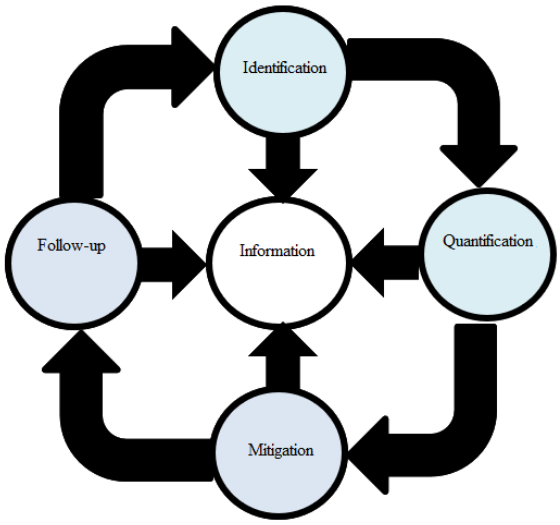

Figure 2 Cycle of an Operational Risk

Source: Moreno, 2016

Mosler's quantitative risk analysis consists of four phases, which will be analyzed in the following sections.

2.3.1 Definition of Risk

The first phase requires defining to which risks the area to protect is exposed, which could be: risk of information, investment, accidents, infrastructure, among others; making a list in each case.

2.3.2 Risk Analysis

A series of coefficients or Function criteria (F) are used for this analysis, which measures what is the negative consequence or damage that may alter the activity and whose consequence has an associated score, from 1 to 5, ranging from very slightly serious to very serious: very severely (5), severely (4), moderately (3), slightly (2), and very slightly (1).

On the other hand, we have the Substitution criteria (S), which measure how easily assets can be replenished in case any of the risks occur and whose consequence has an associated score, from 1 to 5, ranging from very easily to very difficult: very hardly (5), hardly (4), without many difficulties (3), easily (2), and very easily (1).

Regarding the criteria of depth or Disturbance (P), measure the disturbance and psychological effects depending on whether any of the risks is presented, having a score of 1 to 5, ranging from very mild to very serious: very serious disturbances (5), serious disturbances (4), limited disturbances (3), minor disturbances (2), and very minor disturbances (1).

The extension criteria (E), which measure the extent of damage, in the event of a risk occurring at the geographical level, having an associated score, from 1 to 5, ranging from individual to international: international (5), national (4), regional (3), local (2) and individual (1).

As for the aggression criteria (A), they measure the probability that the risk will manifest, they have an associated score, from 1 to 5, ranging from very reduced to very high: very high (5), high (4), normal (3), low (2), very low (1).

Finally, the vulnerability criteria (V), which measure the possibility that given the risk, it actually has a damage and whose consequence has an associated score, from 1 to 5, ranging from very low to very high: very high (5), high (4), normal (3), low (2), and very low (1).

2.3.3 Risk Assessment

After reviewing the phase two, the results are calculated according to the following formulae: calculation of the nature of the risk C.

$$I = F * S \tag{1}$$

Where:

I: Importance of risk.

$$D = P * E \tag{2}$$

Where:

D: Damage caused.

Risk:

$$C = I + D \tag{3}$$

Calculation of Probability PR.

Once having the data of the second phase, where we have the criterion of aggression (A) and the criterion of vulnerability (V).

$$PR = A * V \tag{4}$$

Quantification of the risk considered ER.

$$ER = C * PR \tag{5}$$

2.3.4 Calculation and Classification of Risk

The following qualitative scale is used: score between 1 and 200 reflects a low risk; score between 201 and 600 an average risk; score between 601 and above represents a high risk (Moreno, 2016).

2.4 Fine T or Mixed Quantitative

This method is distinguished by the abandonment of the equal weightings of its factors, and at the same time it introduces quantitative procedures and it moves away from subjective influences that could influence outcomes. It is a sequential method, which allows the risk analysis in 4 stages, which will be analyzed in the following sections.

2.4.1 Definition of Risk

In this first phase, the characteristic elements of risk (the good and the damage) are identified, delimiting its object and scope, to differentiate it from other risks.

2.4.2 Risk Analysis

This section sets out the criteria to be assessed at a later stage: probability criterion (P), concerning the number of times the risk analysed may occur; exposure criterion (E), concerning the times that the harmful agent may occur and the intensity that it may act during these attacks; consequence criterion (C), which makes it possible to quantify in monetary units the damages and costs.

2.4.3 Risk Assessment

At this stage, the criteria defined at the previous stage are quantified, assessed and weighted, and the probability assessment is carried out.

Probability has assigned a parameter that will be greater than zero and less than or equal to ten, as presented below: it occurs almost certainly, it is most likely to occur, whose parameter is 10; it can occur 50% of the time, with the parameter 6; it is possible but unusual, with the parameter 3; it is remotely possible, with the parameter of 1; it has never occurred, whose parameter is 0.5; practically impossible, with the parameter 0.1.

The exposure assessment is then carried out. This exposure concept is weighted between zero and ten: with continuous or permanent exposure graduation, which parameter is 10; frequent or once-a-day exposure grading, weighted at 6; with occasional or weekly exposure grading, with a parameter 3; with unusual exposure grading or once a month, with parameter 2; with rare exposure grading or a few times a year, with parameter 1; and finally with exposure graduation very rare or once a year, with weighting of 0.5.

Surely the assessment of the consequence. The consequence is weighted between zero and one hundred, graduating this valuation as appropriate to the economic magnitude of the potential damages and costs (the cost is not random but has to be fixed according to the financial damage that the Company will assume). Weighted at 10 times the weight assigned to probability or exposure.

After weighting the values of the three criteria mentioned in the previous paragraphs, it is necessary to calculate R.

$$R = P * E * C \tag{6}$$

2.4.4 Clasificación del Riesgo

A classification is established according to the level of risk obtained: level of risk 0 < R?20, acceptable risk classification; 20 < R?70, possible risk classification; level of risk 70 < R?200, Significant risk classification; level of risk 200 < R?400, high risk classification; level of risk 400 < R?10.000, very high risk classification.

This method establishes a list of actions linked to the human, technical and organizational resources of the Security System, to set out in the Security Plan the actions, their speed and resolution in case the event occurs.

It is necessary to determine corrective actions. From here, the actions to be taken can be noted: acceptable risk classification, whose action to be taken is to maintain the operation; possible risk classification, whose action to be taken is to control; considerable risk classification, whose action requires correction; high risk classification, whose action is immediate correction; very high risk classification, whose action is to consider elimination of the operation.

The cost and degree of correction of the Quantitative Method is then determined. As corrective decisions are taken, the values of the criteria analysed will decrease and the level of risk (R) will consequently decrease, whereas the decrease in the level of risk has a cost that is determined by the cost of the means CM.

Then the correction factor FC. It measures the decrease in the level of risk R that takes place when the means used are put into action.

The following formula J allows decisions to be made on the optimisation of the resources used, their cost and the degree of risk correction.

$$J = R/(CM * FC) \tag{7}$$

The criteria for the quantification of the cost of the means are described, considering the assessment of the economic effort involved in the implementation of the measures.

CM cost graduation more than 450.000, whose parameter to apply is 10; grading of CM cost between 82501 and 450.000, whose parameter to apply is 6; grading of CM cost between 15001 and 82500, whose parameter to be applied is 4; grading of CM cost between 2501 and 15000, whose parameter to be applied is 3; graduation of CM cost 451 and 2500, whose parameter to be applied is 1; graduation of CM cost less than 450, whose parameter to be applied is 0.5.

With regard to the correction factor, the grading of the CF cost eliminates the 100% of risk, whose parameter to be applied is 1; the graduation of the CF cost between 100 % and 75% , whose parameter to be applied is 2; the graduation of the FC cost between 75% and 50%, whose parameter to be applied is 3; the grading of the CF cost between 50% and 25%, the parameter to be applied is 4; the grading of the FC cost less than 25%, the parameter to be applied is 6.

Once the parameters have been defined and quantified, the justification formula is calculated J.

With level of justification 0?J < 10, the decision does not justify corrective actions; with a level of justification 10?J < 20, the decision is zone of doubts, reviewing C and FC; with level of justification 20?J, the decision justifies the proposals for action (Moreno, 2016).

3. Research methodology

In the following section, two methodologies are described that are closely related, with respect to the calculations required in the Mosler and Mixed Quantitative methods, and the methodology used in the planning for the design of the software, first of all, the methodologies for the calculations will be described and the section will end describing the tools, techniques, methods and models for the development of the proposed Software.

3.1 Mosler Methodology

The Mosler methodology allows to identify, analyze and evaluate the factors that can influence the expression and materialization of a risk. The methodology is sequential and each phase is based on the data obtained from the preceding phases:

- Definition of risk.
- Risk analysis.

- Evolution of risk.
- Calculation of the Risk Class.

Phases that were fully studied, in the Theoretical Framework section of this article.

The combined methods of statistics and probability both achieve a risk analysis and classification. Statistics play a key role in measuring risk by using central trend measures and dispersion measures.

3.1.1 Measures of Central Tendency

As for the measures of central tendency, the mean, median and mode are used, the most commonly used central tendency measure is the median, which refers to a measure of the centre of gravity of a data set, which one is affected by the extreme values of the series in question (Reinmuth, 2000).

$$\overline{X} = \sum_{1=1}^{n} X / n \tag{8}$$

Where:

$\overline{X}$: Average of variable X.

X: Random Variable.

n: Number of observations of the random variable.

Another Central tendency measure used is the median, it is defined as the observation that falls at the centre when the observations are increasingly ordered, whereas if the number is even, the mean value between the two observations that fall just in the middle of the observed statistical series is selected as a median.

On the other hand, in the statistical analysis mode is also used, which one is defined as the value that occurs most often (Moreno, 2016).

3.1.2 Dispersion Measures

Dispersion measures allow to mediate how much it changes or moves away from its central value, the measures used in the risk analysis are variance, standard deviation, coefficient of variation, tannosis and asymmetry.

Variance is defined as the average of the square of deviations from their mean, that is, how much the observed variable moves in relation to its center of gravity.

$$\sigma^2 = \sum_{i=1}^{n} \left[\frac{\left(X - \overline{X}\right)^2}{n} \right] \tag{9}$$

Where:

σ^2: Variance of the random variable X

X: Random variable

n: Number of observations of the Random Variable.

To obtain the variance in linear unit, the standard deviation is used, which one is the square of the variance, whose formula is:

$$\sigma = \sqrt{\sigma^2} \tag{10}$$

Another measure of dispersion is the coefficient of variation, it is the quotient that results from dividing the standard deviation by the average of the statistical series, and its main objective is to measure the relative dispersion with respect to the average, whose formula is the following:

$$CV = \sigma / \overline{X} \tag{11}$$

Another measure of dispersion employed is asymmetry, which one indicates the symmetry of the distribution of a random variable with respect to its mean, without the need to make the graphical representation.

$$\alpha_3 = \left[\frac{\left(1/n \sum_{i=1}^{n} \left(X - \overline{X} \right)^3 \right)}{\sigma^3} \right] \tag{12}$$

Where:

α_3: Mismatch ratio.

σ^3: Standard deviation.

$\overline{X}$: Average of Random Variable X

X: Random variable

Symmetrical Distribution: when measures of central tendency: mean, median and mode have the same value. Distribution positively biased: when the mean exceeds the median and the mode.

Negatively biased distribution: when mode surpasses median and mean.

Table 1 Biased Value of Distribution

Symmetrical	Positively biased	Negatively biased
= Md = Mo	> Md > Mo	Mo > Md >

Source: Moreno, 2016

Finally, another dispersion measure used is tannosis, it indicates how concentrated the values are around the average, the tannosis is defined from the fourth moment regarding the average of the distribution, which one indicates how flat or pointed the distribution will be.

- leptokurtic: very acute tip, it marks that the values are more concentrated towards the median.
- Mesokurtic: point with flattened shape, it indicates that the values are more dispersed with respect to the median.

$$\alpha_4 = \frac{1/n \sum_{i=1}^{n} \left(X - \overline{X} \right)^4}{\sigma^4} \tag{13}$$

Where:

α_4: Kurtosis coefficient

$\overline{X}$: Average of Random Variable X

X: Random Variable

σ^4: Standard deviation

n: Number of observations of the random variable (Reinmuth, 2000).

Formulas quoted due to their high impact on the present technological development.

3.2 Mixed Quantitative Method

The method consists of consecutive steps, forming a sequential model that has as its particularity the abandonment of the equal weightings of its factors, moving away from subjective influences that could detract from seriousness. The phases are listed below:

1) Definition of risk.
2) Analysis of risk.
3) Assessment of risk.
4) Classification of risk.

Phases developed in the Theoretical Framework section of this article.

3.3 Software Development Methodology

For the design and development of this project, the use of the agile methodology of SCRUM is carried out, in order to reduce documentation and focus on the development of the System; in this methodology there is no established list of processes, it focuses on the production of functional Software instead of devoting valuable time to documentation. Obviously, despite any methodology, documentation must be done, elementary for decision-making. Use case diagrams are described below, that through graphic designs allow to show the reader the actors and their relationships in the Management System and analysis of organizational risk indices based on Mosler and quantitative mixed methodologies.

The diagram of use case (Figure 3) shows that the Administrator logs in to the system, via email with a username and a password in order to access the options menu to perform.

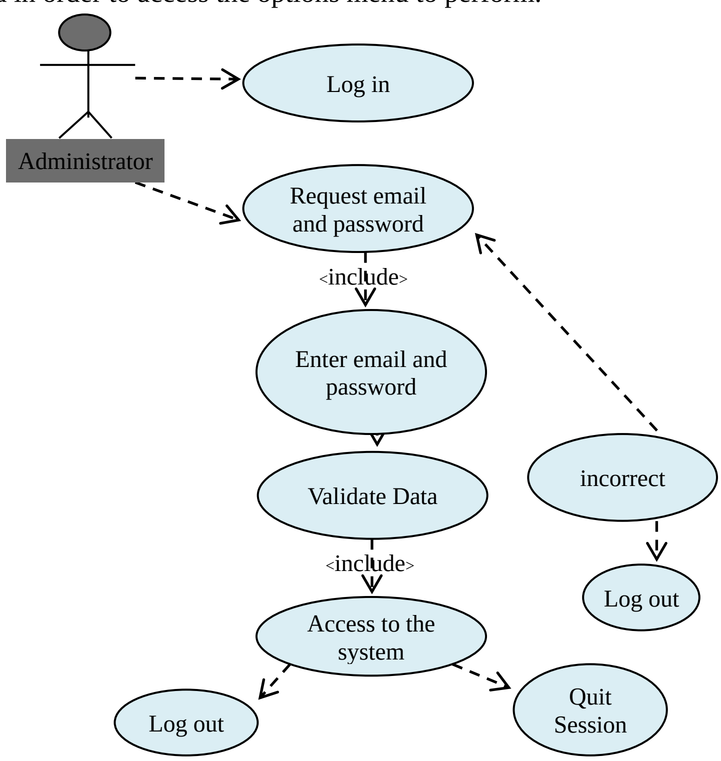

Figure 3 Loging into the System as Administrator

Figure 4 shows the description of the use case, options menu and functions to which the administrator has access.

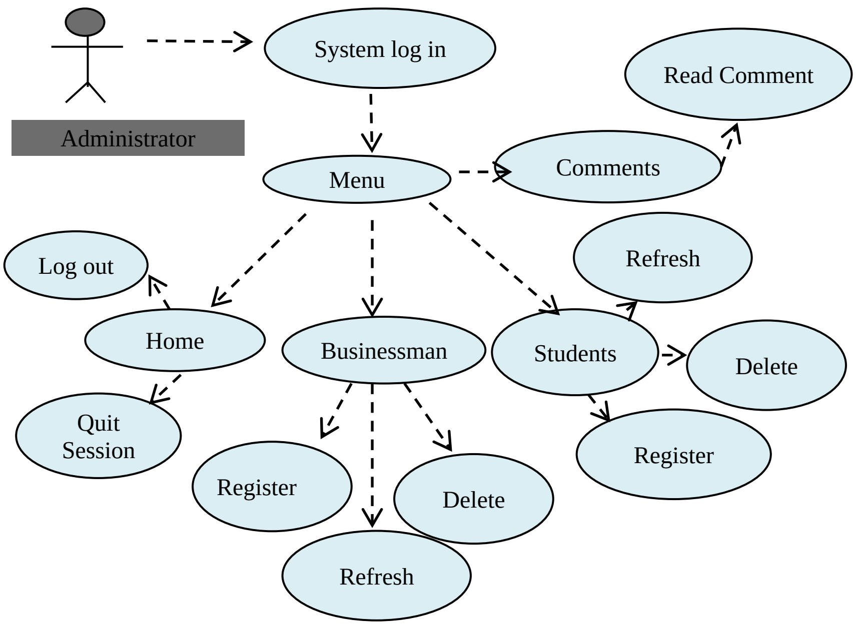

Figure 4 Use Case, Admin Options Menu

Figure 5 shows the description of the use case, options menu and the functions of each option displayed by the user.

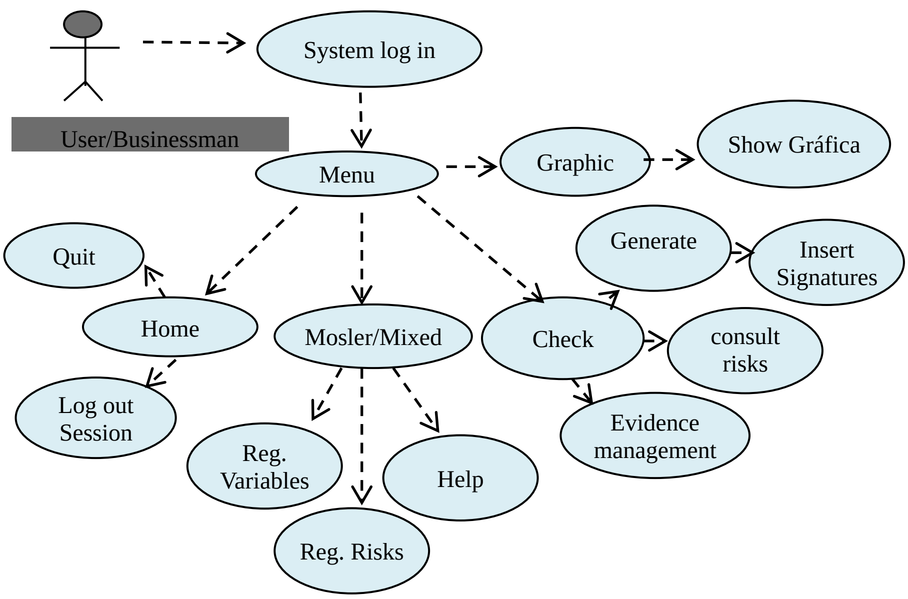

Figure 5 User Options

The Management and Analysis System of Organizational Risk Indices based on Mosler methodologies, allows the recording of risks, variable registration, by calculating the importance of the event, damage caused, risk carcácter, probability and quantification of the risk. The System contains an evidence manager in which the user can upload digitized photographs and formats as evidence of risks, as well as generate the report in PDF and generate graphs, including dynamically the people who perform the validation of the report.

On the other hand, the privileges of administrator user allow the management of entrepreneurs to allow and assign access to them, as well as the management of students to carry out practices related to risk management.

4. Test and Results

Once the Web System of Management and Analysis of Organizational Risk Indices based on Mosler and Mixed Quantitative Methodologies has been designed and implemented, the implementation tests begin and 26 entrepreneurs from the Tlaxcala region are invited, from dairy farmers to micro-entrepreneurs producing handmade soaps in the state of Tlaxcala. We have a simple of nineteen medium and micro-entrepreneurs who agree to carry out tests in the System (Table 1).

Table 1 Participating Companies in Final Pre-auctions of the System

Type of business or field	Number
Aquaculture Centre	4
production cooperative from Tilapia.	2
Dairy businesses	6
Fabrics and Embroidery/Products for Christening	3
Craft Cleaning Products Companies	4
TOTAL	19

Following is a sample of two successful test records where the employer was requested to determine the variables of each risk according to the categories set out in the table, each representative defined the respective variables according to their field (Tables 2 and 3).

Table 2 Determination of Variables Company Packer of Milk

<table>
<tr><th>Company</th><th>Method</th><th>Risk</th><th>Variable</th></tr>
<tr><td rowspan="16">Enterprise 1 Milk processor and packer</td><td rowspan="8">Mosler</td><td rowspan="2">Infrastructure</td><td>Collapse</td></tr>
<tr><td>Humidity</td></tr>
<tr><td rowspan="2">Natural phenomena</td><td>Hail</td></tr>
<tr><td>Wind</td></tr>
<tr><td rowspan="2">Financial</td><td>Loan</td></tr>
<tr><td>Liquidity</td></tr>
<tr><td rowspan="2">Technological</td><td>Failures in cooling tanks</td></tr>
<tr><td>Failures in vacuum packaging</td></tr>
<tr><td rowspan="8">Blended</td><td rowspan="2">Infrastructure</td><td>Collapse</td></tr>
<tr><td>Humidity</td></tr>
<tr><td rowspan="2">Natural phenomena</td><td>Hail</td></tr>
<tr><td>Wind</td></tr>
<tr><td rowspan="2">Financial</td><td>Loan</td></tr>
<tr><td>Liquidity</td></tr>
<tr><td rowspan="2">Technological</td><td>Failures in cooling tanks</td></tr>
<tr><td>Failures in vacuum packaging</td></tr>
</table>

Table 3 Determination of Variables Handmade Soap Processing Company

Company	Method	Risk	Variable
Enterprise 2 handmade soaps	Mosler	Infrastructure	Rent
			Change of address
		Natural phenomena	Hail
			Wind
		Financial	Loan
			Liquidity
		Technological	Failures in heating boiler
			Failures in emulsifier mixer
	Blended	Infrastructure	Rent
			Change of address
		Natural phenomena	Hail
			Wind
		Financial	Loan
			Liquidity
		Technological	Failures in heating boiler
			Failures in emulsifier mixer

The system is run with the proposed risks and variables determined by the representative of the companies with the following results:

Company dedicated to the processing of dairy products, whose opinion denotes in summary that it is evident to have an action plan for cooling tank failures and an alternative route or acquisition of vacuum packaging machinery (Table 4).

Table 4 System Results for Mosler Method, Dairy Processing Company

Risk	Variable	Level of risk
Infrastructure	Collapse	Possible
	Humidity	Significant
Natural phenomena	Hail	Significant
	Wind	Acceptable
Financial	Loan	Significant
	Liquidity	Significant
Technological	Failures in cooling tanks	Very high
	Failures in vacuum packaging	Very high

On the other hand, considering the methodology of mixed quantitative, it is observed that the risk of failure of the cooling tanks and machinery for vacuum packaging have both a very high impact, because it represents the production stoppage. Table 5 summarises the results obtained.

Table 5 Results of the Mixed Quantitative Method System, Dairy Processing Company

Variable	Leve lof risk	Risk classification	Corrective actions	Justification	Leve lof justification
Collapse	15	Acceptable	Keep the operation	2.5	No corrective action is warranted
Humidity	0.01	Acceptable	Keep the operation	0.003333333	No corrective action is warranted
Hail	50	Possible	Controlling	2.5	No corrective action is warranted
Wind	36	Possible	Controlling	3	No corrective action is warranted
Loan	225	High	Immediate correction	18.75	Justifies the proposals for action
Liquidity	135	Significant	Correction required	15	Justifies the proposals for action
Failure in cooling tanks	450	Very high	Consider disposal operation	50	Justifies the proposals for action
Failure in vacuum packing	900	Very high	Consider disposal operation	25	Justifies the proposals for action

As regards the tests carried out on a company for handcrafted cleaning products, specifically the production of craft bath soap, a very high risk level in terms of boiler failure and emulsifier mixer is observed (Table 6).

Table 6 System Results for Mosler Method, Handmade Soap Processing Company

Risk	Variable	Level of risk
Infrastructure	Rent	Significant
	Change of address	Very high
Natural phenomena	Hail	Significant
	Wind	Acceptable
Financial	Loan	Acceptable
	Liquidity	Acceptable
Technological	Failures in heating boiler	Very high
	Failures in emulsifier mixer	Significant

Similarly, through the mixed quantitative method for the same company, a latent and very high risk of humidity factor is observed, this is due to the geographical area where the company is located and the infrastructure for the storage of its products, also a very high risk that involves stopping the production by the failure of the boiler of a single emulsifying mixing equipment is denoted (Table 7).

Table 7 Results of the Mixed Quantitative Method System, Handmade Soap Processing Company

Variable	Leve lof risk	Risk classification	Corrective actions	Justification	Leve lof justification
Collapse	135	Significant	Correction required	15	Justifies the proposals for action
Humidity	5000	Very high	Consider disposal operation	208333333	Justifies the proposals for action
Hail	50	Possible	Controlling	2.5	No corrective action is warranted
Wind	50	Possible	Controlling	2.5	No corrective action is warranted
Loan	45	Possible	Controlling	5	No corrective action is warranted
Liquidity	1.25	Acceptable	Keep the operation	0.416666666	No corrective action is warranted
Failure in heating boiler	900	Very high	Consider disposal operation	75	Justifies the proposals for action
Failure in emulsifier mixed	900	Very high	Consider disposal operation	75	Justifies the proposals for action

5. Conclusions

Keeping in mind an irrigation, before it happens, allows organizations to analyze and evaluate in advance the negative effects that involve processes, in addition to identifying with opportunity the qualitative and quantitative factors that will be affected; which allows preparing for the consequences of an unwanted event.

The present research shows a technological development, which allows micro-enterprises in the state and the region to generate risk reports, where the levels of affectation are broken down by combining the results of the Mosler methodology and the Mixed Quantitative Methodology, which allow to observe a complementary panorama, integrating qualitative and quantitative aspects in the implications.

100% of tests were successful, companies now identify risks they had not considered and know mechanisms to identify potential risks, all companies considered in the tests generate their risk analysis report, which enabled decisions to be made in a timely manner. In addition, 100% of the companies consider, of the utmost importance, to generate alternative action plans to carry out the corresponding actions, in addition to objectively assuming and facing the risk.

Risk is an inevitable part of decision making, and employing Information Technologies in the web system of Management Analysis of Organizational Risk Indices based on Mosler and Mixed Quantitative Methodologies, significantly reduces the uncertainty in the management and risk analysis, allowing the identification of potential risks and the appropriate actions to counteract the effect of the same.

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