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Business Risk Assessment and Measurement Tools: A Risk That the Company Must Manage for the Success of the Business

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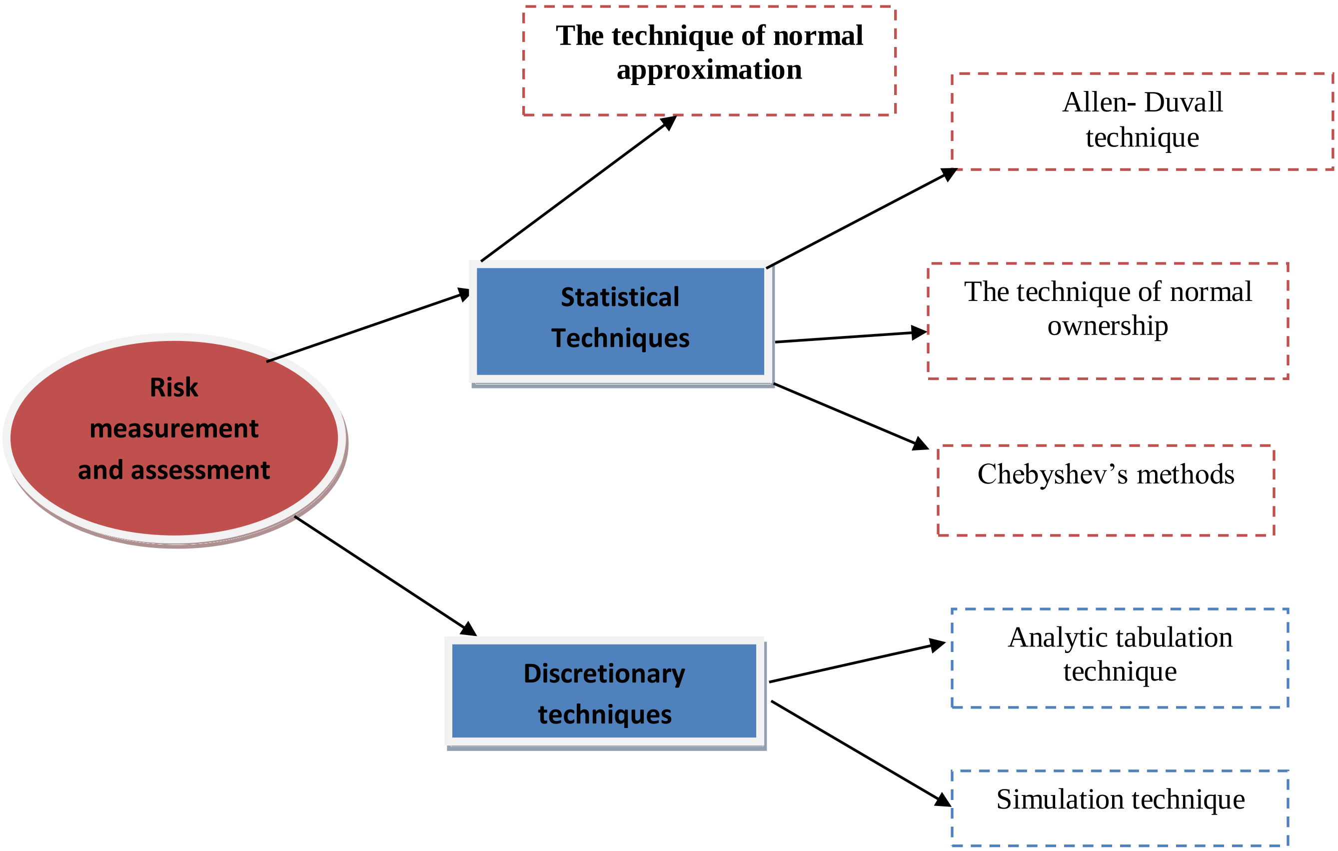
Abstract
Every company in its ordinary activity can run into multiple dangers that can evolve in an unfavorable direction to the company and compromise its development and economic stability with often irreversible consequences. In practice, it involves a complex of risks that could potentially affect the entire social and environmental context if not recognized and overcome. Risks can threaten a business's growth and existence. For this reason, in recent years, increasing attention has been paid to risk management in order to achieve corporate objectives. In the work we assessment center on risk assessment and assessment aims to attribute a value to the dimensions that risk the risk: the severity and frequency.

Keywords: risk management, methodologies for identifying corporate risks

1. Risk measurement and assessment

Risk assessment or measurement, the second step of the Risk Management process, aims to attribute a value to the two dimensions that define the risk: severity and frequency. The two quantities, although conceptually quite distinct, are linked on a practical level by a close bond. There is, in fact, an empirical law that puts the severity of a certain event and its probability in an inverse relationship: events that have very serious consequences tend to be rare, and therefore scarcely probable, while frequent ones, and therefore more probable, tend to to have modest consequences. In both cases it is necessary to prevent the formulation of a series of probability distributions both of the number of events that can generate losses and of the different losses that each event could produce. Since in each case it is a question of making a probabilistic assignment, two possible situations must be considered:

- that in which it is possible to construct, due to the number of observations available from the past, reliable distributions of frequency and severity;
- that in which it is necessary to resort, for the few observations available, to at least partially subjective assignments of probability



It should be emphasized that the first situation is, in the life of the various production units, a limit or theoretical case, while the subjectivity content of the probabilistic assignments grows in inverse proportion to the quantity and quality of the data on which the subject who must rely perform the assessment. Consequently, the weight of the assignments is more important when internal data is scarce and external data must be relied upon. It even becomes preponderant when the data, both internal and external, are almost non-existent. This applies above all to risks, in relation to which it is impossible to proceed on the basis of past observations to predict future risks. This is because each type of risk can be specific, and therefore, not become an element to underestimate the risks to which the company will find itself in the near future. In the first situation it will be possible to arrive at the deriving of the Annual Maximum Probable Aggregate Loss (PAMPA) which can be defined as that value that can equal or exceed, in a predetermined ratio with respect to the total, the total annual loss from a hazard or group of hazards. In the second situation, with the use of techniques for the subjective assignment of probability, such as cumulative loss analyzes or through qualitative risk assessment techniques, such as the Prouty approach, one or more of the following parameters will in any case be defined: the Maximum Possible Loss (MPP), the Maximum Probable Loss (MPP), the Expected Annual Loss (PAA).

The characteristics of a risk, terms of frequency, and severity can be expressed through different techniques with two macro categories: statistical techniques and discretionary techniques. The former use the principles of inferential statistics and are to be preferred in cases where historical information about past risk manifestations are widely articulated. The latter, on the other hand, make use of discretionary assessment criteria and are to be preferred in all cases in which historical information about past manifestations of risk is null or in any case lacking. For both, a judgment of convenience is expressed on the alternative of using the same technique or not by means of the aggregate maximum probable annual loss (P.A.M.P.A.) or the expected annual loss (P.A.A). In other words, for both the P.A.M.P.A and the P.A.A. represent the threshold factor for the decision; they, that is the value of the P.A.M.P.A and P.A.A.

2. Statistical Techniques

The statistical techniques applied to risk assessment the principles of inferential statistics according to which, through the analysis of a limited number of initial observations called a sample, it is possible to underestimate the future trends of a larger number of elements, called population.

The logical sequence to follow is therefore the following:
a) collection of information about past risk manifestations;
b) construction of the probability distributions of the random variables frequency, severity and annual losses;
c) use of the probability distributions of the random variables frequency, severity and annual losses for the evaluation of alternative risk management choices.
The first and natural source of information about the past manifestations of the risk to be underestimated is undoubtedly originating from the past claims that the company in question has suffered.

However, this information can often prove to be lacking, as:
- the sample of historical observations available is limited and therefore not able to allow a significant estimate of the tails of the distributions associated with low probability of occurrence;

- the sample of historical observations available has a low degree of homogeneity, as:

made up of comparable but not comparable observation units

identical (think, for example, of data referring to stable¬

similar minds for the type of process carried out and for machinery

used, but not for fire-fighting equipment);

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• established at different times. The company is constantly evolving: the more the observation period extends, the more likely it is that the same observation units have, over time, changed their characteristics and therefore the characteristics of the risk examined (with the passing of over time the degree of wear and obsolescence of the machinery increases, the effectiveness of the fire-fighting equipment adopted can change, and so on). The use of historical data always presents an inverse relationship between the length of the observation period (and therefore the number of observations available) and the homogeneity of the observations themselves.

In order to remedy these problems, it is often necessary to resort to information of external origin, that is to say to historical information which, although generated by observation units different from the one in question, present a reasonable degree of similar dine. Recourse to them presents, in some ways, problems opposite to those originating from the use of data of internal origin, since in the face of a loss of significance of the results due to the lowering of the degree of homogeneity of the observations, there is a growth in the size of the sample, which makes it possible to make up for the gaps in the data of internal origin, especially in the evaluation of the tails of distributions. The use of data of external origin is therefore advisable only after a careful assessment of the degree of homogeneity between the two sub-sets of information, which can be carried out where possible, through appropriate statistical techniques such as the comparison of the modal zones, otherwise limited to a rational qualitative judgment. The probability distribution of the identified annual losses constitutes the starting point for any decision regarding risk management strategy and optimal allocation of company resources. Before seeing how this is possible, however, it is necessary to identify an "indicator of understanding", capable of transforming it into a single value, representative of the extent of the risk examined. The central limit theorem of statistics, according to which taking the average of the observations of a sample as the average of future observations of the phenomenon can generate evaluation errors (understood as deviations of the actual value with respect to the average) the greater the smaller it is the number of starting observations used for the estimate renders the expected value of the distributions practically meaningless. For this reason, in order to quantify the extent of the risk to be assessed through a single value, a specific summary indicator was developed, able to explicitly consider also the possible deviations from the sample average: the Maximum Probable Yearly Aggregate Loss (MPY), also called the Maximum Probable Yearly Aggregate Loss (PAMPA) or the Maximum Probable Annual Overall Loss. In order to estimate the MPY, various techniques have been developed, including the normal approximation technique, the Chebyshev method, the normal property technique, the Allen-Duvall technique, the analytical tabulation technique. Today, however, the use of these techniques is significantly reduced due to the evolution of computer systems; in fact, the

simulation process that until recently was that of Monte Carlo can take place on any personal computer with negligible costs, and the results obtained from the simulation are decidedly more reliable than the results obtained with the aforementioned alternative techniques.

a) The technique of normal approximation

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This technique, which applies only if it is believed that the total losses are distributed according to a form close to the Gaussian, is based on the assumption that the distribution of the total losses can be approximated by the normal distribution. On the basis of this assumption, the $MPY(AN)$ estimate α% would be equal to the expected value of the distribution of total losses plus a multiple of its standard deviation, according to the formula:

$$MPY(AN) = E(x) + z_{\alpha}^{N} \cdot \sigma_{x}$$

where:

$E(x) =$ is the average of the distribution of total losses

σ_{x} = è is the root mean square of the distribution of total losses

z_{α}^{N} = is the value of z for which $pr(z^{N} \geq z_{\alpha}^{N}) = \alpha$ with α chosen error level.

Of course, the method is based on the hypothesis of the normal approximation of the overall distribution of the amount of costs related to risks and this allows the use of the tabulated values of z_{α}^{N} Basically, the method expresses the concept that the maximum annual probable overall loss is a value greater than the average of the distribution of the total amount of costs related to the risks borne by the company, depending on its dispersion and its trend. This technique has the advantage of linking the amount of losses both to the expected value and to a variability index. The main flaw is that the normal has a symmetrical shape, which happens for loss distributions only when the number of observations is very high. Furthermore, part of the cumulative probability of a normal is wasted on negative values, so that the estimate of the maximum loss is often erroneous downwards. One way to overcome the limitations of this technique is to correct the standard deviation, multiplying by the factor $\sqrt{n/n-1}$, con $n =$ number of observations available. This factor is used in statistics when the true standard deviation is used, but the one derived from sample estimates. Other limits in the use of this technique are inherent in the assumption that the total annual losses are distributed normally. In fact, in many types of hazards the existence of a pronounced asymmetry with respect to the average value is ascertained. Consequently, when this asymmetry is present in the sample of available observations or when there is any doubt that the distribution of the total losses is present, it is prudent not to use this estimation technique. Let's assume we want to estimate one with the normal approximation technique $PAMPA$ to 90%, with $z = 1{,}64$, and we also assume that we have an average equal to $E(x) = 21{,}732$ and a standard deviation equal to $\sigma(x) = 31.524$ we will get that:

$$PAMPA\,90\% = 15.966 + 1{,}64 * 31.254 = 67.222$$

b) The Chebyshev method

The Chebyshev method instead, estimate the $PAMPA$, using the mean and standard deviation of the observed data distribution. The value of the $PAMPA$ it is obtained by adding to the expected

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value of the distribution of total losses k *standard deviations, with the value* k *which is defined by the desired level of probability, according to the formula:*

$$PAMPA = E(x) + k\ \sigma(x)$$

in which $E(x)$ and $\sigma(x)$ they are respectively the mean and the standard deviation of the distribution of total losses. The coefficient k is the resultant of the formula:

$$k = \sqrt{1/1-\alpha}$$

with $\alpha =$ desired probability level for the $PAMPA$.

For example, suppose we want to estimate one $PAMPA$ to 90% we will have that:

$$k = \sqrt{1/1-0{,}90} = 3{,}16$$

and we still assume that $E(x) = 19656$ $\sigma(x) = 35787$ and. Pertanto si avrà:

$$PAMPA\,90\% = 19{,}656 + 3{,}16 * 37.787 = €\,139062.92$$

c) The technique of normal ownership

With this technique, the required estimate is calculated according to the formula:

$$PAMPA = E(x) + [z_\alpha + 1/6\alpha_3(x)(z_\alpha^2 - 1)]\sigma(x)$$

in which $E(x), \sigma(x)$ $\alpha_3(x)$ and they are respectively the mean, the root mean square and the symmetry index of the distribution of total losses, z_α is the value of the standardized normal α e the desired level of probability for the $PAMPA$. Let's suppose we want to estimate one with the normal property technique $PAMPA$ to 90% with $z = 1{,}64$, being $E(x) = 19656$ e $\sigma(x) = 35787$ e $\alpha_3(x) = 7$ we will get that:

$$PAMPA\,90\% = 19656 + [1{,}64 + 1/6\ 7(2{,}6896 - 1) * 35787] = €148830$$

The normal property technique therefore considers the symmetry index as the variables under study beyond the expected value and the mean square deviation[1] and in this way it obviates the main flaw of the normal approximation technique and is considered the most accurate rapid

[1] The symmetry index represents the degree of symmetry with which the results are distributed around the average. A frequently used symmetry index in this regard is that obtained from the mean of the cube of the deviations divided by the cube of the standard deviation according to the formula:

$$\alpha_3(x) = \frac{\sum_{x=1} (x_i - m)^3 p_i}{\sigma^3(x)}$$

method for estimating the $PAMPA$. However, this accuracy is linked to the fact that the symmetry index is of a rather low value. The best results seem to be achieved for index values less than or equal to 2. For higher values, and therefore when the lack of symmetry is accentuated, the technique leads to overestimating the $PAMPA$.

d) The Allen-Duvall technique

This technique, which is applied only if the frequency of the event is distributed according to the Poisson, is based solely on the probability distributions of frequency and severity, completely omitting that of the total losses. To calculate the Maximum Probable Annual Loss, they used the following formula:

$$MPY(AD) = [E(m) + 5\sigma(m)]\, S_{80}$$

where:

$E(m)$ is the average of the frequency distribution of the risks

S_{80} is that monetary amount to which a cumulative probability equal to 80% corresponds

$\sigma(m)$ is the standard deviation of the risk frequency distribution

Example: Let's assume we have a frequency distribution with an average of 1.35 and standard deviation of 0.7985, while the value corresponding to the 80% cumulative probability is € 20,000, according to this technique we will have that:

$PAMPA = [1{,}35 + 5(0{,}7985)] * 20.000 = €106850$

The method has the advantage of simplicity and avoids the need to know or estimate the distribution of the total losses, but, it is more of an estimation procedure based on common sense rather than a method and this is for the unverified assumption of operation of the distribution of Poisson, both because it prevents us from assigning to the $PAMPA$ a level of probability.

3. Discretionary techniques

Often the risk assessment must take place in situations characterized by a low level of information available, or because the information on the subject of claims is numerically small or because it is excessively uneven and therefore not usable for rational statistical analyzes. In such situations, the risk assessment can take place exclusively through discretionary assessments, based on the experience and knowledge of the specific risk by the assessor. Given the wide margin of discretion, however, it is necessary to try to identify guidelines, capable of "objectifying" the analysis, anchoring the evaluation to well-defined reference situations. These guidelines have been drawn up both in terms of frequency assessment and in terms of severity assessment. As regards the subjective assessment of frequency, the approach undoubtedly most used is the one proposed by

Prouty, according to which the frequency of a risk should be classified through the use of four reference classes:

- almost nothing, when it is believed that the event will not happen;
- mild, when there is the belief that the event, even if possible, will not happen for the moment;
- moderate, when it is believed that the event occurs occasionally;
- defined, when you are finally sure that the event happens regularly

The identification of this reference scale obviously does not solve the problem of the lack of objectivity of the evaluation, however, if well applied, it contributes to the reduction of the margins of discretion. For the subjective assessment of gravity, instead, the most applied analysis criterion is undoubtedly the one proposed by Friedlander which, born for the assessment of fire risk, has been increasingly extended to include any type of risk industrial, so much so that one level of its scale, the Maxi ¬ mum Possible Loss (MPL), is normally used as a parameter for evaluating any insurance coverage, especially in the event of fire risk. This evaluation criterion also classifies the severity of each risk into four reference classes, which in the original version concerning the fire risk are as follows:

- *Normal Loss Expectancy*: identifies the expected severity in the hypothesis in which all the means of protection of ¬ come into operation available, both internal to the company (internal teams, sprinklers, ...), and "external" (typically the public ones and, therefore, the fire brigade);
- *Probable Maximum Loss*: identifies the expected severity in the hypothesis in which only some of the internal means of protection of the company and all external ones come into operation;
- *Maximum Foreseeable Loss*: identifies the expected severity in the hypothesis in which only all the external means of protection come into operation;
- *Maximum Possible Loss*: identifies the expected severity in the event that no means of protection are implemented, neither internal to the company nor external.

However, the adoption of subjective assessment techniques, even if articulated according to the assessment criteria described above, does not help in the assessment of alternative management plans, as it is not able to calculate the MPY of a risk and therefore to offer a objective parameter of evaluation. To this end, it may therefore be of undoubted usefulness to merge together the simulation technique illustrated above with the subjective classification techniques, in order to subjectively construct the probability distributions of frequency and gravity to arrive at the estimate of the distribution. potential losses, to be used in the ways described in the previous paragraphs. Obviously, in this situation the expected value of the model is significantly reduced, however this does not substantially affect its usefulness when choosing between different management alternatives. In the second situation, with the use of techniques for subjective probability assignments, such as cumulative loss analyzes (Carter, Doherty and Diacon) or qualitative risk measurement techniques such as the Prouty approach, one or more of the following parameters: the Maximum Possible Loss (MPP), the Maximum Probable Loss (MPP), the Expected Annual Loss (PAA). Remember that the Maximum Possible Loss (M.P.P.) is defined as the worst loss that could possibly happen. Instead, the maximum probable loss (P.M.P.) is defined as the worst loss that is likely to occur, while the expected annual loss (P.A.A.) is defined as the average annual loss that can be expected in the long term all other conditions being equal. It is also useful to note that while the (PAMPA), the (PMP), and the (MPP) refer to the statistical probability of occurrence of harmful events, the (PAA) refers instead to the annual occurrence. In other words, the Expected Annual Loss refers to a frequentist setting that provides only an empirical measure of the probability of a harmful event. This is, however, the only estimate that the company administrator can generally have, who has a limited number of observations.

a) The analytic tabulation technique

The technique of the analytical tab, through a mathematical combination of the distribution laws followed by the frequency of the event and the severity of losses, proceeds to an estimate of the unknown distribution of total losses. Assumed for the adoption of this technique is that from the observed frequency and severity data we can deduce the theoretical distribution law of the two dimensions. Through a mathematical formula it is possible in some cases to proceed to a combination of their combination thus obtaining the theoretical distribution of total losses and this $PAMPA$ at the desired probability level. For example, such a combination formula exists if the frequency can be represented by the distribution of Poisson [2] and gravity from the range distribution. Unfortunately there are very few cases for which these combination formulas are available, although through numerical analysis techniques it is possible to reach high degrees of approximation. The current technique allows you to prevent very precise estimates of the $PAMPA$, but it also requires high degrees of mathematical sophistication.

b) The simulation technique

An alternative approach to that of the analytical tabulation is the use of the simulation technique that takes on a central role in the corporate field as it allows to formulate, by electronic simulators, of the models of reality that you want to examine. The technique requires two subsequent stages and allows to use both theoretical and empirical distributions of the frequency and severity. First, a random number is generated and with frequency distribution it is determined how many times the event will occur in the simulation year. At a later date other

[2] Poisson's distribution provides the likelihood that from a paro event to occur times when the number of evidence tends to infinity. The frequency of the generic value of results from the formula:

$$\frac{\lambda\, e^{-\lambda}}{h!}$$

In which λ It is the average and e constant equal to 2,71828. Distribution has for media $u = \lambda$ and for medium quadratic waste $\sigma = \sqrt{\lambda}$ is Its great value consists in the fact that to apply it it is only necessary to proceed to an estimate of the average number of times that one can expect the event to occur.

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random numbers are generated, one for each time the event will occur. At this point with the help of the distribution of gravity, the extent of the loss can be calculated for each simulated event. Finally, the sum of the simulated losses individually will give the amount of total losses for the year of simulation.

4. Conclusion

In the light of the considerations above highlighted and starting from the assumption that it is rarely possible to have sufficient number of observations so that the distribution obtained can be considered reliable, some methods have been developed, which can be grouped into two categories. The first includes methods that arise from the knowledge of the distribution of probability of total annual losses and use statistical parameters of the observed data. The second, on the other hand, includes methods that try to estimate this distribution.

They belong to the first group:

- The technique of normal approximation;
- Allen-Duvall technique;
- The technique of normal ownership;
- The Chebyshev's method.
- Instead, they are part of the second group:
- The analytic tabulation technique;
- The simulation technique.

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