Qualitative Operational Risk Software -Development of a Software Tool for Determining the Root of Operational Risk

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Abstract

This article shows software that allows determining the statistical behavior of qualitative data originating surveys previously transformed with a Likert's scale to quantitative data. The main intention is offer to users a useful tool to know statistics' characteristics and forecasts of financial risks in a fast and simple way. Additionally, this paper presents the definition of operational risk. On the other hand, the article explains different techniques to do surveys with a Likert's scale (Avila, 2008) to know expert's opinion with the transformation of qualitative data to quantitative data. In addition, this paper will show how is very easy to distinguish an expert's opinion related to risk, but when users have a lot of surveys and matrices is very difficult to obtain results because is necessary to compare common data. On the other hand, statistical value representative must be extracted from common data to get weight of each risk. In the end, this article exposes the development of "Qualitative Operational Risk Software" or QORS by its acronym, which has been designed to determine the root of risks in organizations and its value at operational risk OpVaR (Jorion, 2008; Chernobai et al, 2008) when input data comes from expert's opinion and their associated matrices.

1. Introduction

"The story of this storm in the global markets is the story of how the government intervened to solve the previous crisis and laying the foundation for a new one", the government's mismanagement of the world financial crisis and how we are now dangerously repeating many mistakes that were made such as: monetary policy, subprime policy, and financial innovations combined to create the new worst financial catastrophe, (Norberg, 2009).

As you can see, the world's governments do not address suggestions of experts like the Basel Committee and others that intend to make continuous improvements in processes, seeking the root of the problems, which are assumed to have solved the problems in the medium and long term as it would take some time to implement new management models.

Gregoriou (2009), show how applying only "time series" was produced actual crisis because event risks with low frequency and high severity is thinkable to detect only with qualitative data from expert's opinion or both (qualitative and quantitative data).

2. Structured Abstract

2.1. *Purpose*

The aim of this paper is to systematically analyze the primary sources of operational risk (OpR) in the industry different to financial sector.

The analysis is based on questionnaires handed over in both management and blue collars, from a methodical system designed by authors of this paper founded on Total Quality Control (Falconi, 1992 a and b; Juran, 1990; Deming, 1989) and applying suggestions from *Bank for International Settlements* (BIS, 2011).

The version of Qualitative Operational Risk's Software (QORS) presented herein is primarily based on qualitative methods taken from matrix expert's decision (Manktelow, 2004) applied when is very difficult the agreement between experts and when its necessary the identification and operational risk assessment (Gregoriou, 2009; Jorion, 2007).

2.2. *Design and Methodology*

The software is designed following this sequence:

(i)   Applying techniques for collecting and analyzing information to identify critical process areas.

(ii)   Importing external qualitative data of survey and sample with managerial and technical staff.

(iii)   Transform qualitative data to quantitative data with a Likert's scale.

(iv)   Selecting automatically common data with Excel to know sources of OpR.

(v)   Using of software Visual Basic and Excel as programming language of QOR – software (Garcia, 2004).

(vi)   Calculating typical statistic data of OpR by Excel for users not experts in statistics and forecasting.

(vii)   Integration with others statistics software (SAS, SPSS, Statgraphics Plus, others) for calculating statistic, goodness test and forecasting of operational risks when the user have a lot of experience in statistics.

2.3.   Results

The operational risk's sources have been likely to identify when applying the guidelines of Basel II and III. The aforementioned sources were detected when applying surveys and interviews to managers, professionals and technician's staff in electric service companies. Previously, similar techniques were applied by one of the authors in banking sector (Peña, 2006), hence is possible to implement the suggested methodologies by BIS to any sort of organization.

QORS allowed studying many of the risk's sources proposed by BIS such as government policies, human resources and so on. QORS has been fundamental to establish OpVaR.

This software tool allows stratifying sources of operational risks from matrices called "Paired Comparison Analysis" and "Grid Analysis" (Manktelow, 2004) and other simple matrix designed by authors to explain how the frequency and the impact of the data coming from expert's opinions are caused.

QORS interacts explicitly with other commercial statistical software to help to determine typical statistical values to establish the severity and frequency of OpR and the main ownership comes from the facility to be used by anyone with minimal knowledge of statistics, samples and surveys.

QORS does not intend to displace others sophisticated statistical software, because it only tries to help users when they come up with many arrays, which are very difficult when selecting common data to detect those sources of operational risk.

Furthermore this software selects automatically common data for users with little knowledge, who can realize studies to know the behavior of this operational risk qualitative data then users have having two possibilities to implemented   analysis then users have two options for their studies: Excel and from the most sophisticated software's market (SPSS, SAS and Statgraphics Plus).

2.4. Practical and Social implications

Currently, when people read or listen to financial risk (news) they do not understand the technical language and financial data used. However, these represent an important role for everyone due to the fact that in the global market existing in these times these records affect all aspects in our lives.

It is mainly important to create this software, because anyone who needs to know about his/her investments and risk that will be assumed when considering only expert´s opinion and when only qualitative data of these have.

On the other hand this software allows carrying out statistical studies and forecasting from qualitative data risk for people with basic knowledge about it and also for people with high level of knowledge that need to do fast studies about financial risk.

2.5. Originality/Value

It is common when market's agents need to know about financial risk that studies "time series of financial risk" from data of Fitch (Fitch, 2012), Moody´s (Tudela, 2011), Standard and Poor's (S&P, 2012) and other qualifications agency or from private data or banking data which has been the main source of data, but after financial world crash in 2008, The BIS change in other hand this studies.

Before the financial crisis, the expert´s opinions were despised, because it was said that is not possible to ensure reliability of these information, but now the financial market has understood that is impossible perceive only with time series, risks with low frequency and high severity and for this main reason change this opinion.

In the market exist lots software for study financial risk with time series, e.g. Palisade (http://www.palisade.com/) or RiskAMP (http://www.riskamp.com/), but is difficult find good software when forecasters required analysis from qualitative data.

This software enables to with qualitative data taken from polls of experts opinion, but the principal attribute is likely to put in practice by having a minimum knowledge of statistics.

3. Operational Risk

The formal definition of operational risk that is currently accepted was proposed by the *Bank for International Settlements* (BIS, 2011) as follows:

> *Operational risk is the risk of loss resulting from inadequate or failed internal processes, people or systems, or from external events.*

Under the advanced measurement approach of the Basel II & III Accord, banks are required to measure their total annual operational risk exposures (Gregoriu, 2009; BIS, 2011).

4. Techniques for Effective Decision – Making

Manktelow (2004) said that the techniques applied in this software help you to make the best decisions possible with the information you have available. With these tools, you will be able to map out the likely consequences of decisions, work out the importance of individual factors, and choose the best course of action to take.

Some tools known to resolve conflicts or make difficult decisions:

• Selecting the most important changes to make - *Pareto Analysis*
• Evaluating the relative importance of different options - *Paired Comparison Analysis*
• Selecting between good options - *Grid Analysis*
• Choosing between options by projecting likely outcomes - *Decision Trees*
• Weighing the pros and cons of a decision - *PMI*

- Analyzing the pressures for and against change - *Force Field Analysis*
- Looking at a decision from all points of view - *Six Thinking Hats*
- Seeing whether a change is worth making - *Cost/Benefit Analysis*
- Scenario analysis of expert opinion by Basel II & III – *Qualitative Operational Risk Measurement.*

In this software we look at decision-making tools in two stages. First, we will look at a set of good techniques that help you to select between different options. The second set helps you to decide whether a course of action is worth following.

In the first development of QQRS it was only considered three methodologies: *Paired Comparison Analysis, Grid Analysis* and *Qualitative Operational Risk Measurement*, due to the fact that this software is a complement of other works. In addition it will be likely to develop other techniques in future versions.

4.1. Paired Comparison Analysis

Manktelow (2004) explain that *Paired Comparison Analysis* helps you to work out the importance of a number of options relative to each other. It is particularly useful when you do not have objective data to base this on.

This makes it easy to choose the most important problem to solve, or select the solution that will give you the greatest advantage. *Paired Comparison Analysis* helps you to set priorities when there are conflicting demands on your resources.

To use the technique, compare each option with each other option, one-by-one. For each comparison, decide which of the two options is most important, and then assign a score to show how much more important it is. Figure 1, will show an example of survey with this technique applied an electric company. You can then consolidate these comparisons so that each option is given a percentage importance.

4.1.1. Size of Paired Comparison Analysis

This array compares a quality with others qualities, hence the result of the matrix is square, then:

Matrix's Row Numbers = N

Matrix's Columns Numbers = N.

After that, the generated matrix is N x N.

4.1.2. Level's numbers

It is the number of hierarchical levels of the organization. For instance in the Figure 1 as you may notice the levels are 3: direction, division and departments.

4.1.3. Expert's Number

It is the number of people who complement the polls. The sample taken was 87 experts in the example of the Figure 1.

4.2. Grid Analysis

Manktelow (2004) clear up that Grid Analysis is a useful technique to use for making a decision. It is most effective where you have a number of good alternatives and many factors to take into account.

The first step is to list your options and then the factors that are important for making the decision. Lay these out in a table, with options as the row labels, and factors as the column headings.

Next work out the relative importance of the factors in your decision. Show these as numbers. We will use these to weight your preferences by the importance of the factor.

These values may be obvious, and if they are not, than use a technique such as Paired Comparison Analysis (see 4.1) to calculate them.

The next step is to work your way across your table, scoring each option for each of the important factors in your decision. Score each option from 0 (not important to risk) to 5 (very important to risk).

Dirección / Producción

Legend:

Rango	Descripción
0 - 1	No relevante
2	Poco Relevante
3	Medianamente Relevante
4	Relevante
5	Muy Relevante

Departamento	Ingeniería de Mejoras de Generación		Planta Guri						Protecciones, Supervisión y Control de Generación	
	Investigaciones y Pruebas de Generación	Proyectos de Mejoras de Generación	Mantenimiento Eléctrico	Mantenimiento Mecánico	Ingeniería de Mantenimiento	Operaciones	Mantenimiento de Control e Instrumentación	Servicios Generales	Protecciones y Mediciones de Generación	Centros de Control de Generación
Investigaciones y Pruebas de Generación		3	4	4	4	4	3	4	4	4
Proyectos de Mejoras de Generación			3	3	3	3	4	4	5	5
Mantenimiento Eléctrico				5	5	5	5	5	5	5
Mantenimiento Mecánico					5	5	5	5	5	5
Ingeniería de Mantenimiento						5	5	5	5	5
Operaciones							5	5	5	5
Mantenimiento de Control e Instrumentación								3	3	4
Servicios Generales									3	5
Protecciones y Mediciones de Generación										4
Centros de Control de Generación										

Figure 1. Applying Paired Comparison Analysis – Real Case
Source: Authors (2011)

CVG EDELCA
Dirección de Producción

No relevante	1
Poco Relevante	2
Medianamente Relevante	3
Relevante	4
Muy Relevante	5

PROCESOS DE GESTIÓN

Número Correlativo de Proceso	Nombre del Proceso	Dirección Postulante	Descripción Proceso	Áreas involucradas	Categorías de pérdidas o subcategorías presentes en el proceso	Descripción del impacto en caso de ocurrencia	Pérdidas financieras asociadas al proceso	Reclamos de clientes (internos y externos)	Multas o Castigos	Afectación a la continuidad del negocio	Relevancia dentro del plan estratégico	Afectación de la imagen de la Organización	Observaciones	Puntuación
1	Comunicación con Clientes	División Planta Guri	Determinar e implementar dispositivos eficaces para la comunicación (en tiempo real, reuniones, radio teléfono, fax, correo electrónico) con la finalidad de garantizar la producción de energía eléctrica y la satisfacción del cliente de acuerdo a la retroalimentación del cliente	Planta Guri y Div. de Operaciones	4, 6, 7		5	5	5	5	4	5		97
2	Formular Estrategias y Lineamientos	División Planta Guri	Determinar los niveles de demanda del servicio y con base en la capacidad instalada de la planta, se establece la cantidad de energía a producir en el ejercicio económico.	Div. de Planificación Corporativa, Div. de Comercialización y Servicio al Cliente	3, 6 y 7		4	2	2	4	4	2		60
3	Planificar y Desplegar la Gestión	División Planta Guri	Planificar y desplegar los planes a todos los Dptos. Adscritos a la División Plan de Producción, el Plan de Mantenimiento de Unidades Generadoras, el Plan de Mantenimiento de Equipos Auxiliares y Aliviadero, entre otros y en base a los lineamientos emitidos	Div. de Operaciones, Div. de Planta Guri.	3, 6 y 7		4	3	3	3	4	2		63
4	Seguimiento, Control y Mejoras de la Gestión	División Planta Guri	Asegurar que los requisitos exigidos por el cliente (Div. de Operaciones) en cuanto al producto del Proceso Producir Energía Eléctrica estén de acuerdo a sus lineamientos	Departamento de Operaciones (Div. de Operaciones) y los Departamentos de Mantenimiento de Planta Guri: Eléctrico, Servicios Generales, Control e Instrumentación, Ingeniería de Mantenimiento y Mecánico	3, 6 y 7		4	3	2	3	4	2		60

Figure 2. Applying Grid Analysis – Real Case
Source: Authors (2011)

Note that you do not have to have a different score for each option. If none of them are good for a particular factor in your decision, then all options should score 0. See Figure 2 to clarify this matrix.

Now multiply each of your scores by the values for your relative importance. This will give them the correct overall weight in your decision.

Finally add up these weighted scores for your options show that the highest percentage is the most risky.

4.2.1. Size of Grid Analysis

The matrix studies activities, processes or what the pollster decides, but the value of risk focuses in the characteristics of these procedures, hence this matrix compares a procedure with another one. For this reason generally the matrix is rectangular:

Matrix's Row Numbers = M
Matrix's Columns Numbers = N.

After that, the generated matrix is M x N.

4.2.2. Level's numbers

Mainly, this poll describes the procedure and then it is valued according to preestablished criteria. The number of levels depends on the information that the user wants to describe from the procedures to compare. The example of the Figure 2 shows this array has two descriptive levels.

4.2.3. Expert's Number

Similar to Paired Comparison Analysis's case, it is the number of people who complement the polls. In the next example 58 experts were taken to be polled.

4.3. Qualitative Operational Risk Measurement

These are techniques designed by authors from BIS suggestions (Gregoriou, 2009). Basically the authors carried out a deep investigation about internal and external activities, processes, systems and others considerable issues inside the organization including many brainstorms and meetings with managerial and blue collars.

This article describes risks associated and the experts should expose their impressions and opinions and transforming of these with a likert scale predefined about frequency and severity of operational risk detected. Figure 3, shows this technique.

This arrangement is generally dimensioned with M files and N columns, therefore it is a rectangular matrix M x N. It generally has one level where the information provided about the risks and its associated activities are described.

Likewise to the previously described matrices, the number of people surveyed is associated to the number of experts who have done the arrays. In the Figure 3, expert´s numbers were 58.

ID R.O Consol.	Nombre Actividad y/o Proceso	Nombre del Riesgo	Descripción del Riesgo	Atributo	Categoria	Frec. Promed.	Imp. Promed.
R1	Estimar Ventas Mensuales de Energía	Estimar Ventas Mensuales de Energía Erroneamente	Se produce por eventos externos o fortuitos, ya que su ocurrencia esta asociada a que las grandes empresas suscriptoras no cumplen los planes y programas de consumo de energía, ya sea por: reducción de su producción, fluctuaciones de su mercado, fallas operacionales internas, incumplimiento en la planificación de entrada y salida de sus equipos y unidades de producción, paralización de actividades en una empresa (huelgas), reducción de turnos de trabajo, cambios climaticos, nuevas Leyes o Decretos entre otros.	Prácticas de clientes, productos y negocios, no adecuadas	Externo	12	3
R2	Estimar Ventas Mensuales de Energía	Estimar Ventas Mensuales de Energía Erroneamente	El personal de Planificación Corporativa/Comercialización no tiene el suficiente adiestramiento para realizar los pronósticos de ventas más adecuados y precisos, debido a que no se tiene estipulado o no se cumple que los analistas iniciales de los pronósticos reciban la capacitación académica requerida. Es decir se desconoce la planificacción por escenarios, modelos prospectivistas y perpectivistas, estudios de series de tiempo, estacionalidad, ciclos de producción, estratificación de datos, estudio de tendencia, otros.	Fallas en la ejecución, entrega y gestión del proceso	Procesos	7	7
R3	Estimar Ventas Mensuales de Energía	Estimar Ventas Mensuales de Energía Erroneamente	Las bases de datos de Excel contienen datos espureos no identificados adecuadamente a traves de software estadisticos. Estos datos erroneos se producen por mediciones inexactas, producto de la perioricidad entre una y otra, deficiencias en el SCADA y el SAP, fallas o deficiencias de Hardware, intranet, datos inexactos obtenidos por vias comunicacionales (intranet, internet, telefonos, fax, otros). Adicionalmente, los software (¿Cual(es)?) de pronosticos y manejos estadisticos no son los más idoneos o actualizados para estimar las ventas.	Fallas en la ejecución, entrega y gestión del proceso	Tecnologico	4	4
R4	Estimar Ventas Mensuales de Energía	Estimar Ventas Mensuales de Energía Erroneamente	Negligencia, desatenciones, falta de revisión detallada produce revisiones erróneas en el control de la gestión de datos. Personal insuficiente respecto al volumen de trabajo. Omisión de datos importantes, intensiones poco claras en la elaboración de las estimaciones.	Fallas en la ejecución, entrega y gestión del proceso	Recursos Humanos	14	2

Figure 3. Applying Qualitative Operational Risk Measurement – Real Case
Source: Authors (2011)

5.   Development of Qualitative Data Operational Risk Software

Qualitative Operational Risk Software 1.0.xlsm (QORS 1.0), is a software developed under Excel 2010 and is based on VBA (Garcia, 2004).

VBA is a language object-oriented, generally used to support Office's macros and in this case in particular Excel. These languages have shown much versatility to calculate with financial risk's qualitative data and the risk's event require for the users. Moving onto how the software works and its internal logic:

5.1.   Starting Qualitative Operational Risks Software

Once started the execution, QORS 1.0 shows a graphic of qualitative data in three-dimensional convolution from a real case that is shown in Figure 4. The chart's movements are the result of the consecutive and overlap presentation in the same point of a risk's graph which has been done under the function *LoadPicture* (Microsoft, 2012a).
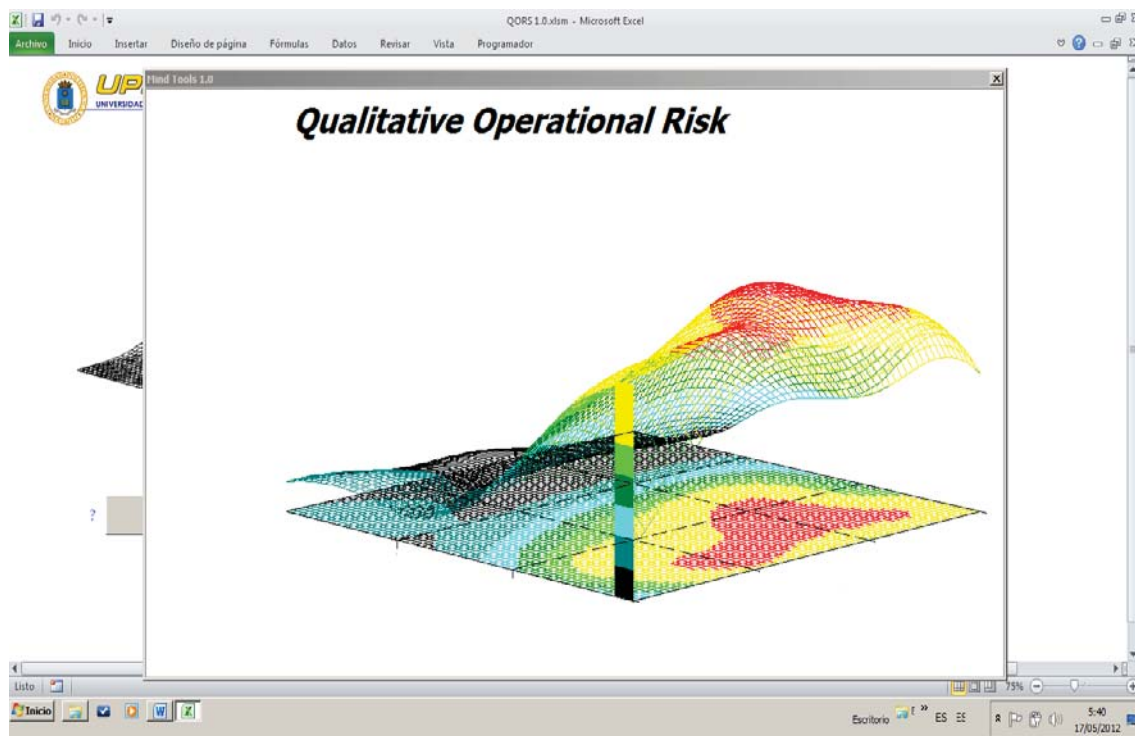
Figure 4. First Screen on QORS
Source: Authors (2012)

The *LoadPicture* function syntax has these parts:

Tabla I. LoadPicture function syntax

Part	Description
filename	Optional. String expression specifying a filename. Can include folder and drive. If no filename is specified LoadPicture clears the Image or PictureBox control.
size	Optional variant. If *filename* is a cursor or icon file, specifies the desired image size.
colordepth	Optional variant. If *filename* is a cursor or icon file, specifies the desired color depth.
x	Optional variant required if *y* is used. If *filename* is a cursor or icon file, specifies the width desired. In a file containing multiple separate images, the best possible match is used if an image of that size is not available. X and y values are only used when *colordepth* is set to **vbLPCustom**. For icon files 255 is the maximum possible value.
y	Optional variant, required if *x* is used. If *filename* is a cursor or icon file, specifies the height desired. In a file containing multiple separate images, the best possible match is used if an image of that size is not available. For icon files 255 is the maximum possible value.

Source: Microsoft (2012a)

The *LoadPicture* was designed in *BMP* format from several points of view. A *BMP* file is a bitmap file, i.e. a graphic image file, with pixels stored in the form of point table and managing the colors either as true colors or using an indexed palette. The *BMP* format has been studied in such a way as to obtain a bitmap that is independent of the peripheral display device (*DIB*, Device independent bitmap).

The structure of a bitmap file is the following: File header, Bitmap information header (also called information Header), Palette, The image body. (Lancaster, 2011).

The figure 5 shows how the graphic has completed an entire rotation; it automatically disappears to show the types of studies which develop the application. These are:

- ✓ Techniques for Effective Decision Making
- ✓ Qualitative Operational Risk Measurement
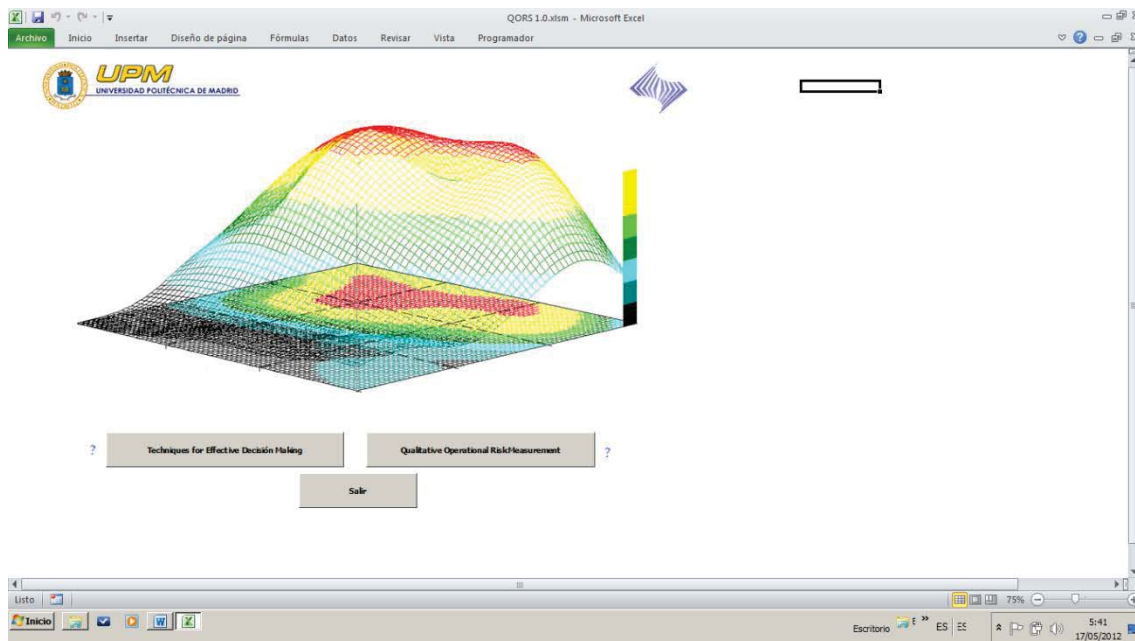
Figure 5. Screen of Option Studies
Source: Authors (2012)

The buttons in the Figure 5, which are shown as options mode, are functions called *CommandButton* (Simon, 2002), that allow identifying the user's decision.

As I said before, even though VBA (an object-oriented language) is employed, it is explained the procedure of the developed techniques, using a structural method, which was used to endow the entire procedure of a sequentially, which allows the user to understand the development of QORS.

The Figure 6 presents the QORS's internal logic flowchart with possible sub-orders when the program is started.

QORS 1.0 only includes the possibility of realize some analysis of the following tools (Manktelow, 2004):

- Paired Comparison
- Grid Analysis
- Qualitative Operational Risk Measurement.

| Proceso: | **A:** Qualitative Operational Risk Software |
| Objective: | Show flowchart of QORS |

| Design by: | Inspected by: | Approved by: | Last Edition: | Page: |
| José del Hierro Marqués | Eng. MSc. Dionicio Peña T. | PhD. Carlos Rodríguez M./ PhD. Pablo Solana | April 27, 2012 | 1 of 1 |

Notes
(1) FRM Technics
(2) To development in the next version
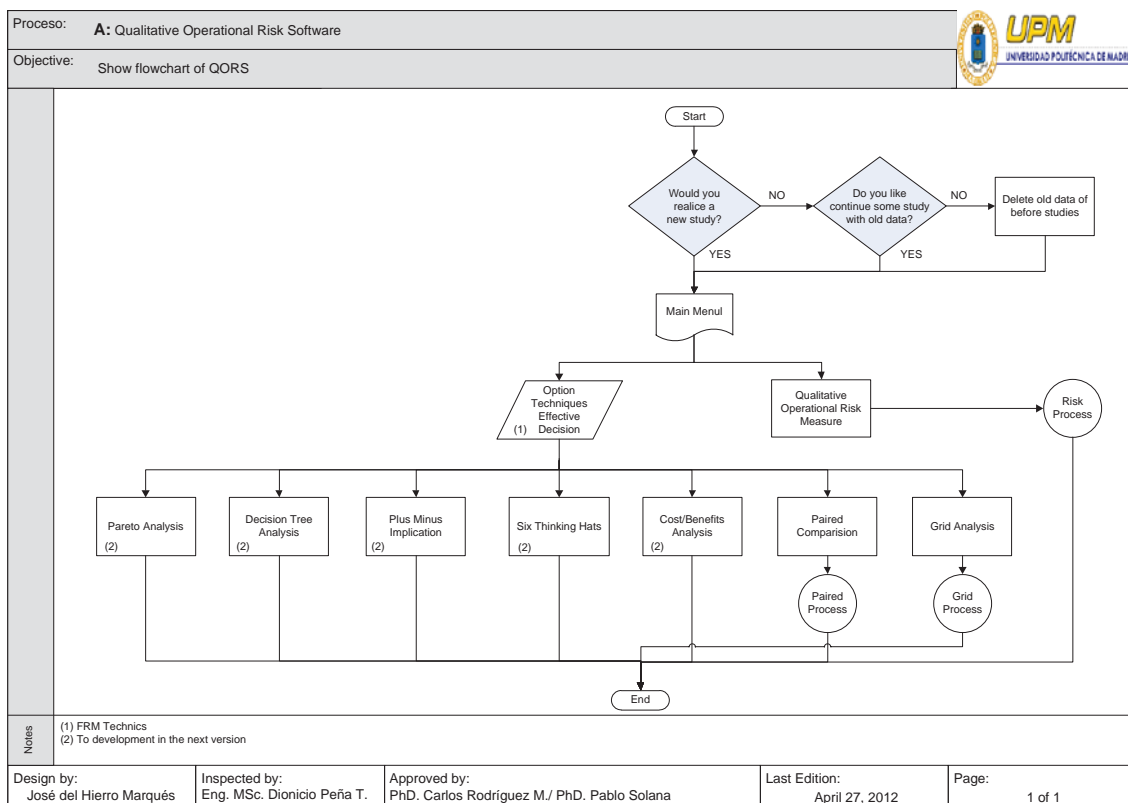
Figure 6. Logic Flowchart of QORS
Source: Authors (2012)

5.2. Helping to Users

The software provides help to the user with in order to clarify the matrix's basic concepts implemented in qualitative polls to identify the operational risks. This option is identify with the question mark and is objects like type *IMAGE*, which once pulsed by the users it will allow them to obtain the basic information regarding to the different polls likely to study by using this tool.

Figure 7, shows how this help is an object like *UserForm* with an object *Label* type, which is included in execution's time in function of selected option (Microsoft, 2012b).

A *UserForm object* is a window or dialog box that makes up part of an application's user interface.

The *UserForms collection* is a collection whose elements represent each loaded *UserForm* in an application. The *UserForms* collection has a *Count* property, an *Item* property, and an *Add* method. *Count* specifies the number of elements in the collection; *Item* (the default member) specifies a specific collection member; and *Add* places a new *UserForm* element in the collection.
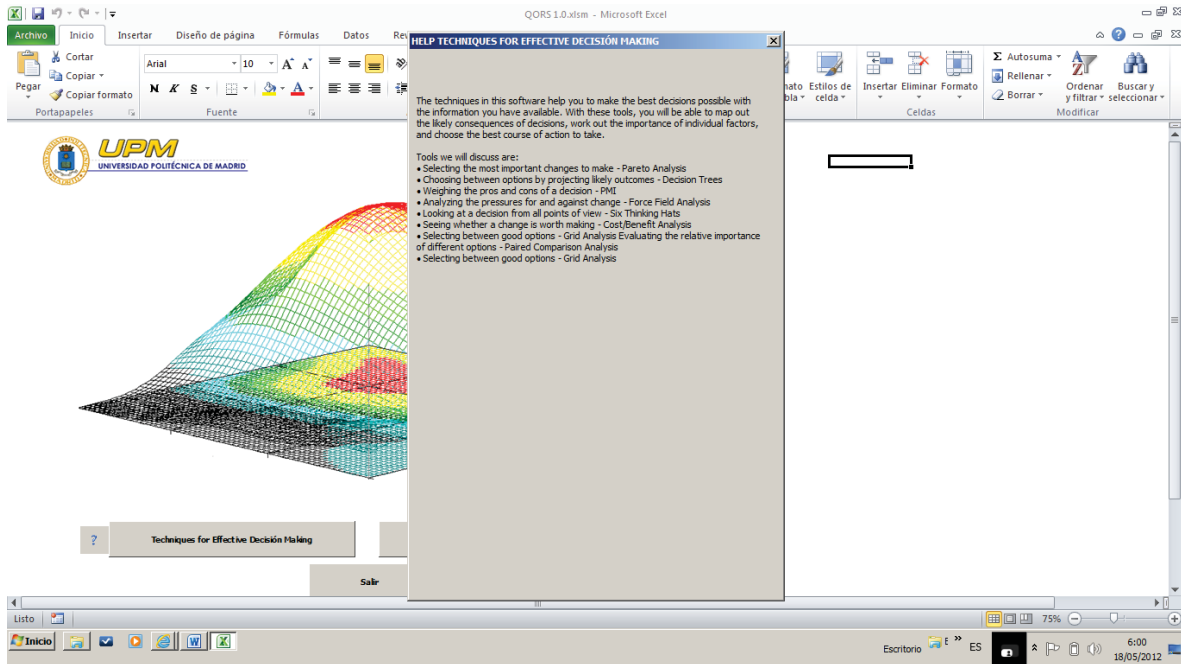
Figure 7. Helping to Users
Source: Authors (2012)

The figure 8 presents how the *frmClean* (Paul, 2002) has been created in order to delete remained data from previous studies, because it is important to have patterns in white at the beginning of any study, so the format and the patterns used differ substantially within techniques.
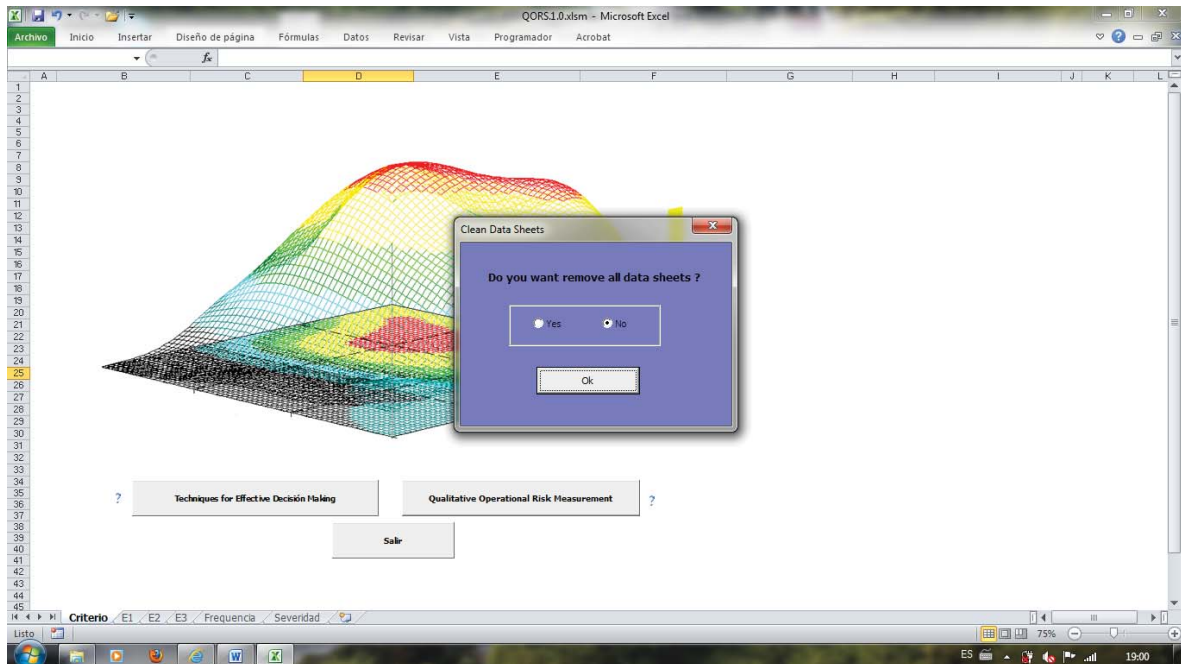
Figure 8. FrmClean
Source: Authors (2012)

This is an object type User Form (Microsoft, 2012b) which is responsible to eliminate all the data from previous executions and leaves the application in its original state.

5.3. Selecting to Techniques to Effective Decision

The figure 9 shows the next image when the option *Techniques to Effective Decision* is selected with the diverse techniques of analysis available according to Figure 5, which can be executed by pulsing the appropriate button.
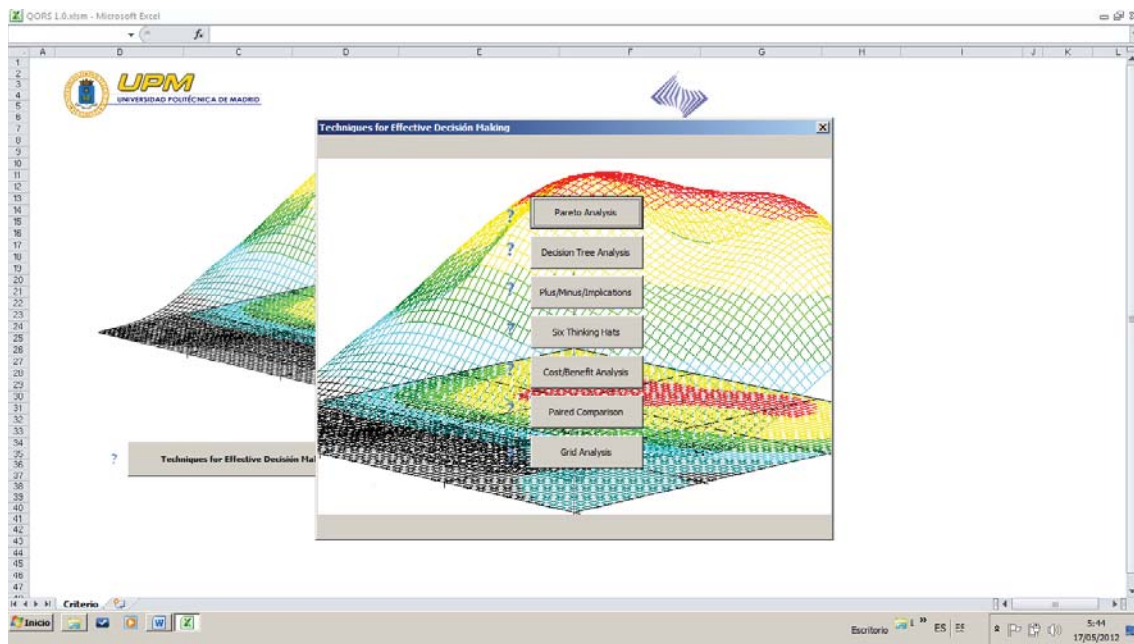
Figure 9. Selecting to Techniques to Effective Decision
Source: Authors (2012)

In the previous figure is observed that beside each of the options, help is presented again with a deeply explanation of the developed techniques. Software apply system 5W + 1H (What, Who, When, Where, Which and How) to resolve studies included for users.

5.3.1. Paired Comparison Analysis

If the user decides to pulse the button *Paired Comparison*, the QORS will assess the respective analysis. The figure 10 shows the internal logic flowchart of the comparison by pairs with QORS´s internal sequences to qualitative analysis.

| Proceso: | **B:** Paired Comparision Analysis | | | | | | |
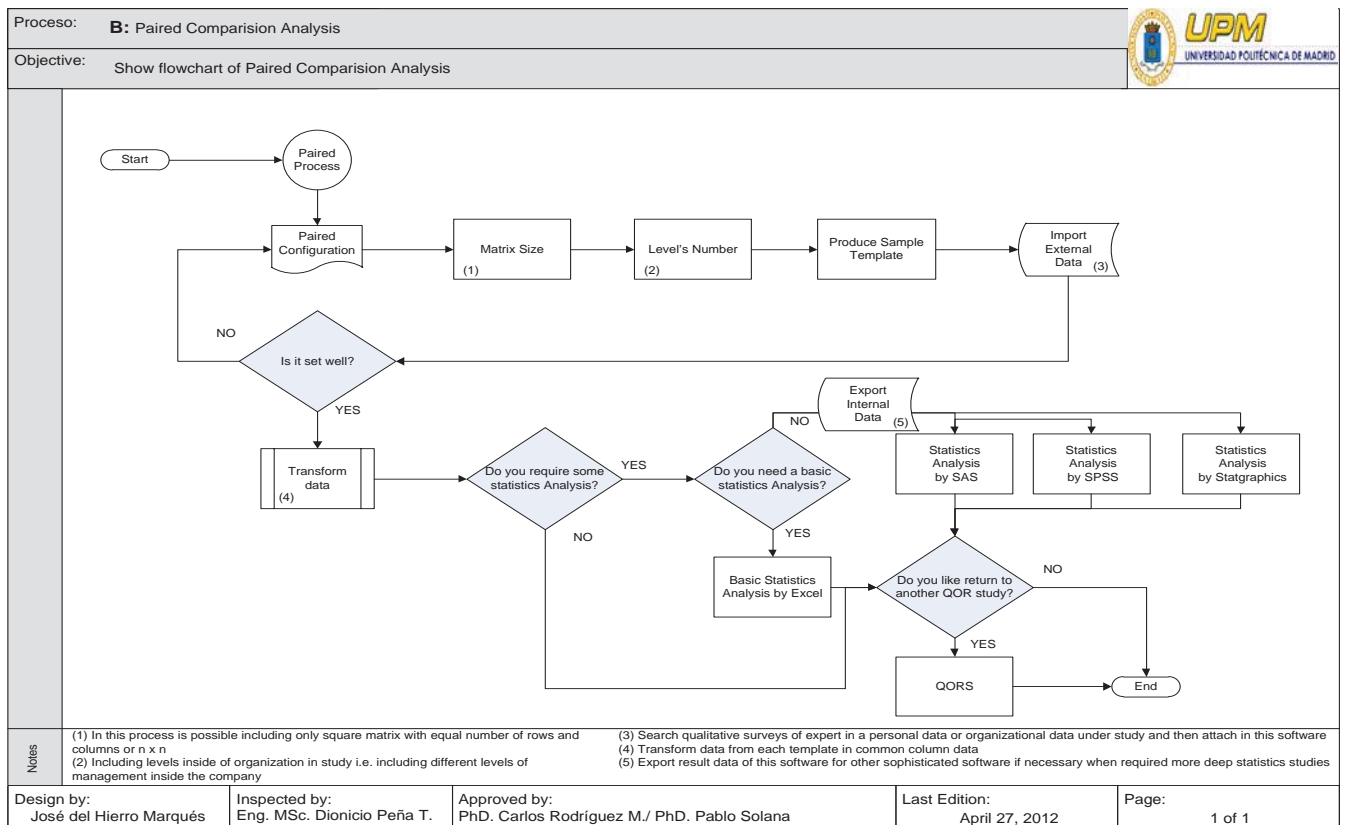
Figure 10. Logic Flowchart of Paired Comparison Analysis
Source: Authors (2012)

Considering the previously describe internal logic, Figure 11 displays how the users are interrogated by the software to include descriptive data from *paired comparison analysis* and how the arrays is internally generated likewise Figure 1 that will be imported from their original files.

Subsequently the matrix data to include QORS 1.0 generates a pattern sheet for all the polls which had been executed. After including the number of polled experts, it will produce as many patterns as the number of polled experts.

Moreover, the user will be able to import all of the polls from any excel's book, obviously with the prerequisite that the matrixes have the same features as the generated patterns.

The user will be able to go backwards as many times as his/her considers necessary to the setting form to modify any of the matrixes previously introduced.

Begin Data Matrix asks about the first numeric data's position in original matrix from which the rearrangement of common data will start.
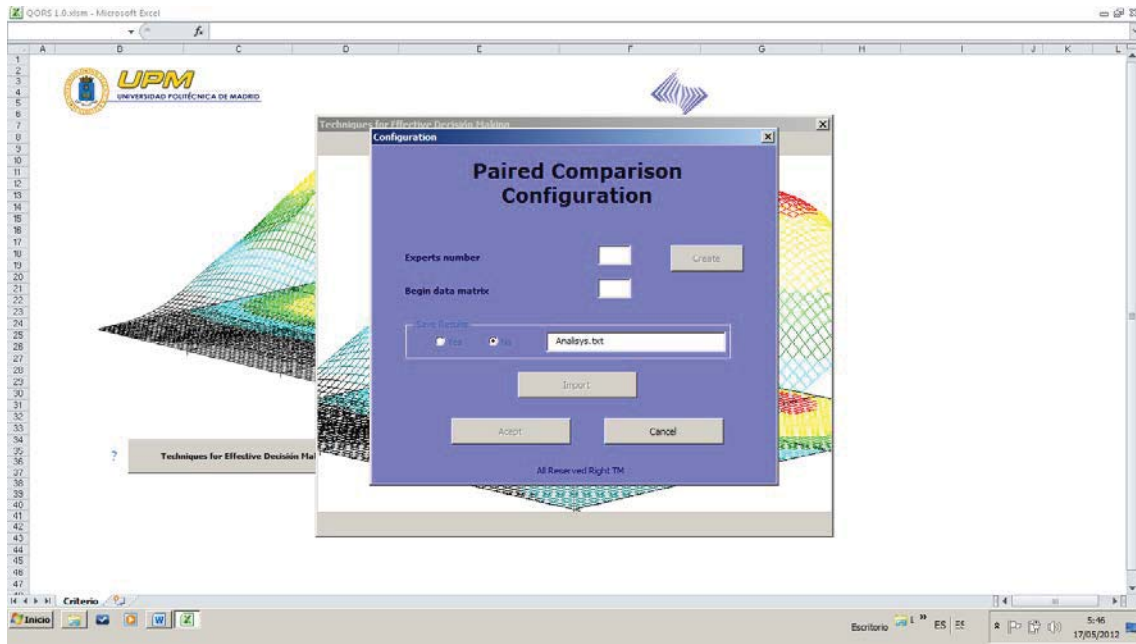
Figure 11. Forming a Paired Comparision Analysis
Source: Authors (2012)

As you may notice, this procedure starts again with a call to the form *Userform*'s type, which allows obtaining from the user all the variables previously described.
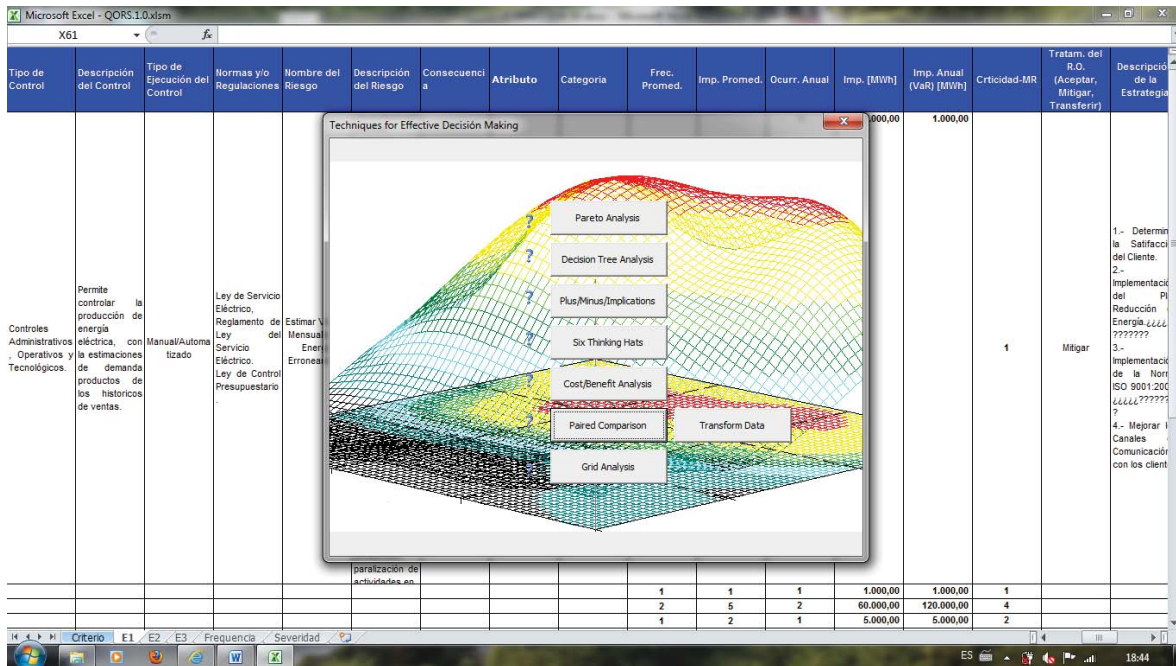
Figure 12. Transforming Data
Source: Authors (2012)

The figure 12 shows the following possible execution from a new *CommandButton* called *Transform Data*, which is presented beside the button *Paired Comparison*. In the Figure 13 the way that QORS execute internally its sequence is shown.
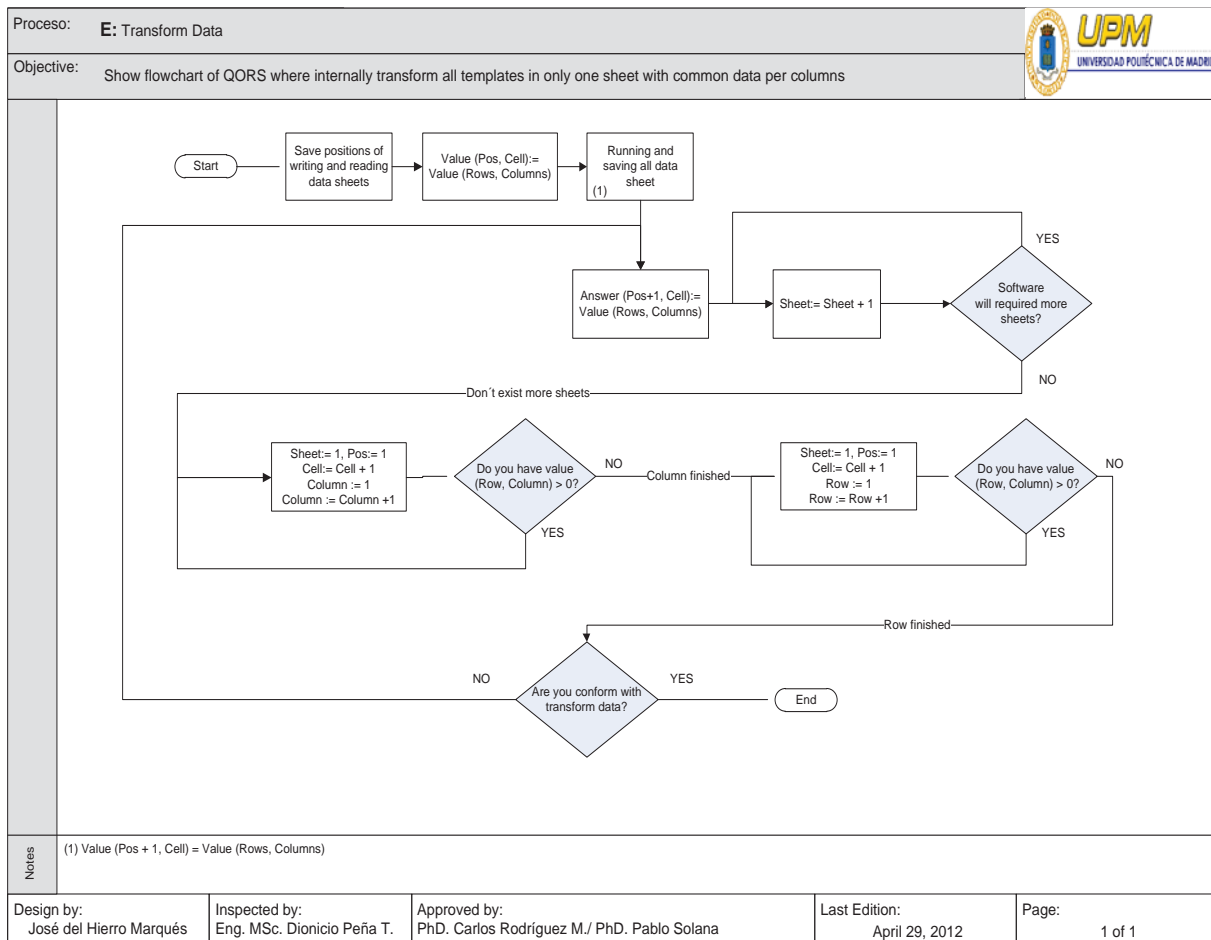
Figure 13. Logic Flowchart of Transform Data
Source: Authors (2012)

By pressing this new bottom *Calculation Paired Comparison,* QORS 1.0 internally executes the calculation´s process which is shown below

- Elimination of the previous execution´s calculations, in the case there are. On the contrary it added to the end of the answer sheet

> *If (Sheets(Sheets.Count).Name = "Analisis") Then*
> *   Sheets(Sheets.Count).Select*
> *   Selection.Delete*
> *Else*
> *   Sheets.Add After:=Sheets(Sheets.Count)*
> *   ActiveSheet.Name = "Analisis"*
> *End If*

- Below, the process is automatically positioned in the first data sheet with the next internal execution.

    Sheets(2).Select

- Subsequently QORS records in memory the starting location of data to the lecture (Variables, Rows and Column) and writing in the results sheet (Position and Cells) with the next commands:

    Range(ComienzoDatos).Select
    'Posicion de lectura origen
    Fila = ActiveCell.Address
    Columna = ActiveCell.Address
    Sheets(Sheets.Count).Select
    Range("A1").Select
    'Posicion de escritura destino
    Pos = ActiveCell.Address
    Celda = ActiveCell.Address

This sequence allows extracting data from each paired comparison and the aforementioned are exported to a new arrangement where the common data are positioned one after the other in the same column, how it is shown in the Figure 14:

Figure 14. Transformed data from square matrix to common data on columns arrays
Source: Authors (2012)

Obtained the previous arrangement how is shown in the figure 10, the user will have 2 statistical options of study: 1 *Basic Statistics Analysis by Excel* or 2. *Sophisticated Statistics Analysis by others software.*

5.3.1.1.   Basic Statistics Analysis by Excel

At the end of the previously ordered arrangement (Figure 14), if the user pulses another *CommandButton* he/she will obtain basic statistical data such as average, mean, mode and standard deviation likewise box and whisker graphs, histograms, scatter plots and so on; thus it is able to detect additionally which is the representative statistical value of his sample.

5.3.1.2.   Sophisticated Statistics Analysis by others software

It was observed that in the Figure 10 the user additionally will be able to export the obtained data (Figure 13) to more sophisticated statistical software and forecast. In the QORS´s 1.0 version will be possible to export to SPSS, SAS and Statgraphics Plus.

This option is presented due to the fact is likely the user wants to obtain results even more confident than the ones obtained under Excel.

Independently on which of the via the user takes, the *Paired Comparison* process demands to get a statistical value which represents compared ordered pair and graphic features displayed in the Figure 16.

The statistical value was chosen by the user many times until the matrix is completed again with them. The array is reorganized (In case that the user choses the option by using Excel, QORS 1.0 updated automatically) and a new arrangement is obtained as the shown in the Figure 15.

1	No relevante
2	Poco Relevante
3	Medianamente Relevante
4	Relevante
5	Muy Relevante

Dirección	División	Departamento	Ingeniería de Mejoras de Generación		Planta Guri						Protecciones,Supervisión		% Peso/Total
			Investigaciones y Pruebas de Generación	Proyectos de Mejoras de Generación	Mantenimiento Eléctrico	Mantenimiento Mecánico	Ingeniería de Mantenimiento	Operaciones	Mantenimiento de Control e Instrumentación	Servicios Generales	Protecciones y Mediciones de Generación	Centros de Control de Generación	
Producción	Ingeniería de Mejoras de Generación	Investigaciones y Pruebas de Generación		2,983	2,500	2,000	2,776	2,431	2,655	2,914	2,793	2,810	53
		Proyectos de Mejoras de Generación			3,000	3,000	2,638	2,310	2,500	2,776	2,586	2,793	52
	Planta Guri	Mantenimiento Eléctrico				3,000	3,155	3,000	3,017	3,534	3,293	3,207	59
		Mantenimiento Mecánico					2,000	3,034	3,069	3,655	3,448	3,466	57
		Ingeniería de Mantenimiento						2,707	2,724	3,379	3,121	3,155	54
		Operaciones							3,259	4,000	3,500	3,655	58
		Mantenimiento de Control e Instrumentación								3,397	3,362	3,397	51
		Servicios Generales									2,000	2,000	34
	Protecciones,Supervisión y Control de Generación	Protecciones y Mediciones de Generación										2,862	42
		Centros de Control de Generación											39

Figure 15. Paired Comparison Analysis obtained
Source: Authors (2012)
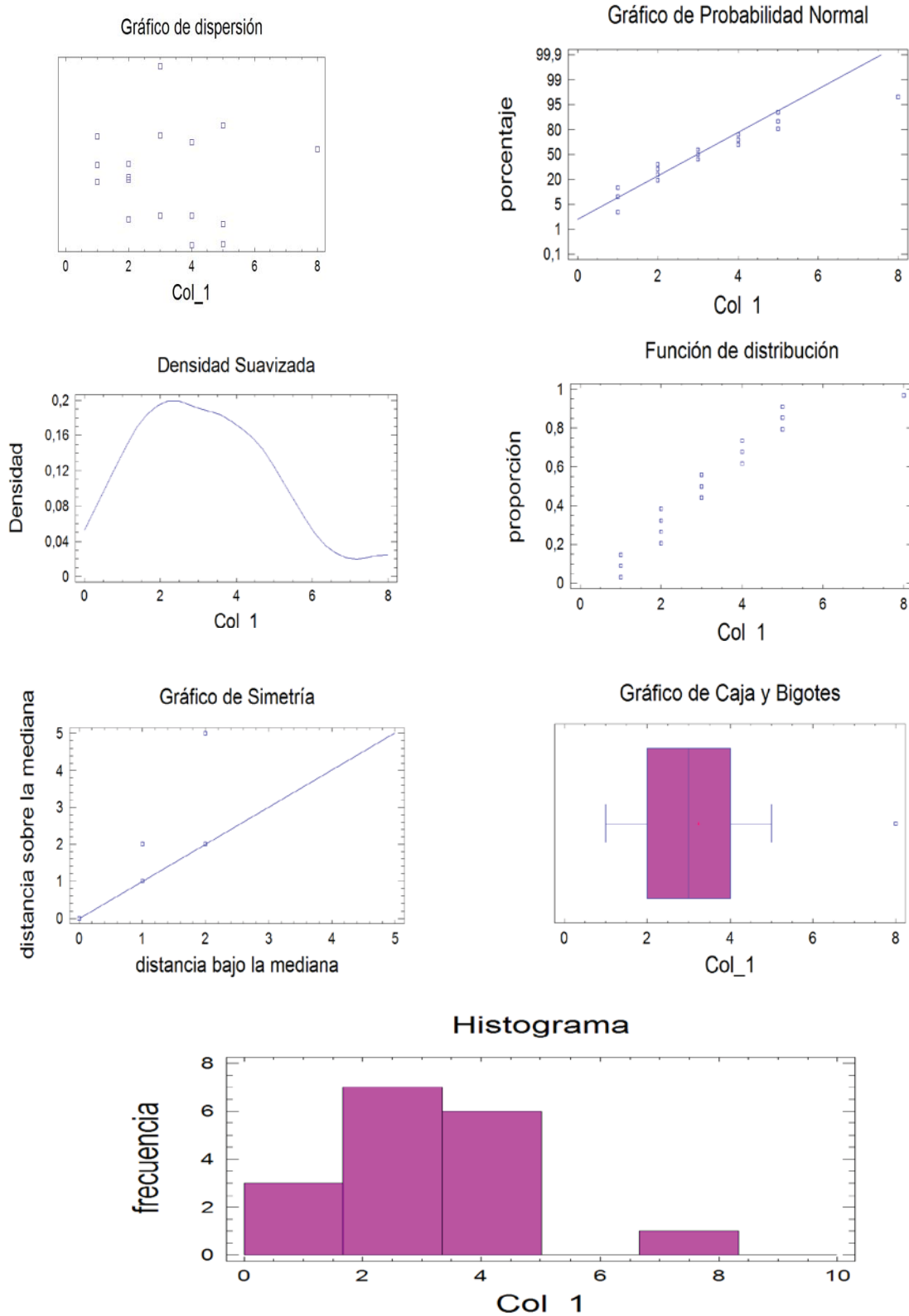
Figure 16. Graphic features of random variables obtained
Source: Authors (2012)

The new detected column is the resultant from the average of each ordered pair, obtained after proving that is a normal value. The biggest resultant weight will be the area studied with the highest operational risk. In the Figure 15, the most risky areas can be seen: *"Mantenimiento Eléctrico" and "Operaciones"*.

To conclude the Paired Comparison Analysis can be used in any field. Although some authors have considered it as a powerful tool even more when there are immense organizations such as the electrical sector´s companies, which has been exemplifying.

The sample´s company presented an organization chart with 8 directions, 22 divisions and 45 departments. The 45 departments were compared among them, therefore a 45X45 matrix was produced and as a result 960 ordered pairs.

The figure´s 15 matrix is the recurrent application following Pareto´s principle 80/20, until reaches the area which generates the mayor quantity of operational risk in the organization.

5.3.2. Grid Analysis

As observed in the figure 9, this is one of the others study´s alternatives which presents QORS 1.0, it has been founded in the presented theorist base in the section 4.2 of this article. In the Figure 17 the internal logic that executes the software for this analysis is shown:
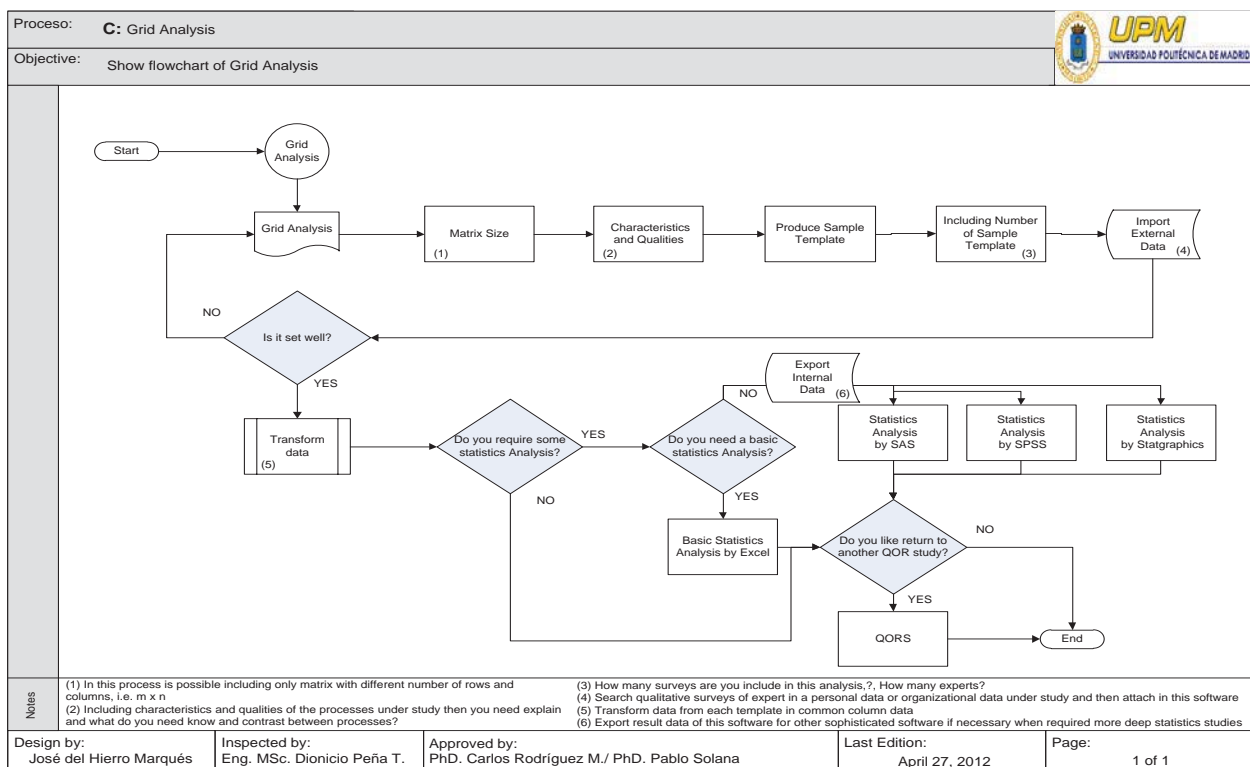
Figure 17. Logic Flowchart of Grid Analysis
Source: Authors (2012)

QORS´s 1.0 internal sequence to make this analysis is similar to the implemented in Paired Comparison Analysis, but it will take the theoretical considerations of section 4.2 among which stands out that for the Grid Analysis. The matrix is M x N and includes explicative alphanumeric data, not only does the software discriminate internally the letters from the numeric data, but also it selects the numeric data. After executing all the commands an arrangement will be obtained similar to the one shown in the Figure 18.

The last column is the resultant of the average in each studied process, which is obtained after proving that it is a normal value. The resultant weight will be bigger than the area o studied process with bigger operational risks. The Figure 18 shows the processes "*Ejecutar el mantenimiento" and "Ejecutar las operaciones"* are the most risky, which allows *Paired Comparion Analysis* to confirm that the operational risk´s initial detection in this organization must be oriented to the maintenance and operations department.

Likewise Paired Comparison Analysis, the grid analysis can be compared with either any company or daily routine, but in the example showed, the authors have considered to deepen in the studied productive processes of an electric corporation. Initially, brainstorms were created to describe the processes and later numerically ranked by those skilled.

5.4. Qualitative Operational Risk Measurement

It was presented in the figure 9 how these matrices are structured and as you may notice QORS 1.0, will do an analysis similar to *Paired Comparison Analysis* and *Grid Analysis*, but in this case the random variables to study are the frequency and loss. As a consequence the probability´s distribution will be studied. After that it will be obtained by applying the Montecarlo´s method (Sobol, 1974) an operational risk´s value approximation.

Monte Carlo simulation in MS Excel is based on the generation of multiple trials to determine the expected value of a random variable (Jeges, 2012). The basis of the method is provided by the following relationship:

$$P_r \left\{ \left| \frac{1}{N} \sum_N \xi - \mu \right| \langle \frac{3\sigma}{\sqrt{N}} \right\} \approx 99.8\%$$

There are a number of commercial packages that run Monte Carlo simulation, however a basic spreadsheet program can be used to run a simulation. In this case the generation of multiple trials is implemented by propagating a basic formula as many times as the number of iterations required by the model. In the Figure 19 the internal logic that executes the software for this analysis is shown.

A real studied case by the electric´s company authors was presented in the Figure 3, from which it is extracted the risk number 35 (R35) called: "*No desincorporar activos fijos*" therefore a process is described to be implemented from QORS.

In particular, binomial, Poisson, geometric, negative binomial, Cox process and mixture distributions were reviewed by using frequency distribution and exponential, log-normal,

Figure 18. Grid Analysis obtained
Source: Authors (2012)

Proceso:	**D:** Qualitative Operational Risk Measurement				UPM UNIVERSIDAD POLITÉCNICA DE MADRID
Objective:	Show flowchart of QORM				

Notes

(1) In this process is possible including only matrix with different number of rows and columns, i.e. m x n
(2)Including characteristics and qualities of the sub processes of the process with most highest operational risk inside organization under study then you need attach templates with qualitative expert's opinion about frequency and severity of risks

(3) How many surveys are you include in this analysis,?, How many experts?
(4) Search qualitative surveys of expert in a personal data or organizational data under study and then attach in this software
(5) Transform data from each template in common column data
(6) Export result data of this software for other sophisticated software if necessary when required more deep statistics studies

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Figure 19. Logic Flowchart of Qualitative Operational Risk Measurement
Source: Authors (2012)

Weibull, gamma, beta, Pareto, Burr, and mixture distributions were considered to loss distribution (Jorion, 2008).Several studies have been revised from the recent literature on the empirical findings with operational loss data. In the electric company in study, Weibull distributions are best describing operational loss magnitudes and Poisson are best describing frequency distribution.

R35 is adjusted to a Poisson´s distribution to the parameterized frequency $\lambda = 19.13$. The loss was designed for a lognormal distribution parameterized $\mu = 9.07$ and $\sigma = 0.999$. Montecarlo´s simulation is used to find a sample of 1.000.000 observations from the Loss Distribution Approach (LDA) that it is a convolution of the frequency and loss or impact.

The percentile 99,9 of the LDA, according to Jiménez (2011) matches Operational Value at Risk (OpVaR). The Figure 19, shows the LDA resultant for R35, the dotted line points out the percentile 99,9, coincident with the value P99 = 585.113MWH which is the OpVaR.

Figure 19. Loss Distribution Approach and OpVaR
Source: Authors (2012)

6. References

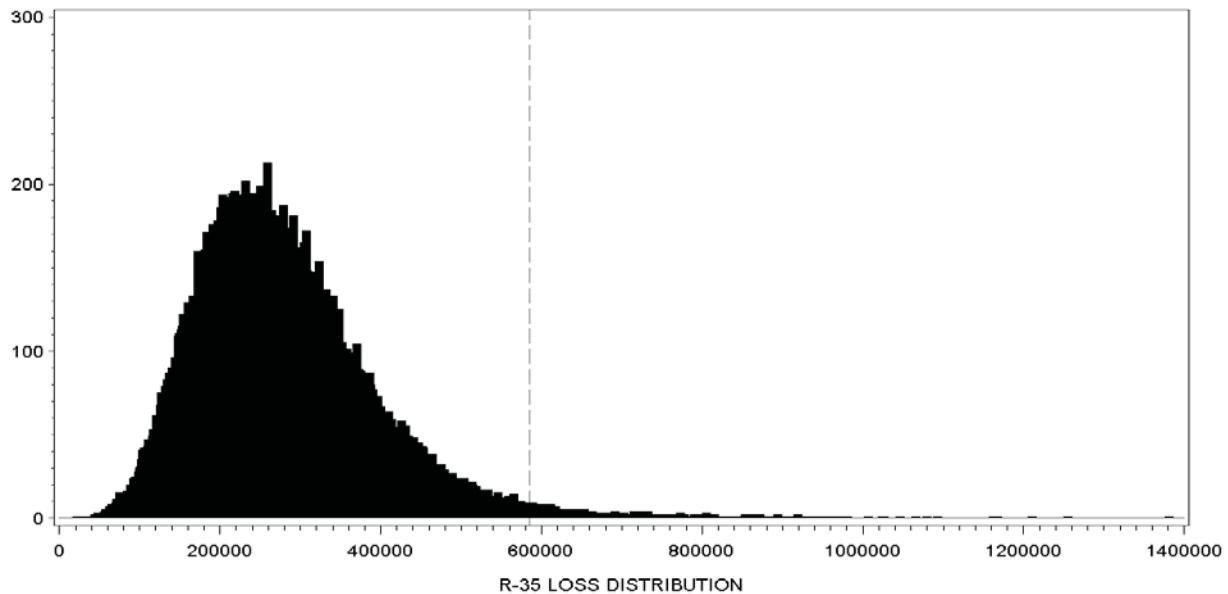Avila, Hector (2008), *"Introducción a la Metodología de la Investigación"*. Edición Electrónica. Available via: http://www.eumed.net/libros/2006c/203/index.htm. Chihuahua – México.

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