

Scientific Management Methods

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Abstract

The world is becoming more and more complex, so do companies. As a consequence, the decisions that managers have to make are increasingly more difficult, since they have to contemplate every single element part of society, such as persons, resources, external environment, etc. Decision making process' goals are quite simple this days: companies try to reduce risks, to increase the probability of their success, to predict impacts and changes with very low margins of errors, in order to be prepared to every single eventuality and increase their survivability odds.

Science was born thousands years ago, and it's being used to understand the world and how it works. For scientists the only way to do this is by having a rational and credible process of study, what they call scientific method. So, it is possible to define two different types of decisions, some as being supported by a rational and credible analysis, in other words by a scientific process; and other decisions by being supported by managers' feelings, intuition, experience.

This research aims to provide deeper understanding about management decisions and their rationality or lack of it, by looking into the subject of business research methods and its presence in management.

The research conclusion is that decisions are becoming more rational since the majority of managers are using rational and scientific tools to support their choices. The study also suggests that companies don't use mathematical and statistical tools as much, which makes their prediction analysis to have higher margins of errors.

Keywords

Science, Management, Business Research Methods, Scientific Management

I. Introduction

The starting point for this study is management and science, two of the most talked/discussed topics today with the exception of technology. The way we look to this subjects has changed over the years and today more than ever, it is important that they stop to be two separate subjects, and start to be analyzed as a single one.

The world is changing faster than ever, and what is considered to be right/truthful today, could in the near future no longer be so. This is happening in all areas of knowledge and in all aspects of our lives.

The question that rises from this facts is: How can businesses compete? This question has many answers, and all of them can be considered part of the solution. Some of them are: the adaptability of companies has to be fast and smooth, since managers have the responsibility to force their enterprises to constantly reinvent themselves.

Because the world is changing faster than ever and becoming increasingly more complex, and all this two facts seems to even increase their pace in the future, managers have to find solutions and become more rational than ever, to be able to react to this fast and complex world. Due to this statements, this study aims to get deeper understanding to the use of science in management, more particular in the decision making processes.

II. Literature Review

A. Science

The word science came from the Latin word *Scientia*, which means knowledge. Regarding the definition, there is not a universal definition accepted by everybody. Merriam-Webster Dictionary defines science as knowledge based on demonstrable and reproducible data. Feynman (1963) states that "*Science is a way to teach how something gets to be known; what is not known; to what extent things are known (for nothing is known absolutely)...*". In 1996 during an interview, the author of *The Demon-Haunted World: Science as a Candle in the Dark* (Carl Sagan) said that "*Science is more than a body of knowledge.*

It is a way of thinking...". More related to those who practice science (the Scientists) Lévi-Strauss (1964) says that they are not responsible to give the right answers, but instead, their main goal is to ask the right questions.

In more general terms, science has helped managers to understand that one model of organizations is not enough to fit all circumstances, therefore other models are forcedly developed to help on justifying the complexity and increase the environment understanding. This is however a never ending cycle, like the evolution-revolution concept, due to the fact that those initial models don't seem to be able to capture all the relevant aspects of the organizations, forcing scientists and managers to develop new models (Beard and Van Fleet, 2013).

B. Management

First and foremost to help us understand what Management is, Rosemary Stewart (1967) said that a Manager is someone who accomplishes things by getting help from people and by using resources. Stewart extrapolates then that Management is the activity of getting things done by using the help of people and by exploring resources.

The majority of management theories started to appear in the beginning of the 20th century, however before that, some authors have written and talked about important subjects regarding management.

One of those examples is *The Wealth of Nations* (1776) written by Adam Smith. In this book, Smith described how it's possible to increase productivity by changing the entire production process, something he called division of labor. The example he used to explain this, was the pin production process where he concluded that by performing only few tasks repeatedly, each worker is able to develop increase dexterity; that time is saved if the worker doesn't need to go from one task to another; and that it is possible to create machinery to increase productivity, as soon as each task is simplified and made routine (Brue and Grant, 2012).

Bose (2012) states that the evolution of management thought and theories during time can be divided into four groups: Pre-Scientific

Management School (Before 1880); Classical Management School (1880-1930); Neo-Classical Management School (1930-1950) and Modern Management School (1950-present).

In the late nineteenth century industrial organizations started to grow in size and complexity, which have resulted in the increase difficult in organizing human effort efficiently and effectively (Rollinson, 2005: 9).

Taylor's management theory was one of the first to appear, and describes the creation of a true science, with the scientific selection of workers, their education and development and their well-defined relation with management (Huang, K. & Tung, J. & Chung, S. & Chou, M., 2013). It can be summarized in the "art of knowing exactly what is to be done and the best way of doing it" (Bose, 2012).

Some years after Taylor's theory, Henri Fayol developed his management model, which he called Administrative Management. Fayol's main goal was to use facts and with them create general rules, which he called principles or ground rules (Silva, 1960). He was one of the first persons to describe the main management elements. He called them: planning, organizing, command, coordination and control. All this elements together would represent what he called "the management process" (Wren & Bedeian, 2009). He has also defined 14 management principles, such as the division of work and unity of command (Rodrigues, 2001).

As soon as society became more complex, and companies start to grow and reach unthinkable sizes, management processes began to need new planning and organizing processes that would help on managing the enterprises. Companies' core activities started to be concentrated on specialized units, and more than ever, rules and regulations, hierarchy, precise division of labor and detailed procedures were needed. Max Weber, considered the 'father' of Bureaucratic Management, was one of the first persons to realize that bureaucracy was making office operations more routinized, like machines were in the production line (Boddy, 2008).

Still in the beginning of the twentieth century, some theorists such as Mary Parker Follet and Elton Mayo recognized the limitations of the classical management school (Boddy, 2008).

Follet main idea of management is getting things done through people. She wanted to replace bureaucratic organizations with organizations design based on the network concept, where workers have individuality to analyze and solve their problems, in order to implement themselves the solutions. Follet states that workers and managers should share power, and all have responsibility on the decision making process. She was one of the first writers to defend the concepts of empowerment, motivation and leadership (Boddy, 2008; Chandra, 2013).

Elton Mayo analyzed the output of the Hawthorne experience, where he concluded that the so called 'economic man' in scientific management, should be called instead 'social man' (Boddy, 2008). Mayo stated that it's possible to increase productivity by only giving a special attention to the workers and their needs (Coombs, & Smith, 2003).

A lot of authors tried to model human behavior into several theories. Some examples of this, are the work of Abraham Maslow, Frederick Herzberg, Douglas McGregor and David McClelland.

Maslow theory defends that individuals have a constant inner motivational drive that can justify and classify their motives. The writer has developed what he calls hierarchy of needs/pyramid needs. This so called Maslow pyramid is divided in five levels, where accordingly to Maslow the lower-levels needs must be satisfied first, before going up in the pyramid (Pardee, 1990).

Herzberg theorized something different than Maslow in is theory called Motivation Hygiene Theory/Two factor theory, and defends the idea that motivation has two different sources. Therefore, being satisfied or unsatisfied could be a result of motivational factors (satisfiers) or hygiene factors (dissatisfiers). The motivational factors are responsible to directly increase satisfaction, and accordingly to Herzberg they are primarily intrinsic. In the other hand, the hygiene factors cannot motivate, and if they are used with the goal to do it, it can actually have negative motivational effects. Instead, the absence of this factors can provoke dissatisfaction, which makes them extrinsic causes (Pardee, 1990).

Another well-known theory was developed by Douglas McGregor, where the writer was able to define two profiles/contrasting set of assumptions made by managers. This is called the Theory X and Theory Y. In theory X, McGregor assumes that all workers are unmotivated and don't like what they do, and because of that this workers must be coerced, controlled and directed. The average worker would prefer to be directed than have responsibilities. On the other hand, the Theory Y describes workers that take responsibilities and that are motivated to achieve their goals. This workers also seek for challenges, are self-driven and consider work as a natural part of their lives, which makes them problem-solvers by nature (Bolden & Gosling & Marturano & Dennison, 2003).

David McClelland approaches the motivation subject from another angle, where he proposes that having strong needs, can be used as a primary effect to motivate a person in order to satisfy those needs (Pardee, 1990). Regarding this theory, McClelland divided the different needs into three groups: need for achievement, need for affiliation and need for power (Shanks, 2007).

The modern management school theories appeared in a context where complexity is present everywhere. Companies, persons, environments and relations need to be understood, as well as the interactions between them (Chandra, 2013). Some examples are the system theory, contingency approach, management science and chaos theory.

The system theory in management, looks at companies as if they were collection of unified parts that have a similar overall goal. The nature of the entire system (company) is made by the integration of every single part that composes it. If some part of that system disappears, the entire nature of system also changes. In this theory, this parts are classified into four main areas: inputs, processes, outputs and outcomes (Olum, 2004). Writers that theorized the contingency approach state that there is no perfect way to manage people or work, since every situation is unique in its own way. The most important conclusion is the importance of analyzing every single aspect of a decision, since those aspects are key to the situation (Olum, 2004). A very important 'rule' is that something that worked in the past in a similar situation, will not necessarily work in a more recent situation (Thenmozhi, 2007).

Management science theory has the premise of bringing to the decision making process in management, the tools based on the scientific method. This tools can be statistics, linear programming, network analysis, decision trees, computer simulations, information models and/or mathematical models. The main goal of this theory is to rationalize every step and part of the decision process, with the intent of reducing uncertainty and all risks associated (Raduan & Jegak & Haslinda & Alimin, 2009).

As the years passed in the 20th century, the world started to become more chaotic and less predictable, so as companies. Despite this change, managers for a long a time acted like organizational events were always predictable. The huge turnaround regarding

this reality happened when managers recognized that this chaos was actually reality, which allowed them to start preventing and anticipating the chaos itself. This increased the importance on the so-called 'small decisions' or 'small actions', since managers realized that those decisions could have huge impact in the entire system (Olum, 2004).

C. Business Research Methods

For Managers today knowing about all aspects of their business is a crucial step that will dictate the success or failure of the entire management process. Doing business research is to increase awareness and understanding regarding business problems and opportunities, is to develop and execute alternative plans, and finally is to monitor business performance with factual data (Zikmund&Babin&Carr& Griffin, 2010).

The entire goal of what we call business research is for it to be used as a support platform and facilitator to the decision-making, by providing crucial information in order to decrease risks of making wrong decisions, which will lead to the increase probability of success of the problem-solving and decision making activities (Zikmund&Babin&Carr& Griffin, 2010). This provides a systematic way of getting information into the managerial decisions (Cooper & Schindler, 2013).

To support the process of getting data and analyze it, there are a lot of tools and techniques that provides to the entire process the rationality and rigor needed. Some examples of this tools are: Benchmarking, Focus Group, Interview, Regression/Correlation Analysis, Control Group, Observation, Simulation, Market Study, Survey/Questionnaire, Expert Judgement, Historical Reports/ Reports (Cooper and Schindler, 2013), Gap Analysis (Ritchey, 2013), Operational Risk (Samad-Khan, 2008), Trend Analysis (Greener, 2008), Wisdom Crowd (Yi & Steyvers & Lee & Dry, 2012), Prototyping (O'Leary, 1988), Hall Test (Dumas, 1999) and Three Points Estimate (Rothschild, 2011).

The steps of discovering and generating factual and objective information to the decision-making in management, have particular steps that are extremely important to the credibility and reliability of the research data. The cycle starts with the historical knowledge and present knowledge that analyzed together will help the formulation of Hypotheses in the research process. This Hypotheses then need to be tested and validated against reality, what can be done through experimentation. By the end of the entire cycle this methods will either support or contradict the Hypotheses defined, which will lead to the creation of knowledge (Zikmund & Babin & Carr & Griffin, 2010).

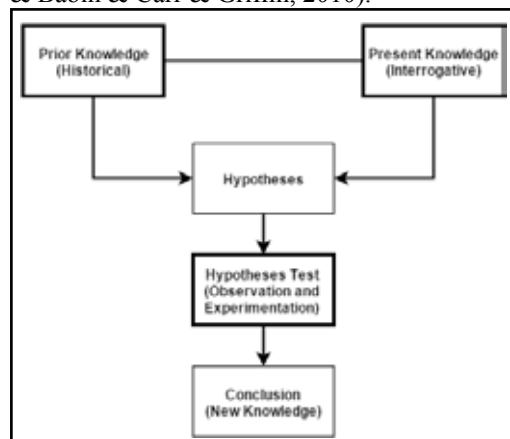


Fig. 1 : A summary of the scientific method (Adapted from source:Zikmund&Babin&Carr& Griffin, 2010)

III. Research Methodology

The problem to be researched has to do with the decision making of managers today. As described in the literature, the world is becoming more and more complex, so do companies. Managers are towards questions increasingly more difficult than before, and their analysis has to contemplate not only every single element in the entire system, but also the relations between those elements. In this increasingly complexity it's becoming harder to predict decisions impacts and risks, since even a small decision can have huge repercussions in the entire environment. It is possible to summarize the research problem here identified with the following question: **How do managers decide today?**

Possibly, the only tool available to man besides technology, that is able to transmit integrity and reliability to the decision making process today, is science. So the context for this study, as shown before in the literature, will be the business research methods, because it's the only 'bridge' known and defined, that can connects Management decision making process with Science. Because of it, the context of this study will take into consideration the tools and techniques of business research methods. For the context to be completed, are going to be added the three main steps of the scientific method, that are responsible to formulate the hypotheses and reaching the conclusions, while grouping the tools into each of the steps. This steps are the **Interrogative** (Observation), **Historical** (Prior Knowledge) and the **Experimentation** (Hypotheses Test) steps.

It is possible to state that managers can only make decisions based on two types of tools. The science tools, which would be the use of business research tools and techniques. Or in the opposite side, by using their personal tools, such as intuition, feelings, past experience, rules of thumb, etc.

This study intends to analyze managers' decision making, and whether or not science is part of that process. Because of that, the target population intended for this study were middle-top managers.

The survey created to support this research was released between May 2015 and September 2015, and was sent to 193 deciders. In total were received 96 complete and valid answers, which represents a final response rate of 50%.

IV. Data Analysis

The participants were asked in which regularity they use business research tools. This question was based on a 5 point scale with the following answers: never, rarely, frequently, always and don't know. It was attributed a value to each of the answers, in order to simplify the result analysis. To the don't know answer was given the value of 0, to never the value of 1, to rarely the value of 2, to frequently the value of 3 and to always the value of 4.

To begin with the sample characterization are going to be analyzed the Company Size and Job Role of the 96 participants. In what regards to the Company Size, 35% of the participants work in companies which have more than 25 employees and less than 99 employees, 18% work in companies where the number of employees is between 100 and 499, also 18% work in companies with more than 5000 employees, 12% of the companies have more than 2 employees and less than 9, 7% have between 1000 and 4999 employees, 6% between 500 and 999 and finally 4% have more than 10 employees and less than 24. Regarding the job role, 40% of the participants have the job role of manager, 22% are operational, 14% are directors or senior managers, 13% are executives and 11% team leaders.

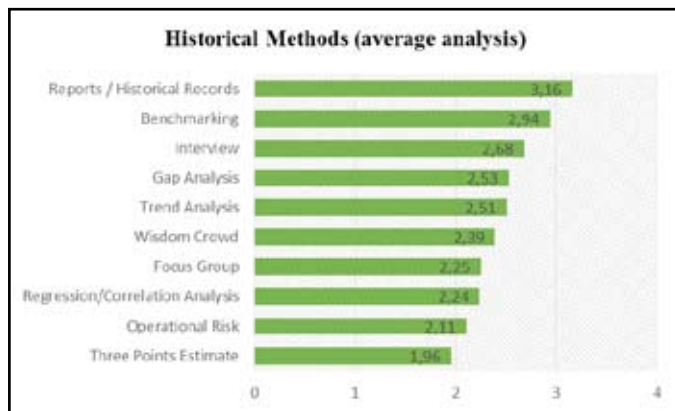


Fig. 2 : Historical Methods (average analysis)

The historical methods are in most cases rarely used, since they got an average value superior to 1.50, and in the other half of the cases are at least frequently used, since they got an average value superior to 2.50. Reports/Historical reports is by far the most used historical method with an average score of 3.16, which means that in most cases is a frequently used tool. This method is followed by Benchmarking with a score of 2.94, then by Interviews with 2.68, then by the Gap Analysis and Trend Analysis, with respectively 2.53 and 2.51. With lower values, we have the Wisdom Crowd with 2.39, the Focus Group with 2.25, and at the end of the table the techniques of Regression/Correlation Analysis, Operational Risk and Three point estimate, with the values 2.24, 2.11 and 1.96 respectively.

Interesting enough, is the fact that the top 3 historical methods are simple methods that involve almost none mathematical calculus. In the other hand, the less used tools/techniques are related with mathematical calculus and statistical models. We can also extrapolate that the use of this methods could be related with their complexity or simplicity, where simple tools seems to be more frequently used than the more complex methods.

The fact that mathematical and statistical methods are the least used could be an indication of the inexistence of data to be serve as an input to this methods. This data could be business metrics and company indicators, which probably is only available and used when the decision to make is considerable and worth's the time effort and investment to use more complex methods.

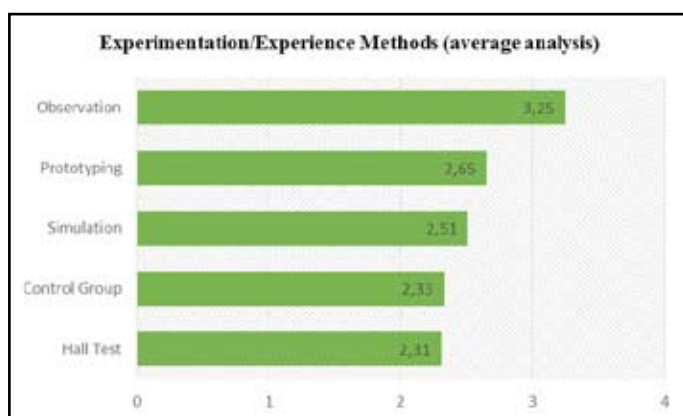


Fig. 3 : Experimentation/Experience Methods (average analysis)

All experimentation/experience methods, are in most cases at least frequently used, since they got an average value superior to 2.50. Observation is by far the most used tool (3.25), and the only

one that in average is frequently and in sometimes always used. It is followed by prototyping that scored 2.6, then by simulation with 2.51. The last two tools scored 2.33 (control group) and 2.31 (hall test).

An interesting fact, is that the less used tools in this group (control group and hall test), are tools related with group interviews or discussions, which involve using people's knowledge and opinion to gather data. Then we have prototyping and simulation that besides being different techniques, have the concept simulating in common, because prototyping also represents a simulation of what is going to be the final product (for example). With this we can conclude that for managers to test data, it is easier to do it by the simple technique of observing, followed by simulating and afterwards by using clients/stakeholders inputs.

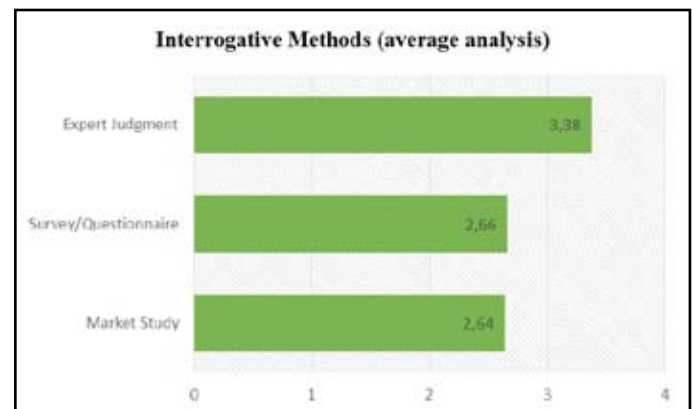


Fig. 4 : Interrogative Methods (average analysis)

All interrogative methods are frequently used, since they got an average value superior to 2.50. Expert judgment is by far the most used tool (3.38), and the only one that in average is frequently used and in sometimes always used. It is followed by the surveys/questionnaires that scored 2.66 and then by market studies with 2.64.

We can conclude that the most used interrogative method is the technique where it's faster to obtain data, and that the other two tools have almost the exact same use/importance, and need more time to be implemented.

Related with companies' sizes, which in this studied was measured by the number of employees, it is important to analyze the importance of business research tools in both realities, and compare it. Therefore, are considered small companies those who have less than 100 workers, and big companies the rest (more than 100 workers).

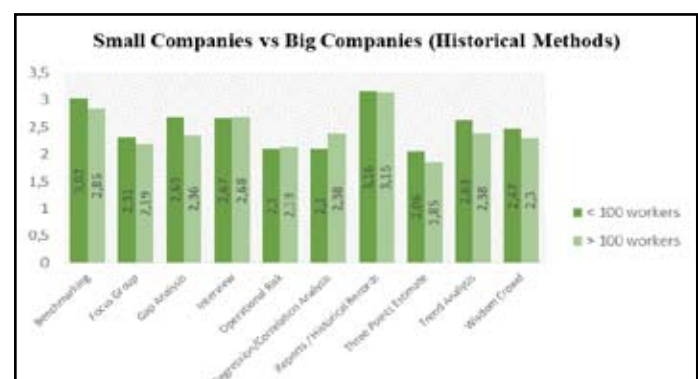


Fig. 5 : Small Companies vs Big Companies (Historical Methods)

The results are quite interesting to say the least. Figure 5 shows that small companies actually use more the historical techniques, than the big enterprises. Are only a few exceptions to this statement, such as the tools, interviews, operational risk and regression/correlation analysis, which big companies use more. This can probably be justified by what we call big data. Operational risk and correlation/regression analysis demand for large quantities of data to serve as input, and big companies are able to generate and get this amount of data easier than smaller companies. Related with interviews and because big companies have more workers, and in most cases more clients, it's normal that this technique is used more in bigger enterprises, since face-to-face formal communication probably doesn't happen as often in smaller companies, which probably use more informal communication channels.

Regarding the other historical techniques, smaller companies actually use it more, and probably the main reason is due to competition and need of adaptation. The task of survivability for small companies is probably more challenging and competitive than it is for bigger companies, because they have to compete with a large number of companies (the other small companies and some of the bigger enterprises). Another reason could be that their financial capacity and political power is reduced. This facts makes it imperative for smaller companies to be constantly comparing themselves with others (benchmark), to compare their results with their expectations and goals permanently (gap analysis), to predict what the future may be and how things are probably going to evolve (trend analysis) and to use society in order to gather data (wisdom crowd).

Generically speaking, historical methods are more used by smaller companies since they have to reduce the risks of their decisions to the maximum, because a bad decision could mean a threat to their survivability.

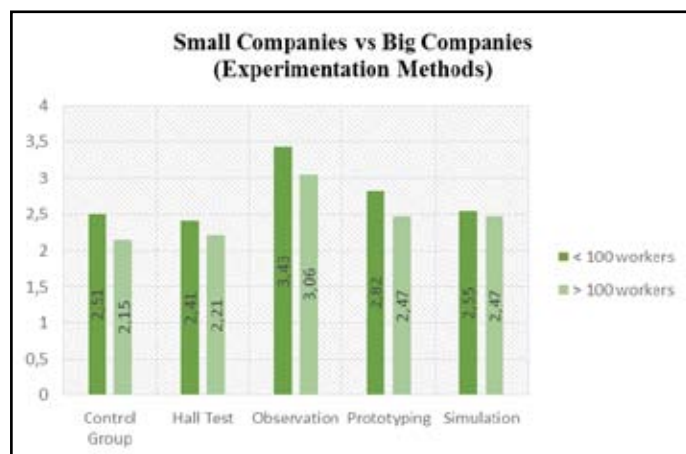


Fig. 6 : Small Companies vs Big Companies (Experimentation Methods)

Figure 6 continues the comparison analysis regarding big and smaller companies, and we can observe that companies with less than 100 workers use more, all the experimentation techniques. The explanation for this topic could be the fact that smaller companies don't have the luxury of making bad decisions (for example the launch of a bad product), because their financial capacity is smaller than big companies' capacity.

Because of the facts enunciated it's normal that small companies have to prototype all their new products to test them out and to not make any mistakes what so ever. It's also normal that they have to use simulation techniques in order to replicate scenarios,

in order to reduce risks. Usability tests, observation and control group techniques can also be used to reduce the probability of a decision to provoke negative impacts to the companies.

Summarizing, smaller companies attribute more importance to experimentation techniques, because every decision made must be experimented rigorously to decrease the risks that could threaten the success of their decision making process.

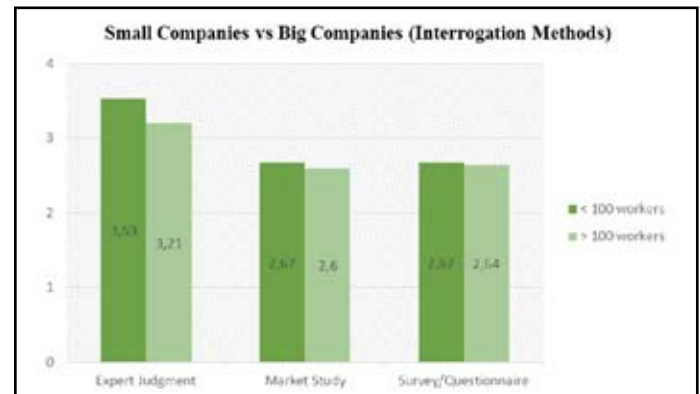


Fig. 7 : Small Companies vs Big Companies (Interrogation Methods)

To finalize the analysis between large and smaller companies, figure 7 shows that smaller companies use more interrogative techniques. There is not a high disparity in the results regarding the market study and survey/questionnaire techniques, which makes us conclude that the importance of this tools are the same for all company sizes.

The only noticeable difference is related with expert judgement, that is used by both company sizes at least frequently, however smaller companies use it a bit more regularly. This could be justified by the fact that using expert judgment in most cases means to get help from outside the company, for example with consulting firms. Still in the same line of thought, and because big companies have more workers, they probably don't need to quite often use external persons, since the probability of not finding internal experts is more reduced than it is for the smaller companies.

To conclude it seems that smaller companies use more interrogation techniques, specially due to expert judgment, that small companies are more likely forced to use, since their internal 'experts' are less.

Table 1 : Top 3: Most used Techniques

Technique	Average Use
Expert Judgement	3,38
Observation	3,25
Reports/Historical Reports	3,16

The three more used techniques by companies are expert judgment, observation and historical reports. All of them are used by enterprises frequently (average use higher than 2.5), which mean they are present in almost every decision making process. Another very interesting fact is that each technique have a different type. Expert judgment is considered to be an interrogative technique, observation an experimentation technique and reports an historical technique. This means that in the top 3 more used techniques all the technique' types from the scientific method are present (historical, experimentation and interrogative).

Table 2 : Top 3: Less used Techniques

Technique	Average Use
Three Points Estimate	1,96
Operational Risk	2,11
Regression/Correlation Analysis	2,24

The three less used techniques are three point estimate, operational risk and regression/correlation analysis. All this techniques are in average rarely used by companies, which means that managers don't support their decisions, in most cases, by using them. There are two facts that should be stated: the first one is that all this techniques are considered to be historical tools and the second one is that the three less used tools by managers are related with statistics and mathematic, which can probably be justified by the difficulty on getting big data (necessary to the use of the techniques) or by the fact that it could be more complex to use this techniques than the others, since mathematical/statistical knowledge is quite often more limited inside the companies.

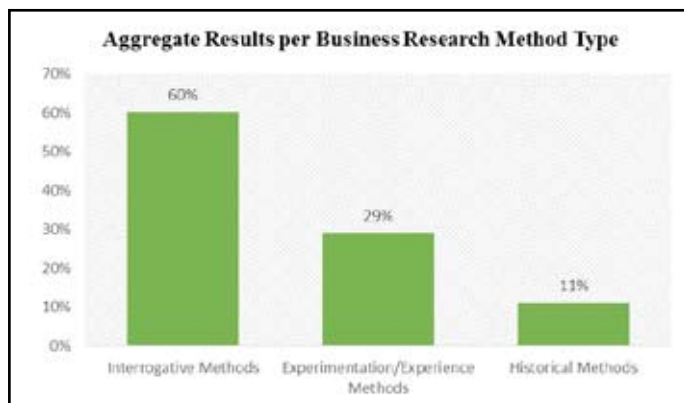


Fig. 8 : Summary Results per Business Research Method Group

To finalize the study analysis was calculated the aggregated results per business research method type. The results show that 60% of the companies use more interrogative methods, than other types of methods. 29% of the enterprises use more experimentation/experience methods. And 11% of the companies give more importance to the use of historical methods.

This means that the majority of the companies prefer to use interrogative methods to support their decisions, such as the techniques of expert judgment, market studies and surveys.

V. Conclusions

This research aimed to provide a deeper understanding about the presence of science in the decision making process of managers. According to the two types of decisions defined earlier, the decisions based on science, and the decisions based on feelings, the goal is to understand which type of decision is more common among the managers.

Based on the results gathered and their analysis, the main conclusions and findings can be summarized on:

- The study states that the majority of managers (53%) use at least frequently historical methods in their decision' processes, which means that it's important for them to understand the past and how it may evolve;
- Another finding is that 58% of the managers are frequently supporting their choices with Experimentation/Experience tools, which states the importance of testing and replicating scenarios for managers' decisions;

- In making decisions, 69% of the managers use at least frequently interrogative methods with the main goal of gathering data that will help on understanding better the situations and variables involved;
- Regarding the entire process of making a decision, we can state that for the majority there are already traces of rational and scientific thinking, since 57% managers admits to at least frequently use business research tools;
- This study also helped to understand that managers most used tools are expert judgment, observation and historical reports. Regarding them, each tool belongs to a different method type;
- Small companies rely more on using science in their decisions, since they don't have the luxury of making bad choices, since it could threaten their survivability;
- Another interesting finding is that the less used scientific tools are related with mathematical/statistical methods, such as the operational risk, three points estimate and regression/correlation analysis, which managers rarely use. This could be justified by the difficulty on gathering big data or by the lack of qualified persons in the areas.

Summarizing the conclusion, everything points to the fact that science is becoming more important to managers and their decisions, as a way to 'fight' the increasingly complexity of the world. As a final statement, I would like that this study would be a starting point for future researches regarding this topics.

A. Limitations

It is possible to consider that this descriptive study has the necessary methodology qualities to produce viable and valid conclusions. However, and because there is no perfect study, there are some limitations that should be mentioned.

The first limitation is the sample method used, which was a convenience sample. In other words, only managers present in the researcher' network would be possible to participate in this study, fact that doesn't guarantee the sample to be representative.

The second limitation is the sample size, which is justified by time and geographic constraints. The number of participants makes it impossible to extrapolate conclusions to the universe of management in the entire world.

B. Future Research

This is what we can consider a very preliminary study on this subject, therefore I would like to present some suggestions about what could be interesting to explore regarding this topic in the near future:

- This study has analyzed the presence of science in the decision making process of managers, through the concept of Business Research Methods. It would be interesting to analyze it by using other perspectives (like technology);
- Another suggestion is to make this analysis using a larger survey to generate data that would make possible to understand the topic at a global scale;
- Increasing the number of techniques present in the study would also provide a deeper understanding about the decision making process;
- Studying the custom technologies, such as software and systems, built by companies to support their decisions, would also increase our knowledge regarding what managers are doing regarding their decisions.

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