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STRENGTHS AND LIMITATIONS OF QUALITATIVE AND QUANTITATIVE RESEARCH METHODS

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Abstract:
Scientific research adopts qualitative and quantitative methodologies in the modeling and analysis of numerous phenomena. The qualitative methodology intends to understand a complex reality and the meaning of actions in a given context. On the other hand, the quantitative methodology seeks to obtain accurate and reliable measurements that allow a statistical analysis. Both methodologies offer a set of methods, potentialities and limitations that must be explored and known by researchers. This paper concisely maps a total of seven qualitative methods and five quantitative methods. A comparative analysis of the most relevant and adopted methods is done to understand the main strengths and limitations of them. Additionally, the work developed intends to be a fundamental reference for the accomplishment of a research study, in which the researcher intends to adopt a qualitative or quantitative methodology. Through the analysis of the advantages and disadvantages of each method, it becomes possible to formulate a more accurate, informed and complete choice.

Keywords: research methods, qualitative analysis, quantitative analysis, research process

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1. Introduction

The scientific methodology is a tool of fundamental importance for the knowledge of the methods that are used in the elaboration of a scientific document, such as a manuscript, dissertation or a work of completing a university course. Scientific methodology includes the study of the methods or the instruments necessary for the elaboration of a scientific work.

Flanagan (2013) claims that the scientific method is the most powerful tool for discovering truths about the world, explore new theories and perform their empirical validation. Therefore, scientific research is the process of performing systematic and intensive inquisitions, which aims to discover and interpret the facts that are inserted in a certain reality. In relation to its approach, scientific research can be qualitative or quantitative.

Qualitative research is not concerned with numerical representativity, but with the deepening of understanding a given problem. In qualitative research, the researcher is both the subject and the object of his research. The objective of the qualitative methodology is to produce in-depth and illustrative information in order to understand the various dimensions of the problem under analysis.

Qualitative research is therefore concerned with aspects of reality that cannot be quantified, focusing on the understanding and explanation of the dynamics of social relations. Maxwell (2013) advocates that qualitative research works with the universe of meanings, motives, aspirations, beliefs, values and attitudes, which corresponds to a deeper space of relationships, processes and phenomena that cannot be reduced to the operationalization of variables.

On the other side, in quantitative research, the data can be quantified. Because the samples are generally large and considered representative of the population, the results are taken as if they constituted a general and sufficiently comprehensive view of the entire population (Martin & Bridgmon, 2012). Disciplines such as mathematics and statistics assume a fundamental importance in the process of analysis and generalization of the results obtained.

Quantitative research focuses on objectivity and is especially appropriate when there is the possibility of collecting quantifiable measures of variables and inferences from samples of a population. Quantitative research adopts structured procedures and formal instruments for data collection. The data are collected objectively and systematically. Finally, the analysis of numerical data is performed through statistical procedures, often using software such as SPSS, R or Stata.

Table 1 summarizes the main differences between the quantitative and qualitative research methodology through looking for several dimensions, such as....

Table 1: Differences between quantitative and qualitative research methodologies

Dimension	Quantitative research	Qualitative research
Focus on understanding the context of the problem	Smaller	Bigger
Dimension of group studies	Smaller	Bigger
Proximity of the researcher to the problem being studied	Smaller	Bigger
Scope of the study in time	Immediate	Longer range
Researcher's point of view	External	Internal
Theoretical framework and hypotheses	Well structured	Less structured
Flexibility and exploratory analysis	Lower	Higher

The study of the potentialities and weaknesses of the various research methodologies has been of interest to several researchers. However, in practice, there are several difficulties in choosing the most appropriate research methodology and methods best suited to a given study. This work intends to give an important contribution in this decision process, through the systematic analysis of several research methods in order to emphasize its strengths and limitations. The paper is organized as follows: First, we perform a review of the state of the art in the field of qualitative and quantitative methodologies. Then, we present the adopted methodology, followed by the comparison of the most relevant advantages and disadvantages offered by each research method. Finally, we draw the conclusion of our work.

2. State of the Art

There are several studies that analyze generically the fundamental models of scientific research, in which qualitative and quantitative methodologies are used. Atieno (2009) looks to the strengths and weaknesses of qualitative research and discusses how those limitations can be overcome by the option of quantitative research methods. Borrego et al. (2009) analyzes the presence of quantitative, qualitative and mixed research methods in engineering education. They reach to the conclusion that there is a primacy by the adoption of quantitative methodologies, but they advocate that the choice must be driven by the research questions. Castellan (2010) uses two service-learning research projects to explain the differences between quantitative and qualitative research methodologies. Choy (2014) compares the strengths and weaknesses of qualitative and quantitative studies. He reaches to the conclusion that both methodologies can be appropriate, but he advocates that a complementary approach between qualitative and quantitative approaches for a same research topic may provide better results than use only just one isolated methodology.

There are studies that look in detail for several methods that can be used in qualitative research projects. Williams (2007) presents and discusses the potentialities

and vulnerabilities of the three most common research approaches, qualitative, quantitative, and mixed methods. Baxter & Jack (2008) offer a concise guide targeted undergraduate students that identifies and summarizes the key elements for designing and implementing qualitative case study research projects. Roshan & Deeptee (2009) justify the increasing use of qualitative research methods due to their potentiality to explore several areas of human behavior that cannot be quantified. Crescentini & Mainardi (2009) study the limitations of qualitative research articles in order to establish a set of guidelines that should be followed to increase the effectiveness of a research paper. The study concludes that the adoption of qualitative research techniques is not a handicap for publishing a research article. Then, the study identifies that the most important elements are: (i) well structured; (ii) transparent adoption of the research process; and (iii) easily understood by readers.

Starman (2013) presents a full description of the case study methodology. He gives a detailed description of its definition, some classifications, and several advantages and disadvantages. Oppong (2013) analyzes the sampling issues in qualitative research in order to ensure that the sample size of a given study is adequate or representative. Alshenqeeti (2014) critically assesses the value and limitations of interviewing as a research instrument. He looks at the practical issues of adopting interviews and he discusses the validity and reliability of interviews in research studies. Jamshed (2014) advocates the use of interviewing and observation as two main methods to have an in depth and extensive understanding of a complex reality.

Qualitative studies have been used in a wide range of domains. Moriarty (2011) describes how the qualitative research has been successfully in social care. Mori & Nakayama (2013) perform a bibliometric analysis study to identify the academic impact of qualitative studies in healthcare. For that, they compare the number of publications in the field and the number of citations received by qualitative and quantitative studies. The conclusion points out that despite the lower number of qualitative studies, its impact in terms of citations is not statistically different. Noble & Smith (2015) evaluate the effectiveness of qualitative studies into care delivering. For that, they look into issues of validity and reliability in qualitative research and compare how concepts such as reliability, validity and generalizability can be valid in qualitative studies. Ponelis (2015) describes how to use a case study method in the context of a doctoral degree in the field of information systems and entrepreneurship. Almeida & Monteiro (2017) adopt case studies together with in-depth interviews to understand the approaches adopted by web design companies to offer UX web experiences. Rahman (2017) discusses the advantages, disadvantages, and ethical issues of employing qualitative and quantitative methods in a research project in the field of language testing and assessment.

The importance of quantitative studies and the analysis of their many several methods are also addressed in the literature. Kelley et al. (2003) propose a set of good practices to conduct a survey research and guides the reader through the processes of data collection, data analysis and reporting. Schneider (2013) looks to the limitations of using statistical significance tests in research assessments. Maher et al. (2013) confirm the limitations of adopting statistical significance testing techniques and propose the measure of the effect size to increase the robustness of the analysis. Felix (2015) looks into the implications of adopting parametric and non-parametric statistical methods in marketing research studies. Special attention was given to the interpretation of results and to the process of making inferences. Etikan et al. (2016) analysis and compares two non-probability sampling techniques for quantitative studies.

Finally, several book references can also be found in the literature. Kothari (2013) publishes a book around the big concept of research methodology. In this book, both qualitative and qualitative methodologies are explained in detail. It also includes a chapter about the use of computer software as an indispensable part of research equipment. Creswell (2013) includes in his book also a chapter dedicated to the analysis of mixed methods research and makes an extensive coverage of the ethical issues that can be found in each research methodology approach. Books describing the several methods that can be used in qualitative research studies can be found in literature (Merriam & Tisdell, 2015; Creswell & Poth, 2017). The same applies to quantitative research techniques (Martin & Bridgmon, 2012; Hoy & Adams, 2015).

3. Methodology

In order to get a comprehensive background for understanding the current knowledge in research methods for qualitative and quantitative methodologies we adopted a narrative literature review. Two very important of this approach are the following (i) it is helpful in developing conceptual or theoretical frameworks (Coughlan et al., 2007); and (ii) it can be undertaken independently of a research study (Polit & Beck, 2006).

For each methodology, we capture its main methods and we describe the various needed steps in the application of each of the methods. A mind map representation of these identified methods may be found in Figure 1 and Figure 2. According to Davies (2011) mind mapping is a very useful tool for understanding a complex reality and it also promotes creative thinking, and encourages brainstorming.

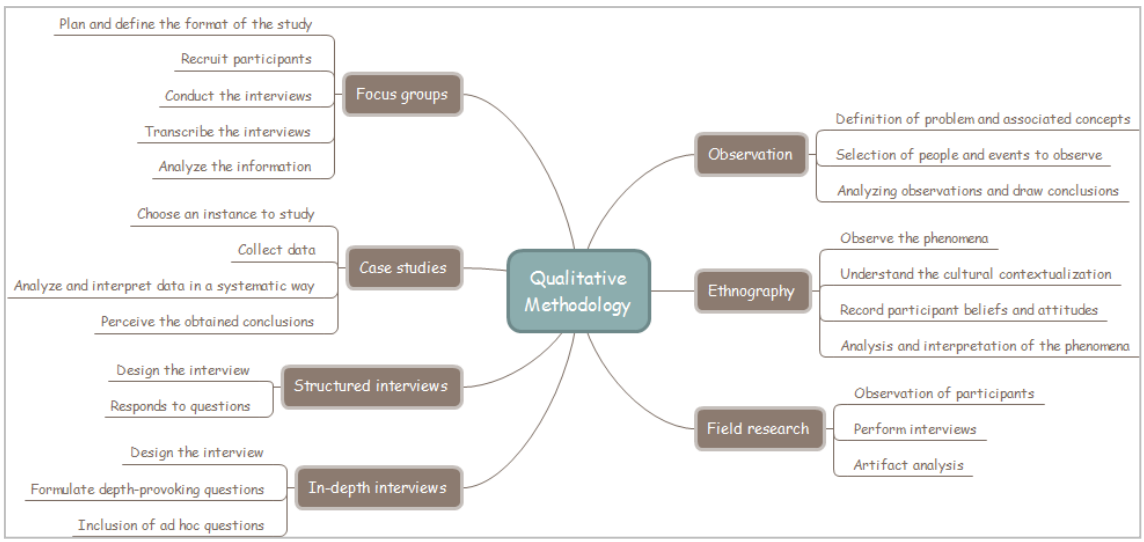

Figure 1: Mind map representation for qualitative methodologies

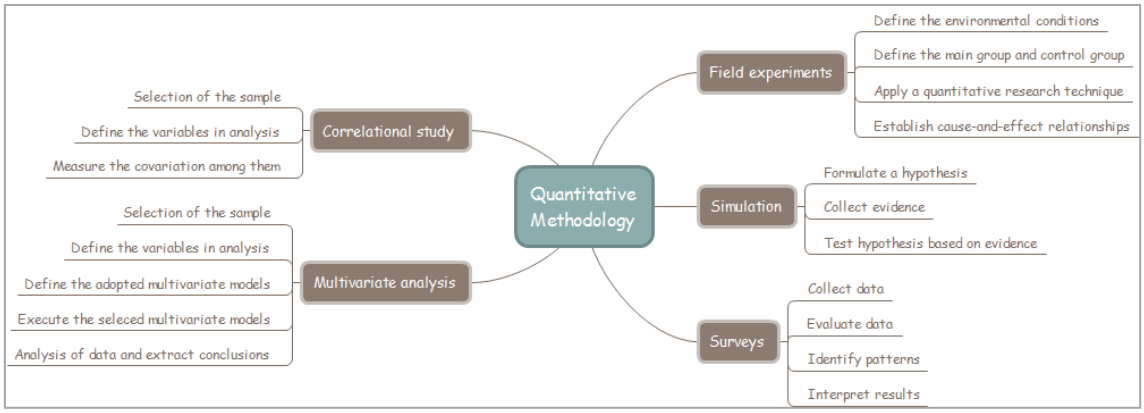

Figure 2: Mind map representation for quantitative methodologies

After that, we synthesize the main characteristics and properties of each of the identified methods, both for qualitative and quantitative methodologies. In a first step, we present the evolution of the total number of publications for each method. Then, we describe each method and, in a second phase, we perform a comparative analysis of the advantages and disadvantages of each method. This approach will enable a reader of this manuscript to easily identify in which situations the use of each of the methods is advised.

4. Results and Discussion

4.1 Qualitative Methodologies

Figure 3 provides an overview about the evolution of the number of published research studies indexed by Web of Science (WoS), Scopus and EBSCO that use qualitative methods. The total number of publications includes academic journals, books,

conference proceedings, reports, dissertations, among others. A total of around 23 million of studies that use qualitative methods were identified.

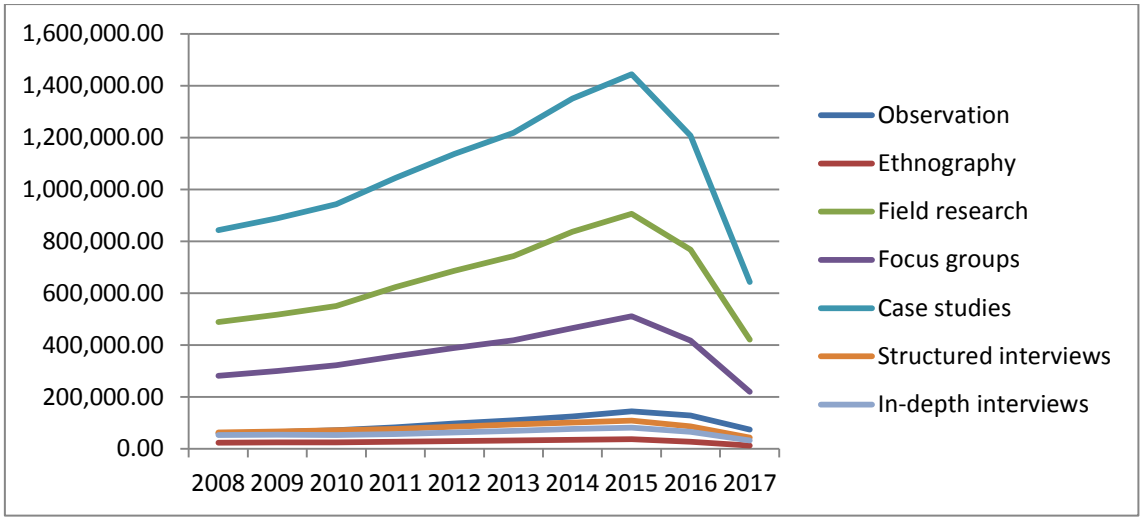

Figure 3: Evolution of studies that adopt qualitative research methods

There is a steady increase in the number of studies published using qualitative methods over the past ten years. However, in 2016, there is a decrease in the number of publications regardless of the considered method. Two reasons may justify this behavior: (i) number total of publications in 2016 may be decreased; and (ii) some studies may not yet be indexed, since the average indexing time typically extends for several months. In the year of 2017, only the studies published until August of 2017 were considered.

Figure 4 shows the distribution of the total number of publications by each qualitative method. We highlight the following three kinds of methods: (i) case studies; (ii) field research; and (iii) focus group.

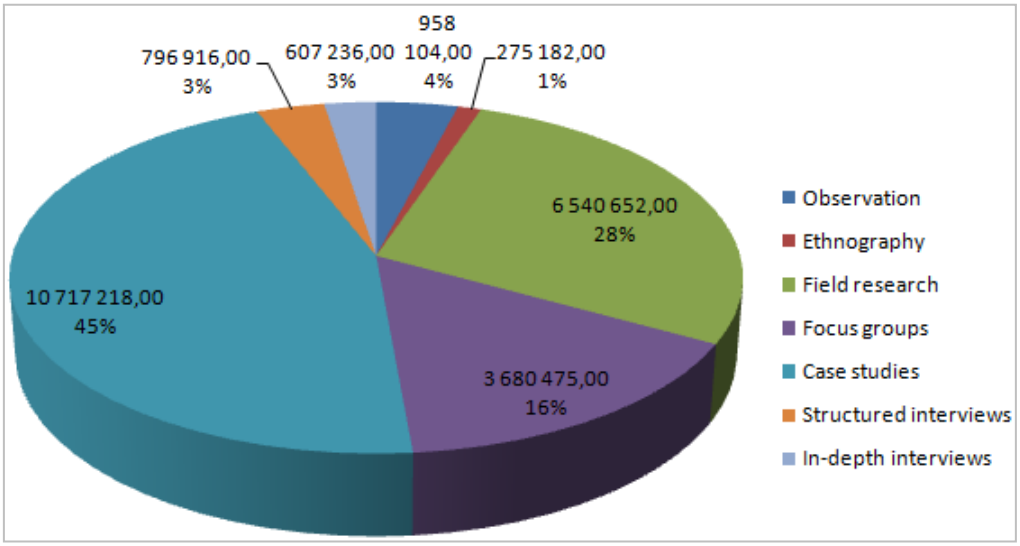

Figure 4: Distribution of publications by each qualitative method

4.1.1 Observation

Observation is a systematic process of collecting information, in which researchers observe a given phenomenon in their natural environment. This method is especially indicated when a given topic is relatively unexplored and it becomes important to understand in detail a given phenomenon, while maintaining the environmental conditions in which it occurs.

Observation is a good way of collecting data simultaneously with the occurrence of the event, without interfering with the occurrence of the event. It is an unobtrusive and very flexible method, oriented to the discovery of knowledge. In some situation, such as the analysis of the behavior of people and animals, is the only way to obtain data in a reliable way. On the other side, it is a very time consuming method, which requires prior preparation and the availability of the researcher to visit the place where the event occurs. Moreover, the method is quite sensitive to the independence of the researcher's analysis, since the interpretation of the data is done exclusively by him/her.

4.1.2 Ethnography

Ethnography consists of observing a situation and conducting interviews with its participants. In an ethnographic research the researcher tries to interpret the situation being observed from the perspective of the participants. According to Nurani (2008), two basic characteristics of ethnography can be found: (i) the observation takes place in a natural setting, and (ii) researchers must understand how an event is perceived and interpreted by the people in a speech community. Observation and ethnography are very similar methods. However, Charmaz (2006) states that in ethnography the researcher must have a more holistic view, where the researcher should examine the details of all the aspects available.

The biggest advantage of ethnography is that the researcher can have an in-depth knowledge about the situation in analysis. On the other side, ethnography requires a huge investment in the researcher's time and the results produced by the study can be very diverse and it can become difficult to extract precise and targeted conclusions.

4.1.3 Field research

Field research allows researchers to have a depth perception about people and processes. The collection of data is done on the field and it can occur over an extended period of time. As stated by Blackstone (2012), social facts may not appear and be revealed to a researcher in a first moment, but they can be discovered over time during the course of a field research project.

Field research is an excellent method for understanding the behavior of people and their experiences. However, it is not easy to generalize this approach to a very large number of people or groups, and documenting observations may become a challenging process.

4.1.4 Focus groups

Focus groups are a very popular and useful method to investigate complex behavior, where the research can interact with the participants. The information is typically provided more quickly than if people were interviewed separately. Two main characteristics that differentiate focus groups from other techniques are: (i) the information source is a group; and (ii) the heuristic value of this technique lies in the kind of interaction that emerges during the debate (Acocella, 2012).

Focus groups can provide a broader range of information and they offer the opportunity to seek clarification, if there are topics that need further clarification. However, focus groups can be hard to control and manage. Additionally, it can be difficult to encourage people to participate and, therefore, they may not be representative of non-users.

4.1.5 Case studies

Case studies provide a mean to investigate complex situations with multiple variables under analysis. Case studies are particularly appealing for advancing a field's knowledge base. They are very popular in the fields of applied sciences in the areas of social sciences, education and health.

Case studies offer a good opportunity for innovation and challenge current theoretical assumptions. They can also be a good alternative or complement to the focus group method. However, it can be difficult to establish a cause-effect connection to reach conclusions and it can be hard to generalize, particularly when a small number or case studies are considered.

4.1.6 Structured interviews

Structured interviews are an assessment method design to get and compare responses from all the interviews. The interviewee is inquired about past experiences and/or proposed hypothetical situations. The process is standard for all people interviewed.

Structured interviews typically offer a high response rate and the interviewer is present to explain the question to avoid misinterpretation from respondents. However, preparing a structured interview can also be time consuming. Additionally, they don't have the same flexibility in the choice of the answers that are predefined, which cannot

be changed by the researcher, even if during the interview new lines of research sound interesting to be explored.

4.1.7 In-depth interviews

In-depth interviews are a kind of unstructured, direct, and personal interview with each respondent. In this process, the researcher typically begins with a generic question, and then encourages the respondent to speak freely about the topic. There is also a variant that considers the existence of semi-structured interviews, in which there is a set of pre-defined questions, but in which freedom is given to explore one of the questions in greater depth.

In-depth interviews provide very rich information and it offers the opportunity to ask follow-up questions, probe additional information, justify previous answers, and establish a connection between several topics. It also offers a comfortable atmosphere in which people may feel more comfortable to establish a conversation. However, there are some limitations and pitfalls, because it is time-intensive and it is not generalizable.

4.1.8 Comparison of approaches

Table 2 summarizes the main advantages and disadvantages associated with each method considered for the qualitative methodology.

Table 2: Comparison among qualitative methods

Method	Advantages	Disadvantages
Observation	- Collect data simultaneously with the event occurrence - Unobtrusive way, which is not dependent on upon someone's response - Flexible and oriented to knowledge discovery	- Very time consuming - Dependent on the observer's impartiality - Requires significant preparation - Difficult to collect data in real time
Ethnography	- Based on observation and interviews with the direct involved authors - Provide in-depth findings - Suitable to explore new lines of research	- Very time consuming - Difficult to get concise and precise conclusions - Researcher needs to have a deep knowledge of the problem domain
Field research	- Adequate to get very detailed data - Emphasizes the role and relevance of social context	- Difficult to generalize and get data from a very large number of people or groups - Dependent on the observer's impartiality - Documenting observations may become a challenging process
Focus groups	- Adequate to get detailed information about personal and group	- Hard to control and manage - Difficult to get the participation of

	- Offer opportunity to seek clarification - Lower costs and time when compared to individual interviews	people - Can be no representative of all population
Case studies	- Provide detailed information about individuals - Offer a good opportunity for innovation and change current theoretical assumptions - Can be a good alternative or complement to focus groups	- Difficult to establish cause-effect connections - Hard to generalize from a small number of case studies - Ethical issues, especially of confidentiality, may appear - Difficult to create a case study that suits all subjects
Structured interviews	- Well-structured and easy to compare respondent's answers - Can reach a large sample - Easy to replicate - Conducting an interview is fairly quick to conduct	- Very rigid - Low flexibility in the response's choice - Difficult to obtain detailed data - Preparing an interview can become time consuming
In-depth interviews	- Adjusted to get detailed and insightful information on a given domain - Need only fewer participants to provide useful and relevant insights - Can be performed in informal environments	- Time consuming and relatively high costly - Longer verification process to extract compared information - Participants should be carefully chosen to avoid bias - Not generalizable

4.2 Quantitative Methodologies

Figure 5 shows the evolution of the number of published research studies in the last 10 years that use quantitative methods. The approach followed is identical that was performed for the qualitative methodologies. A total of around 16 million of quantitative studies were considered.

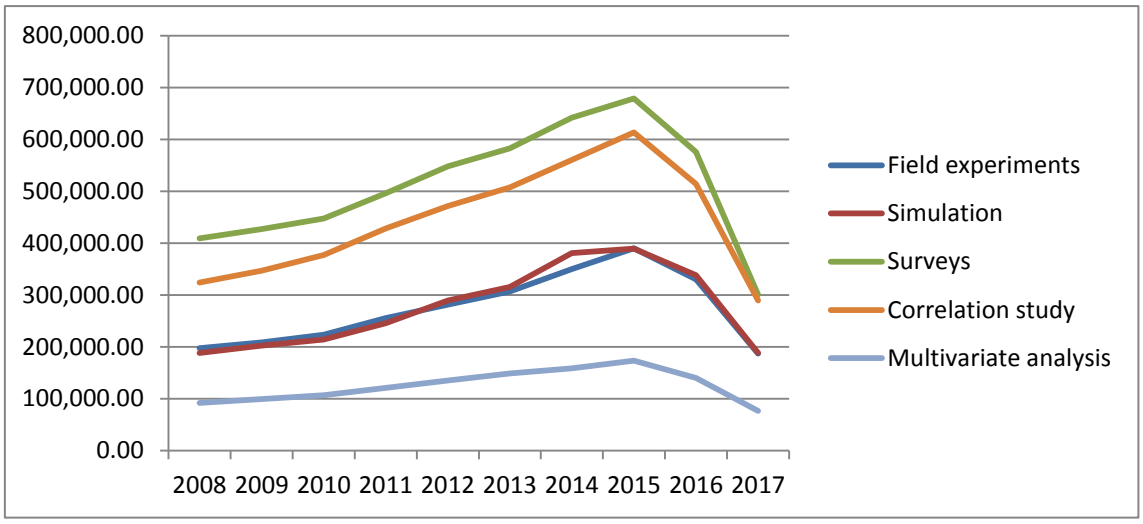

Figure 5: Evolution of studies that adopt quantitative research methods

The behavior followed by quantitative studies is in every respect similar to what happened with qualitative studies. Based on Figure 6 it is possible to realize that two quantitative methods stand out against the others: (i) surveys; and (ii) correlational studies.

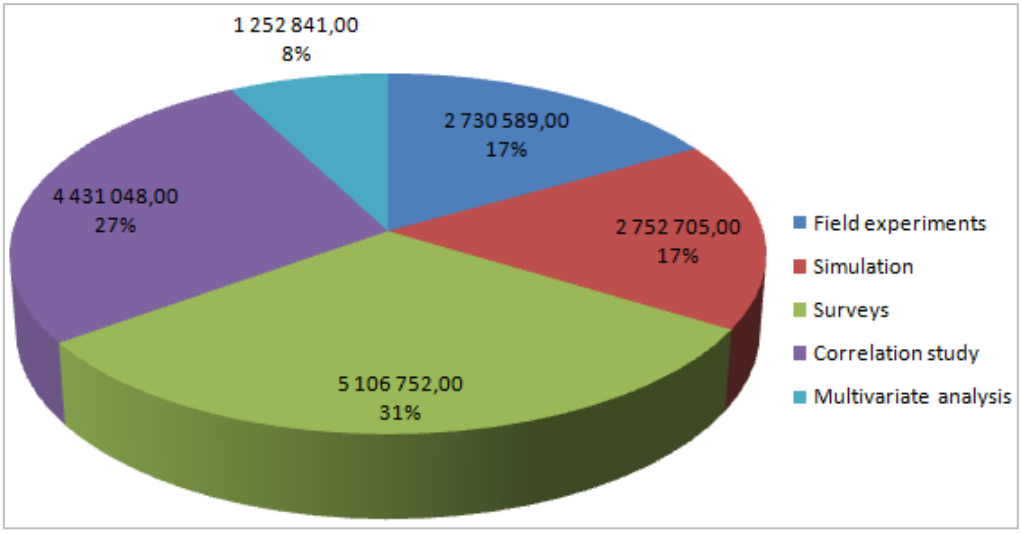

Figure 6: Distribution of publications by each quantitative method

4.2.1 Field experiments

Field experiments take place in real life settings. It involves the isolation and manipulation one or more variables to test the effect. It allows the researcher to observe more natural behavior, but he/she will have a lot more variables to consider. This approach is also common in sociology and applied science like bioengineering and medicine.

Field experiments offer significant strengths when compared to lab experiments. It offers a natural setting rather than an artificial lab setting. It is suitable to observe

large groups of people, which are generally better representativeness. On the other hand, it is more difficult to control variables and, therefore, replicate the same conditions is very challenging. Additionally, and because it is difficult to control the environment, unanticipated actions can appear, which can adversely affect subjects and participants.

4.2.2 Simulation

The simulation consists in the adoption of certain mathematical techniques, used in computers, which allow imitating the operation of almost any type of operation or process of the real world. Therefore, it represents the behavior of real systems through the exercise of models. Simulation can be used to describe the behavior of the system, construct theories and hypotheses considering the observations made, or use the model to predict future behavior.

Simulation is an appropriate method to analyze complex and large practical problem, when it is not possible to model it previously using a mathematical model. Additionally, it can be used to compress a time frame, which is suitable to investigate quickly the effects of a change in a real life situation. However, the simulation also presents disadvantages, such as model building requires deep knowledge of the field and it can be time consuming and expensive.

4.2.3 Surveys

Surveys are a research technique that allows the collection of data directly from a person involved in the researcher through a set of questions organized in a certain order. It is one of the most used quantitative techniques, since it allows obtaining information about a given phenomenon, through the formulation of questions that reflect the opinions, perceptions and behaviors of a group of individuals.

Surveys offer several benefits. Two of those most important benefits include the high representativeness of the entire population and the low cost of the method when compared to other alternatives. On the other side, the reliability of survey data is very dependent on the survey structure and the accuracy of answers provided by the respondents.

4.2.4 Correlational study

Correlational research is essentially an exploratory technique that seeks to determine whether there is a relationship between two or more variables. There is no manipulation of variables, but only an investigation of the extent to which the variables are related. The strength and direction of the relationship are two characteristics highlighted by a correlational study.

Looking at the correlation coefficient, we can easily quantify observational data. At the same, we can collect a wide range of information from many domains at one time and it is possible to study the interrelations among those variables. However, correlation doesn't indicate causation, because the association between two variables could potentially be explained by a third variable.

4.2.5 Multivariate analysis

Multivariate analysis consists of a set of methods that can be used when multiple measurements are made for each individual or object of one or more samples. The methods typically applied are included in the large group of descriptive statistics and inferential statistics. These techniques can be applied in a wide range of situations, such as market research, process optimization and quality control.

Multivariate techniques allow researchers to explore relationships between variables using the most appropriate methods for each situation. The statistical process to be adopted should be adjusted to suit the characteristics of the environment under analysis. However, these techniques are generally complex and require the use of specialized statistical software, which is generally expensive.

4.2.6 Comparison of approaches

Table 3 performs a comparative analysis of the main advantages and disadvantages that can be found in each quantitative method.

Table 3: Comparison among quantitative methods

Method	Advantages	Disadvantages
Field experiments	- Works in natural setting - Larger scale research - Subjects are not influenced by the observations of the experiments	- Difficult to control variables - Difficult to replicate the same conditions of the study - Ethical problems can arise
Simulation	- Used to study complex systems - Compress a time frame, which allows to study the behavior of the system more quickly - "What-if" questions can be tested and answered	- Model building requires deep knowledge of the field - Time consuming and expensive - May require specialized hardware and software tools
Surveys	- Low development time - Cost-effective - Easy data collection and analysis using statistical methods - Can reach high audiences - High representativeness - Not affected by the subjectivity of the researcher	- Reliability of data is very dependent on the quality of answers and on the survey' structure - Rigidity of the structure - Don't capture emotions, behavior and changes of emotions of respondents

Correlational study	- A lot of information and different domains can be explored - Degree of association between two variables can be easily calculated - No manipulation of behavior is required	- No direct cause and effect can be inferred - May lacks internal/external validity - Doesn't provide a conclusive reason for the existence of a correlation between two variables
Multivariate analysis	- Several statistical tests and techniques can be used - A lot of information and different domains can be explored - Technical rigor of the process	- Complex of the employed techniques - Requires the use of specialized statistical software

5. Conclusion

Scientific studies are fundamental to increase the horizons of theories and explain the phenomena of society. Research methods are used for the development of scientific studies, which allow specific analysis according to the methodology employed by the researcher.

The researcher is responsible to choose the research methodology that best suits the situation under analysis. Two methodologies of qualitative and quantitative nature stand out for their usefulness and wide acceptance in the scientific community. Case studies, field research and focus group are the most adopted methods within the qualitative methodology. On the other hand, surveys and correlational studies are the most common methods to perform a quantitative research. The choice of method to be adopted should take into account the advantages and disadvantages of each method, and also the questions, specificities and the nature of the research study.

As future work, we intend to explore the potentialities and limitations of mixed methods research. The idea is to analyze the most promising qualitative and quantitative methods that could be used together to explore the strengths and mitigate the weaknesses of both quantitative and qualitative research.

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