

Quantitative Methods In Research On The Use Of Information Technology In Budgetary Processes

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Abstract:

This article maps the utilization of quantitative methods in research employing information technology in budgetary processes. With a descriptive scope, quantitative approach, and use of indicators commonly applied by bibliometrics to analyze a bibliographic portfolio of 18 articles published up until 2020 in national and international databases. The research results were able to identify that the most commonly used method was the Regression Analysis technique, and in relation to the other quantitative methods, only Correlation Analysis was used more than once, with the remaining techniques only being used once. It was also identified that the most frequently used data collection instrument within the sample was the questionnaire, representing about 55% of them. The remaining articles used secondary data for analysis. Cronbach's alpha and composite reliability were the reliability analysis techniques used, and the Likert scale was employed in 44% of the articles that conducted questionnaire applications. Regarding the limitations presented, gaps were observed in relation to the addressed theme, and it can be considered that the present research may contribute to and encourage future studies that address the use of statistical models, in addition to expanding and providing other perspectives on the addressed theme.

Key Words: *Quantitative methods. Statistics. Information Technology. Budget.*

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I. Introduction

From the 20th century onwards, there was an exponential growth in research geared towards the social sciences, and in fields encompassing this branch of science, such as accountancy, administration, and economics, consequently increasing the volume of scientific research on this topic. However, it was only in the 1980s and 1990s that the use of quantitative methods in studies was significantly identified, as this development occurred due to technological advances that enabled the application of more sophisticated methods in research¹.

Within this context, the fields of Administration and Accountancy currently present many researches with a quantitative approach, indicating that decision-making processes are carried out through these results, allowing the identification of problems and difficulties, and from this analysis, potential solutions can be concluded². Thus, studies warn that the use of quantitative methods is necessary for professionals in this area, even if their speciality is distant from the content employed³.

Research emphasises the importance of choosing the appropriate statistical technique in quantitative approach research, as it can influence acceptance in periodical publications. In this sense, research points out the main causes of article rejection in Brazilian journals in the field of Administration, some points being indicated as: biased samples with little representativeness, insufficiency or poor detailing of the variables employed, inadequacy in the form of data treatment, and conclude that the section most likely to contribute to direct rejection (desk rejection) is the method section^{4,5,6}.

Issues related to the method, such as lack of clarity in the sampling process and the choice of statistical technique employed, are in second place, losing only to literature review issues such as outdated and/or restricted coverage. Authors further warn that there are reasons why certain statistical techniques are used more than others, and that methodological innovation needs a scientific justification. In this case, bibliographic and bibliometric research can help researchers to understand the area and guide their methodological choices^{7,8,9}.

In view of this context, the research question that guides the present scientific investigation is: how is the application of quantitative methods used in research that utilises information technology as a tool in

budgeting processes? To answer this question, the aim of this research is to map the use of quantitative methods used in research on the use of information technology in budgeting processes.

Therefore, the present study seeks to survey the published bibliography on this theme and conduct an investigation of its approaches. And in this context, this research is justified by the dimensions of importance and feasibility, as the theme is considered important, from the moment it is linked to a research question that deserves continuous attention in specialised literature¹⁰.

This article is divided into five sections: introduction, where the contextualisation of the theme addressed was presented; section 2 presents the theoretical review; in section 3 the methodological procedures employed are presented; in section 4 the analysis of results and discussion is made, and in section 5 the conclusion is presented.

II. Theoretical Review

In this section, we present the theoretical review of studies addressing the application of different quantitative methods in scientific research in the field of Management and Accounting. These studies seek to identify the statistical techniques used, their findings, and their main conclusions on this topic.

What studies say about the use of quantitative methods: For a better understanding of the aspects involved in quantitative research, studies discussing the application of different statistical techniques are analysed. These highlight the reliability of results and the discussion around the employability of these techniques. Scientific research is steered through data collection and from these results, conclusions can be reached in accordance with the proposed question. However, the author warns that to obtain reliable results, data collection and analysis of information must be precise and meticulous¹¹.

Analysis of the proceedings of the three largest Brazilian accounting conferences concluded that there is an increase in quantitative research over the years. Researchers found that articles use different types of statistical tools, notably statistical inference, which can be conducted through hypotheses and estimates. Also employed were regression analysis techniques and descriptive statistics, which translate information through charts and tables, identifying variables and trends. Nevertheless, the authors caution that more complex methods are very rarely used¹².

Analysis of the methods used in articles on the Servqual scale in information systems highlighted the need for correct use of statistical techniques in quantitative research, as this decision can positively or negatively influence research outcomes. The authors also pointed out the lack of more sophisticated methods, since most research only utilises simpler methods, such as descriptive statistics¹³.

Analysis of the use of exploratory and confirmatory factor analysis techniques in the area of Production and Operations concluded that in some Brazilian articles, the use of Exploratory Factor Analysis when Confirmatory Factor Analysis should have been used, ended up "destroying the theory"¹⁴.

Exploratory Factor Analysis seeks to reduce complex data, obtaining the smallest possible number of variables from the collected data, summarising the information, thus enabling the researcher to interpret the results correctly¹⁵.

Analysis of methods used in research on hospitality identified that the Factor Analysis technique was the most used¹⁶.

Research on the use of quantitative methods in studies on the Servqual scale, focused on the area of information systems and higher education, identified that the most used technique was Factor Analysis, and all the analysed articles used the questionnaire as a data collection instrument and the Likert scale for variable measurement. Other statistical techniques were also used on a smaller scale, such as hypothesis testing, cluster analysis and Structural Equation Modelling^{13,17}.

According to the research cited above^{13,16,17}, there is a broad use of Factor Analysis which stands out among multivariate analysis techniques. This is a technique that prepares data to support other statistical techniques and can merge one or more techniques^{15,18}.

Analysis of techniques used in relationship marketing research with graduates identified that the most used quantitative methods were structural equation modelling techniques, confirmatory factor analysis and descriptive statistics⁴. The most employed scale reliability analysis was Cronbach's Alpha, and the Likert scale was the most used measurement scale⁴.

Brazilian authors identified that over the years there has been a reduction in the use of descriptive techniques that are typically simpler in achieving results, giving way to more complex and more developed techniques. The authors emphasise the combination of statistical techniques, demonstrating that researchers have been expanding and diversifying their employability and obtaining their results¹⁹.

The analyses identified that more robust methods are being used more frequently, contributing to the development and scientific evolution²⁰.

Thus, it is clear that the choice of statistical technique should be directly aligned with your research problem, as there is a distinction in the objectives of each technique and each has a specific purpose. These techniques have inherent, mathematical and statistical characteristics, and for this reason, to ensure the results are not negatively influenced, there must be correct application of the technique in conjunction with the research problem^{21,22,23}.

Finally, in a study conducted by Brazilians, they sought to investigate the role of the works of Professor Joseph F. Hair Jr., analysing his production of books and identifying the works that most stood out in the field of quantitative research. In the study, articles presented at EnANPAD (Meeting of the Brazilian National Association of Graduate Studies and Research in Administration) were analysed, searching for all articles that cited Professor Hair Jr. The three most cited works of this author were: *Multivariate Data Analysis*, *Fundamentals of business research methods*, and *A primer on partial least squares structural equation modelling*. The books explain in a more didactic way the methods and techniques exposed, being highly regarded in academia, presenting clearly and practically how to conduct research in management. Following the analysis, it was concluded that Brazil is still in its nascent stage in the field of business research, and that these books are essential for their readers to gain knowledge and understand the presented techniques in a more accessible and pedagogic manner²⁴.

III. Methodological Procedures

This section delineates the methodological choices of the research, as well as the procedures adopted. With respect to its purpose, this research can be classified as descriptive. Descriptive research aims to characterise or define a certain subject and/or theme, enabling the profiling of a group of problems, people or events and can be conducted in various environments. It may pertain to a question or a hypothesis, wherein we seek to ask or answer something concerning the size, form, distribution, or existence of a particular variable²⁵.

Regarding the approach, it is a quantitative research, considering that the current study seeks to collect data that enables the delimitation of specific information, conducting a measurement and quantification that is converted into a numerical value (quantifiable data) for subsequent analysis by statistical techniques²⁶. Quantitative research provides summarised information on several characteristics and enables the analysis of larger samples²⁵.

The current research has a bibliometric bias and bibliometric studies can be viewed as mathematical and statistical analyses conducted through the examination of publications²⁷. Bibliometrics can be considered a set of research methods, used to describe the structure of a specific knowledge, utilising a quantitative and/or statistical approach of various bibliographic data²⁸.

The bibliographic portfolio obtained in the research originated from secondary data, existing from a publication or a file, without necessitating the researcher to engage with the population to access them²⁹. Secondary data may include: third-party studies, document publications, data files, research reports, among other documents²⁵.

Sample of articles: The sample of studies related to the use of information technology in budgetary processes consisted of articles found in the following databases: Scopus, Science Direct, Google Scholar, and Web of Science. The databases were selected according to their relevance to the study. One of the major difficulties encountered by researchers in bibliographic research is the dependence on the availability of bibliographic databases, which may pose a problem in the selection of articles to assist in research construction³⁰.

The keywords used for the survey of publications in each database were as follows: budget and information technology. The choice of words was due to the preference for the search of international articles that analyse this theme. In order to refine this search, the aforementioned words were combined, using the following combination: "budget and information technology". It is emphasised that to aid this combination, Boolean operators AND and * were used, wherein a total of 129 articles were identified. Data collection from the databases occurred in July 2020. It is noted that there was no initial time frame as the start was considered from the publications found in the bibliographic portfolio.

In the second phase, each of the 129 publications was analysed by reading the titles, abstracts and keywords, to confirm their relationship with the research theme. This procedure resulted in the elimination of 105 articles that did not align with the theme, the purpose of the study and were not empirical research, including only articles that employed quantitative methods, thus obtaining a selection of 24 articles.

In the final verification stage, it was noticed that of the 24 articles aligned with the research theme, six (6) were duplicate articles (published in more than one database), and hence were removed from the analysis. Thus, the bibliographic portfolio comprised 18 articles aligned with the theme of the use of information technology in budgetary processes, as illustrated in Table 1.

Table 1: Papers

Title	Authors	Year
The Utilization of Information Systems Technology and Its Impact on Organizational Decision Making: The Case of State Budgeting Offices ³¹	Anthony G. Cahill, John M. Stevens and Josephine M. LaPlante	1990
Analyzing Cost-Effectiveness of Organizations: The Impact of Information Technology Spending ³²	Sabyasachi Mitra and Antoine Karim Chaya	1996
The Production of Information Services: A Firm-Level Analysis of Information Systems Budgets ³³	Vijay Gurbaxani, Nigel Melville and Kenneth Kraemer	2000
Information technology and the performance effect of managers' participation in budgeting: evidence from the hotel industry ³⁴	Lanita Winata and Lokman Mia	2005
Determinants of budget overruns on IT projects ³⁵	Fethi Calisir and Cigdem Altin Gumussoy	2005
Abandoning current faulty budgeting process through information technology and systems reengineering ³⁶	Sean D. Dessureault	2007
Budgeting for information technology ³⁷	Akhilesh Chandra, Nirup M. Menon and Birendra K. Mishra	2007
Innovation budget pressure, quality of IS information, and departmental performance ³⁸	Alan S. Dunk	2007
Determinants and Consequences of Firm Information Technology Budgets ³⁹	Kevin W. Kobelsky, Vernon J. Richardson, Rodney E. Smith and Robert W. Zmud	2008
Do IT managers learn how to control spending on new information technology?: a study of IT budget growth in Chinese companies ⁴⁰	Kai Reimers, Xunhua Guo and Guoqing Chen	2009
The effect of budget participation to managerial performance using information technology use, motivation, job satisfaction and stress as moderating variables ⁴¹	Bella A. P. Sriwidharmanely and Madani Hatta	2011
Efficiency Analysis of Government Budget to HRD Program in the field of Information Technology _ IT Research Center Case ⁴²	Jung-Mann Lee and Won-Suk Cheon	2012
Time, Budget, And Functionality?—IT Project Success Criteria Revised ⁴³	Przemysław Lech	2013
Hospital Budget Increase for Information Technology During Phase 1 Meaningful Use ⁴⁴	Harold Neumeier, Eta S. Berner, Darrell E. Burke and Andres Azuero	2015
The effect of information technology Usage on the relationship between budget planning, human resources competency and budgetary implementation at state University in Bali, Indonesia ⁴⁵	Verawati Ni Made Adhika, Wirakusuma Made Gede, Putri Igam Asri Dwija and Suputra Idg Dharma	2018
Analysis of The Influence of The Quality of Human Resources, Planning, and Budget Implementation on Budget Absorption at The SKPD of The North Sumatera Provincial Administration with The Use of Information Technology as Moderating Variable ⁴⁶	Novie Bertina Karokaro Purba, Tavi Supriana and Tapi Anda Sari Lubis	2018
On the Economies of Scale and Budget Allocations in Information Technology Services Provision ⁴⁷	Sunil Mithas, Kunsoo Han and M. S. Krishnan	2018
Digitization of the budgeting process: determinants of the use of business analytics and its effect on satisfaction with the budgeting process ⁴⁸	Mareike Bergmann, Christian Brück, Thorsten Knauer and Anja Schwering	2020

Considering the significant number of publications produced in the fields of accounting and information technology, difficulties were encountered in the search for studies that connect these two themes. Traditional budgeting techniques present many variations and errors, and from this perspective, information technology emerges offering opportunities, increasing user access and creating solutions that yield improvements³⁶. Besides providing detailed information on a large scale, considering all levels of the organisation, enabling the history of records to assist in achieving general and specific goals. The use of information technology in budgetary processes strengthens the decision-making of the organisation and consequently increases the information processing capacity and its competitive advantage³⁴.

IV. Results and Discussion

This section presents the results of the current research, indicating the quantitative methods employed, the characteristics of the collection instruments, as well as the measurement scales that were used, and the most cited keywords in the bibliographic portfolio directly related to the study theme.

Employed Quantitative Methods: This analysis sought to identify the quantitative methods used in the studies of the bibliographic portfolio. Table 1 presents the techniques used and their absolute frequency.

Table 2: Quantitative methods

Quantitative Methods	Frequency
Regression Analysis	14
Correlation Analysis	2

Structural Equation Modelling	1
Descriptive Statistics	1
Data Envelopment Analysis	1
Confirmatory Factor Analysis	1
Data Mining	1

According to the results obtained, it is noticed that the most used technique was Regression Analysis, considering the diversification of its application in research, this technique was used in a total of 14 studies, resulting in its use in 77.78% of the sample. The following Regression Analysis techniques were identified: Simple, Linear, Non-Linear, Canonical, Sure, Multiple, either used separately or in conjunction with their variations.

Regarding the remaining percentage of 22.22%, the techniques of Correlation Analysis, Structural Equation Modelling, Confirmatory Factor Analysis, Generalized Estimating Equation (GEE), Descriptive Statistical Analysis, Data Mining and Data Envelopment Analysis (DEA) were used, but only Correlation Analysis was used more than once.

The regression analysis model is based on the evaluation of the correlation of the variables studied, allowing the relation of independent and dependent variables and the intensity of these relationships, being a technique that has a confirmatory character and enables the analysis of one or more variables and their influences^{12,49,18,21}. It was also noted that more than one statistical technique was used in three studies, the following techniques being combined: Correlation Analysis with Regression Analysis, Structural Equation Modelling with Confirmatory Factor Analysis, Linear Regression Analysis with Correlation Analysis and with Data Envelopment Analysis.

It was also possible to identify the supporting bibliography on quantitative methods in studies on the research theme, in which the citation of 30 bibliographies used as a reference for the statistical analysis of these studies was observed. All knowledge production related to a certain research theme, must be discussed, analyzed and published, to assist in the construction of knowledge on this theme in question³⁰.

In addition, it was identified that two works were referenced by two different authors at the same time, the first being the book "Statistical Power Analysis for the Behavioral Sciences", by author Jacob Cohen, with 181,790 citations on Google Scholar on 26th August 2020, cited in the two works^{33,48}.

The second bibliographic reference is the book "Econometric analysis", published in 1993 by author William H. Greene, cited 73,768 times on Google Scholar, and currently the book is in its 8th edition, published in 2017. The other quantitative methodology references raised in the article were used once each, among these citations was found the article by Lee J. Cronbach, published in 1951, in which the author describes this coefficient that bears his name, used to evaluate the reliability of a measurement scale.

Measurement Scales: For statistical analysis to be possible, it is necessary to correctly measure variables as they can be measured in various ways, depending on the analysis process and the chosen theoretical models²⁵. In accordance with the composition of the portfolio, it was identified that 8 studies utilized some form of scale, with two types of Likert scale used, and the remaining studies merely used secondary data.

The Likert scales identified in the sample ranged from 5 to 7 points. This type of scale can be utilized with different quantities of points or levels of detail; the larger the number of points used in the scale, the more precise the responses will be⁵⁰. The Likert scale is one of the most used in research as it presents a simpler structure, facilitating the questionnaire application for the interviewer and the interviewee⁵¹. Table 3 illustrates the frequency of scales used in the analyzed studies.

Table 3: Scales

Scales	Frequency
Likert - 7 points	14
Likert - 5 points	2

The Likert scale can be used in questionnaires without the presence of a researcher, thus facilitating its application and demonstrating no significant difficulties on the part of the respondents in understanding it. Furthermore, it can be considered a simple structure, easy to prepare and apply⁵².

Results of the Data Collection Instrument Composition: Data collection begins with the application of instruments created for the research and the selected techniques to collect data and subsequently analyze this information⁵³. According to the sample obtained from the bibliographic portfolio, it was identified that 10 studies used a questionnaire as a data collection instrument and the remaining studies utilized information obtained through secondary data.

A questionnaire is a set of questions that seeks certain information from the interviewee, highlighting its easy application which can be performed in various ways⁵². The questionnaire can also be considered a scientific instrument that allows verifying and measuring characteristics of companies, individuals, events, and phenomena⁵⁴. Questionnaires are different from forms as they are filled out by the respondents themselves, making the presence of the researcher unnecessary⁵⁵.

In the studies that applied questionnaires, the following forms of delivery were used: online link (one work), email (two works), phone (two works), printed form (two works), and by post (two works), with three studies not specifying the method of questionnaire delivery. Moreover, it is emphasized that the author who chose to send the questionnaire electronically did not specify the tool used. It was also verified that three studies stood out for carrying out more than one form of delivery, aiming to reach the largest number of respondents^{38,40,48}.

Furthermore, related to the questionnaire, it was identified in 8 studies the number of questions applied, varying from 4 to 46 questions. Additionally, 3 studies presented the general structure of the questionnaire applied in the research, either demonstrated in the body of the article or in the appendix, allowing for replication of the collection. Regarding the techniques used in the reliability evaluation of the instrument, it was observed that only 6 studies reported their use, with five using Cronbach's Alpha coefficient and one using composite reliability.

Keywords: The keywords present in the articles provide information about the relevant content of the journals and their perspective of correlation between the words. Thus, the most frequently mentioned keywords in the selected bibliographic portfolio were identified according to the theme and the analyzed sample. However, two studies that did not present the keyword format were excluded, thus a total of 16 studies were considered for analysis. Below in Chart 1, we can observe the frequency of words and citations.

Chart 1: Word Cloud



A total of 142 keywords were identified in the studies, and according to the result of the word cloud, it was observed that the most cited words were: information, technology, budget, planning. It was also noticed that the other words cited in the cloud are also related to the theme in question. The cited words are considered important and highly relevant, since they can be directly related to the research theme, reinforcing the credibility of the bibliographic portfolio of the sample.

V. Conclusion

The present research aimed to map the use of quantitative research methods in publications related to the theme of information technology use in budgeting processes. Searches conducted in databases demonstrated the novelty of publications about the theme referenced here, as out of the four databases consulted: Scopus, Science Direct, Google Scholar, and Web of Science, only 18 articles were found, indicating a lack of studies related to the use of information technology in budgeting processes. According to the consulted databases, it was evident that Google Scholar was the base that obtained the most selected articles to compose the sample, with a total of 12 articles.

Thus, it is believed that the proposed objective has been achieved as the quantitative methods used in studies that utilise information technology in their budgeting processes have been identified. The results indicated that the most frequently used statistical analysis method was the Regression Analysis technique, presenting a percentage of 77.78% over the sample selected for analysis. Techniques different from Regression Analysis were used, namely: Simple, Linear, Non-Linear, Canonical, Sure, and Multiple, even with these variations for analysis purposes it was considered as a single quantitative method, and in second place, only Correlation Analysis was used more than once.

It was identified that 55.56% (10) of the articles applied the questionnaire as a data collection instrument, through online link, email, phone, printed form, and post, however, 3 studies that used this method did not specify the form of dispatch. Furthermore, it was evidenced that only 6 studies specified some method of reliability assessment of the questionnaire, in which Cronbach's Alpha and composite reliability were used. Moreover, regarding the questionnaire, 8 of the studies used the Likert scale, which showed a variation of 5 to 7 points, the remaining studies, which represent 44.44% of the sample, used only secondary data for analysis.

In order to reinforce the relevance and alignment of the selected bibliographic portfolio with the research theme, the frequency of the most cited keywords in the articles is highlighted. The most cited word was Information Technology, which appeared in 11 articles, the second most cited word was Budget with representation in 7 articles, and lastly with only 2 citations, Planning appears, it should be noted that for this analysis only 16 articles were considered, as there was no mention of keywords in two articles.

Regarding the limitations presented, theoretical gaps were observed in relation to the addressed theme, and we can consider that the present research may contribute to and encourage future research that addresses the use of statistical models, as well as expand and provide other perspectives on the theme addressed.

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