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Quantitative Research Approach and its Applications in Library and Information Science Research

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Abstract

This paper discusses the quantitative research approach and how it applies to Library and Information Science (LIS). Although many different research methodologies are used in the diverse subject of LIS to analyze data, the quantitative approach is frequently preferred. Quantitative research is most appropriate for phenomena stated in numbers since it requires numerical measurements and the analysis of variables to get results. The most common quantitative research techniques employed in LIS nowadays are survey studies, correlation research, descriptive research, and experimental research. To assess many facets of library activities and user satisfaction, the current study scientifically examines numerous quantitative research methods, including checklists, structured interviews, and questionnaires. Researchers can examine the effect factors of scholarly communications thanks to the study's insights into bibliometrics, scientometrics, informetrics, webometrics, and altmetrics for research trends in metric studies. The study also highlighted the advantages, disadvantages, and limitations of quantitative research methodologies when researchers use this strategy.

Keywords: *Quantitative research, Research methods, LIS research, Survey research, Descriptive research, Library information science.*

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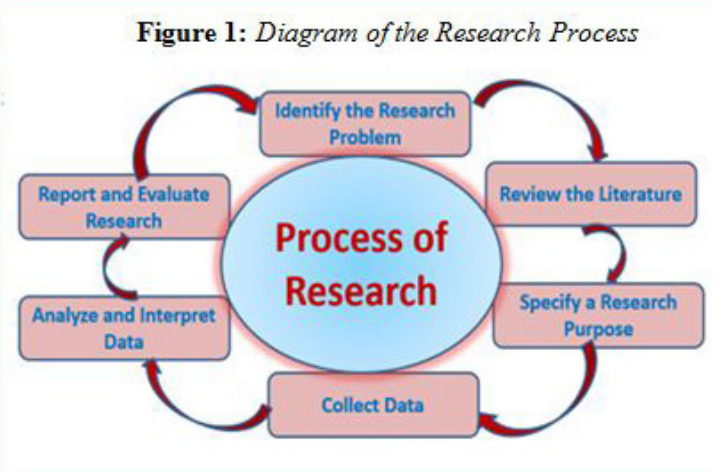
1. Introduction:

Research methods are central to scholarly endeavours in research. In the research process, selecting the research method by the scholar is a critical step as it enlightens the path of a further process of the complete research. Research is an organized and systematic way of finding answers to research questions. Research consistently focuses on relevant, helpful, and essential questions to produce research outputs. Without questions/ hypotheses, research has no focus, drive, or purpose.

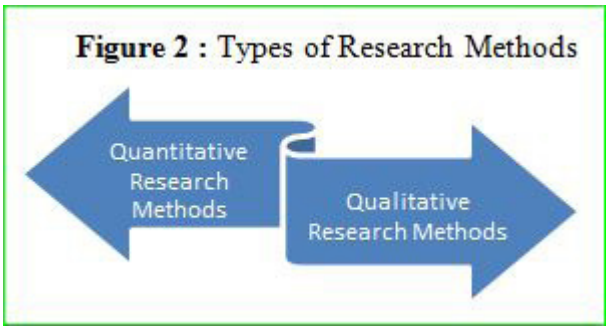
Figure 1: *Diagram of the Research Process*



The discipline of Library and Information Science (LIS) is a dynamic field that utilizes various research techniques and strategies that are continuously improving and developing (Hider & Pymm, 2008). Many philosophers and LIS professionals have developed various classification schemes for analyzing research approaches for conducting LIS research. LIS discipline has rapidly developed with computer science, information, and communication technology applications for information management in a digital environment. LIS researchers provide implementation analyses of technologies and services for the development of library systems. Quantitative research is also used in a comprehensive and correlational analysis of library users' information needs and behaviours.

The LIS research is interdisciplinary in its practical approach, and it has been highly affected by the nature of research problems & designs developed in the selected research study. In the 20th century, LIS professionals conducted various studies using quantitative research approaches, especially metrics studies. Nowadays, bibliometrics, scientometrics infometrics, webometrics, and altmetrics are heavily used in LIS research to analyze the published literature, web contents, usage of e-resources and research visibility. The authors present an updated summary of quantitative approaches in this paper to assist researchers, academics, and students in conducting research projects. Adopting qualitative research methodologies in LIS research is beneficial for applying improved tools for data processing and interpretation in a scientific method.

2. Types of Research Methods:



Several authors designed and developed various research methods to process research in sociology and humanities disciplines, but research methods are broadly categorized into quantitative and qualitative methods. Quantitative methods deal with numerical data, and qualitative methods are used for non-numerical data (e.g., text, images, audio, or video). Both of them have applicable different situations, phenomena and characteristics.

3. Quantitative Research Method:

Quantitative research involves a systematic investigation of a phenomenon through the gathering of numerical data and the utilization of statistical or computational tools and techniques. Quantitative research measures various characteristics and applies to phenomena that can be described using quantitative values. Quantitative methods mainly identify patterns and averages, predict outcomes, test causal relationships, and generalize results to a group or population.

In contrast, qualitative research involves collecting and analyzing non-numerical data. Many scholars define quantitative research as a numerical data-based research process in sociology and humanities disciplines. According to Kothari (2004, p.4), "quantitative techniques provide the decision-maker with a systematic and powerful means of analysis and help explore policies for achieving predetermined goals".

Slevitch (2011) defined positive paradigms are the primary sources of quantitative research and advocated for approaches that are based on statistical breakdowns, as well as other strategies like inferential statistics, hypothesis testing, mathematical exposition, experimental and quasi-experimental randomization, and questionnaires that have a limited variety of prearranged responses. Dudwick et al. (2006) unequivocally establish the importance of using quantitative data to establish correlations between pre-defined variables and research outcomes. They emphasize that such data is crucial for independently replicating the analysis and validating the original findings.

A researcher of quantitative study will meticulously "record and verify information which is almost always in numerical form and usually transfer the data into computer-readable format" (Neuman, 2006, p.48). Quantitative research is a standard technique of scientific investigation, gathering quantitative information and activity by applying mathematics or statistical techniques.

4. Objectives of the Study: The objectives of the study are:

(i) To know the various types of research methods

(ii) To determine the importance of the quantitative research method

(iii) To find out various components, including different types of quantitative research methods

(iv) To examine the strengths and weaknesses of the quantitative research

(v) To identify various metrics used in Library and Information Science

(vi) To determine the effectiveness of treatments in a quantitative research approach, particular reference to Library and Information Science

(vii) To examine the different challenges of using the quantitative research method.

5. Quantitative Research Method:

5.1 Steps in Quantitative Research

Quantitative research is a well-structured and systematic procedure for collecting and analyzing numerical data using statistical methods to ascertain results. The following 13 steps are primarily used in quantitative-based studies.

(i) Identifying and selecting of problem

(ii) Review of literature

(iii) Formulating questions/objectives related to research

(iv) Constructing hypotheses

(v) Identifying and defining variables

(vi) Research design

(vii) Identifying research area group/population and sample

(viii) Designing a data collection tool

(ix) Selecting statistical tests for testing the defined objectives/research questions and hypotheses

(x) Data collection.

(xi) Analyze the collected data using appropriate statistical tools (using an ICT application).

(xii) Draw findings and conclusion.

(xiii) Report writing regarding carried-out results.

5.2 Data Collection and Analysis in Quantitative Research:

Quantitative research always follows a well-structured process and formal instruments for data collection in the standard format. In a quantitative research study, research data are collected objectively in a systematic way from select groups and areas as per the researcher's needs. Traditionally, mailing (posting), delivery and collection, and e-mailing are the methods of administrating the research instrument for data collection. However, due to technological advancement, substantial online ICT applications like Monkey Survey, Google Forms & MS Forms are available, where researchers design

& develop an online questionnaire related to their research study and share it for specific groups/areas. Therefore, it is feasible for researchers to cover wide areas for data collection. The data collection instrument is administrated in the following way to conduct quantitative research.

(i) Online platforms (Google Forms, MS Forms & Monkey Survey)
(ii) E-mailing the questionnaire
(iii) Mailing (posting) the questionnaire
(iv) Delivery and collection
(v) Interview schedules (Direct interviews, Group interviews, Virtual Meetings, Telephonic interviews)

Apart from Spreadsheets, researchers can use diverse computer applications like SPSS, Stata, R & R, VOSviewer, Bibexcel, and so on to analyze the collected data by applying the required statistical calculations.

5.3 Essential Skills for Applying Quantitative Research Methods:

Researchers need the following essential skills to conduct quantitative research for better and more accurate results.

(i) The skill of identifying & understanding research problems
(ii) Formulating of hypothesis
(iii) Understanding of research design, selecting study area
(iv) Measurement technique (population and sampling)
(v) Comprehensive knowledge of the used variables
(vi) Designing data collection instruments (offline & online)
(vii) Good understanding of statistical analysis
(viii) Knowledge and handling skills in data analysis applications (Spreadsheet, SPSS, Stata, etc.)
(ix) Knowledge and skills in statistical calculations
(x) Skills in drawing figures, charts, tables, graphs, and other diagrams
(xi) Evaluating, critiquing and modeling collected data using mathematical concepts
(xii) Reporting and documentation of the research study

5.4 Types of Quantitative Research Methods:

Quantitative research has been categorized into several types, depending on the scope of the study. Sukamolson (2007) defined the quantitative research methods into four types: survey research, correlational research, experimental research, and causal-comparative research. In the LIS discipline, quantitative research was conducted using four methods: (i) descriptive research, (ii) correlational research, (iii) experimental research, and (iv) survey research.

5.4.1. Descriptive Research Method: Descriptive research is a type of research methodology that aims to observe and identify the unique characteristics of a particular phenomenon or situation. This type of research is also useful in exploring and establishing links between two or more entities. Unlike other research methodologies, descriptive research does not start with a hypothesis. Instead, the researcher collects data and then develops a hypothesis based on the information gathered. It has mainly used to explain the components of information. Systematic data classification requires careful selection of the units and measurements of every variable. Descriptive research is similarly treated as causal-comparative research when it describes existing conditions. LIS researchers currently employ the descriptive research approach, divided into four parts: i) survey studies; ii) developmental studies; iii) inter-relationship studies; and iv) content analysis studies. The characteristics of the descriptive method are the following:

(i) Descriptive research mainly involves the use of numerical and statistical data.
(ii) It is usually non-experimental and cannot change, manipulate, or control the variables.
(iii) Often, descriptive techniques are used objectively and empirically.
(iv) Data are collected through observation of people or groups or a survey or questionnaire at one time.
(v) Descriptive research results are generalized to a large population and
(vi) appropriate variable testing and hypothesis formulation.

5.4.2 Correlational Research Method: Correlational research is a valuable scientific tool that enables examining relationships between variables through statistical analysis. This method involves observing the variables in their natural state and does not involve any manipulation. It should be noted that correlational research can only demonstrate a relationship between variables and not establish causality. This method helps identify patterns, generate hypotheses, and analyze the main differences between correlated variables. The most significant features of correlational research include its statistical approach and ability to provide insights into the relationship between variables. The main characteristics of the correlational method are:

(i) The correlational method helps to measure and describe the relationship between two or more variables.
(ii) Minimum two variables are identified and defined in the correlation study
(iii) No manipulating the variables under study or correlational research measures variables as they exist naturally.

(iv) It concerns only quantitative data and can be analyzed statistically.

(v) It is used to find human behaviour or natural phenomena

(vi) Cannot establish causation in correlation research.

(vii) Data is collected at one general point in time.

5.4.3 Experimental Research: Experimental research is a highly precise and scientific method to examine cause-and-effect relationships between variables. It involves developing a hypothesis, operationalizing variables, selecting participants, randomly assigning them to different groups, manipulating the independent variable, measuring the dependent variable, analyzing data, and drawing a conclusion. This methodology is considered the gold standard because it allows researchers to identify the associations between two or more variables with certainty. The characteristics of experimental research are as follows:

(i) Experimental research involves testing specific hypotheses or research questions.
(ii) The researcher manipulates one or more independent variables in this study
(iii) It involves measuring dependent and independent variables, where the dependent variables are measured before and the independent variables later.
(iv) Randomly assigned the participants in different groups in this study
(v) Repetition is needed to confirm the results and ensure their reliability and validity
(vi) Ethical consideration is most important in this research.

5.4.4 Survey Research Method: Survey research is a quantitative method involving data collection using a structured questionnaire or surveys and data analysis through statistical procedures. This method is mainly used to find information about attitudes, opinions, beliefs, and behaviour of the people or groups. A survey study can be conducted using several methods, such as face-to-face, telephonic, and questionnaires (online or offline). Survey research can be used in social science, library science, marketing research, education, public health, management and commerce. The well-planned steps are followed as defining research questions, determining the sample population and sample size, drawing a survey instrument, administrating the instrument, collecting data, and analyzing and interpreting the collected data. Survey research is generally applied in the study of many populations or groups. The researcher can widely explain and generalize a group or population's opinions, attitudes, and characteristics. Characteristics of survey research are as follows:

(i) Survey research requires a rigorous process for generating sound, valid, and

reliable questions to prepare a questionnaire.

(ii) Researchers must ensure that their questions accurately correspond with the intended topics measured through reliability and validity testing.

(iii) Researchers must consider local culture, economic conditions, and legal frameworks to conduct surveys to prepare effective sampling methods.

(iv) Surveys provide numerical data for research analysis and reporting.

(v) Survey research is typically quantitative and deals with current events.

5.5 Strengths of Quantitative Research:

Quantitative research can be administered and evaluated very quickly. There is no need to edit and restructure the collected data. Researchers can apply various statistical approaches to measure the cause and effect of phenomena. The study findings can also be presented in tables, graphs, figures and textual form. Some other strengths of quantitative research are the following:

(i) It is reliable and consistent by critical analysis.

(ii) It takes a short time to administrate the research instrument.

(iii) Permit a more extensive study, expanding the sample size and improving the results' generalization ability.

(iv) Groups and respondents' levels of agreement or disagreement were made easier to quantify.

(v) The quantitative approach looks at the correlation and causality

(vi) The quantitative approach allows the adoption of different statistical tools and then analysis, interpretation and comparison with similar studies.

(vii) It is easier to compare organizations or groups using quantitative data to determine if respondents agree or disagree (Yauch & Steudel, 2003).

(viii) A conclusion is drawn from vast sources of information.

(ix) Personal bias can be prevented by bridging the gap between the studied subjects and the computational methods.

5.6 Weaknesses of Quantitative Research:

Quantitative research methods are paid a significant role in conducting a survey-based case study in social science and humanities. However, it also has its weaknesses. The weaknesses of quantitative research methods are the following.

(i) Large sample sizes are required for effective quantitative research (Carr, 1994). Sometimes, such large-scale research is impossible due to the crises

of resources.

(ii) Data is more effective and can test hypotheses but may need to capture contextual information.

(iii) Sometimes it may oppose real-world consequences

(iv) Uses a statics and rigid approach

(v) It takes enormous resources for large-scale research

(vi) Not available depth experienced description

(vii) Collect much narrower and sometimes datasets

(viii) Difficulty in Analyzing the Data Collected

(ix) Dependence on an Electronic device (Computer, laptop, calculator, smartphone)

(x) Data outcomes are usually generalized

(xi) The quality of data is the most significant limitation

(xii) Answer validity always creates a cloud of doubt about the final results

(xiii) There is no access to specific feedback

5.7 Metrics Studies in Library and Information Science

In the tremendously changing scenario of information management, libraries and information centres are collected and analyzed a large amount of published literature data using a quantitative research approach. "LIS professionals' common challenge is presenting such data meaningfully and using it effectively for decision-making" (Orcutt, 2009, p.31). Currently, almost libraries play a vital role in managing collection & services in both formats (print & electronic) for instant accessibility & delivery of information as their patrons require. Quantitative research is a cost-effective scientific approach for determining patron usage of library materials and services. Therefore, metrics studies assist researchers and librarians in exploring the published literature and web content in various ways. Table 1 presents the background of quantitative research-based metrics studies in the LIS discipline, and Figure 3 depicts the relationship between metrics terms.

Table 1 : *List of Quantitative Research-based Studies in the LIS Discipline*

S.No.	Name of Study	Name of Founder	Established Year
1.	Librametrics	Dr S R Rangnathan	1948
2.	Bibliometrics	Alan Pritchard	1969

S.No.	Name of Study	Name of Founder	Established Year
3.	Scientometrics	Vasilij Vasilevich Nalimov and Z.M. Mulchenko	1969
4	Informetric	Otto Nacke	1979
5.	Webometrics	T.C. Almind and P. Ingwersen,	1997
6	Althmetrics	Euan Adie	2011

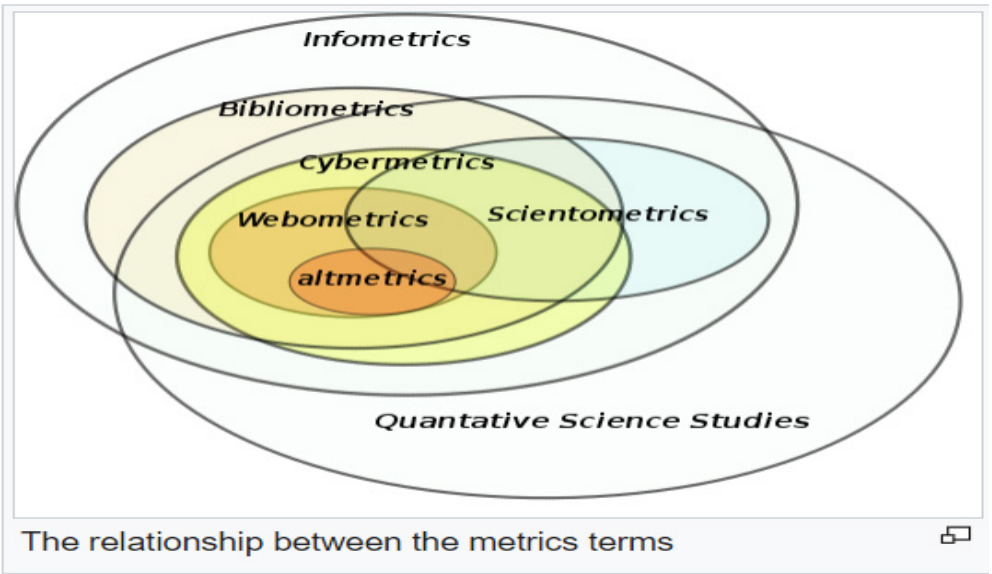


Figure 3: *Relationship Between the Metrics Terms*

Source: *Informetrics (2022)*

***Librametrics*:** The "Librametry" term was [first] introduced by Dr SR Ranganathan during the ASLIB's conference in 1948 held at Lemington. Librametric, as the quantitative method, is used to analyze the library collection and services in a mathematical and statistical process. This librametric method can be used to find the usability of library collection and services to improve the organization, collection, space, and furniture to deliver library services effectively.

***Bibliometrics**:* Prichard first coined the term "Bibliometric" in 1969. Bibliometrics is highly useful for quantitatively analyzing published literature, including books, articles, and other documents. Bibliometrics was first applied in library science, but now it is applied in another discipline also. Therefore, bibliometrics analysis has a broad scope in the academic world. The uses of bibliometrics are:

(i) To evaluate citation impacts such as h-index, journal impact factors, and citation counts.

(ii) To measure the productivity, impact and patterns of usage factor of the scholarly community.

(iii) To evaluate institutions, individual researchers, research groups and entire research stakeholders.

(iv) Evaluation of research, policy-making, and funding decisions.

Scientometrics*:* It is mainly concerned with quantitative methods of the research approach. "Scientometrics" was first used to denote the "measurement of information process" by Vasilij Vasilevich Nalimov and Z.M. Mulchenko in 1960. Scientometrics is used to analyze the bibliometric and citation analysis to measure and analyze the various aspects of a scientific research field. Scientometrics involves the study of science indicators, the growth of literature, the behaviour of scientists, social science, and the historical growth of science.

Informetrics*:* The "Informetrics" term was introduced by Otto Nacke in 1979. Informetrics is also used for the quantitative research approach of information to study several aspects, including information production and dissemination in various formats. It is used to analyze and interprets information productivity.

Webometrics*:* "Webometrics" is also known as Cybermetrics, and it is used to analyze the World Wide Web (WWW) contents to observe information properties regarding types and the number of hyperlinks, usage patterns and structure of web contents using the quantitative method. This term was first used by T.C. Almind and P. Ingwersen in 1997. Cybermetrics is a new term in a metric study in the academic field. It mainly focuses on bibliometric and informatics analyses of the internet content's use of information resources, technologies and structures.

Altmetrics*:* The "Altmetrics" term was founded by Euan Adie in 2011, and it is the latest approach in the metric study. This Altmetrics study is used for comprehensive analysis of scholarly impact by measuring and analyzing the usage of scholarly communication. Altmetrics is used to count the cover of views and downloads, sharing through media, citations, discussion in wikis and blogs, comments and counts, and more of academic literature.

Knowledgometrics*:* This term was first used at Wuhan University Research Centre, China, for scientifically evaluating research activities. This new concept of "knowledge metrology" is helpful for the multidisciplinary research study. Knowledgometrics is also

used to study the interdisciplinary human knowledge system using quantitative methods. This study covers the bibliometrics, informetrics, scientometric and network metric studies to analyze the knowledge system metrics.

5.8 Quantitative Research Approach - LIS Research Areas

Keeping a view of the changing research trends, especially in the LIS discipline, there are many areas; researchers can conduct research quantitatively. Below are areas where LIS research can be studied using the quantitative approach.

(i) Analysis of the reading habit and information-seeking behaviour
(ii) Analysis of feedback from library users
(iii) Analysis of the contents of the library website
(iv) Analysis of the reason for visiting the libraries
(v) Analysis of usage and success of a library
(vi) Analysis of the effect of the application of ICT on select libraries
(vii) Analysis of aspects of library education and information literacy
(viii) Growth study (collection development, usage & user's study)
(ix) Evaluation and usage of e-information resources
(x) Investigate the information behaviour and user studies
(xi) Analysis of information management and knowledge organization
(xii) Evaluation of user ICT skills and competencies
(xiii) Analysis of the trend and policy of professional development for LIS professionals
(xiv) Explore the adopting level of emerging technologies
(xv) Investigate the LIS professionals' perception towards emerging and AI technologies
(xvi) Explore how digital technologies can create and manage a digital collection.
(xvii) Bibliometrics studies of published literature
(xviii) Scientometrics studies (quantitative analysis of science and scientific field)
(xix) Webometrics of different websites and their contents.
(xx) Altimetric study of online published literature
(xxi) Knowledge metrics (quantitative measurement of interdisciplinary human knowledge)
(xxii) Measuring the impact of emerging technologies on the reading habits

5.9 Challenges for Quantitative Research

LIS area is a multidisciplinary subject. Therefore, researchers need help with conducting quantitative research studies.

(i) Problems with select samples among the group or population
(ii) Formulation of hypotheses
(iii) Lack of scientific training for researchers
(iv) Lack of statistical analysis knowledge
(v) The researcher may have challenges selecting authentic measurement tools
(vi) Very difficult to analyze massive data, if the researchers have no depth knowledge
(vii) Lack of knowledge in research ethics.
(viii) Insufficient interaction between researchers and study groups/populations
(ix) Inadequate confidence among the researchers
(x) Inadequate assistance from the competent authorities
(xi) Improper library management
(xii) High cost of publishing research outputs
(xiii) Unavailability of required data from the library
(xiv) Lack of time and resources cause quantitative research to consume more time and resources.
(xv) Absence of finance
(xvi) Challenges to adopting technology for research conduct
(xvii) Due to routine work, the researcher needs more time to conduct research.

6. Conclusion:

Quantitative research mainly focuses on objectivity and is especially suitable when there is the possibility of quantitative collection of defined variables and inferences from study groups or select samples of a population. The library uses quantitative and qualitative approaches in its research, with other methods also employed. Researchers use tools such as questionnaires, checklists, and structured interviews, which can be administered online or offline. With the availability of various ICT tools, data collection has become more streamlined. Metrics methods, including bibliometrics, libra metrics, scientometrics, informetrics, webometrics, altmetrics, and knowledge metrics, are used to analyze research trends, literature growth, authorship patterns, co-citation and bibliographic coupling, and other aspects of published literature. In the digital age, quantitative methods have gained popularity among researchers in the LIS field due to their flexibility and versatility in data collection. However, researchers should take certain

precautions. This study provides insights into how quantitative approaches will allow researchers to investigate library users' perceptions, collections, systems and services, functions, and staff attitudes in LIS research because they enable the analysis of large populations and rely on numerical data. Furthermore, this study is a reference resource for anyone seeking to understand quantitative research methods better.

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