**Scientific Research Methodology**

**Vs.**

**Social Science Research Methodology**

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**Abstract**

The multiple research methodologies used in scientific and social science research such as conceptual research, empirical research, model research methodology, experimental research, formal methodologies, build research methodology, process research methodology and simulation method are discussed. The recursive scientific research cycle has been explained. The research process is compared with respect to both scientific and social science research. The less demarcation between the methodologies used in scientific and social science research is highlighted.

**Introduction**

“Research is an art of scientific investigation”.

----- Kothari, C.R. (2004)

Is there any clear demarcation between scientific research methodology and management or social science research methodologies? Are they complementary and cannot be separable? Science is derived from different domains and uses the research methods such as experimental, theoretical and simulation (Freitas, 2009). Any science consists of body of knowledge. Ancient philosophers such as Aristotle, Plato, and Socrates have studies domains such as astronomy, philosophy, mathematics, logic and medicine. Aristotle and Galileo are the initial contributors of scientific research. Current day researchers are studying basic sciences, core sciences, engineering sciences, applied sciences, social sciences, natural sciences, biological sciences, zoological sciences, medical and health sciences. The current day social sciences include history, political science, sociology, anthropology, psychology, linguistics, philosophy and cultural studies.

Information systems research requires combination of technological and social issues (Berndtsson et al., 2008). It is derived from the domains such as cognitive science, computer science, ergonomics, organizational theory, management science, political science, economics, organization science, psychology, language theory and organizational behaviour. Information systems research can also be technical or behavioural in nature (Ramesh et al., 2003). The research process involves revising theories, facts and applications. The goal of current day research is discovery and dissemination of knowledge and information. The traditional research concentrated on finding and developing knowledge on the unknowns.

This article explains the different research methodologies used in both scientific and social science research. Those methodologies include conceptual research, empirical research, model research methodology, experimental research, formal methodologies, build research methodology, process research methodology and simulation method. The ‘Methodology’ has origins from Greek word.

**Conceptual Research**

It is useful for making derivations, definitions, propositions and deriving hypotheses based on literature gaps. This basically identifies the basic constructs in the subject knowledge base and finds the interconnections and links between constructs, factors and variables. Conceptual research is useful to make conceptual models pertaining to the subject area. Further, conceptual models are used to do empirical, causal and experimental research. Conceptual research is the primary step for empirical, causal or experimental research (Figure 1).

Conceptual Research

Definitions

Concepts

Constructs

Components

Factors

Variables

Hypotheses/

Propositions

Empirical Research

Experimental Research

Causal Research

Conceptual Model

Figure 1: Social Science Research Methods

Based on the results of the experiments and observation, the hypotheses are adjusted in scientific research. Where as, adjusting the hypotheses is not possible in management research after data analysis. In management or social sciences research, the hypotheses are either supported or not supported after data analysis. The hypothesis is consistent here.

Scientific theory is based on empirical knowledge came out of observational experimentation (Freitas, 2009). The *scientific research cycle* is as shown in Figure 2. The scientific research cycle is recursive in nature. The research methods followed in scientific research are mostly quantitative in nature (Warfield, 2010). Where as, research methods followed in social sciences are mostly qualitative in nature. There are cases that mixed methods are also followed in both scientific and social sciences research.

Experimental Research

Data Collection

Empirical Research

Data Analysis

Findings

& Conclusions

Theory Building

&

Body of Knowledge

Conceptual Research

Figure 2: The Scientific Research Cycle

**Empirical Research**

*Empirical research* is mostly used in social sciences, behavioural sciences, sociology, psychology, industrial psychology and economics. It is based on data collection, hypothesis proving based on data and deriving conclusions from it. For example, for the past two decades, extensive empirical research is going on in areas such as software engineering, computer science and information systems. This indicates that engineering and scientific research is also using empirical methods. Empirical research methods are used in project management research also. The experimental software engineering brings in the domains such as sociology, economics, psychology and computer science.

Empirical research uses techniques such as questionnaires, interviews and case studies. Using questionnaires nominal, continuous, ordinal, interval, ratio (Holz et al., 2006) and discrete data is collected. This data is further analysed for hypotheses testing and deriving conclusions using statistical techniques. The empirical research considering organizational and societal variables should be able to analyze the qualitative comments and textual inputs (Berntsen et al., 2004).

**Model Research Methodology**

*Model research methodology* is used to define an abstract view of a complex system. Models are built to avoid the higher costs in building the entire complex systems. These models can be used to test and modify and further can be used for simulation purposes. Models are also required for experimentation. Model research methodology is usually used in combination with other research methodologies such as experiment, empirical, etc. The models built in scientific research or engineering research are physical models different from the conceptual models developed in management or social science research.

In management or social science research, conceptual models can be represented as written text or diagrams. Where as, in scientific research models are represented in the form of physical things. In case of computer science, models can be software applications running with minimal functionality. Model is built as interacting components. It can also be a data model. Using models, one can even test the what-if scenarios, does experimentation and simulations. Model is an abstraction of a real world thing. Model is an instrument used or developed by the researchers. It is not the final objective of research. Models often give qualitative and quantitative details to the researchers.

Either in management research or in scientific research, modelling the research problem should be the first step. After modelling further research methods/methodologies can be applied to either conceptual model or the physical scientific model.

**Experimental Research**

*Experimental research methodology* is the common research methodology followed in both sciences and social sciences. However, in most of the cases it is applicable to scientific research. Experimental research has two phases in it. They are exploratory phase and evaluation phase. In *exploratory phase*, the research thinks about the questions to ask about the system to be evaluated and in *evaluation phase* he finds the answers to those questions.

In a study of 628 research papers of Computer Science published between 1995 and 1999 done by Ramesh et al. (2003), they found that 73.41% of the papers are based on conceptual or mathematical analysis, 15.13% of the papers are based on conceptual analysis, 2.87% are based on proof of concept and only 1.75%arebased on laboratory experiments. Rest of the papers have followed different research methodologies. If you keenly observe in computer science research during that five years period, only 1.75% of the research publications are based on laboratory experiments. Why this percentage is very less? To make ground breaking innovations like Thomas Alva Edison and Albert Einstein, their research is purely laboratory based research changing the experimental conditions all the time. This kind of experimentation requires lot of patience and dedication. Unless these are present, future generations may not see the ground breaking innovations which make the life better. When the survival is the biggest questions, very few individuals are dedicating and venturing into these kinds of research methodologies.

Maintaining records of experimental results is very much important in each execution of the experiment. This record keeping should be in such a way that the experimental results should be able to retrieve at a later date. Repeating the experiments in social sciences or management research is not possible or difficult because of the changing organizational conditions. Where as, in scientific research, the experiments can be repeated under the same conditions. The steps in experimentation include experiment definition, experiment planning, experiment operation, analyze results, interpret results, and record the outcomes.

**Formal Methodologies**

*Formal Methodologies* are used in computer science to verify certain facts before automatic verification such as finding the algorithm time and space complexity (Amaral et al., 2006). Formal methodologies are widely used in theoretical computer science. Formal methodologies also make uses of building abstract and mathematical models. These formal methodologies are used to find efficient algorithms in areas such as distributed systems, parallel computing, cryptography, combinatorials and geometry.

**Build Research Methodology**

In scientific research, *build research methodology* is also followed to build a new artefact which is not present earlier. The artefact built using this approach should have unique features which none of the artefacts have them earlier. In computer science research, build research is widely used to design and build the software systems. While building the software systems, the software components can be reused, specific programming language is selected and continuous testing is done to the software system.

**Process Research Methodology**

*Process research methodology* is used in certain areas such as artificial intelligence, software quality, software process improvement and software engineering to find out the processes accomplishing things. Process research methodology is widely used where human interaction is more. It is used in human-computer interaction, vision, and cognitive sciences.

**Simulation Methodology**

*Simulation methodology* is usedwhere in real implementation is complex, time consuming and costly. For example in domains such as astronomy, economics, and physics, computer simulation methods are widely used.

There are other research methodologies such as action research, interpretative research, grounded theory, protocol analysis and ethnography used in scientific research. The main skills required for researchers in both scientific and social science research are the expressive, cognitive, organizational and meta-cognitive skills (Holz et al., 2006). The specific skills required for researchers in these areas include scanning papers, searching papers, critique literature, analyze literature, design models, collect data, analyze data, draw conclusions, interpreting results, finding literature gaps, linking to previous research and building body of knowledge. The researchers filter the world through their conceptual lens (Berntsen et al., 2004).

**Conclusion**

Thus, empirical and experiment research methodologies are used in both scientific and social science research. Conceptual research and model research are used in both scientific and social science research. Simulation is used in both economics and computer science. These finding indicates that there is no clear demarcation or the demarcation is very less in the methodologies used in scientific and social science research. All the methodologies are helping the researchers in both the areas in using, interpreting and making right conclusions.

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**About the Author**

**Dr Goparaju Purna Sudhakar, PhD, PMP** with over a decade of experience in IT industry is currently working as Faculty Member at The ICFAI University Group, Hyderabad, India. Earlier worked as **Sr. Faculty and Head (In-Charge),** IT Division at **Engineering Staff College of India**, Hyderabad and **Consulting Editor** at **ICFAIResearchCenter**, The ICFAI University, Hyderabad, India. He worked in **USA, UK, Ireland, Finland and India**as **Software Professional**. He has **B.Sc., MCA, M.Tech. and Executive MBA**. He is Project Management Professional (**PMP**®) certified from Project Management Institute (PMI), USA. He was awarded **PhD** in Business Administration from Aligarh Muslim University (AMU), India. He is member of All India Management Association (AIMA).

He worked as employee or consultant to companies such as IBM, Siemens, Interwoven, Wipro Technologies, Citicorp, Nokia, Salomon Smith Barney, SIAC, DSET Corporation, IONA Technologies, Birla-Horizons International, and PCL Mindware.  He held both managerial and technical roles in IT industry. He worked as Project Manager at Citicorp Overseas Software Ltd(COSL), Hyderabad during 2001-03. He worked as Systems Manager at Wipro Technologies during 1999-01. The reuse domain software product he managed, *Scorpus* was identified as one among the top 100 IT innovations by NASSCOM (2007).

*He worked in Banking, Financial Services and Insurance (BFSI), Telecom, E-Commerce, Enterprise Content Management, Enterprise Software Asset Management (ESAM), Health Care and HR domains.* He has extensive experience in project management, program management, general management, quality management, business process re-engineering, HRM, Organizational Behavior and human aspects of project management. He has wide experience in management consulting.

He has over **60** published papers. His papers were published in *International Journal of Project Management Research*(IPMA, Netherlands), *Team Performance Management* (Emerald, UK), *ActaUniversitatisDanubius. Economica***,** *Scientific Annals of the “AlexandruIoanCuza” Univesity of Iasi: Economic Sciences***,** *The annals of the Stefan cel Mare University of Suceava* (Romania), *The Serbian Journal of Management*, *Journal of Enterprise Information Management (*Emerald, UK), *Sprouts: Working Papers on Information Systems* (Netherlands),*CSI Communications* (Computer Society of India), *HRM Review* (ICFAI University Press), *Indian Management, The Global Educator*, *Express Computer*, *Projects and Profits*(ICFAI University Press), www.pmhub.net, *Computers Today,* andThe Hindu, *Businessgyan*, and *Business & ManagementChronicle*.

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