

Evaluating and Designing Research Methodology for Investigating Research Problem Having Interdisciplinary Applications

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ABSTRACT

Management by nature is interdisciplinary; these areas certainly have overwhelming impact on management and its related problems. In order to achieve better solution, which can be leveraged to gain competitive advantage, a focused pursued into these interdisciplinary avenue need to be investigated, collaborated and be given primary in solution centric diagnostic approach. System approach also advocates this thinking and raises the curiosity, how things influence one another within overall organization in holistic perspective. This paper investigates the importance of interdisciplinary research, critically analyze different research paradigms and research methodology for perusing such researches. In the paper firstly different research paradigm and approaches have been discussed and after proposing the appropriate methodology, the research paradigm for supply chain management research including detailed research design has been proposed.

Keywords: Environmental Auditing, Research Paradigm, Research Design, Interdisciplinary Research, Supply Chain Management, System Integration

1. INTRODUCTION

The term 'research' refers to a search for knowledge. It is a scientific and systematic search for pertinent information on a specific topic. Redman and Mory (1923) define research as a "systematized effort to gain new knowledge". Today researches are going on in every discipline. Now interdisciplinary, multidisciplinary or cross disciplinary researches are on lime light and Research funding agencies and academic institutions are focusing on it. According to the report presented by the European universities' Research Advisory Board (EURAB) in a EUA European University Association workshop on 'research management: Exploring New Types of Interdisciplinary Research Projects' - "Research systems which are weak in addressing interdisciplinary needs may miss research opportunities, fall behind in research areas, and lose many of their most innovative researchers."

The System approach in its fundamental sense considers the organization to be an open and interactive system made up of subsystems working in harmony to achieve

organizational results (Weihrich, Cannice & Koontz, 2010). The varying nature of dynamicity in organizational framework as perceived in system approach accommodates that there is a significant influence of external environment forces on structure, performance parameter and overall functioning of organization (Camponovo, 2010) which is generally result of adoption to achieve organizational ends. It also works for conversing, all functional components of business organization to deliver a unified outcome and also develop oneness of action and ideas giving rise to system thinking (Ramji & Shipp, 2009). System thinking is guiding and encouraging research toward interdisciplinary (Miri, David & Uri, 2007) and gives opportunity to higher degree of integration by visualizing organizational system and process level hierarchies, globally connected information, new and highly complex qualitzing where convergence of seamless nature is creating avenues of ternary level research through solving problem encountered in technology adoption and migration.

Interdisciplinary research is a heterogeneous approach and it represents multiple research methods (Lyll &

Meagher, 2008). It can be effectively used for enhancing the knowledge base and providing valuable insight for practical problems (Lyall & Meagher, 2008). Despite this fact, researchers have still not been able to discover and formulate methods of interdisciplinary research (Robertson et al, 2003).

Interdisciplinary research is like a new born baby, thus it demands special care at this stage. Research methodology, research methods, hypothesis formulation, data collection techniques, data collection, data analysis, hypothesis testing, validation, interpretation and report writing for these kinds of researches need special attention and precautions. This is because of involvement of more than one discipline and complexity associated with them. Benefits of interdisciplinary research are-

- ◆ It explores new universe of research
- ◆ It advances the wealth of human knowledge
- ◆ Evolution of new area of study like bio-informatics
- ◆ It empowers us to find the solutions for untracked problems

According to Clark et al. (1984), methodology means identification, formulation and analysis of research

problem through effective usage of tools and methods developed for this purpose. Methodology is description or study of methods. It deals in procedure, techniques tools and documentation. Research Methodology as a study is important as it helps to make out the problems, presuppositions and consequences of research efforts (Miller,1983).The research method devised is generally based on research strategy and method which helps us to identify the fundamental nature of the research problem (Naslund,2002). Identification of appropriate methodology is needed to explore these newly evolved research disciplines (Yin, 2003).

This paper is an effort for *Evaluating and designing research methodology for investigating research problem having Interdisciplinary Applications.*

2. RESEARCH PARADIGM AND APPROACH

The term “knowledge” is an integral dimension of research paradigms and ontology, epistemology and methodology are associated with it (Guba and Lincoln, 2005). “Ontology” as a concept is difficult to characterize because of its inherent nature of social elements (Mason, 2002 and Thomas, 2004). In other words, one can say

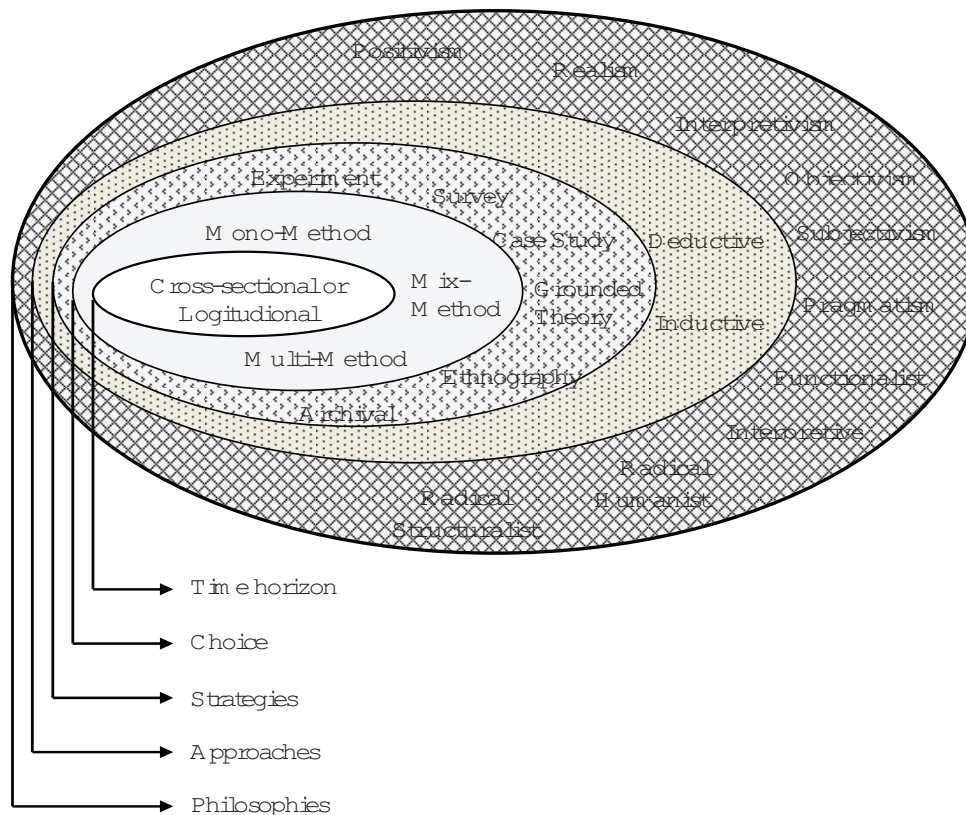


Figure 1: The Research Onion (Source: Saunders, et al., 2007)

that ontology is centered on bringing ‘reality’ in the research process. Epistemology on the other hand tries to put forward the authenticity and legality of the research process which helps us to work out the social elements in the knowledge domain (Mason, 2002). The basic difference between ontology and epistemology is that the latter implies adhering to the principles, practices, procedure and norms of natural science for understanding the research domain (Bryman and Bell, 2007).

Both epistemological and ontological branches of philosophy help us to take the decisions regarding methodological approaches to be pursued for research. The identification and adoption of the appropriate research tool is as important as formulating the original research in itself. The blueprint/guidance for the researcher will always be from the streams of ontology and epistemology (Mason, 2002; Frankfort-Nachmias and Nachmias, 1996). Saunders, *et al.* (2007) compares the research process with an ‘onion’, where each layer of ‘onion’ is in consonance with the assumptions made by a researcher at each stage of his research process (Fig 1).

Positivism, post-positivism, critical theory and constructivism are the four main research paradigms (Guba and Lincoln, 2005), which can be explained through ontology, epistemology and methodology approaches.

2.1. Positivism

Positivism as a concept looks out for facts on the basis of associations and correlations between variables. Post Positivism is a recent and added dimension of positivism. Post positivism is in consonance with the concept of positivism and states that the objective world exists and the relations between variables are deterministic and not probabilistic. Therefore the spectrum of positivist has grown beyond the testing and verification of hypothesis to the adoption of qualitative methods to facilitate gathering information beyond readily available measurable variables. However the main concern is not to verify a relationship but to falsify it. The positivist approach also aims in laying down the principles of sample and sampling designs. It also tries to draw a line of distinction between subjective and objective data interpretation (McKensie, 1997).

2.2. Post-Positivism

The qualitative methods predicted in positivistic methods and experimental design have been the main point of

focus for post positivism (Miles and Huberman ,1993). This paper makes an attempt to put forward the various methodological challenges to qualitative methods that a post positivists faces in his approach towards research. At times when application of statistical controls and quantitative measurement is not possible then the post positivists resorts to grounded theory to determine the relationships between variables. Grounded theory is used in interpretative research for understanding important patterns and behaviour of various variables associated in a research while in post positivism grounded theory is used for the proof of hypothesis- its validation or falsification. The future for post positivism lies in devising methods which will impart more meaning to the data with the help of interpretive and critical postmodernist approaches.

2.3. Critical Theory

Critical theory is focused at unveiling and rediscovering the various power associations that are inherent in a societal culture, it also aims to set free the various members of the culture from any type of domination that exists in a culture on the basis of studies conducted in these respects so far (Gall, et al., 1999:131).

The concept of criticality in the critical theory can be interpreted as a systematic and careful identification and analysis of various cultural trends prevalent in it. The seven basic assumptions that are used in the critical theory, as put forward by Joe Kincheloe and Peter McLaren (1994) are as follows:

1. Few groups in the society are privileged over others.
2. Oppression has many faces.
3. The identification and formation of language is the main area of study in culture.
4. The relationship between concept and object and between signifier and signified is never stable or fixed and is often mediated by the social relation of capitalist production and consumption
5. All processes are directed in a culture through various power relations that are inherently created.
6. Facets can never be isolated from the domain of values or removed from some form of ideological inscription
7. The findings of research are replicated to solve societal domination in respect to age, gender, class and race.

In the recent times an amalgamation of two different concepts is used – critical theory and postmodern scholarship. Ideas developed by famous personalities like Karl Marx, Max Weber, Hegal and Kant at The Frankfurt School in Germany was considered as the guiding light behind the critical theory (Kincheloe and McLaren, 1994: 138).

2.4. Interpretive and Constructivism

As the name suggests interpretive research aims to give meaning to the various situations that a member encounters in the society (Schwandt, 1994:118).It is concerned around building a second order theory (Schutz, 1973). Interpretation simply implies giving meaning and hence it is not based on thinking and reasoning of humans –rather it is an objective knowledge. The concept of shared meaning in any cultures often forms the essential features of Interpretivism while constructionists read knowledge

in an anti-essentialist level. Constructionists believe that truth is the outcome of perspective (Schwandt, 1994: 125).

The main theme of interpretivist and constructionist is related to subjective meanings – how the various elements of the society understand and interpret the various social events occurring in the society (interpretation) and how they respond to these events and draw inferences (reflexivity).Constructionists try to weave the subjective, objective and intersubjective domain of knowledge to make it more meaningful. Interactivity aims to know and understand others mind but the question that has gathered huge criticism in philosophy from everyone is that – how can we understand or read others mind (Schutz,1973). Language, written texts are some forms through which intersubjectivity occurs. Berger and Luckmann, 1967 points out that social constructionism is another important form of interpretative research.

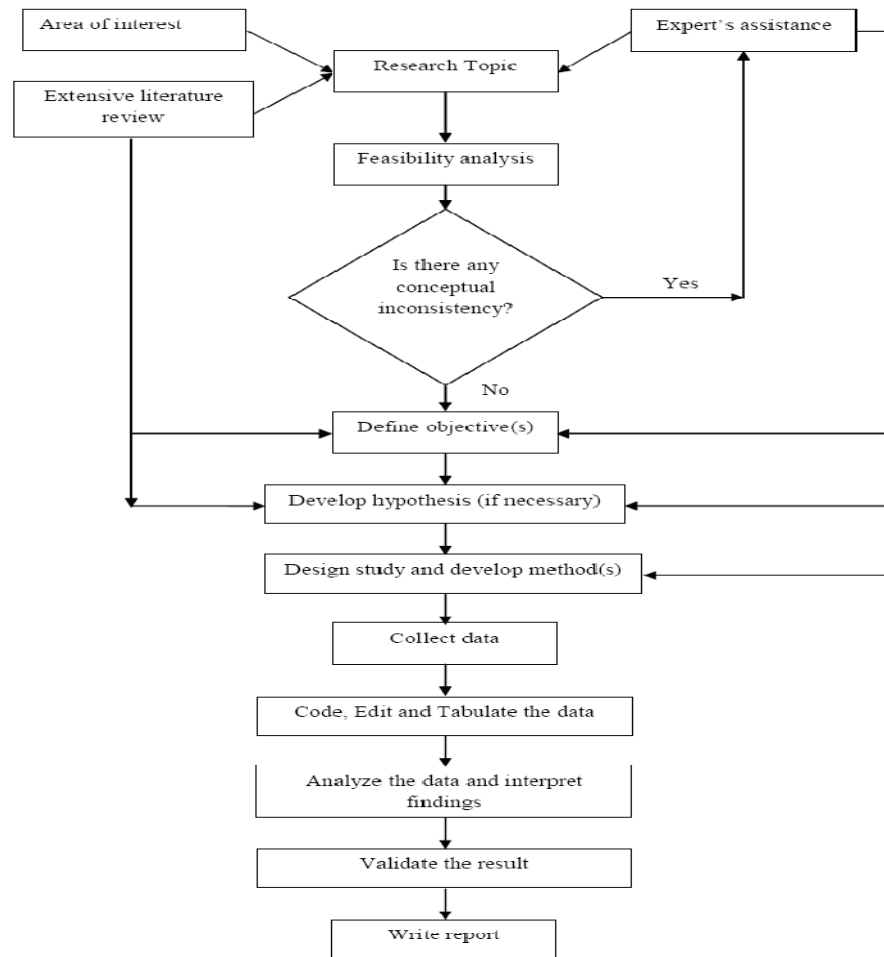


Figure 2: Interdisciplinary Research Process (adapted from Kothari, 1990)

3. RESEARCH DESIGN

3.1. Formulation of Research Problem

Two types of research problem are formulated in social science and management research (Kothari, 1990).

1. Those which relates to states of nature
2. Those relates to relationship between variables

Formulation of research problem covers research area selection, feasibility testing, ambiguity removal and formulation of research topic into specific research problem (fig 1). The following steps are usually adopted in the formulation of research problem:

- a Understanding the problem thoroughly
- b Rephrasing the same into meaningful term from an analytical point of view

Formulation of interdisciplinary or multidisciplinary research problem is a tedious job as compared to single disciplinary. This could be considered as one of the biggest reason for the small number of interdisciplinary researches being undertaken (Sachan and Datta, 2005).

3.2. Literature Survey

Literature survey is the backbone of any credible research as it creates an identifiable linkage between the current work and previous knowledge developed in the area as contribution from different researchers from time to time. It serves as a barometer of research quality and also accessing the direction of the research. It has been found that appropriate referral to previous cited & published work in the area provide us with substantial scope for theoritization of the research problem and also enabling the researcher to substantiate and validate on the appropriate mesh of the research problem.

Literature review is a qualitative content analysis of available information already published in some form (Klopper, et. al., 2007). It can be a study about problems related to your area of research for finding the research problem or can be related to your research objectives alone with the purpose of finding information about structure, attributes, relationship between attributes, previous studies, if any, related to your objective (es). It empowers and prepare the strong background for our research. The ways and means adopted by other researchers for providing a solution to a problem helps other researcher to pave their way by adding in it the element of suitability

and effectiveness (Sarantakos 1998: 129). O'Neill in Wellington et al. (2005: 89) compared literature review with climbing a pyramid- the area covered while climbing represents the total work done in the past related to your problem identified and the area uncovered sets the range to be unveiled.

The aims of a literature review are:

- ◆ To establish which of the problems identified for solution by means of empirical research have been solved by other researchers so that they can be removed from the research equation
- ◆ To give readers a clear idea of the nature context of one's Research
- ◆ To convince the reader of one's knowledge of the field
- ◆ To build a case for the empirical part of one's study

3.2.1. Matrix Method

It summarizes complex aspects of knowledge generation and provides a quick view of them. The matrix method of literature review given by Garrard (1999) became a prevalent research tool in the field of health sciences and it was later reprinted as Garrard 2004. It helps in strengthening the conceptual domain of knowledge known as epistemology. The researcher can arrange the matrix in a way that enables him to have all the relevant information pertaining the literature review at his disposal.

The matrix can be re-organized according to: (conclusion of Klopper, et. al., 2007)

- ◆ Publication date, demonstrating longitudinal aspects of the topic
- ◆ (time-ordered matrix)
- ◆ Table rows containing verbal information about the view of role occupants on a specific issue of the project (role-ordered matrix)
- ◆ Integrated data on a summative index or scale, thus organizing several components of a single, coherent variable (checklist matrix)
- ◆ A central theme (conceptually clustered matrix) Outcomes and dependent variables (effects matrix)
- ◆ Present forces that are at work in particular contexts showing processes and outcomes (site dynamics matrix)

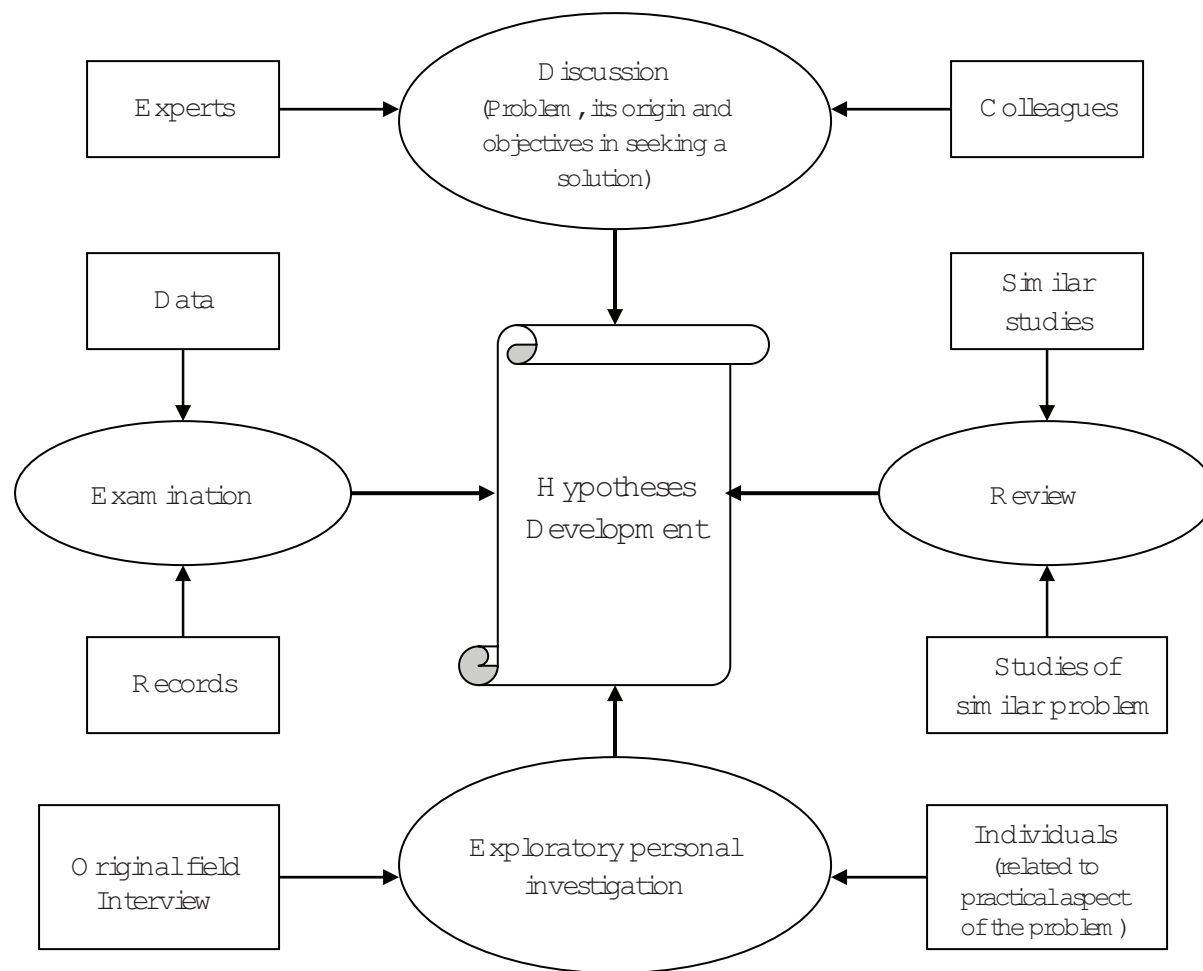


Figure 3: Working Hypotheses development model

3.3. Hypothesis Development

All theories and fundamentals prevalent in any study can be conceptualized into the nature of hypothesis (Popper, 1959). The researcher is in a state to pen down his hypothesis only after extensive literature review. A statistical hypothesis is a claim (assertion, statement, belief or assumption) about an unknown population parameter value (Sharma, 2007). According to Sharma (2007), "A working hypothesis is a hypothesis that is provisionally accepted when no alternatives are available, or when the philosophical implications of the alternatives are considered to be absurd or otherwise undesirable. Working hypothesis is tentative assumption made in order to draw out and test its logical or empirical consequences.

Working hypothesis is result of prior thinking about the research objective, extensive literature survey, examination of expert's reviews and interested parties. For a good research interested parties are researcher, research guide, institute, society and industry. In order to

be effective the working hypotheses should be clear, short and precise. It is a point to keep remembers that for all the researches it is not necessary to formulate hypothesis especially in the case of exploratory or formulative researches. Role of hypothesis are-

- ◆ Delimiting the area of research
- ◆ Keep the researcher on the right track
- ◆ Sharpens the researcher thinking abilities and enhances its attention capabilities to deal with the problem presented.
- ◆ Indicates the type of data required and type of methods of data analysis to be used

3.3.1. Working Hypotheses Development Model

Discussion, examination, review and exploratory personal investigation, approaches could be used by researcher for formulating the hypothesis. Researcher can-

- ◆ Seek the solution of the problem in consultation with the colleagues and experts to understand the problem – its objectives and origin.
- ◆ Examine the available data and records for ascertaining an insight on the trends and patterns
- ◆ Review the similar studies in the area or the studies on similar problems
- ◆ Do exploratory personal investigation which involves original field interviews on a small sample of people for gaining insight into the practical aspect of problem.

Hypothesis can be stated in the form of **if-then** statement, directional hypothesis and non-directional hypothesis. For showing the significant difference between two or more population with respect to any of their common parameter, hypothesis can be stated in the form of if-then statement. For showing the direction i.e. positive, negative, more than, less than etc, directional hypothesis is used. It indicates the direction of the relationship between two or more population under the study with respect to a parameter value. Non-directional hypothesis indicates the relationship or difference but offer no indication of the direction of relationship.

In social science research and management research generally develop hypotheses for two purposes, one for establishing the relationship between two elements or two set of elements and another for establishing the transitive relationship between two elements or set of elements.

Suppose there are two set of elements 'x' and 'p'.

Then researcher makes hypothesis or hypotheses for establishing the relationship 'f' between 'x' and 'p'.

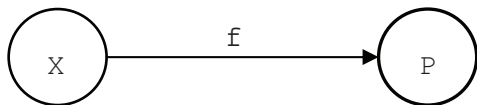


Figure 4:

Assumption 1: There is a factor say 'x' which has 'f' relation with problem 'P'

Assumption 2: There is a factor say 'y' which has 'g' relation with 'x'.

Then there must be some relation say 'h' between 'y' and 'p'

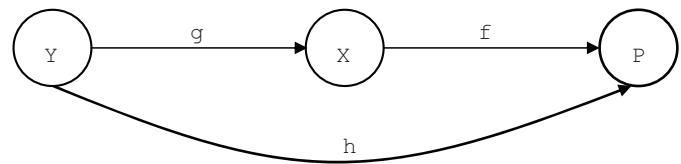


Figure 5:

It will also be true if 'x' and 'y' represent the set of factors.

3.3.2. Procedure for Hypothesis Testing

For knowing the reality of developed hypothesis it is tested through a procedure (Fig 6).

3.4. Research Design Study and Develop Methods

Sachan and Datta (2005), reviewed SCMIJ, JBL and IJPDLM journals (supply chain management and logistics journals) and presented the table which shows the percentage of research papers which had tested hypothesis.

Mentzer and Kahn (1995) reviewed JBL and found that only 4.30 percent of supply chain management and logistics researches did hypothesis testing during the time period of 1978-1993 while Sachan and Datta (2005) found that during 1999-2003; 15.6 % of supply chain management and logistics researches did hypothesis testing. These studies show the increasing trend of hypothesis testing in the field of SCM and logistics (Table 4).

Table 3: Forms of Hypothesis

Hypothesis	Type of Hypothesis
If ICT advances take place then effectiveness of supply chain increases	If-then statement
If ICT advances take place then efficiency of supply chain increases	
Advancement in ICT has positive impact on supply chain efficiency	Directional hypothesis
Advancement in ICT has positive impact on supply chain efficiency	
Advancement in ICT technology and increase in the effectiveness of supply chain are related	Non-directional hypothesis
Advancement in ICT technology and increase in the efficiency of supply chain are related	

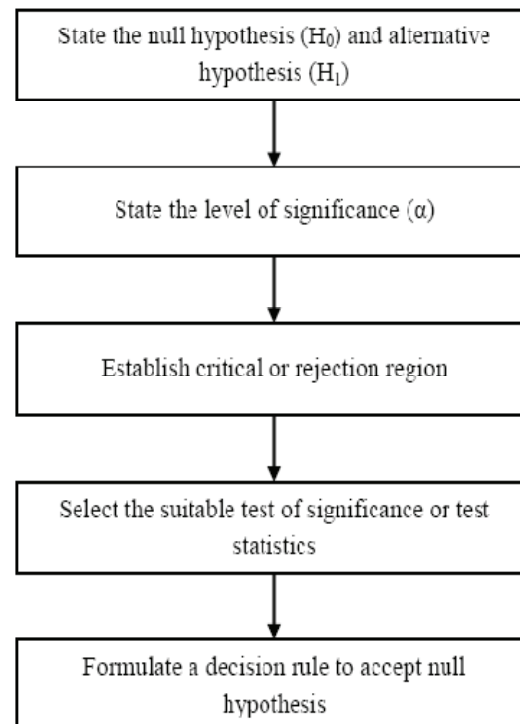


Figure 6: Hypothesis Testing Procedure (adopted from William a., 1967)

Table 4: Comparison of Sachan and Datta (2005) and Mentzer and Kahn (1995) Results

Journals	Percentage of hypothesis testing
SCMIJ	9.52
JBL	37.36
IJPDLM	10.34
Total	15.6
Mentzer and khan (1995)	4.30

Research design for SCM and logistics research

Table 5 presents the matrix of research design published in three journals from 1999 to 2003. 55 percent of the papers out of 442 papers are qualitative (empirical and desk). In JBL 80% of the papers are qualitative while in IJPDLM 56% of the papers are qualitative. It shows that SCM and logistics researches are more inclined toward *positivist paradigm*. The use of Multi method techniques (empirical triangulation) is negligible. Empirical quantitative methods have been used by most of the papers.

Data collection

Before collecting the data, sampling design is essential because of time and money constraints. Fig 5 illustrates the different techniques of sample selection.

Characteristics of a good sample design

- ◆ It should truly represent the population
- ◆ Small sample error
- ◆ Viable in the context of fund available for the research study
- ◆ Result of sample study can be applied for universe with a reasonable level of confidence

Table 5: Research Design (Source: Sachan and Datta, 2005)

Research design	JBL (%)	SCMIJ (%)	IJPDLM (%)	Total (%)
Empirical quantitative	52 (57)	38 (26)	72 (35)	162 (37)
Empirical qualitative	5 (5)	41 (28)	32 (16)	78 (18)
Desk quantitative	22 (24)	14 (10)	42 (21)	78 (18)
Desk qualitative	13 (14)	53 (35)	51 (25)	117 (26)
Empirical triangulation		1 (1)	6 (3)	7 (1)
Total	92 (100)	147 (100)	203 (100)	442 (100)

Element selection technique ↓	Representation basis	
	Probability sampling	Non-probability sampling
Unrestricted sampling	Simple random sampling	Convenience sampling
Restricted sampling	Complex random sampling	Purposive sampling

Figure 5: Basic sampling design

Survey, simulation, interview, math model, case studies and conceptual model are major research methods for SCM based researches (sachan and data, 2005; Mentzer and kahn, 1995)

3.5. Editing, Coding and Tabulation of Data

Collected raw data (especially in surveys) may carry errors, thus for more accurate result researcher should carefully scrutiny the data and make the corrections wherever it is possible. This process is named editing. It assure that the data are accurate, consistent with other facts gathered, uniformly entered as completed as possible and have been well arranged to facilitate coding and tabulation. Field editing and central editing are two types of editing which is based on the points or stages of editing.

After editing researcher should assign numbers or symbols to answers (coding) so that answers can be put into limited number of categories or classes. It is necessary for efficient analysis and through it the several replies may be reduced to a small number of classes which contain the critical information required for analysis.

After coding, data is classified according to attributes and class-intervals. Researcher may adopt H.A Sturges' formula for determining the class intervals:

$$i = R / (1 + 3.3 \log N)$$

Where

i = Size of class interval

R = Range

N = Number of items to be grouped

Classified data is tabulated in the form of rows and columns.

3.6. Analysis and Interpretation

For finding the pattern and relationship between the data, statistical and descriptive analysis is done. Different data analysis methods are mentioned in Table 6.

Mentzer and kahn (1995), analysed the researches published in JBL since 1978 to 1993 and present the list

Table 6: Data analysis methods

Analysis of data		
Descriptive and causal analysis	Uni-dimensional analysis	Central Tendency
		Dispersion
		Skewness
		One-way ANOVA, Index Number, Time series analysis
		Simple correlation and regression (paired data)
	Bi-variate analysis	Simple correlation and regression
		Association of attributes
		Two-way ANOVA
	Multi-variate analysis	Multiple regression and multiple correlation/partial correlation
		Multiple discriminant analysis
Multi-ANOVA		
Canonical analysis		
Inferential analysis/statistical analysis	Estimation of parameter values	Point estimation
		Interval estimation
	Testing hypothesis	Parametric test
		Non-parametric test or Distribution test

Table 7: Comparison of shift in SCM and logistics research analysis techniques

Techniques	Mentzer and Kahn(1995) (in %)	Sachan and Datta(2005) (in %)
Descriptive analysis	66.7	39.88
Regression analysis	5.7	14.11
Factor analysis	--	13.50
Discriminant analysis	4.6	2.45
Correlation analysis	3.4	5.52
Cluster analysis	--	0.61
Conjoint analysis	--	0.61
MANOVA	1.1	1.84
Path analysis	1.1	0.61
DEA	--	2.45
Logit model	--	0.61
SEM	--	8.59
Others (e.g. case study)	17.20	9.20

of analyses method used by the researchers during that time period. After this Sachan and Datta (2005), presented another table to show the analysis methods used during the time period of 1999 to 2003.

When we compare both results (Table 7) we see the shift in research analysis techniques. Although descriptive

analysis techniques was most popular technique of data analysis in both results but it had lost its popularity over time and new techniques like factor analysis, conjoint analysis, cluster analysis, DEA, logit model etc were gaining popularity. Regression analysis has become almost two and half times popular (14.11%) as compared to previous study in which it was 5.7%.

Interpretation of research result defines the level of utility and usefulness of result. Through interpretation researchers can link their studies with other studies and find the abstract principle that works beneath his findings, establish the explanatory concept that can serve as a guide for future research studies, appreciate his research findings with reasons. Researcher should reasonably explain the result, use extraneous information to explain the result, consult someone having insight into study before embarking on final interpretation.

For the acceptance or rejection of hypothesis, empirically validation is required. Empirical testing is pivoted around statistical methods and conceptual formulation.

4. CONCLUSION

The implicative result of investigative into variety of approaches and methods based on earlier research and related reporting in the journal of repute for significant research contribution in related area of interest spanning over two decades. It has been significantly found that a research design for-interdisciplinary research in the area of supply chain should be of the following nature.

“A study having positivism in the basis of research design having scope of empirical validation using complex probability sampling method and deriving varied consequences, relationship through usage of statistical methods [factor analysis, regression analysis etc.] and reporting the same through associative representative representation with appropriate theoritization, validation and utility of study.”

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