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# GET ALONG WITH QUANTITATIVE RESEARCH PROCESS

Khawaja Khalid<sup>1</sup>, Haim Hilman<sup>2</sup>, Dileep Kumar<sup>3</sup>

1 Research Scholar, Othman Yeop Abdullah Graduate School of Business,  
Universiti Utara Malaysia.

2 Senior Lecturer of Strategic Management, Universiti Utara Malaysia.

3 Professor- Strategic Management, Othman Yeop Abdullah Graduate  
School of Business, Universiti Utara, Malaysia.

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## **Abstract**

The world progresses through research. Empirical research relies on scientific procedures and uses a systematic approach to find answers to research problems. Every research is inherently ambiguous and requires extreme delicacy on the part of researcher for its execution. For the research results to be accepted, a research project requires disciplined approach towards an enquiry into the research problem. It demands extreme dedication, skilfulness, mastery and temperament from the researcher. It is generally observed that the researchers fall short of application of research methodology, whether it is qualitative or quantitative, when they write their research papers and working papers. This article is an attempt to understand the basic process of conducting research particularly quantitative research and to discuss considerations a researcher must be bearing in mind while undertaking quantitative research.

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3 Corresponding Author

## **Introduction**

Empirical Research is an investigation based on experimentation or observation (Bruns, 2007). It entails adoption of scientific methods for its conduct and is divided into two broad categories: quantitative research and qualitative research. According to Walliman (2005), research is not just about gathering facts without purpose, or presenting information or data without interpretation. Rather, research is something which is undertaken to find out things in a systematic manner where data is collected and interpreted systematically and there is a clear purpose guiding the enquiry (Saunders, Lewis & Thornhill, 2009). It involves series of well-planned and carefully executed activities to find solutions to research problems (Sekaran & Bougie, 2010). In a good research project, the purpose of research is clearly defined, research process is detailed in form of research proposal, research design is thoroughly planned, research relies on adequate analysis, findings are presented unambiguously, conclusions are properly justified, limitations are frankly revealed and high ethical standards are applied (Cooper & Schindler, 2006). A research activity has to produce *information* through careful analysis of data – primary or secondary or both (Sekaran & Bougie, 2010). The data collected may be quantitative or qualitative or combination of the two. Although empiricism is normally associated with quantitative research, many authors on qualitative research lay an equal emphasis on the importance of empiricism as the foundation for any investigation (Bryman & Bell, 2003).

The focus of this article is basically on quantitative research. It starts by briefly distinguishing among deduction and induction, quantitative research and qualitative research, pure and

applied research. Afterwards, the article proceeds towards describing the basic research process in form of series of steps followed by a brief description of each of the steps. In every step of the research explained in the article, the researcher is warned about important considerations he should take into account in order to execute and complete a successful research project.

### **Deduction and Induction**

In any field of research, a researcher has to understand general tone of research and the direction of logic which is guided by either of the two approaches – deduction and induction.

A general distinction made between the two logical paths to knowledge is that *induction* is the formation of a generalization derived from examination of a set of particulars, while *deduction* is the identification of an unknown particular, drawn from its resemblance to a set of known facts (Rothchild, 2006). Simply speaking, it can be said that deduction is a process which goes from general to specific while induction is a process which goes from specific to general (Decoo, 1996). In deduction, researchers use “top down” approach where conclusions follow logically from premises and in induction, researchers use “bottom up” approach where conclusion is likely based on premises (Burney & Mahmoud, 2006). However, deduction contains an element of induction and the inductive process is likely to contain a smidgen of deduction (Bryman & Bell, 2003).

### **Quantitative and Qualitative Research**

Quantitative research relies on deductive reasoning or deduction (Sekaran & Bougie, 2010) and makes use of variety of quantitative analysis techniques that range from providing simple descriptive of the variables involved, to establishing statistical relationships among variables through complex statistical modelling (Saunders et al., 2009). Quantitative research calls for typical research designs where the focus of research is to describe, explain and predict phenomena, uses probability sampling and relies on larger sample sizes as compared to qualitative research designs (Cooper & Schindler, 2006). By using particular methodologies and techniques, quantitative research quantifies relationships between different variables. In quantitative research, involving two variables, for example, the aim of researcher is to study the relationship between an independent (predictor) variable and a dependent (criterion) variable in a population (Hopkins, 2000).

In comparison to quantitative research, qualitative research uses inductive reasoning (Sekaran & Bougie, 2010) and aims to acquire an in-depth understanding of human behaviour and the reasons of occurrence of that behaviour. Qualitative research can also be called as interpretive research as its primary objective is not generalization but to provide deep interpretation of the phenomena (Cooper & Schindler, 2006). It is used in many academic disciplines such as social sciences, and market research (Denzin & Lincoln, 2005) particularly where the objective is to probe in human behaviours and personalities. Given unique purposes of qualitative research, it adopts typical research designs, uses non-probability sampling, relies on smaller samples (Cooper & Schindler, 2006), and uses different data collection and analyses techniques as compared to quantitative research (Neuman, 2005).

Certain research problems call for combining both quantitative and qualitative methodologies. Researcher might adopt therefore, mixed methods approach where both quantitative and qualitative data collection techniques and analytical procedures are used in same research design (Saunders et al., 2009).

A good researcher chooses to go for quantitative or qualitative or sometimes, a combination of the two types of researches based on his problem statement and the study objectives.

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## **Types of Research: Pure and Applied Research**

Research at broader level is divided into two categories: pure and applied. Applied research has a practical problem-solving emphasis (Neuman, 2005). In business research, it may help managers and researchers to reveal answers to practical business problems pertaining to performance, strategy, structure, culture, organizational policy and the like. Pure or basic research is also problem solving, but in a different sense. It obtains answers to questions of a theoretical nature and adds its contribution to existing body of knowledge (Sekaran & Bougie, 2010). Thus, both applied and pure researches are problem based, but applied research helps managers in organizational decision making.

## **The Research Process**

*Typically a research process consists of following steps (Cooper & Schindler, 2003):*

- Identification of the problem.
- Defining the management question and the research question(s).
- Conducting exploratory study (if required), to clarify the problem and/or to refine management question/research question(s).
- Developing a research proposal.
- Outlining a research design specifying type, purpose, time frame, scope, and environment of research.
- Developing an instrument for data collection and conducting pilot study to test the instrument for validity and reliability.
- Data collection (through observation, experiments, or surveys – the choice of data collection method depends on nature of study).
- Data Analysis.
- Reporting research results.

Although research process is outlined in form of sequence above but in actual it is quite muddled and a researcher may be required to simultaneously work on more than one aspects at a time and revisit some of the steps (Saunders et al., 2009). Therefore, given the uniqueness of every research activity, factors like; time period and money required for the research, and problems faced by the researcher would vary among different research projects.

As explained before, the focus of this paper is more on how to conduct a good quantitative research. The following portions of the article will be discussing important considerations that a researcher must deal with while conducting quantitative research.

## **Literature Review**

The first task for any researcher undertaking research activity is selecting a topic and going for literature review. Literature review is not only about gaining knowledge regarding what past studies have contributed to a particular topic of study (Neuman, 2005), but it should entail element of critical reading and analysis to help reader understand about contributions and limitations of previous researches (Saunders et al., 2009).

There can be two main purposes of literature review:

1. The first one is to gain awareness of the knowledge of certain field or topic: Researcher must be able to understand well, contributions of past researches towards theories, their strengths and weaknesses (Cooper & Schindler, 2006) and the links between different areas or theories pertaining to his field of knowledge.

2. Second is to provide a base or logic for doing further research on the topic. Researcher must analyse the literature critically and come out with a problem statement to develop research questions and hypotheses for his study (Sekaran & Bougie, 2010). He should be able to explain why conducting a particular research will be useful and what it would contribute to the body of knowledge.

Therefore, any research, whether quantitative or qualitative, starts with a problem statement which can only be developed through comprehensive literature review. Literature review enables researcher to identify research gaps and helps him develop problem statement for his study which further leads towards development of research questions and research objectives (Sekaran & Bougie, 2010). Usually a researcher has certain theory regarding the topic of investigation. Based on this theory certain hypotheses are proposed which later on must be tested and proved to be either true or false.

### **Developing Research Problem**

Based on above discussion we can argue that if anyone asks a question: “Is research always problem based?”. The answer must be “yes” (Cooper & Emory, 1994). Research is always conducted to know the unknown. If there is no problem, there is no need to conduct research. Formulating a research problem is perhaps most difficult aspect of any research project. A problem statement describes discrepancy between ‘what is’ and what ‘ought to be’ and represents a knowledge gap which needs to be filled (Bwisa, 2008). According to Tejero (2007), a good problem statement:

- Provides motivation to researcher and is interesting enough for him to conduct a research.
- Is useful for concerned people in the field. A researcher should select an area of investigation so that he could share benefits of his research work with concerned people in his field.
- Is unique. It really contributes to existing body of knowledge (in case of pure research).
- Requires unique and complex research design addressing particular data collection methodology and sampling technique etc.
- Is feasible to be researched in a given time frame.
- Doesn't call for unethical practices in any stage of research project.

### **Research Questions and Hypotheses**

After formulating statement of the problem, a researcher moves towards outlining his research questions and developing research hypotheses. According to Ohab (2010), research questions and hypotheses provide a sound conceptual foundation for a research project. According to Stuermer (2009), developing research questions is the most important task in your research project as it influences every aspect of your research including; theory to be applied, method to be used, data to be gathered and unit of analysis to be assessed etc. Well thought out research questions provide focus to a researcher and determine what, when, where and how the data will be collected and provide an important link between conceptual and logistic aspects of research project (Ohab, 2010).

In a good research project, hypotheses flow naturally from the research questions formulated. Hypotheses testing starts with an imaginary statement about population parameter and is a procedure based on sample evidence and probability theory to determine whether the

hypotheses is right or wrong (Lind, Marchal & Wathen, 2008). The number of hypotheses formulated in a study depends on the number of relationships being studied and the overall complexity of research framework. According to Cooper and Schindler (2006), a good research hypothesis fulfils three conditions:

1. ***It is adequate for its purpose.*** It means that the hypothesis depicts original research problem, explains whether the research study is descriptive or explanatory (causal), indicates suitable research design for the study and provides the framework for organizing the conclusions that will result.
2. ***It is testable.*** It means that hypothesis requires acceptable techniques, reveals consequences that can be deduced for testing purposes and needs few conditions or assumptions.
3. ***It is better than its rivals.*** It means that the hypothesis is what the experts believe is powerful enough to reveal more facts and greater variety or scope of information than its competing hypothesis.

Once a researcher outlines his research questions and formulates hypotheses, he proceeds towards selecting his research design.

### **Research Design**

The statement of the problem, research questions and research objectives will call for a specific *research design* (Saunders et al., 2009). Research design addresses important issues relating to a research project such as purpose of study, location of study, type of investigation, extent of researcher interference, time horizon and the unit of analysis (Sekaran & Bougie, 2010). Research designs, however, will vary from simple to complex depending on nature of the study and the specific hypotheses formulated for testing. Certain designs will ask for primary data and others for secondary data. Some research designs may require researcher to collect primary as well as secondary data. Moreover the data collection modes will be different for different researches. Some researches will require observation; others may rely on surveys, or secondary data (Zikmund, 2000). Some researches will call for experiments, where based on the results of the experiment, the theory on which the hypotheses and predictions were based will be accepted or rejected (Goodwin, 2005). Research design sets the scope of the study specifying whether it needs to be *descriptive, explanatory (or causal) or predictive*. It is important for a researcher to be familiar with the differences between the major research designs like experimental, cross-sectional, longitudinal, case study and comparative (Bryman & Bell, 2003). Hence a researcher must be very careful while selecting research design as it will dictate overall plan and technology of research project.

### **Variables**

According to Cooper and Schindler (2003), descriptive study mostly seeks answers to *who, what, when, where* and *sometimes how* questions and explanatory study seeks answers to *how* and most importantly '*why*' questions. Explanatory study is also called causal study because it seeks to study *cause and effect* relationship between different variables in the study.

According to Zikmund, Babin, Carr and Griffin (2009), there can be number of variables in a research study among which a researcher may want to study relationships such as:

- Independent variable(s)
- Dependent variables(s)
- Moderating variable(s)
- Mediating variable(s) and

- Extraneous variable(s)

An independent variable is the predictor variable which is supposed to be the cause of change in the dependent variable (criterion variable). In a hypothetical relationship between advertising expenditures and sales growth, for example, 'advertising expenditures' is independent variable, whereas 'sales growth' is dependent variable. A moderator variable or moderator is one that has a strong contingent effect on the relationship between independent and dependent variable (Sekaran & Bougie, 2010). In statistical terms, the effect of a moderating variable on the relationship between independent and dependent variable is termed as interaction (Cohen, Cohen, West & Aiken, 2002). In the relationship between advertising expenditures and sales growth, for example, 'type of media' may be considered as moderating variable.

A mediating variable, also called as mediator or *intervening variable* is one that provides a causal link between independent and dependent variable (Sekaran & Bougie, 2010). In the relationship between advertising expenditures and sales growth, for example, 'product awareness' may be considered as mediating variable.

It is important for a researcher to understand the nature of variables in his study and how to measure those variables. Measurement of variables may be easy or difficult depending upon their complexity. A variable may be uni-dimensional (concept) such as age or occupation, or multi-dimensional (construct) such as personality, job stress or motivation and for the measurement of later, researcher needs to develop *operational definitions* (Cooper & Schindler, 2006). Once a researcher develops hypotheses or lists research questions, he has a clear idea about the related variables in his research activity. Equally important for researcher is to know that how the variables will be measured and what sort of data he will collect regarding each of the concerned variables. The data may be nominal, ordinal, interval or ratio.

According to Zikmund et al. (2009):

- A ***nominal scale*** is one in which letters or numbers assigned to objects, people or places only help us in their identification, or categorization, e.g. gender, employment status.
- An ***ordinal scale*** is one that arranges objects, people or places according to their magnitude in a particular order, e.g. students' academic status in a college: freshman, sophomore, junior and senior.
- An ***interval scale*** is a scale that not only arranges objects, people or places according to their magnitude in a particular order, but also distinguishes this ordered arrangement in *units of equal intervals* e.g. the temperature scale (thermometer). However, interval scale does not have a natural zero.
- A ***ratio scale*** is a scale that possesses all the characteristics of above scales and also has an absolute (natural) zero e.g. salary, sales.

Usually a researcher will obtain more than one type of data for his purpose. It is important to understand the nature of data as it determines the type of analysis that can be conducted.

## **Sampling**

The foremost objective of quantitative research is to generalize. In every quantitative research, it may not be possible for the researcher to study the whole population of interest. To get information about population of interest and to draw inferences about the population, researchers use *sample* which is a subgroup of the population (Lind et al., 2008). By using sample, researchers save lot of time and money, get more detailed information, and they are

able to get information which may not be available otherwise (Bluman, 2009). Although there are number of sampling methods to use but the choice of right method is dictated by the nature of study and the specific research questions and hypotheses. Researchers can select from broad categories of probability and non-probability samples. Following probability sampling methods are available to a researcher.

- ***Simple random sampling***

Simple random sampling involves researcher to select a sample at random from the sampling frame using either random number table manually or on computer, or by an online number generator (Saunders et al., 2009).

- ***Systematic random sampling***

In systematic sampling, researcher begins sampling with a random selection of an element in the range of 1 to k and then every k<sup>th</sup> element in the population is selected as sample (Cooper & Schindler, 2006). The k<sup>th</sup> element or skip interval is calculated as:

$$k = \text{skip interval} = \text{population size} / \text{sampling size}$$

- ***Stratified random sampling***

Stratified random sampling involves process of stratification (different strata are made on the bases of different factors such as life stages, income levels, management level etc.) and a random sample is then drawn from each stratum (Sekaran & Bougie, 2010). Additionally, a stratum is homogenous from within but heterogeneous with other strata.

- ***Cluster sampling***

In cluster sampling, population is divided into clusters (a cluster is a natural aggregation of elements in a population) and then randomly some clusters are drawn from the group. In a selected cluster, all elements may be selected for study or a random sample can be further drawn from the cluster (Sekaran & Bougie, 2010).

Accordingly, following non-probability sampling methods are available to researcher.

- ***Convenience sampling***

In convenience sampling (also known as haphazard or accidental sampling), a sample of units or people is obtained, who are most conveniently available (Zikmund, 2000).

- ***Judgment sampling***

Judgment sampling (also called as purposive sampling) requires researcher to use his personal judgment to select cases that he thinks will best answer his research questions and meet his research objectives (Saunders et al., 2009).

- ***Quota sampling***

Quota sampling is a sort of stratified sampling but here, the selection of cases within strata is purely non-random (Barnett, 1991).

- ***Snowball sampling***

Snowball sampling (also known as network chain referral, or reputational sampling), based on the idea of rolling snowball is where one or few people are initially sampled and then the sample spreads out on the basis of links to initial people (Neuman, 2005).

## **Validity and Reliability**

A research design calls for a particular data collection methodology. In a research study, the data can be collected through surveys (interviewing, questionnaires), observation or experiments (Cooper & Schindler, 2003). The data to be collected may be primary or secondary or both (Sekaran & Bougie, 2010). If the research study requires researcher to

collect primary data, then one of the most important task waiting for him is to develop an *instrument*. Instrument development can be time consuming process and it may contain several important issues. One of the important aspects of instrument development is checking for its validity and reliability through pilot testing (Saunders et al., 2009).

Reliability and Validity examine the fitness of measure. According to Whitelaw (2001), reliability and validity can be conceptualised by taking chocolate cake recipe as an example. He says that:

*“Reliability suggests that any person, provided that they follow the recipe, will produce a reasonable chocolate cake, or at least something that you can identify as a chocolate cake. Validity suggests that if the recipe includes chocolate, then the cake will look like a chocolate cake, smell like a chocolate cake and taste like a chocolate. That is, - the proof is in the pudding. When we think it in this way then it becomes clear that a measurement device must first be reliable and then it must be valid. In other words, you have to be confident that what you get is consistently reproducible (i.e. the recipe consistently produces something like a cake). Once you are confident in the consistency of the output, then you can scrutinise it to assess whether it is what it purports to be (ie. a chocolate cake)”.*

Based on the above example, we can say that reliability is the degree to which a measure is free from *random error* and therefore gives consistent results. It indicates internal consistency of the measurement device. It refers to the accuracy and precision of a measurement procedure (Thorndike, Cunningham, Thorndike, & Hagen, 1991) and can be expressed in terms of stability, equivalence, and internal consistency (Cooper & Schindler, 2003).

**Stability** is the extent to which results obtained with the measurement device can be reproduced. Stability can be assessed by administering the same measurement device to the same respondents at two separate points in time (Zikmund, 2000). This is called test-retest method. However, as Zikmund (2000) elaborates, there are problems associated with this method. The first measure may sensitize the respondents and may influence the results of the second measure. Results may also suffer due to inadequate time between test and retest measures.

**Equivalence** shows the degree to which alternative forms of the same measures are used to produce the same or similar results (Cooper & Schindler, 2003).

**Internal Consistency** is the extent to which items in a scale or measurement device are homogeneous and reflect the same underlying construct (Cooper & Schindler, 2003). Most commonly used method to evaluate internal consistency is Cronbach's Coefficient Alpha (Cronbach, 1951). Most of the survey instruments use Likert-type scale and it is important to calculate Cronbach's alpha when researcher decides to use this type of scale. If one doesn't report Cronbach's alpha, the reliability of the items is considered to be low or unknown.

Alpha coefficient ranges in value from 0 to 1 and may be used to describe the reliability of factors extracted from various types of questionnaires or scales. The higher the score, the more reliable the generated scale is (Delafrooz, Paim & Khatibi, 2009). According to Nunnaly (1978), Cronbach's alpha score of 0.7 is considered to be acceptable reliability coefficient.

**Validity** is the extent to which a score truthfully represents a concept. Simply speaking, it is the accuracy of measurement device and represents the ability of a scale to measure what it is intended to measure (Cooper & Emory, 1994; Zikmund, 2000). Validity is expressed in two types: External and Internal (Saunders et al., 2009). External validity is about generalization and internal validity ensures that a researcher's research design closely follows the principle

of cause and effect. While administering any measurement device a researcher must ensure that his device has *face validity*, *content validity*, *criterion validity* and *construct validity* (Neuman, 2005).

*Face validity* is the extent to which a measure apparently reflects the content of the concept in question. A researcher must establish face validity if an instrument is being developed for the first time. Face validity can be ensured by obtaining subjective judgments by the experts of the concerned field (Bryman & Bell, 2003).

*Content validity* is closely related to face validity. It makes sure that a measure includes an adequate and representative set of items to cover a concept. It can also be ensured by experts' agreement (Sekaran, 2003)

*Criterion Validity* is the degree of correlation of a measure with other standard measures of the same construct (Zikmund, 2000). It has two types: concurrent validity and predictive validity.

*Concurrent Validity*: In concurrent validity, the researcher employs a criterion on which cases (individuals, organizations or countries, for example) are known to differ and that is relevant to the concept in question (Bryman & Bell, 2003).

*Predictive Validity*: is the extent to which new measure is able to predict a future event. Here the researcher uses a future criterion instead of contemporary one. (Bryman & Bell, 2003)

*Construct Validity* is the degree to which a measure/scale confirms a network of related hypotheses generated from theory based on the concepts (Zikmund, 2000). It has two types: *convergent validity* and *discriminant validity*

*Convergent validity* results when two variables measuring the same construct highly correlate (Straub, Boudreau & Gefen, 2004)

*Discriminant Validity*. A device has discriminant validity if by using similar measures for researching different constructs results into relatively low inter correlations (Cooper & Schindler, 2003).

Apart from ensuring validity and reliability of measurement device, a researcher must resolve other issues in the process. There are number of decisions to be taken while designing the measurement device (Cooper & Schindler, 2003) such as:

- Variables to be studied about the respondents based on the study objectives.
- Response form; where researcher can use rating scales, ranking scales, categorization scales or combination of these. A researcher can use variety of rating scales based on his study's objective such as single category or dichotomous scale, multiple choice scale, checklist scale, Likert-scale, semantic differential scale, stapel scale. Similarly researcher can use variety of ranking scales such as paired comparison scale, forced ranking scale, and comparative scale.
- Number of dimensions to be studied.
- Nature or type of data to be obtained – nominal, ordinal, interval or ratio.
- Scale construction.

There are number of questions which a researcher needs to ask himself while designing a measurement scale (Cooper & Schindler, 2003) such as:

- Does the question need to be asked?
- Can the question be answered?
- How to frame the items?

- Which response strategy to select?
- How to compile the items?
- How to conduct pilot testing?

While developing questionnaire, researcher has to avoid asking biased questions, using confusing words, asking double-barreled questions, using double negatives in questions and ordering questions improperly (Bluman, 2009). One can use Item Analysis technique to evaluate the questionnaire.

### **Data Analysis**

When the researcher is finished with the data collection, he has to start data analysis which again involves numerous issues to be answered. Importantly, the data should be accurate, complete and suitable for further analysis (Sekaran & Bougie, 2010). Researcher has to record and arrange the data and then apply various descriptive and inferential statistics or econometrics concepts to explain the data and draw inferences (Saunders et al., 2009). Selection of inappropriate statistical technique or econometrics model may lead to wrong interpretations. This may in turn result in failure to solve the research problem and answer research questions. The researcher's task is incomplete if the study objectives are not met.

### **Factor Analysis**

One of the important tools in data analysis is the Factor Analysis. In most of the empirical researches, there are number of variables that characterize objects (Rietveld & Van Hout, 1993). In social sciences, research may involve studying abstract constructs such as personality, motivation, satisfaction, and job stress. In study of mental ability for example, questionnaire could be very lengthy as it would aim to measure it through several sub tests, like verbal skills tests, and logical reasoning ability tests (Darlington, 2004). In a questionnaire, therefore, there can be number of variables measuring aspects of same variable thus making the study complicated. In order to deal with these problems, factor analysis was invented. Factor analysis attempts to bring inter-correlated variables together under more general, underlying variables. Hence, the objective of factor analysis is to reduce the number of dimensions to limited number explaining a particular phenomena or variable (Rietveld & Van Hout, 1993).

Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) are two techniques a researcher can use to conduct his analysis. According to DeCoster (1998), the basic purpose of EFA is to find out the nature of constructs which are influencing a particular set of responses while the purpose of CFA is testing whether a particular set of constructs is influencing responses in a predicted way.

DeCoster (1998) suggests following steps to perform EFA:

1. Collect measurements
2. Obtain the correlation matrix
3. Select the number of factor for inclusion
4. Extract your initial set of factors
5. Rotate your factors to a final solution
6. Interpret your factor structure
7. Construct factor scores for further analysis

Similarly DeCoster (1998) has specified following steps to perform CFA:

1. Define the factor model
2. Collect measurements

3. Obtain the correlation matrix
4. Fit the model to the data
5. Evaluate model adequacy
6. Compare with other models

Hence EFA and CFA are powerful statistical techniques and a researcher must determine the type of analysis before answering his research questions (Suhr, 2006).

Another technique for similar purpose which is often confused with Exploratory Factor Analysis is *Principal Component Analysis (PCA)*. According to DeCoster (1998), EFA and PCA are different statistical techniques and produce different results when applied to same data. He asserts that both are based on different models and the direction of influence between 'components' and 'measures' are different and that in EFA we assume that the variance caused in the measured variables can be separated for common factors and for unique factors, whereas; in PCA, the principal components developed include both common and unique variance. In conclusion, we conduct EFA when we want to extract certain factors or constructs which are responsible for particular set of responses while we use PCA when the purpose is simply to reduce data.

Furthermore, depending upon the nature of data, researcher can make use of other advance statistical techniques as well such as discriminant analysis, cluster analysis, and time series analysis.

### **Use of Other Descriptive and Inferential Statistics**

According to Lind et al., (2008), researchers can use number of other descriptive statistics concepts to explain data such as frequency distributions or cumulative frequency distributions, frequency polygons, histograms, various types of charts like bar charts & pie charts, scatter diagrams, box plots etc.

Researcher can make inferences and draw conclusions based on inferential statistics. Two main objectives of inferential statistics are (1) to estimate a population parameter and (2) to test hypotheses or claim about a population parameter (Triola, 2008). Researcher has to carefully select between varieties of inferential statistics techniques to test his hypotheses. For example, based on whether the researcher is using sample or census, he has the choice of using either t-tests or z-tests (Cooper & Schindler, 2006). In hypotheses testing, depending upon the number and nature of samples, researcher has to decide among using either one sample t-test, or two sample (independent or dependent) t-tests, or doing ANOVA/MANOVA (Lind et al., 2008).

In explanatory or causal study, researcher must rely on statistical or econometrics techniques having the ability to test correlation or cause. *Pearson Coefficient of Correlation* is the most commonly used measure of finding correlation between two or more variables. A correlation exists between two variables when one of them is related to the other in some way (Triola, 2008).

Formula to compute Linear Correlation Coefficient is:

$$r = \frac{\sum(X - \bar{X})(Y - \bar{Y})}{(n - 1)s_x s_y}$$

The value of  $r$  always lies between  $-1$  and  $+1$  inclusive. If it lies near to  $-1$ , it shows a strong negative correlation but if it lies near to  $+1$ , it shows a strong positive correlation.

**Regression and Multiple Regression:** Regression models can be used in an explanatory study where researcher is interested in predicting the value of dependent variable based on the value of independent variable. Researcher can use simple linear regression, if the number of independent variables in the study is only one while in case of more than one independent variables in the study, researcher has to make use of multiple regression models (Lind et al., 2008). Importantly however, regression doesn't assume causation (Gujarati & Porter, 2008).

A general multiple regression equation can be expressed as:

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

According to Triola (2008), following *cautions* can be adopted while using regression equations:

- Don't use the regression equation if there is supposed to be no linear correlation between the variables. Sometimes the relationship between independent variable and dependent variable is curvilinear. In those cases other techniques must be used.
- Stay within the scope of the available sample data when using the regression equation for predictions.
- A regression equation based on old data may not necessarily be valid later on.
- Don't make predictions about a population that is different from the population from which the sample data were drawn.

As discussed before, researcher's conceptual framework might involve number of variables such as moderating variables, mediating variables and extraneous variables. *Moderated Regression Analysis* can be used for studies involving moderating variables(s). Therefore, a researcher has to pick the right tool for operating his framework.

### **Use of Softwares**

As discussed before, researcher must carefully select among the right statistical, mathematical and econometric tools most suitable for the type of analysis he wants to do on his data (Lind et al., 2008). While at the data analysis, a good researcher never emphasizes quantity of analysis but quality. He must conduct all the analysis sufficient enough to provide required interpretations and conclusions as required by study objectives. The advent of many software packages, particularly relating to regression and other econometric techniques, such as SPSS, SAS, STATA, MINITAB, ET, LIMDEP, SHAZAM, Microfit and others have made it easy for the researcher to work on the analysis part of his research project (Gujarati & Porter, 2008).

### **Conclusion**

Good quality research requires a researcher to follow scientific approach. Researcher must follow scientific method in conducting literature review, identifying research gaps, writing problem statement & outlining research questions and research objectives. Researcher must carefully select among different research designs, the selection of which depends on specific research questions and the overall objectives of the study. Decisions like choosing among data collection methods and sampling techniques require researcher to exercise logical reasoning and thought. This applies to all forms of research whether pure or applied,

quantitative or qualitative. It is only through applying this logical thought and the scientific method that researcher can enhance accuracy of his research. Quantitative research is about making generalizations. It requires researcher to pick suitable research design, understand well his variables, select most appropriate sampling method, ensure validity and reliability of his instrument, go for right data collection method and perform most appropriate data analysis techniques to arrive at powerful conclusions.

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