Statistical Tools and Analysis in Human Resources Management

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Detailed Table of Contents

Every field of study generates a huge amount of data. The volume of data generated leads to information overload, and the ability to make sense of all these data is becoming increasingly important. This requires a good understanding of the data to be analyzed and different statistical techniques to be used in that context. On the basis of the issues important to the data set as well as other practical considerations, it is necessary to select appropriate methods to apply to the problem under study. This work focuses on different issues arising in the context of data analysis which need attention like understanding classifications of data, magnitude of errors in measurement, missing observations in the data set, outlier observations and their influences on the conclusion derived from the data, non-normal data, meta analysis, etc. In the process of discussion some examples have been included to illustrate how critical a data analysis procedure could be in order to make a meaningful decision from a data set.

The appropriate use of data-gathering tools and statistical analysis is a formidable challenge in several domains of HRM research. The application of Brunswik's lens mode offers an innovative strategy in this context. Brunswik's lens model is presented and its procedural application as suggested by Hammond in terms of social judgment theory is elaborated. A broad range of application domains including multiple-cue learning, cognitive conflict, policy formation and social issues is described. Studies carried out in Indian context are reviewed. The immense possibility of application in HRM domain is indicated. The idiographic-statistical elements are pointed out. It is asserted that the application of lens model in HRM research would pave the way for greater elegance and expansion of research.

Application of statistics in HR research has been briefly explained in our introductory chapter. It is now acknowledged, with statistics, we can ensure our HR research is more effective. Such research results can also help to take critical HR decisions at organization level. In this chapter, we have discussed on application of statistics in HR research in two critical areas, i.e., human resource planning (HRP) and performance management. Both in HRP and performance management, we can make extensive use of various mathematical, econometric, and statistical tools. Also, we have many established models. However, here our focus is restricted to only some of the simple statistical tools that can help in research in this two-critical human resource management areas. As the purpose of this chapter is to explain use of statistics in two major areas of HR research, it will cover only some selected areas of application. At the outset focus is on the specific research nitty-gritty, as these may help prospective researchers to get their basics clear, before they proceed for research in HRP and performance management areas.

Recruitment and selection processes focus on the acquisition of suitable human resources. Recruitment refers to the firm's efforts to attract the maximum number of minimally-qualified applicants while selection refers to the firm's efforts to choose competent and suitable candidates. The parameters for identifying minimally-qualified candidates come from job analysis. Statistical processes used in recruitment include summing the scores on different parameters; finding mean scores of applicants and rejecting candidates with scores below the cutoffs. The selection procedure focuses on designing tests that identify superior talent from the candidate pool. Statistical procedures used in selection include development of scales for capturing competencies, measuring the reliability of the scales, that is, how well they capture the underlying construct, measuring the validity of the scales, that is, how well the competencies relate to job performance and optimal combination of the selection instruments.

Compensation and Benefits continues to be the most researched field with more than thousand academic studies. Given the extensive research on Compensation in academia, there has been evolution in approaches to explore and keep pace with recent trends along with research methodology and technology. As a Research Scholar, I began to realize that while dominant literature on Compensation and Benefits favoured quantitative research to study its impact on organizational outcomes such as performance, turnover, job satisfaction, commitment, etc., both qualitative and quantitative research are needed to be able to study and explore unexplored areas of the said field. The book chapter will elaborate the specific applications of qualitative and quantitative statistical applications in Compensation Research with relevant basic examples. I am hopeful that the book chapter will be of use to academics, researchers and students focusing their studies and research on Compensation and Benefits.

The aim of this chapter is to provide quantitative techniques and guidance for analyzing different problems related to the measurement of diversity and inclusion practices present in organizations. The example of only one dimension of diversity; viz Gender diversity is given in this chapter. However, these Quantitative tools can be used to explore other facets of diversity as well. In this way, this chapter shall seek to provide a basic understanding of how to analyze and study the data collected for research on Diversity and Inclusion practices in organizations.

Employee engagement refers to a condition where the employees are fully engrossed in their work and are emotionally attached to their organization. An "engaged employee" is one who is fully involved in, and enthusiastic about their work, and thus will act in a way that furthers his/her organization's interests and productivity. There is a clear and mounting evidence that employee engagement keenly correlates to corporate performance in areas such as retention, productivity, customer service and loyalty. This timely treatment provides a comprehensive framework, language, and process that genuinely connects People Strategy with Business Strategy. Aimed at HR Professionals and People Managers, this chapter offers a complete, practical resource for understanding, measuring and building engagement with the use of data. Grounded in engagement theory and an understanding of psychology combined with practical tools, techniques and diagnostics this will help professionals make better and more informed decisions across the Engagement, Retention and People Satisfaction space.

The aim of this paper is two aspects: to provide an overview of organizational wellbeing (OW) research; to present a new model of OW focusing on successful outcomes and its operationalization of the construct and the recommendations for future. A summary literature review of the OW literature, focusing on organizational well-being and its possible consequences. The literature is used to develop and propose a new model of OW and its success indicators. Testable relationships are proposed between these indicators. The research model has not been tested empirically. It is an external representation, is a new and untested concept in the OW literature. The paper provides a model that leaders, managers and newcomers may find useful to successfully establish the OW process. The model proposed is novel and raises the important issue of appropriate OW success indicators. New propositions are made regarding relationships between antecedents and output variables.

HR business partner, Business Excellence are some buzzwords in the industry nowadays. Profitability and efficiency are being driven through various strategic initiatives aligned to the vision of the organization. Customer satisfaction is now being replaced by customer delight. Organizations are taking steps ahead of voice of customer. The consumer insights are thoroughly analyzed and interpreted. Data analytics is not restricted to only finance and operation functions but are widely used across the support functions along with line functions. Human resource is now considered as an asset. Organizations are also trying to find out ways to capitalize the full potential of human asset. Various tools and methodologies are paving its way to bring efficient human resource management practices. Six Sigma is one of the tools, which is booming into the application space of Human Resource Management. Six Sigma is being considered as a business process and is helping the in shaping and improving their bottom line by designing and monitoring various activities to reduce the defects.

Preface

Human resource management (HRM) function has now emerged as a strategic and business function, from the normative approach of management of organizational human resources. Even most of the definitions of HRM centered around such normative approach. With the extended scope of HRM function, HRM research has now become important. HRM research does not just fulfil our academic inquisitiveness, it even helps HR managers to take critical HR decisions at organizational level. Over the years we see increasing dependence on HR analytics and predictive analytics for HR decision making. HR managers often see it as an automated process of decision making, without understanding how they get the results through data analysis. With basic knowledge of statistics, such problems can be resolved.

Use of statistics, statistical tools, and statistical models in HRM of late has increased because of HR analytics and predictive HR decision making. We have many HR analytics solutions, which are capable to churn HR data into HR information and even capable to develop suitable algorithm that can help HR managers to take decisions guarding against possible errors. Even statistical modeling based on HR information can help in designing predictive decisions for managing HR in future. Despite its tremendous importance, we find HR managers and so also HR students (future HR managers) fail to make best use of technology support like; HR analytics, Predictive analytics, etc. for poor knowledge in statistics, and its application. Obviously, this book can meet this gap with the detailing of application of statistics in every sphere of HRM functions/activities. The book will meet the demands both for the HR professionals and HR students.

This book is primarily intended to elaborate on the application of statistics in HRM research in simple and lucid form, specifically focusing on some of the important HRM areas. Use of statistics can make HR research process more scientific and authentic. While doing HRM research, it is important for a researcher to select appropriate statistical tools and statistical tests. Selection of statistical tests depends on data type, sample characteristics, and inferences. Similar attention is needed in understanding number of variables and groups, normality of data, hypothesis or research question, etc. Even for further strengthening of HRM research results, HR analytics and Predictive analytics can be used meaningfully, when HR managers understand basic statistics. HRM research may be conducted for transactional HRM activities, business-aligned HRM activities, tactical and strategic HRM activities. Also, HRM research helps organization in framing policies and embracing suitable HRM practices to achieve business excellence and long-term sustainability. Some of the important areas of HRM research are; performance management, human resource planning and recruitment and selection, compensation management, diversity management issues, leadership, organizational culture, talent management, etc. In this book, we have discussed on all these areas, collating inputs from various scholars who are known in their areas of research.

The book is divided in 11 chapters. Each chapter focuses on specific areas of HRM research.

Chapter 1 is on 'Introduction to HR Research Using Statistics' by Dipak Kumar Bhattacharyya. The chapter highlights the importance of organizing and summarizing data with the use of different statistical tools and methods for HR research. In day to day HR decision making, we need statistics. For example, to analyze the trend in employee attrition, HR managers can analyze the time series data and relate with prevalent HR practices for better understanding of the problem and effective decision making. Even with published data from secondary sources, HR managers can take decisions, and so also a HR researcher can frame suitable hypothesis for getting deeper insights on specific research issue. In all HR functions, we see use of statistics can help. While for some HR researcher statistics help in finding answer to a research issue or a problem; for HR manager statistics can help in taking critical HR decisions with minimum chances of error. Thus, statistics promotes fact based approach in HR research and HR decision making. This introductory chapter discusses issues like; basic statistical methods and tools for data analysis, quantitative and qualitative research, parametric and non-parametric statistical tests, ethical issues on HR research, etc.

Chapter 2 is on 'Application of Statistics in Human Resource Management' by Roma Puri and Pooja Sengupta. The chapter first explains how HRM function shifted from intuitive to quantitative decision making, embracing statistical techniques and evidence-based approach. Some of the basic and applied statistical techniques, now used in organizations, have been outlined in this chapter. Historically, HR decisions were based more on personal judgment, intuition and experience and hence were very subjective in nature. This did not help HR to become more credible and also did not recognize HR's contribution to organizational value chain. HRIS, HR metrics, dashboards, HR Scorecard, and subsequently statistics could gradually make HR function more important in the organization.

Chapter 3 is on 'Uncovering Data for Decision Making With Critical Statistical Analysis' by Soma Roychowdhury and Debasis Bhattacharya. Data are lifeblood of every science, and it is through data we can have the scientific understanding of the events happening around us. All fields of study gather and store data, so also human resource management, for making optimum decisions based on the information collected. The chapter deliberates the need for data analysis using different statistical techniques for effective decision making. However, while doing so, it is important to understand classifications of data, magnitude of errors in measurement, missing observations in the data set, outlier observations and their influences on the conclusion derived from the data, non-normal data, meta analysis etc. In the process of discussion, the chapter includes some examples to illustrate how critical a data analysis procedure could be in order to make a meaningful decision from a data set.

Chapter 4 is on 'Application of Lens Model in HRM Research: An Effective Tool for Measurement and Analysis' by Fakir Mohan Sahoo. The chapter acknowledges use of appropriate date gathering tools and statistical analysis is a formidable challenge in HRM research. A basic problem in social and behavioral research concerns measurement and analytic tools. While measurement of relevant variables is generally carried out in the form of questionnaires, survey instruments and psychometric tests, the scientific rigor demands that two fundamental requirements be met. First, the tools must have culture-specific meaningfulness. Second, the measuring devices must have equivalence across groups or cultures. Cross-cultural investigators term it emic-etic dilemma. The recent emphasis on globalization with its catchy slogan "think globally and act locally" has stressed scientific efforts to look for novel ways of dealing with this emic-etic dilemma. Lens model offers immense possibilities to meet challenges in this direction. In this chapter lens model is presented and its procedural application in terms of social judgment theory is elaborated. A broad range of application domains including multiple-cue learning, cognitive conflict, policy formation and social issues is described. Studies carried out in Indian context are reviewed. The immense possibility of application in HRM domain is indicated.

Chapter 5 is on 'Application of Statistics in HR Research' by Dipak Kumar Bhattacharya. It is now acknowledged, with statistics, we can ensure our HR research is more effective. Such research results can also help to take critical HR decisions at organization level. The chapter discusses on application of statistics in HR research in two critical areas, i.e., human resource planning (HRP) and performance management. Both in HRP and performance management, we can make extensive use of various mathematical, econometric, and statistical tools. Also, we have many established models. However, here our focus is restricted to only some of the simple statistical tools that can help in research in this two-critical human resource management areas. As the purpose of this chapter is to explain use of statistics in two major areas of HR research, it covers only some selected areas of application. At the outset focus is on the specific research nitty-gritty, as these may help prospective researchers to get their basics clear, before they proceed for research in HRP and performance management areas.

Chapter 6 discusses on 'Statistics for Recruitment and Selection' by Sanket Sunand Dash. Organizations are conventionally defined as a deliberately structured and coordinated activity systems linked to the external environment and consisting of a group of people who come together to achieve a common set of objectives. Organizations source inputs, both human and material, from the environment and exchange outputs, such as goods and services, with the environment. The human resource management function includes the sourcing of employees from the environment and developing them to meet the organizational objectives. The HRM function includes the processes of ascertaining demand for employees and acquiring, training, appraising, and compensating employees. Ascertaining demand is the domain of human resource planning processes and acquiring employees from the external environment, or internally within the firm, falls under the recruitment and selection function. The recruitment and selection processes of a firm usually follow the demand ascertainment or human resource planning (HRP) process.

Chapter 7 is on 'Methodological Considerations for Research in Compensation Management' by Jeeta Sarkar. For management research to progress, it is important for researchers to assess the methods they employ. The impact of management studies depends upon the appropriateness and rigor of the research methods chosen. Design choices about instrumentation, data analysis, and construct validation, and more may affect the types of conclusions that are drawn. Choices about the settings of organizational studies, research designs, and analyses have important implications for the accumulation of knowledge over time. It is found that Compensation research has been largely quantitative and empirical, reflecting the dominant methods. Primary type of data analysis, in compensation research, was mostly carried through univariate and multivariate analyses of variance and covariance and t-tests. Linear regression analyses included simple, multiple, hierarchical, moderated, and mediated regression. Correlation techniques, meta-analysis, and linear techniques for categorical dependent variables (for instance, logistic regression analysis) were found. Factor analytic and clustering techniques included confirmatory factor analysis, multidimensional scaling, and discriminant analysis. Structural equation modeling and path-analytic techniques were combined. The chapter deliberates on the relevant quantitative techniques along with its calculation in SPSS.

Chapter 8 is on 'Measuring the Different Facets of Diversity Using Quantitative Methods' by Gargi Banerjee'. Quantitative methods help to objectively measure and analyze data that have been collected by a researcher through polls, questionnaires, surveys or through pre-existing statistical data. Quantitative research methods focus on using statistical and analytical techniques to solve a particular phenomenon. Data valuation and measurement is central to this research method as it provides the basic connection between that which is empirically observed and its mathematical expression. Usually statistics, different mathematical tools and certain data mining software are used for the measurement of quantitative data. This chapter concentrates both quantitative and qualitative methods to evaluate and analyze diversity and inclusion practices in organizations, with specific focus on gender diversity research.

Chapter 9 is on 'Driving Employee Engagement Through Data Analytics' by Saveeta Mohanty. With recent focus in data-driven analytics, and the resultant improved capabilities in working with huge datasets, strategic planning has become more complex for business units, and subsequently for the People function. Today well-intentioned 'textbook' ideas that are not rooted in data to support their value have no place in modern people practices. Over the last couple of years, data analytics has become a huge buzzword in the business world. Whether this data comes from social networks, analyzing purchase histories, web browsing patterns or surveys, the vast amount of consumer information that brands can gather and analyze has allowed them to improve and personalize their customers' experiences. However, use of data analytics hardly focuses on employee engagement. This chapter explains how data analytics can help employee engagement research.

Chapter 10 is on 'Organizational Well-Being: A New Theoretical Model and Recommendations for Future Research' by Kalpana Sahoo. Well-being plays an important role in a variety of ways. It impacts an employer's approach to traditional benefits and HR policies. But just as important, making employee well-being a priority will have a positive return on the organization's workforce availability and performance, labor-related costs, and output—including innovation, customer service, and quality of products and services. Research undertaken in various social science disciplines supports the adoption of well-being—in all its many dimensions—as a concrete, achievable employer goal. Creating a future-ready approach to employee well- being requires a vision of the end-state and a strategy. It should start with an analysis of the employer's expectations and needs and objectives to identify areas of greatest need and the corresponding effort required for success. This chapter has two aspects; to provide an overview of organizational well-being research, and design a new model of organizational well-being research.

Chapter 11 is on 'Six-Sigma in Human Resources: Application in the Domain Function' by Sushree Lekha Padhi. Data analytics is not restricted to only finance and operation functions but are widely used across the support functions along with line functions. Human resource is now considered as an asset. Organizations are also trying to find out ways to capitalize the full potential of human asset. Various tools and methodologies are paving its way to bring efficient human resource management practices. Six-Sigma is one of the tools, which is booming into the application space of Human Resource Management. Six-sigma is being considered as a business process and is helping in shaping and improving their bottom line by designing and monitoring various activities to reduce the defects. This chapter elaborates on six-sigma application in human resource management functions. Six-sigma requires extensive use of statistical tools.

Chapter 1
Introduction to HR Research Using Statistics

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ABSTRACT

HR research through collection, collation and analysis of data, using statistics, immensely help. Even in day to day HR decision making, we need statistics. HR managers can take decisions, and so also a HR researcher can frame suitable hypothesis for getting deeper insights on specific research issue. In all HR functions, we see use of statistics can help. While for some HR researcher statistics help in finding answer to a research issue or a problem; for HR manager statistics can help in taking critical HR decisions with minimum chances of error. Thus, statistics promotes fact based approach in HR research and HR decision making. With statistics, it is also possible to take predictive HR decisions, when we simultaneously make use of HR analytics. Predictive HR decisions help in understanding the future implications of HR decisions, which help HR managers to initiate corrective actions well in advance, before the catastrophic failure in organizations.

INTRODUCTION

With the application of statistics in HR, we can explore unknown facts, and these can help in understanding applications of theory. For example, what would be the menu in Google's canteen, can greatly help Google's HR to study the impact on employees' performance. Hindustan Unilever in India (as part of Unilever Group) never had major problem of voluntary attrition. However, with the recent restructuring effort, i.e., putting out of shelves those products that sell less than one billion Euro,

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they could observe middle level managers are voluntarily leaving the company. Reasons that could be verified were attributable to managers' typical feeling that putting products out of shelf, which were anchored by them, is like orphaning their children. Obviously, such phenomena can be better understood with the application of statistics. HR managers, with statistics, can build knowledge and theory and get deeper insights to HR issues through the process of identification, critical examination and generalization. Obviously, these help in successful human resource management (HRM) practices in organizations. Scientific HR research is now important for strategic significance of HR functions in organizations. Statistics in HR can broadly help organizations in understanding the way they are structured and function, practices followed in decision making, people-centric issues in organizational operations, selection of right-fit strategies to enhance organizational effectiveness, etc.

HR RESEARCH AND SCOPE OF STATISTICS IN HR

Traditionally organizations use statistics in HR for descriptive purposes. For example, when costs of some operations are higher than other, collating data and then using statistical analysis, we can identify possible causes; based on which managers can intervene to rationalize costs bringing desirable changes in the operation. Use of statistics in HR is very much situation specific. Broadly it can be theoretical, academic, or action-oriented.

Through pure basic HR research, we intend to resolve, illuminate, and exemplify theoretical HR issues. Through objective HR research, we try to find a solution to a HR problem with established knowledge. Evaluative HR research focuses on assessment of some aspects of organizational function, analysing effectiveness of a given problem. Applied HR research tries to solve a specific HR problem through application of appropriate knowledge. Through action research in HR, we not only try to solve a problem, also in the process of solving, we also try to improve existing knowledge repository on the subject. Depending on the nature of HR research issue, we can categorize them in any specific type.

Before we think on use of statistics in HR research, another important aspect is initial concept mapping exercise. A concept map is a formative assessment and research tool, and it helps in visualizing relationships between concepts. It is also known as cognitive map both for the organization and the person. HR managers benefit from a concept map from different perspectives. These are like; understanding research issue, exploring new information and relationships, accessing prior knowledge, gathering new knowledge and information, designing structures or processes, and finally dealing with the problem solving.

With initial concept mapping, once research issue become clear, HR managers can ground research, based on the available knowledge repository on the issue. Research may require the need for developing suggestive model for solution, understanding cause and effect between different relationships. With statistical tools, we can develop such models to portray key concepts and proposition of a theory.

For classifying various types of HR research, we use three important dimensions; applied vs. basic research, exploratory vs. confirmatory research, and quantitative vs. qualitative research. Applied research solves a problem circumstances, while basic research helps us in understanding the underlying principles behind the research problem. Exploratory research is research into the unknown, while for a confirmatory research, HR researcher must have pretty good idea about the research issue. Quantitative research measures variable using numeric scales. Qualitative research studies are based on direct observations of behaviour. Irrespective of the types of HR research, we can apply statistics. Basic HR research helps us to understand interrelationship between various HR variables. Applied HR research helps us to solve an immediate HR problem. In applied HR research, we can make effective use of inputs from front-line managers, particularly in employee management, management of operational costs, allocation of work, monitoring work progress, coaching, performance evaluation, discipline and grievance handling, and recruitment and selection.

Some of the important areas of HR research particularly in organizations are; performance management, leadership development, career and succession planning, change management, talent retention, organizational culture, compensation and benefits, etc.

Using Statistical Tests in HR Research

Like any statistical investigation, for HR research also we follow certain generic steps, like; deciding on research question, designing of research and data collection, exploring the data, and then drawing inferences through significance estimation, and drawing conclusion by generalizing the observations.

The right statistical test is needed for conducting HR research. Selection of the right statistical test depends on following factors:

- Type of data
- Sample characteristics
- Inferences to be made

Before choosing a statistical test, we need to know the following:

- How many variables?
- How many groups?
- Is the distribution of data normal?
- Are the samples (groups) independent?
- What is our hypothesis or research question?
- Is the data continuous, ordinal, or categorical?

Even though there is no right style for a HR research report, there are some basic principles for writing a research report. Report preparation involves three basic steps: understanding, organizing, and writing. The general guidelines that should be followed for any HR report or research paper are:

- Consider the audience
- Be concise, but precise
- Understand the results and drawing conclusions

Detailing Use of Statistics in HR Research

In HR research when we apply quantitative methods to solve business problems, we use mathematical and statistical systems. Mathematical systems depend on set of elements (rational numbers, whole numbers), operations that are applied to such elements (like; addition, multiplication), relationships (like; equation: $1 + 1 = 2$), and axioms, i.e., accepted rules (expressed in equation $a = a$). Statistical systems require the application of special rules and operations within the set of rules of the mathematical system. In a sense, it makes the statistical methods, a subset of the entire mathematical system that we use. This is essential to remember since statistical methods cannot exceed the limitations of normal mathematical boundaries. It is also important to remember that not all the tests or approaches may be appropriate, because the boundaries of normal mathematics might be exceeded in given situations. In statistics, these boundaries are called assumptions. For example, assumptions that bell-shaped curve of performance evaluation differs between men and women. Such assumptions, however, require us to ensure that observations are independent, evaluation is done from a normally distributed population, populations must have the same variance, measurement must be atleast on an interval sale, and effects must be additive.

Statistics and Statistical Modeling for HR Research and HR Decision Making

To make sense of data, HR managers use statistical analysis. Statistical analysis involves collection, analysis, interpretation and presentation of data for decision making and for predicting the future. For managerial decisions, we use both descriptive and inferential statistics. Descriptive statistics help in describing the existing data, using measures like; average, sum, etc. Inferential statistics help in finding patterns and relationships in data. Obviously, this involves statistical testing, using various statistical models.

HR research helps us in understanding how organizations are structured and functions; how decisions are made; what factors affect organizational operations; and finally, what strategies are important for gaining sustainable competitive advantages. Sometimes this research is carried out for descriptive purposes, like; to assess why operations costs of some operations are higher over others. Obviously, this requires collection of data and analysis. Also, such research may be normative, prescriptive, and strategic. Through normative research we define the population, indicate its phenomena, and interpret the results. Prescriptive research is recommendatory, as it prescribes solutions to problems or situations. Strategic research involves systematic data collection and analysis both for evaluating and developing strategies. Irrespective of research scoping; data collection, analysis, statistical modeling, and use of HR analytics for predictive decision making are required for meaningful HR research.

In all functional areas of HR, we use statistics for various researches, which can help in improving future HR decisions. For example, research in recruitment and selection can significantly help in future decision making on issues like; how best we can attract talents, what can ensure better diversity, how we can optimize recruitment costs, etc. An extended recruitment research even can provide direction for successful on- boarding, workforce planning, etc. Even in compensation and benefits management practices, we can make use of statistics for various researches to improve our future decision-making process. Likewise, in performance management, training and development, employee motivation, and in many strategic HR management issues, we can use statistics. For doing HR research with statistics, we need to have data, hence data identification process is critical. In all HRM areas like; descriptive, conceptual, and normative, we can make use of statistics for necessary research. Briefly descriptive HR considers getting facts right, conceptual aspects consider how facts relate to each other, while normative aspects consider things that we should do for obtaining a specified goal.

Again, HR research issues encompass resource-based views and behavioural perspectives. Resource-based view assumes physical, organizational and human resources differences between the organizations, which make differences in their potentiality. Behavioural perspectives focus on HR practices that can best shape employees' behaviour for achieving goals and objectives of organizations. Carrying out HR research from both these two perspectives require extensive use of statistics and data driven research.

Another important focus of HR research is on strategic human resource management, which gives thrust on competency-based approach for sustaining competitive advantage for organizations. To assess social and economic dimension of strategic HRM (SHRM), understanding relationships of SHRM with business performance, relationships between SHRM and development of organizational capability, etc. we make use of statistical models and predictive HR analytics for our research.

In Table 1, we are mapping possible HR research areas based on statistics, statistical modeling and subsequent HR analytics for predictive decisions making.

HR Research Tools and Techniques

HR research can be either quantitative or qualitative. Quantitative data are gathered through; experimental/clinical trials, observations and recording of events, collection of data from data bases like; enterprise resource planning (ERP) and management

Table 1.

HR Functions	Research Areas
Recruitment and selection	Outsourcing or direct recruitment, contractual or on permanent payroll, multi-skill attributes or specialization are some of the issues considered at this level.
Career Development	Career mapping, succession planning and management development, integrating career development with OD initiatives are the factors considered in this area.
Performance Management	Designing appropriate tools and aligning such appraisal with training needs, promotion, transfer and relocation are the issues deserve attention at this stage.
Training and Development	Developing in-house training, ROI models for evaluating training, training budgets, etc. are considered for this research.
Compensation and Benefits Plan	Designing compensation and incentive schemes, suitable to attract talent and retain them, non-wage labour cost aspects, etc.
Human Resource Planning (HRP)	Developing a Human Resource Information System, aligning HRP with corporate strategies, skill and competency mapping are important aspects of strategic HRP.

information systems (MIS), survey reports, etc. Qualitative research covers historical data analysis, and even collection of narrative data for understanding phenomena through discourse analysis.

In all types of research like; descriptive, correlational, casual-comparative, and experimental; statistical analysis helps. Descriptive researches engage in data collection and testing of hypotheses; say for measuring satisfaction level of employees. Correlational research helps us in determining relationships among variables to establish a cause-effect relationship; say to study how new incentive scheme co-relates with employees' performance. Casual-comparative research helps in comparing two relationships; say determining cause of differences between two groups of employees. Experimental researches study cause-effect relationships by comparison, manipulating one variable, while controlling other variables. Irrespective of the types of HR research, we can use statistics and statistical modeling for better research results.

Again, in HR research and decision making, we make use of different levels of measurements, i.e.; nominal, ordinal, interval, and ratio. Nominal measurement is classification of objects in two or more categories; hence we call it categorical measurement. Ordinal measurement classifies objects in order from highest to lowest, from the most to least. It can indicate one object is better than the other, but cannot say, how better it is. Interval measurement combines both the characteristics of nominal and ordinal measurements. Employees are measured using such measurement tool, which can have a scale with arbitrary maximum and arbitrary minimum score (say zero point). Ratio measurement along with the properties of interval measurement can analyze differences in scores and the relative magnitude of scores. All these measurements require usage of different scales, and then make use of statistics for better inferences.

Quantitative data collection strategies in HR research include:

- Experimental/clinical trials
- Observing and recording events
- Obtaining relevant data from ERP/MIS
- Administering surveys with structured close-ended questions

Qualitative research includes historical research and collection of narrative data, to understand phenomena by using verbal synthesis.

Types of Quantitative Research

There are various types of quantitative research. HR researcher selects a quantitative research based on specific requirements.

1. **Descriptive Research:** It involves data collection and testing of hypotheses to determine and report the current phenomena. This type of research is more suitable for measuring employee satisfaction level.
2. **Correlational Research:** It determines the degree of relationship among variables using a correlation coefficient and not for establishing a cause-effect relationship.
3. **Cause-Comparative Research:** It establishes the cause-effect relationship, comparing two relationships. In this research, we cannot manipulate the cause.
4. **Experimental Research:** It establishes the cause-effect relationship by comparison, manipulating the cause or the independent variable.

DATA ANALYSIS FOR HR

After data collection for HR research and HR decisions, we need to organize and summarize data primarily with two statistical techniques, i.e., measurement of central tendency, and measurement of dispersion. Central tendency is measured calculating mean, mode, and median. Mean is the average, mode is the value that occurs most, and median is the mid value, midpoint or the fiftieth percentile. Dispersion or variability is measured using range, quartile deviation, and standard deviation. Range measures the difference between the highest and the lowest score in a data set. Quartile deviation is the difference between the upper quartile and the lower quartile in a data set. For example, if the upper quartile of a data set is in 90th percentile, it means there are 90% scores below that point. It can also be interpreted as: 90th percentile is in the top 10 percent bracket. Standard deviation is the square root of the variance and it is the distance of each score from the mean.

Measurement of relative position indicates performance score of an employee in relation to others. This helps in understanding how well the employee has performed compared to others. Two most frequently used measures of relative positions are percentile ranks and standard scores. A percentile rank indicates the percentage of scores that fall at or below a given score. If a score of 65 corresponds to the 80th percentile, it means that 80% of the scores in the distribution are lower than 65. A standard score is a derived score that expresses how far, a given raw score is, from some reference point, typically the mean, in terms of standard deviation units. The most commonly reported and used standard scores are z scores, t scores, and stanines. The z score expresses how far a score is from the mean in terms of standard deviation units. The t score is expression of z score in different form. Stanines are standard scores that divide a distribution into nine parts. It stands for standard nine. It may be used as a criterion for selecting employees for special programmes.

This introductory discussion therefore helps us to understand importance of statistics in HR research, and so also for HR decision making process. HR decisions become more and more scientific with the use of statistical tools. Preliminary statistical analysis further requires us using some statistical models and then making use of HR analytics for predictive HR decisions.

Parametric and Nonparametric Tests

Depending on the nature of data, and pattern of HR decisions, we can use parametric or nonparametric statistical tests. Characteristically data-sets for both these tests are different. For parametric tests, data have at least one interval level measurement, populations from where samples are drawn are normal, variances of the populations are expected to be equal, and sample size is large. For nonparametric tests, data-sets are not from normal populations. Hence, we also call it non-normal data analysis, or distribution free tests. Parametric data being having normal distribution, we can draw conclusions mathematically. In HR research, we use both parametric and non-parametric tests.

Although we have list of several parametric and non-parametric tests, some of the commonly used tests are indicated in Table 2.

Table 2.

	Parametric	**Non-Parametric**
Pattern of distribution	Normal	Non-normal
Variance pattern	Homogeneous	Non-homogeneous
Data Type	Ratio or interval	Ordinal or Nominal
Data-set relationships	Independent	Any
Central tendency measure	Mean	Median
Benefits	Possibility of drawing more conclusions	Simple and less affected by outliers
Type of Tests		
Correlation	**Pearson**	**Spearman**
Independent measures of two groups	Independent-measures t-test	Mann-Whitney test
Independent measures of more than two groups	One-way independent measures ANOVA	Kruskal-Wallis test
Repeated measures of two conditions	Matched-pair t-test	Wilcoxon test
Repeated measures of more than two conditions	One-way repeated measures ANOVA	Friedman's test

The list in Table 2 is not exhaustive. We have number of parametric and non-parametric tests for HR research. Depending on the data-set and our research query, we can select appropriate tests.

Reliability and Validity in HR Research

Reliability refers to the reproducibility of a measurement. Validity refers to the agreement between the value of a measurement and its true value.

Reliability measures dependability or trustworthiness of an assessment instrument. It is the degree to which a test consistently measures whatever it intends to measure. It is expressed numerically in terms of a coefficient. A high coefficient indicates high reliability and high reliability indicates minimum error variance. Test-retest, equivalent forms, and split-half reliability are all determined through correlation analysis.

Validity is quantified by comparing our measurements with values that are as close to the true values as possible. Validity is the degree to which a test measures what it intends to measure and thus allows appropriate interpretation of results. Validity is categorized into content, predictive, construct, and concurrent types.

Content validity is the degree to which a test measures an intended content area. It has two areas; item validity and sampling validity. Item validity measures intended content area (based on expert judgment), and sampling validity test samples in the total content area in the context of statistical tests. For example, an item validity test will establish how far the questionnaire items are valid for understanding employees' satisfaction level. A sampling validity test will establish whether the samples drawn correctly represent the population.

Construct validity measures the degree to which a test measures a hypothetical construct. It requires a thorough understanding of various statistical tests and matching the tests in the context of hypothesis constructs.

Concurrent validity measures simultaneous validity to understand how the degree of a test scores relates to another. It is ascertained by determining a validity coefficient.

Predictive validity measures the degree to which a test is successful in predicting the success of individual samples in a future situation. For example, to predict the successful job performance success of its employees, an organization may assess its general capability to learn.

Levels of Measurement

Levels of measurement refer to the relationships among the value that is assigned to the attributes for a variable. There are four levels of measurement; nominal, ordinal, interval, and ratio.

- Nominal measurement classifies persons or objects into two or more categories. It is referred as categorical measurement. We cannot get mathematical properties of subjects using this scale; we can only measure the mode.
- Ordinal measurement puts the subjects in order from the highest to lowest, from the most to least. It indicates some subjects are higher or better than others, but cannot indicate how much better or higher.
- Interval measurement has both the characteristics of nominal and ordinal measurement. Achievement tests, aptitude tests, and intelligence tests, etc. represent interval measurement. Such scales typically have an arbitrary maximum score and an arbitrary minimum score, or zero point.
- Ratio measurement has the properties of an interval measurement together with a fixed origin or zero point. It permits the researcher both differences in scores and the relative magnitude of scores.

Scaling Techniques

The nature of responses largely depends on the type of scale used by the researcher. Each scale has unique properties. Various types of scales used in research fall into two broad categories – comparative and non-comparative. In comparative scaling, the respondent is asked to compare one brand, product, or incentive plan against another. With non-comparative scaling, respondents need to evaluate a single product, brand or incentive scheme.

- **Semantic Scales:** These scales make extensive use of words rather than numbers. Respondents describe their feelings about the products or brands on scales with semantic labels. Semantic scales (Good – Bad) with bipolar adjectives at the end points of the scales are termed as semantic differential scales (Important – Unimportant).
- **Likert Scales:** A Likert scale is what is termed a summated instrument scale. Here the numerical values assigned to the response categories for each

question are simply added to produce a single scale score. In fact, a Likert scale is a composite of itemized scales. Using Likert summated rating scale; we sum or average the scores to yield an individual respondent's score. On the other hand, Likert item analysis scale helps us to track responses in terms of five degree of agreement or disagreement, like; strongly agree, agree, undecided, disagree, and strongly disagree. Each statement thus becomes a scale having five points.

- **Thurstone Equal Appearing Interval Scale:** This scale can represent the attitudes of a group on a specified issue in the form of frequency distribution. The various opinions or items on a scale are allocated to different positions in accordance with the attitudes expressed by the respondents.
- **Guttman Cumulative Scale:** It is a unidimensional scale to measure only one variable. It is normally used to measure highly subjective attitudes.

Framing of Hypotheses

Hypotheses are assumptions, which need to be validated through some testing measures. At organizational level HR research, hypotheses framing at times may be required. We may have number of null or alternative hypotheses depending on our research objectives, viz.,

- **Nothing Happened:** This is known as Null Hypothesis, indicated by H_0
- **Something Happened:** This is known as Alternative Hypothesis, indicated by H_1

Meta-Analysis

In HR research, meta-analysis is used to integrate the results of several related independent studies. Such objective appraisal helps us to explain the heterogeneity between the results of combinable independent studies, if any. It is known as analysis of analyses. Results of meta-analysis being provide better estimation of populations relationships, and capable to eliminate inconsistencies in previous researches, in HR research it is preferred. However, heterogeneity, small sample sizes, and validity of previous research studies; often falter the meta-analysis results.

ETHICAL ISSUES IN HR RESEARCH

Ethical issues in HR research deals with the moral treatment of employees in an organization. International Labor Organization (ILO) called for the fundamental rights of employees to liberty and safety in workplace, freedom of association, right to organize, collective bargaining, abolition of forced labour, equality of opportunity and treatment, etc.

Unethical HR practices further only the interests of internal stakeholders of organizations, often excluding the interests of employees.

Ethical issues in HR have two dimensions; macro level and micro level. At the macro level, all the strategic HRM initiatives and their implications on HR practices at the organizational level are reviewed. At the micro level, ethical assessment of individual practices ranging from recruitment to retrenchment is made.

Ethical guidelines for HR research are:

- Employees can be selected as research subject only if they consent to participate in the research. Organizations must help the employees to make their informed choice.
- To ensure employees right to privacy and confidentiality.

SUMMARY

HR researcher needs to organize and summarize the data using different measures of central tendency. Similarly, by measuring relative position, HR researcher can judge a score in relation to other scores in the distribution. Like for example we can judge how an individual employee performed compared to other employees of the organization. Such relative positions are measured in terms of percentile ranks and standard scores. A standard score is a derived score that expresses how far a given raw score is from some reference point, typically the mean, in terms of standard deviation units. The most commonly reported and used standard scores are z scores, t scores, and stanines.

To make sense of data, HR managers use statistical analysis. Statistical analysis involves collection, analysis, interpretation and presentation of data for decision making and for predicting the future. For managerial decisions, we use both descriptive and inferential statistics. Descriptive statistics help in describing the existing data, using measures like; average, sum, etc. Inferential statistics help in finding patterns and relationships in data. Obviously, this involves statistical testing, using various statistical models.

In all functional areas of HR, we use statistics for various researches, which can help in improving future HR decisions.

HR research issues encompass resource-based views and behavioral perspectives. Resource-based view assumes physical, organizational and human resources differences between the organizations, which make differences in their potentiality.

Behavioral perspectives focus on HR practices that can best shape employees' behavior for achieving goals and objectives of organizations. Carrying out HR research from both these two perspectives require extensive use of statistics and data driven research.

HR research can be either quantitative or qualitative. Quantitative data are gathered through; experimental/clinical trials, observations and recording of events, collection of data from data bases like; enterprise resource planning (ERP) and management information systems (MIS), survey reports, etc. Qualitative research covers historical data analysis, and even collection of narrative data for understanding phenomena through discourse analysis.

Depending on the nature of data, and pattern of HR decisions, we can use parametric or nonparametric statistical tests.

In HR research, ethical guidelines need to be followed strictly. For example, employees can be selected as research subject only if they consent to participate in the research. Organizations also must ensure employees right to privacy and confidentiality.

Chapter 2
Application of Statistics in Human Resource Management

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ABSTRACT

The chapter gives an outline of the shift in HRM from being intuitive to quantitative in its decision making and overall functioning. The role of HRM is transforming with application of statistical techniques that make HR more evidence based and accountable. The chapter will discuss some successful applications of statistical techniques, basic and, in HRM by renowned organizations worldwide as well as elucidate upon some of the most applied statistical techniques. After reading this chapter learner will appreciate the need for applying Statistics in HRM, have an understanding of the avenues for application of statistical tools and get an outline of the various statistical techniques that are appropriate for different HR functions.

INTRODUCTION

HRM departments, since inception have been a hub for employee data as information has to be captured from the entry to exit for all the employees in organizations. Setting up of HRIS was an advancement over maintenance of a simple database. Unfortunately, the rich base of information was not put to good use. HR professionals were not aware of applications or tools to exploit this data for informed decision-

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making. Historically, HR decision were based more on personal judgment, intuition and experience and hence were very subjective in nature.

Although there were significant innovations in the realm of HRM in terms of the processes and practices over the last few decades, HRM could not establish its credibility or gain recognition for its contribution to the organizational value chain. HR witnessed a significant shift in its responsibilities from “doable” to “deliverable” (Ulrich, 2013), hence the focus not on outcomes rather than actions. HR initially grappled with its role as strategic partner as HR needed analytic and databased decision making competencies to mesh HR practices and processes with business strategy. For a fairly long time it lacked the right metrics and analytical models (Lawler, et al., 2004). HRM investments were seen as wasteful and it was imperative for HR to enhance efficiency in its systems and derive metrics for their optimum functioning. The targeted areas initially were refining workforce planning and recruitment, reducing recruitment and retention costs and retaining critical talent (Narula, 2015).

This led to the emergence of HR metrics, dashboards and the HR Scorecard (Becker, Ulrich and Huselid, 2001). Organizations utilized different arrays of metrics to assess the effect of HR initiatives in terms of efficiency, effectiveness and impact on business strategy and business performance (Boudreau ad Ramstad, 2005). These metrics reflected current scenarios but failed to provide pointers or projections needed for strategic alignment of HR.

Earlier numerical analysis entailed usage of basic visualization tools such as bars and charts to depict trends and patterns of HR data. The emergence of quantification of decisions in different fields of management called for rigorous use of numerical data (Pfeffer & Sutton, 2006 and King, 2016). Researchers emphasized upon the need for HRM to become more evidence based with application of appropriate numerical rigour in their work (Lawler, 2007). It was felt that metrics by themselves were not adequate and there was a need for application of sophisticated statistical tools but in most cases the process of utilization of numerical data had been elementary (Mondore, Douthitt and Carson, 2011; Lawler, Levenson and Boudreau, 2004). This led to the re-emergence of analytics in the field of HRM. The concept of analytics was not new to HR, the very basic application began with statistical analysis of training investments (Fitz-Enz, 2010). Fitz-enz in 1978 had advocated the use of analytics proposing that HR initiatives and their linkages with the bottom-line should be explored but this new idea did not find any takers at that time (Handa and Garima- 2014). During present times, application of quantitative techniques in HR has been triggered by the datafication of HR (Bersin, 2013), evidence based HR (Lawler, 2007) and use of big data in management (George, Haas and Pentland, 2014).

HR analytics includes the application of statistics, research design, identifying meaningful questions, using appropriate data, applying scientific standards to evaluate the results into meaningful business reports (Narula, 2015 and Levenson, 2005). KPMG's (2013) definition of HR Analytics states that it is the application of statistical techniques (e.g. factor analysis, regression and correlation) and the synthesis of multiple sources to create meaningful insights (factors X & Y predicting employee performance or turnover). HR analytics, hence, is understood to be the application of mathematical, statistical and data mining techniques to human resources and business data to explore concepts and ideas and solve or respond to HR related business problems HR analytics warrants for processing of HR data with advanced algorithms as well as statistics to get meaningful interpretation of existing data.

There is no inclusive definition of HR analytics, what is important is the process to affect the overall role of HR in an organization (Mondore, Douthitt and Carson, 2010). The use of analytics has aided in demonstrating the impact of HR on business results. Statistical techniques and experimental approaches have successfully anchored the causality between particular HR initiatives and outcome measures such as customer satisfaction, sales per employee and the profitability of business activities (Heskett and Schlesinger, 2008).

The benefits of a meaningful analysis of HR data using appropriate statistical tools would be:

- Channeling resources towards favorable employee initiatives
- Calculating the return on such investments via their impact on top and bottom line
- HR Department can be held accountable for impacting the bottom line and
- HR executives can be included in the business conversation as they can now quantify their numerous impacts on business outcomes (Mondore, Douthitt and Carson, 2013).

Analytical techniques can be applied to any vertical of the HR function to assess their levels of efficiency and contribution to the bottom line (Narula, 2015). Some of the areas in which data analysis assumes importance in HR are trends of attrition, selecting and monitoring indicators of organizational health, identifying which units or individuals need attention, determining which actions have the greatest impact on the bottom line, forecasting workforce levels, studying how to adapt the workforce to changes in the business environment (Davenport, Harrris and Shapiro, 2010 and King, 2016).

There has been proliferation in the usage of HR analytical techniques in research published in reputed journals. The major applications of analytics were done by academicians, behavioral scientists and researchers but with the advent of HR analytics, these tools have entered the corporate domain too (King, 2016). In recent times, HR professionals are busy locating appropriate analytical tools and software and seeking application of these quantitative aids (Bersin, 2013). Today the HR talks center around making projections, forecasts, people modelling, ascertaining causalities, linkages and associations among apparently disjointed fragments of data (Narula, 2015).

Despite the increasing recognition of HR analytics and its potential of being valuable to organizations, very few firms even now base their decisions on unbiased facts or thoroughly considered objective data (Fitz-enz and Mattox, 2014). According to a survey, among the list of important things, as ranked by HR and Business Professionals, big data and people data are deemed to be least important (Jones, 2015). Some of the reasons for this apathy coupled with lackadaisical attitude may have to do with gaps in knowledge, skills and attitudes towards Data Analytics and its applications in the domain of HR (Handa and Garima, 2014). Although HR professionals are excited about the potential of analytics, most of the literature surrounding this topic is more promotional than descriptive and provides little information on how to translate ideas to practice (Angrave, Charlwood, Kirkpatrick, Lawrence & Stuart, 2016 and King, 2016).

Research also shows that there is a gap between what HR is trying to accomplish and the level of proficiency desired in data analysis (Jones, 2015). HR professionals have to master statistical techniques and tools and learn their application in the context of the various HR scenarios. As analytics in HRM and application of statistics are here to stay, enhancing analytical literacy should be on every HR manager's agenda. Experts have compiled a list of analytical competencies which would be essential in the domain of HR.

LEVELS OF DATA ANALYSIS

Analysis of data would include descriptive or inferential statistics or both and may involve descriptive, predictive or prescriptive analyses. One of the common methods used by organizations is descriptive analysis which gathers data on past events or trends. Examples of its application would include measures such as turnover rates (Kumar, 2016) or cost to hire a new employee. When analysis shifts from the summaries of current state to what-if questions an organization moves from descriptive to predictive analysis. Predictive analysis assesses the causes behind the past trends and the anticipated changes. An example would be to increase the probability of selecting the right candidate for a job. Predictive HR analytics provides a glimpse into future scenarios by stating the probabilities thereof. It attempts to minimize risk and increase return on investments and this is being projected as the future of HRM. It would assist managers to make correct forecasts about the availability of resources as well as availability of critical talent in the future (Handa and Garima, 2014).

Table 1. HR analytical competencies

Analytical competencies related to statistical techniques		
Category	Examples	Level of statistical expertise required (and approximate educational equivalent)
Basic data analysis	• Mean • Median • Minimum & maximum; range • Percentiles	• Beginning course in basic statistics • Minimal on-the-job experience applying the techniques • High school / undergraduate level education
Intermediate data analysis	• Correlation • Statistically significant differences • Standard deviation	• One to two courses in basic statistics • 3-6 months on-the-job experience • High school / undergraduate education
Basic multivariate models	• ANOVA / ANCOVA • Regression • Factor analysis	• Course in advanced statistics • 1-2 years on-the-job experience • Undergraduate / MBA education
Advanced multivariate models	• Structural equations models • Hierarchical linear models • Bivariate / multivariate choice models • Cross-level models, including adjustments for grouped and non-normal errors	• Degree or concentration in statistical methods • Substantial experience applying the techniques on-the-job (multiple years) • Graduate degree (Masters or Ph.D.)
Other analytic competencies		
Data preparation	• Identify data for analysis • Prepare / clean the data for analysis (transform, identify outliers, etc.)	• One to two courses in basic statistics • 3-6 months on-the-job experience • High school / undergraduate education
Root cause analysis	• Identify causal paths • Six Sigma analysis	• One to two courses in basic statistics • 6-12 months on-the-job experience • High school / undergraduate education
Research design	• Treatment vs. control groups • Experimental design (exogenous variation created by researcher) vs. "natural" experiments (exogenous variation that already exists in the data)	• Course in advanced statistics • 1-2 years on-the-job experience applying the techniques • Undergraduate / MBA education
Survey design	• Sample selection • Survey item design; validity; reliability	• Course in advanced statistics • 1-2 years on-the-job experience • Undergraduate / MBA education
Qualitative data collection and analysis	• Interview techniques • Interview coding • Content analysis	• Course in research design • 1-2 years on-the-job experience • Undergraduate / MBA education

Source: Levenson, 2011 and Narula, 2015.

Prescriptive analysis would include evaluation of correlation, regression models, or structural equation modelling techniques (Fitz-enz and Mattox, 2014) and more advanced data driven decision making would move past these methods to experimental studies that identify how human capital inputs affect organizational performance (Angrave et al, 2016 and King 2016).

Another classification of analysis is done as descriptive, predictive and optimization techniques (Narula, 2015 and Watson, 2010).

Application of HR analytics (Narula, 2015)

Table 2.

Descriptive	Data visualization, Dashboards/ Scorecards, OLAP reports, SQL queries	Turnover rates, Costs to hire a new employee
Predictive	Decision trees, genetic algorithms, neural networks	Modelling to enhance the probability of selecting the right candidate on the job
Optimization	Mathematical programming such as linear, integer and simulations	Modelling to evaluate how alternative investments in employee training affect the firm's bottom line.

Source: Narula, 2015 and King, 2016.

- HR planning by identifying employees in high risk groups by job category, identifying employees who would probably leave on their own volition, predicting attrition, causes of attrition, understanding turnover.
- Assessing employee engagement levels based on absence trends
- Benchmarking HR performance and employee performance
- HR process analytics and measurement by assessing recruitment and retention data
- Talent management by tracking high performers and nurturing talent in-house
- Linking compensation to overall business performance

Davenport, Harris and Shapiro (2010) in a Harvard Business Review article have given several successful examples of application of quantitative analysis for management of talent by some of the most successful organizations in the world.

In spite of the proven advantages of application of statistics in human resource management, there are challenges which have to be overcome.

Identifying Appropriate/Relevant Information

It is important to identify critical issues, locate key information, establish robust causalities and metrics to obtain meaningful results otherwise the principle of GIGO (Garbage In and Garbage Out) would prevail. Fitz-enz & Mattox (2014) advice that identification of potential causes behind problems is necessary before looking for answers to problems using analytics.

Cleaning of Data

HR Professionals need to learn the techniques of capturing & cleaning of data, understand the algorithms and the interpretation & inferences to be drawn from the quantitative analysis.

Table 3.

Harrah's Entertainment has successfully used metrics to create appropriate person-job fit, modelling to ascertain the optimal number of staff to man front customer desks and other service points, evaluation of health and wellness programs and their effect upon employee engagement and bottom line.
AT&T and Google have used analytics to discover the competencies that can predict future good performance. At the time of hiring they do not pay much attention to the pedigree of belonging to prestigious schools but the demonstrated ability to take initiative.
Google's success has to be attributed in large part to the fact that it is the world's only data-driven HR function. The people analytics team reports directly to the VP and it has a representative in each major HR function. It produces many products, including employee surveys that are not anonymous and dashboards. It also attempts to identify insightful correlations and to provide recommended actions. The goal is to substitute data and metrics for the use of opinions (Sullivan, 2013). Google uses employee performance data to map low and high performing individuals and uses suitable interventions to enhance performance of the lowest 5% performers of the performance distribution curve.
Sprint has identified factors that affect fast employee attrition (Jue, 2012)
JetBlue has created an employee satisfaction metric based on its employees' willingness to recommend the company as a place of work and its impact on compensation changes and executive bonuses. There is also monthly tracking of employee engagement.
Lockheed Martin has developed a performance management system to link it with organizational objectives, training initiatives and potential appraisal.
Sysco has established causal relationships between employee satisfaction, higher revenue, low attrition, and greater customer loyalty. It has also explored the dimensions of work environment. Analytics helps the organization to establish which management actions have the highest impact on revenue.
Dow Chemicals has advanced its workforce planning techniques using historical data of its 40,000 strong employee base. It can accurately forecast promotion rates, internal transfers and overall labour availability. It performs an analysis by age groups and job levels to do its workforce projections.
Hewlett Packard tags its more than 330,000 workers with a so-called Flight Risk score. This simple number foretells whether each individual is likely to leave his or her job. (Siegel, 2013).

Source: Puri & Sengupta, 2017.

Collaborating and Seeking Informational Resources From Other Departments

HR professionals may have to deal with resistance to data sharing due to issues of confidentiality and sensitivity of data as other departments could be the custodian of relevant data. Top level support would facilitate collaboration and sharing of data (King, 2016). HR very often has to struggle to get backing for its analytical efforts (Angrave et al, 2016)

Balancing Numerical Analysis and Personal Judgment

Numerical analysis has its limitations and needs to be supplemented with intuition and simple personal judgment and instinct (Davenport, 2006). According to Goleman

(2015) Big Data is only as good as the questions being asked and some algorithms make unhelpful assumptions.

Developing Relevant Rubrics for Measuring HR

Very often HR lacks the most rudimentary rubrics that can be used for measuring HRM. Till date most of the HR professionals worth their salt have employed efficiency based descriptive HR metrics only (Fitz-enz & Mattox, 2014). It is important to develop rubrics that would capture and reflect organizational realities better.

Making Appropriate Choice of Analytical Software

In today's market there is an abundance of readymade analytical software. HR needs to choose the one that would aid in making the most appropriate use of their HR data. In certain cases a customized software may serve better than a readymade sophisticated analytical solution.

Interpreting the Results of the Analysis

HR professionals need to be well versed with quantitative techniques, especially statistical methods and tools. The real challenge does not lie in running the analysis but in understanding the meaning inherent in the results. Comprehending the patterns and nuances of human behaviour as shown by the statistical analysis, what actions are to be taken based on these patterns are issues that HR managers need to grapple with.

Respecting the Confidentiality of Employee Data

Very often, HR is expected to capture and store very sensitive employee data to make meaningful predictions about employee behaviour. There could be resistance from employees as there could be issues of lack of trust and suspicion. The apprehension of potential abuse of data could be very real. Hence assuaging these fears and winning employees' trust is a primary responsibility of the HR professionals.

APPLICATIONS OF STATISTICS METHODS IN HRM METHODS

Descriptive Statistics Techniques

Any data analytic technique draws strength from the information available on the subject. Information is in fact in the form of data collected using one or more of the standard data collection instruments or questionnaires. But the translation of the huge amount of data into usable information requires an understanding of the different data analytics techniques. The collected data are broadly two kinds: qualitative and quantitative. Qualitative data techniques, although limited, have scope for analysis with meaningful insights. The quantitative techniques are used extensively to gain insight into the business. Most commonly any analysis, whether qualitative or quantitative, can be either exploratory or confirmatory. Exploratory analysis relies heavily on the graphical representations. Whereas confirmatory analysis depends on the rigorous statistical techniques. In the next few sections, we will discuss some of the exploratory as well as confirmatory analysis of qualitative and quantitative data.

Chi-Square Test

Qualitative data are mostly categorical in nature, i.e. they are all about categories and names on which we cannot perform any arithmetic operations. Thus the common summary statistic measures for such data are out of the question. With categorical data we can only analyse frequencies. The best way to start the analysis is by doing a cross-tabulation of the frequencies.

A simple example could be a cross-tabulation showing the frequencies of male and female employees and whether they were promoted in the past year or not. The cross-table will look somewhat like this;

If we want to look at the data descriptively, then we would focus on the frequencies for all possible combination of the categories of the two variables. If we wish to test the possibility of any relationship between the gender of the employee and promotion, then we would perform a Chi-square test of hypothesis. This type of test is called Chi-square test of independence. The test statistic is given by;

$$Chi^2 = \frac{\left(Observed\ frequency - Expected\ frequency\right)^2}{Expected\ frequency}$$

Table 4.

Gender	Promotions		
	Not Promoted	Promoted	Total
Male	127	6784	6911
Female	49	8378	8427
Total	176	15162	15338

with the degrees of freedom (r – 1)X (c—1), where r is the number of rows and c is the number of columns. For testing the null hypothesis of no association between the two categorical variables, the critical value is obtained from the chi-square table with the above mentioned two degrees of freedom and pre-fixed level of significance.

The calculations involved in the test are done by the software of your choice. All the calculations in the examples in this chapter were performed using SPSS version 22.

Tests for Mean (2 Sample T-Test and ANOVA)

The two sample t tests are employed to identify whether there is a significance difference between the mean of two samples. The two samples that we compare are data taken from two completely different groups of employees or teams (independent sample t test) or two sets of data from the same groups of employees or teams (paired sample t test). In a two sample comparison we can simply look at the descriptive measures such as mean to conclude whether there is any similarity between them. We use the procedure to test the significance of the difference that exists between the two means.

- If we wish to test whether women employees generate more sales revenue or not. Then we would consider two independent samples, one of female employees and another of male employees. The average sales revenue generated by the two groups of employees are then tested using an independent sample t test.
- On the other hand in case we wish to compare employee satisfaction rating in June of a given year with the employee satisfaction rating in September of the same year after they have undergone training. In such cases, two sets of data from the same group of individuals is used to test the effectiveness of the training programme.

Correlation Analysis

In case of qualitative / categorical variables the association between them can be tested using the Chi-square test of independence. Determination of whether two continuous variables are interrelated or not is done using the Pearson Correlation Coefficient. This measurement is an important activity in establishing the predictive techniques. When we carry out certain predictive analytics using SPSS, the software automatically produces the Pearson's correlation coefficient between all possible combinations of the variables. The test of Pearson's correlation coefficient gives the analyst an idea of the extent to which the two continuous variables are correlated to one another. The coefficient of correlation ranges between -1 and +1. The sign of the coefficient depicts the direction of the relationship between the two variables. A positive sign will mean as one variable increases the value of the other increases as well. A negative sign will mean an increase in one variable will result in the decrease in the other variable. When the value of the coefficient hovers around zero then there is no linear relationship between the two variables. On both sides of zero, as the magnitude of the correlation coefficient between two variables increases and approaches 1, the relationship is stronger between the two variables.

From an HR perspective, if the two continuous variables of choice are performance score of the employee and tenure of the employee, then a measure of association between the two can tell us whether an employee who has been with the company longer performs better than the one who are comparatively new or vice versa. Thus using Pearson's product moment correlation coefficient can measure the association/ interrelation between the two variables.

Regression Techniques

Regression models are an essential part of predictive analytics. In regression we focus on establishing a mathematical equation as a model to represent the inter-relationship between different variables in consideration. For different business context we have different regression models. Some of the more frequently used models are discussed below. For the understanding of the reader these models are also accompanied by numerical examples depicting real life problems that the HR handles using predictive analytic techniques.

Linear Regression Model

In linear regression model, we analyse the relationship between the response variable and the predictor variables. The response variables are called the dependent variable and they are dependent on the predictor variables which are called the independent variables. There are generally two types of linear regression, one where there is one dependent variable and one independent variable. Such a model is called a Simple linear regression model due to the simplicity of the mathematical form of the model. The other type of linear regression is where one dependent variable is dependent on several independent variables. Such a model is called multiple regression model.

A simple regression model draws its mathematical expression from the equation of a straight line. The simple regression line is used to establish the relationship between a dependent and an independent variable when they are linearly related. Generally the equation of a straight line is given by the equation

$$y = mx + c$$

where m represents the slope of the line and c represents the intercept.

In a regression setup, the y denotes the dependent variable and x denotes the independent variable. But in regression we have the additional term e, where e denotes the error in the model. The simple regression has the mathematical form

$$y = b_0 + b_1 x + e$$

The goal of fitting such a model to the data is to estimate the regression parameters of the model so as to minimize the sum of squared errors. This is known as the ordinary least square (OLS) estimation and the results of such technique is best linear unbiased estimate (BLUE) of the parameters. Thus using the fitted model as a predictive tool we can forecast y given the values of x. The estimate of the parameters are $\widehat{b_0}$ and $\widehat{b_1}$; in terms of the parameter estimates the dependent variable can be estimated as

$$\hat{y} = \widehat{b_0} + \widehat{b_1 x}$$

The estimate $\widehat{b_1}$ is interpreted as the change in the value of y for a unit change in x.

In case of a multiple regression the regression equation looks like;

$$y = b_0 + b_1 x_1 + \ldots + b_n x_n + e$$

where x_1, x_2,.., x_n are the independent variables and e is the error term. In a multiple regression setup, the estimate of the dependent variable can be obtained using the estimates of the regression coefficients;

$$\hat{y} = \hat{b}_0 + \hat{b}_1 x_1 + \ldots + \hat{b}_n x_n$$

Each of the estimates of the regression coefficients can be interpreted as the amount of change in y for a unit change in the corresponding independent variable, when the other independent variables are kept constant. Thus, for a unit change in x_1 the amount of change in y is given by $\hat{b}_1$, when all the other independent variables are kept fixed.

Once the model has been fitted we will be interested to know if the predictor variables indeed belong to the model. In other words, whether the predictor has a reliable contribution to the model or not. This we can check using the statistical significance of the models coefficients which can be measured using the t-statistic. This basically amounts to testing the null hypothesis whether the coefficient is significantly different from zero. Overall, the performance of the model can be assessed by the R^2 statistic. It measures the predictive power of the model, i.e. the proportion of total variation in the dependent variable that is explained by the independent variable(s).

In order to illustrate the use of simple linear regression in HR practice, we have used a dataset with the employee performance rating and the percent salary hike they receive. The data was analysed using SPSS version 22.

Table 5 gives the model summary, depicting the predictive power of performance rating in forecasting Percent Salary hike. According to the table, R^2 value of 0.598 indicates that almost 59.8 or 60 per cent of the variability in Percent Salary hike can be explained by their performance rating score.

Table 6 shows the ANOVA table. The ANOVA table shows the break-up of the variability in the dependent variable attributed to the regression model and the error in the estimation, termed as Residual. If we focus on the variability explained by the regression model, the F ratio in the output is used to test the significance of the regression model as a whole. This can also be done through the p-value (0.000) and comparing it with the standard level of significance (<0.05). Thus the p-value suggest that there is less than 5 in 100 chance of randomly finding this pattern of

Table 5. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.774[a]	.598	.598	2.3202

a. Predictors: (Constant), Performance Rating

Table 6. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11774.595	1	11774.595	2187.193	.000[b]
	Residual	7902.872	1468	5.383		
	Total	19677.467	1469			

a. Dependent Variable: PercentSalaryHike
b. Predictors: (Constant), PerformanceRating

shared variance between Performance rating and percent salary hike. Hence the model is significant.

Looking at Table 7 we can see the coefficient estimates. Using these the regression model can be written as;

$$\hat{y} = -9.536 + 7.846x$$

where y is Percent salary rating and x is performance rating. In addition to the coefficient estimates the table also test the significance of the predictor performance rating. Using the p-value (<0.05) we conclude that the predictor is significant in the model.

If we now wish to extend to the multiple regression setup, we include five independent variables and one dependent variable. The independent variables are, Hourly rate, Monthly income, Percent salary hike, Years working at the company and Work Life Balance. The dependent variable is Performance Rating.

When we run a multiple regression we look for a number of key things in the output. The multiple R^2 is very important in our analysis because it is indicative of the total variance in our dependent variable that can be accounted for by our independent variables. The closer the value of this measure is to 1 the better is our model. From our fitted model we can see that the value of R^2 is 0.60. So roughly 60% of the variability in Performance rating is explained by Hourly rate, Monthly income, Percent salary hike, Years working at the company and Work Life Balance. Although we are talking about R^2, in a multiple regression setup we mostly focus on the adjusted R^2. The reason behind this is, as we increase the number of independent variables in the model the value of R^2 increases. But we do not wish to increase the goodness of fit of the model at the cost of the complexity of the model with more number of predictors. We thus look at the adjusted R^2. In this new measure the value of R^2 has been adjusted for the number of regression coefficients that are estimated in the model. Thus for an increase in the number of

Table 7. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-9.536	.533		-17.905	.000
	PerformanceRating	7.846	.168	.774	46.767	.000

a. Dependent Variable: PercentSalaryHike independent variables in the model the adjusted R^2 will not show a huge increase which can justify the inclusion of the predictor variable.

In Table 6, similar to the simple regression, the F ratio and the corresponding p-value (Sig.) helps test the significance of the whole model. In other words, we can test how significant the model is as a whole in estimating the dependent variable. As we can see the p-value (0.000) is less than the level of significance, which is the required criteria for the significance of the model.

Using the coefficient estimates from Table 7 we can write the regression equation as follows;

$$\hat{y} = 1.97 + 0.000096x_1 - 0.0000013x_2 + 0.076x_3 + 0.003x_4 + 0.002x_5$$

where the x's are the independent variables and y is the dependent variable "Performance Ranking". Also, a perusal of the p-values for each coefficient reveals that only two independent variables are statistically significant in the model, namely, "Percent Salary Hike" and "Years at Company".

Polynomial Regression Model

- **Discrete Choice Models:** As explained in the previous subsection, multivariate linear regression is used generally when the response variable is continuous and has an unbounded range, i.e. it can take any possible value between positive and negative infinity. However, often times the response variable may not be continuous but rather discrete. Although it is mathematically feasible to fit a multiple regression model to such a data, the interpretation of the final estimates obtained from such a fitted model maybe out of range. Also the standard assumptions behind the theory of multiple linear regressions no longer hold. Thus we look elsewhere for techniques such as discrete choice models which are better suited for this type of analysis. If the dependent variable is discrete, some of the sophisticated models are logistic regression, multinomial logit model and probit models. Specifically for binary response we use the logistic regression and probit models.
- **Logistic Regression Model:** In a binary response setting, assigning probabilities of each type of outcome to the observations is achieved through the use of logistic regression model. As mentioned before the response in a linear regression is continuous and can take any value on the real line. However, when speaking of the probabilities of outcomes we are restricted to the range of zero to one. Thus even if we mathematically fit a multiple linear regression model to the data, the resulting outcome will not fall in the

probability range. Thus, giving us meaningless results. In logistic regression model fitting we are basically transforming information about the binary dependent variable into an unbounded continuous variable and estimate a regular multivariate model.

Suppose, the response is denoted by y which can take only two possible values, 0 or 1. As we have seen in the regression setting, we wish to model the expected value of the dependent variable for given values of the independent variables. For a binary dependent variable with only two possible values the expected value of y is given by $P\left(y=1\right)$. Thus the equation stands as

$$P\left(y=1\right)=\hat{b}_0+\hat{b}_1 x\,.$$

But, given that the independent variable can take any real value, the estimated probability of $y=1$ also can take any value on the real line. However, there is a constraint on the possible values of the probability. It can only lie between 0 and 1. Thus, instead of the linear form of the regression model we use the logistic function so that the range constraint is taken care of. The form of the logistic regression is given by;

$$P\left(y=1\right)=\frac{e^{\hat{b}_0+\hat{b}_1 x}}{1+e^{\hat{b}_0+\hat{b}_1 x}}\,.$$

In multiple linear regression the interpretation of the regression coefficients is quite simple. However when it comes to logistic regression the interpretation is not so straight forward. Sometimes we do some algebraic manipulation so that the above logistic regression equation takes the following form;

$$\log\frac{P\left(y=1\right)}{1-P\left(y=1\right)}=\hat{b}_0+\hat{b}_1 x$$

where the expression on the left hand side is called the logit function of the probability of $y=1$ and the ratio is called the odds of $y=1$ against $y=0$.

As an illustration of the use of logistics regression we would like to demonstrate using the employee data that tell us the likelihood for leaving for each of the employees. In SPSS we use the binary logistic to fit such a model to the data set. The dependent variable is whether that particular employee has left the organization or not. The independent variables that influence the decision of leaving or not leaving are Education, Monthly income, Percent salary hike and Years at the Company.

Perusing the coefficient estimates from the above table, we can see that only the p–values corresponding to Monthly Income and Years at Company are significant in the model. The logistic regression model can thus be written as;

$$\log\frac{P\left(y=1\right)}{1-P\left(y=1\right)}=-0.484+0.001x_1-0.049x_2$$

where x_1 is Monthly Income and x_2 is Years at Company.

Table 8. Case processing summary

Unweighted Cases[a]		N	Percent
Selected Cases	Included in Analysis	1470	100.0
	Missing Cases	0	.0
	Total	1470	100.0
Unselected Cases		0	.0
Total		1470	100.0

a. If weight is in effect, see classification table for the total number of cases.

Table 9. Dependent variable encoding

Original Value	Internal Value
No	0
Yes	1

Table 10. Classification table[a,b]

Observed			Predicted		
			Attrition		Percentage Correct
			No	Yes	
Step 0	Attrition	No	1233	0	100.0
		Yes	237	0	.0
	Overall Percentage				83.9

a. Constant is included in the model.
b. The cut value is .500

Table 11. Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 0	Constant	-1.649	.071	540.645	1	.000	.192

Table 12. Variables not in the equation

			Score	df	Sig.
Step 0	Variables	Education	1.447	1	.229
		MonthlyIncome	37.557	1	.000
		PercentSalaryHike	.267	1	.605
		YearsAtCompany	26.550	1	.000
	Overall Statistics		43.884	4	.000

Table 13. Omnibus tests of model coefficients

		Chi-Square	df	Sig.
Step 1	Step	54.104	4	.000
	Block	54.104	4	.000
	Model	54.104	4	.000

Table 14. Model summary

Step	-2 Log Likelihood	Cox & Snell R Square	Nagelkerke R Square
1	1244.479[a]	.036	.062

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Table 15. Classification table[a]

Observed			Predicted		
			Attrition		Percentage Correct
			No	Yes	
Step 1	Attrition	No	1233	0	100.0
		Yes	237	0	.0
	Overall Percentage				83.9

a. The cut value is .500

Table 16. Variables in the equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Education	-.029	.071	.171	1	.679	.971
	MonthlyIncome	.001	.004	17.267	1	.000	1.000
	PercentSalaryHike	-.016	.020	.591	1	.442	.985
	YearsAtCompany	-.049	.018	7.383	1	.007	.952
	Constant	-.484	.388	1.554	1	.213	.616

a. Variable(s) entered on step 1: Education, MonthlyIncome, PercentSalaryHike, YearsAtCompany.

To test the statistical significance of each coefficient b in the model, we use the likelihood-ratio test or the Wald's test. For assessing the overall goodness-of-fit of a logistic regression model we look at the "percentage correctly predicted".

In the table we see the coefficients, their standard errors, the z-statistic, associated p-values, and the 95% confidence interval of the coefficients. Both Monthly Income and Years at Company are significant are statistically significant. The logistic regression coefficients give the change in the log odds of the outcome for a one unit increase in the predictor variable.

For every one unit change in Monthly Income, the log odds of attrition (versus non-attrition) increases by 0.001.

For a one unit increase in Years at Company, the log odds of attrition (versus non-attrition) decreases by 0.049.

- **Multinomial Logistic Regression Model:** An extension of the binary logit model to situations where we have a dependent variable with more than two categories. To collapse such a data into two categories will lead to loss of information. In such situations a multinomial logit model is appropriate.
- **Probit Regression Model:** As an alternative to the logit model for modelling categorical dependent variables, sometimes we use what is called the probit regression model. Probit models are just as popular as logit models, especially in the social sciences like economics. However, the fundamental difference between the two models Is to assume a latent variable z. We do not observe z but instead observe y which takes value 0 or 1. The difference lies in the fact that in logit regression we assume y to follow a logistic distribution. In the probit model we assume that y follows a standard normal distribution.
- **Logit vs. Probit Regression:** When it comes down to a comparison between the probit and logit model against each other, there are merits and demerits of both. The probit model has been around for longer than the logit model. The logistic distribution has a similar bell-shaped distribution but only flatter than

the standard normal distribution curve. Because the probit model required the numerical calculation of the integrals, the logit model was formulated. Computationally the logit model is much simpler. Although in recent times, due to the advancement in technology and softwares, fitting either one of the models has become fairly easy. The coefficient estimates for both the models are near about same as each other. All said and done, there are some practical reasons why we should prefer fitting a probit model rather than a logit model;

  - There is a strong belief that the underlying distribution is normal
  - The actual event is not a binary outcome but a proportion.

- **Markov Analysis and Succession Analysis:** In Human Resource, supply forecasting is the process of estimating availability of human resource followed after demand for testing of human resource. For the purpose of forecasting supply of human resource we need to consider internal as well as supply from external sources. Internal supply of human resource are available by way of transfers, promotions, retired employees and recall of laid-off employees, etc. Source of external supply of human resource is availability of labour force in the market and new recruitment. Some of the important factors that influences external supply of human resource are mentioned below:
  - Supply and demand of jobs.
  - Literacy rate of nation.
  - Rate of population
  - Industry and expected growth rate and levels
  - Technological development.
  - Compensation system based on education, experience, skill and age. The most important techniques for forecasting of human resource supply are Succession analysis and Markov analysis.
  - **Succession Analysis:** Once a company has been able to forecast the demand for labour, it needs a measure of the firm's labour supply. Determining the internal labour supply calls for a detailed analysis of how many people are currently in various job categories or have specific skills within the organization. The planner then modifies this analysis to reflect changes expected in the near future as a result of retirements, promotions, transfers, voluntary turnover, and terminations. Demand forecasting helps in determining the number and type of employees required in future. The next step in human resource planning is forecasting supply of potential employees. The purpose of supply forecasting is to determine the size and quality of present and potential human resources available from within and outside the organisation to meet the future demand of human resources. Supply forecast helps in

Table 17. Transition matrix for 12-month period

	Exit	Manager	Supervisor	Line Worker
Manager	0.15	0.85	0.00	0.00
Supervisor	0.10	0.15	0.70	0.05
Line Worker	0.20	0.00	0.15	0.65

estimating the number and kind of potential personnel that could be available to the organisation.

- **Markov Analysis:** Markov Analysis for human resource heavily relies on the transition probability matrix. Transition probability matrix is developed in order to determine the probabilities of job incumbents remaining in their jobs for the forecasting period.

A transition matrix, can be used to model the internal flow of human resources. These matrices simply show the probabilities of the employees' movement as the average rate of historical movement from one job to another within the organisation. The table below, presents a very simple transition matrix. For a line worker, there is a 20% probability of being gone in 12 months, a 0% probability of promotion to manager, a 15% probability of promotion to supervisor, and a 65% probability of being a line worker this time next year. Such transition matrices form the bases for computer simulations of the internal flow of people through a large organization over time.

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Chapter 3
Uncovering Data for Decision Making With Critical Statistical Analysis

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ABSTRACT

Every field of study generates a huge amount of data. The volume of data generated leads to information overload, and the ability to make sense of all these data is becoming increasingly important. This requires a good understanding of the data to be analyzed and different statistical techniques to be used in that context. On the basis of the issues important to the data set as well as other practical considerations, it is necessary to select appropriate methods to apply to the problem under study. This work focuses on different issues arising in the context of data analysis which need attention like understanding classifications of data, magnitude of errors in measurement, missing observations in the data set, outlier observations and their influences on the conclusion derived from the data, non-normal data, meta analysis, etc. In the process of discussion some examples have been included to illustrate how critical a data analysis procedure could be in order to make a meaningful decision from a data set.

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1. INTRODUCTION

Data are lifeblood of every science, and it is through data we can have the scientific understanding of the events happening around us. All fields of study gather and store data, e.g., human resource department of an organization stores employee data on all relevant parameters, retail companies gather information on sales, insurance companies gather information on claims, meteorological department measures and collects data related to weather conditions, department of research and development of pharmaceutical companies generate data through clinical trials at various phases etc., with the purpose of making optimum decisions based on the information collected. The process of taking the raw data and converting them into meaningful information necessary to make decisions is the focus of this study.

Prior to starting any data analysis, the data should be characterized, cleaned, transformed (if necessary) and partitioned into appropriate form for further processing. Preparation of data is one of the most time-consuming parts of any data analysis exercise. How the data have been collected and prepared is critical to the confidence with which decisions can be made. The data should be reliable, and it should relate to the target population. The quality of the results obtained through data analysis depends on the quality of the data. By reliability of a measurement we mean that the measurement taken on the same individual or object for time after time produces the same result. A data set with reliable measurements constitutes a reliable data set. A valid measurement is one that actually measures what it claims to measure. If we try to measure job satisfaction using an IQ test, we would not get a valid measure of job satisfaction.

One should always exercise caution in data analysis. Let us consider the following two studies, where one may reach at a misleading conclusion if he or she does not have proper understanding of data handling.

A study was conducted to see how the time spent (in hours per week) on watching television programmes affect the academic performance of students as reflected in their grade point averages (GPA) out of 4 (see Table 1).

The correlation between television watched (hrs/week) and GPA comes out to be -0.02, which is negligible, almost zero, as if there is no relation between time

Table 1.

Hrs/Week	2.5	3.25	4	5.25	5.5	5.75	6.5	7	7.5	8	9.25
GPA	3.1	3.2	3	2.6	2.8	3.1	2.4	2.5	2.9	2.6	2.4
Hrs/Week	9.5	10.5	11	12	13	14	15	15.5	18	19.1	
GPA	3.1	3.6	3.4	2.6	3.3	2.1	3.8	2.1	3.9	2	

spent on TV watching and academic performance. Is this finding acceptable? What should an analyst do at this point- just make a conclusion based on this result, or go for further critical study?

Further study reveals that there are two distinct groups of students- one who watched mostly the educational programmes and the other group watched mostly the entertainment programmes. Then accordingly the data set was split into two groups and a separate analysis was made. Group 1 consists of students who watched mostly the educational programmes, and group 2 consists of students who watched mostly the entertainment programmes (see Table 2).

The correlation comes out to be 0.90, for group 1 and -0.8, for group 2. The separate analyses show a strong positive correlation between the time spent on watching educational programmes and academic performance, while a strong negative correlation has been found between time spent on watching entertainment programmes and academic performance.

Let us consider another study, where ten individuals of same physique, who perform a particular type of physical exercise, were observed on two variables - time spent (hour) on exercise and calorie intake. These variables were recorded for two weeks, and the average time spent on exercise and the average calorie intake for each individual were reported (see Table 3).

In order to see if higher time spent on exercise corresponds to higher intake of calories, a correlation analysis was done. The correlation comes out very negligible, almost zero, which does not seem to be very realistic. A critical study found that the data on individuals 2 and 8 are not conforming to the rest of the data. Individual 2 spent less time on exercise but his calorie intake was very high, whereas individual 8 spent much time on exercise while his calorie intake was low. It is difficult to

Table 2.

Hrs/Week (Group 1)	5.25	7.5	8	9.5	10.5	11	13	15	18			
GPA	2.6	2.9	2.6	3.1	3.6	3.4	3.3	3.8	3.9			
Hrs/Week (Group 2)	2.5	3.25	4	5.5	5.75	6.5	7	9.25	12	14	15.5	19.1
GPA	3.1	3.2	3	2.8	3.1	2.4	2.5	2.4	2.6	2.1	2.1	2

Table 3.

Individual	1	2	3	4	5	6	7	8	9	10
Time (in Hours)	0.6	0.8	1.1	1.3	1.6	2	2.2	2.2	2.5	3.2
Calorie Intake (in 100 Calories)	18	35	18	25	25	27	28	15	30	32

accept these two data points as regular, because all individuals under study were of similar physique. After deleting these two data points, correlation coefficient was recalculated and found to be strong positive (0.94). Here the actual correlation was masked due to the presence of those two irregular data points. This phenomenon is known as masking of correlation.

The subsequent sections present various important aspects one should be careful about, before analyzing any sort of data. In this context, classification of data, errors in measurement, data cleaning, missingness in data, identification of an outlier in univariate and multivariate cases, handling non-normal data, data transformation, value mapping or coding, discretization, meta analysis are discussed.

2. UNDERSTANDING DATA-CLASSIFICATION

The procedure to be adopted to analyze a data set depends on the type of data. Data come in two basic types, viz., qualitative data and quantitative data. Qualitative or categorical data can further be classified as ordinal and nominal. Quantitative or numerical data are classified as discrete and continuous. Another way to classify data is according to their level of measurement. There are four different levels of measurement-nominal level of measurement, ordinal level of measurement, interval level of measurement and ratio level of measurement. Data measured by nominal level and ordinal level are always qualitative, while data measured by interval level or ratio level are always quantitative in nature.

Measures that indicate the difference between the units by presence or absence of a characteristic or attribute are termed as non-metric data. The measures that indicate the difference between the units by the amount or magnitude of the variable under study are termed as metric data. Data measured in nominal or ordinal scale are non-metric, and data measured in interval or ratio scale are metric data.

Understanding data type is very important, as the procedure to be adopted depends on the nature of data. All statistical measures or procedures cannot be applied indiscriminately. For example, measure of correlation is not appropriate for categorical data. There one should use some measure of association, such as gamma coefficient, Cramér coefficient, Yule coefficient, odds ratio etc. (see Bhattacharya and Roychowdhury, 2010a, 2010b) For regression analysis, one should be careful about choosing the appropriate method depending upon the nature of explanatory variable and response variable or explained variable. Similarly, for measuring variability of categorical data, usual sample variance (s^2) or sample standard deviation (s) does not make any sense. Here we discuss some useful measures for measuring variability in qualitative data which are rarely discussed in the statistics literature.

Measuring Variability of Qualitative Data

The variability of qualitative data can be measured by observing the heterogeneity of the observed distribution. One such measure is Gini index of heterogeneity, which is given by:

$$G = 1 - \frac{1}{N^2}\sum_{i=1}^{k} f_i^2$$

(Gini, 1921), where category *i* has the relative frequency $\frac{f_i}{N}, i = 1, 2, \ldots, k$.

$G = 0$ implies $f_i = 1$ for any one *i* and $f_j = 0$ for all $j \neq i$, which implies perfect homogeneity. $G = 1 - \frac{1}{k}$ implies perfect heterogeneity. Here $f_i = \frac{N}{k}$, for all *i*, which means that the observations are uniformly distributed among *k* categories.

Normalized Gini index, another measure of variability derived from Gini index, is defined as

$$G' = \frac{G}{\left(1 - \frac{1}{k}\right)},$$

where $G' \in [0,1]$.

Entropy is generally defined to measure the disorder, but here we may consider it to measure the heterogeneity in the distribution. In the context of entropy measure, Shannon (1948) and Theil (1967) are referred to. The definitions are given below:

Entropy index of heterogeneity is defined as

$$E = -\sum_{i=1}^{k} f_i^* \log f_i^*, \text{ where } f_i^* = \frac{f_i}{N}.$$

$E = 0$, in case of perfect homogeneity, $E = \log k$ implies perfect heterogeneity.

Normalized entropy index for measuring heterogeneity is given by

$E' = E/\log k$, where $E' \in [0, 1]$.

3. ERRORS IN MEASUREMENT

The amount by which each measurement differs from the true value is known as measurement error. A reliable measurement, as defined before, can also be erroneous. The most reliable measurements are obtained if it is obtained through precise measuring instrument. It is much easier to get a reliable measurement of weight than of job satisfaction. An error which consistently affects all measurements is called systematic error. It is caused by an error in the measurement system that affects all measurements in the same way. Systematic error can make all the measurements too high or too low. Random errors occur because of unpredictable errors in the measurement process. Most measurements are prone to some degree of variability, i.e., they are likely to differ from one time to the next or from one individual to the other, because of unpredictable errors, causes of which cannot be explained.

A systematic prejudice in one direction is called a bias, and measurements which are systematically off mark in one direction are called biased measurements. We are often interested in the size of the errors irrespective of the nature of error - random or systematic. In other words, we may be interested to know if the error is big enough and a matter of concern, or the error is small enough and may be considered unimportant. The size of the error is measured by either absolute error or relative error. Absolute error measures how far the measured value lies from the true value and relative error compares the size of the absolute error to the true value. Thus,

$$\textit{absolute error} = |\textit{measured value} - \textit{true value}|$$

$$\textit{relative error} = \frac{|\textit{measured value} - \textit{true value}|}{\textit{true value}} \times 100.$$

The accuracy of a measurement can be judged from the absolute error. It is defined as the deviation of a measured value from its true value. As such, if error decreases, accuracy increases by the same amount. The precision of a measurement is defined as the deviation of different measurements from the mean value. Thus, it is possible for a measurement to be highly precise, without being accurate.

4. DATA CLEANING AND MISSINGNESS IN DATA

It is important to clean the data by resolving any ambiguities, removing errors, redundancy and problematic data points, prior to data analysis. Secondary data need more scrutiny for relevance, as it was initially collected with some objective, but later used for some other purposes. For variables measured in nominal and ordinal scales where there are fixed number of possible values, it is possible to scrutinize all possible values to uncover any mistakes or inconsistencies. Any assumptions made concerning the possible values that the variable can take should be tested. Cleaning of data on variables measured on interval or ratio scale needs special attention, since they can take any possible value within a range. During the process of data cleaning, any duplicate entries should be removed. It may also happen that some observations in a data set are missing. Missing values are the values that the researcher had planned to collect, but due to some reasons beyond his or her control, could not be obtained. There are different procedures to estimate the missing data value(s). Where there is enough knowledge about the possible value for the missing data, we may replace the value on the basis of the knowledge. Here we will address this important aspect of data analysis - how to handle missing observations in the data pool.

Having missing data in a data set is very common, and there are many reasons for which the data can be missing. Some reasons can be stated as follows: respondent refused to answer one or more questions, interviewer inadvertently skips one or more questions, experimental subject (animal, human being, or so) dies before the completion of the study, respondent is not available when the interviewer arrives for an interview etc. For detailed discussion Craig (2010) may be referred to.

Using data set with missing values for data analysis may lead to wrong inferences. What do we do when some information are unobtainable or missing from the data pool? ignore missing data? fill in arbitrarily the missing values to complete the data set? The basic idea of statistical inferences presupposes that all population values are not present (missing, in other words) in a sample, and decisions are made on the basis of those sample observations. But the sample drawn for statistical inferential purposes presumes that the units in the sample are drawn randomly. Thus, if data are missing in random manner, the analysis does not produce poor result in general. Data with missing observations produces biased results if the missing values are not missing at random. The different patterns of 'missingness' of data are as follows:

1. **Data Missing at Random (MAR):** Here, in a set of data on two variables (categorical or numerical) where no x-value is missing, for a known x-value, the missing values of y are random. Missing value of y depends on x-value, but not on y-values. Missing y-value is MAR if the probability of y missing depends on x-value, but for a given x, the probability of y missing is unrelated to y-values.

In a market survey, if respondents are asked about their 'profession' (service, business etc.) and 'income', respondents may not be unwilling to report their 'profession', but they might be unwilling to report their income, within a particular type of profession. For a known type of profession, the missing value for income may be random. The probability of missing value for income depends on nature of profession, but it does not depend on income itself, in case of MAR. If income data are missing at random (MAR), conditional on nature of profession, the distributions of missing and available incomes will be similar among the respondents of same nature of profession.

2. **Data Missing Completely at Random (MCAR):** Here, the missing value of y neither depends on x, nor on y. The level of randomness is more in this case. When data are missing completely at random, the missing values may be viewed as a subset of randomly chosen values from the whole set of population values. In this case, the distribution of missing values and available values are similar.
3. **Data Missing Not at Random (MNAR):** Here the probability of y missing depends on y-value. For example, in a survey, the respondents with high income is less likely to report their income. Thus, probability of missing values for income depends on income itself in case of MNAR.

It has been observed that as the conditions of the data move from MCAR to MAR to MNAR, the distribution of the data values becomes increasingly different from that of the population. The pattern of missing value is much more of importance than the number of missing values in order to handle the complexity of the situation. Of course, the more number of missing data, the more loss of information will be and the lower will be the precision of the statistical inference based on the data. Before analyzing the data with missing values, it is important to see if the missingness is random or not. To assess if the missing data occurs randomly, we may form two groups - one consisting of cases containing missing values and the other group consisting of cases without missing values. Then two groups are compared for patterns of significant difference. If these patterns are found, then that suggests a nonrandom process of missing data.

If the missingness of data is of the type MCAR, one technique is to simply delete subjects with missing data. It is known as case deletion or list-wise deletion. This method is straightforward but has significant disadvantage of increasing standard error through the deletion of the entire subject. This method works well if only few subjects are responsible for substantial portion of the missing data, or if a very few data are missing. When missing data are not MCAR, the results derived by using case deletion approach may be biased.

Another approach to handle missing value is to use imputation techniques. Imputation refers to estimating missing values by some method and then using the estimates in subsequent statistical analysis as if there were no missing data. Many different forms of imputation are available in the literature. The most simple method is the mean (or mode) imputation or mean (or mode) substitution. This method uses the mean (or mode) value of a variable for any subject with missing data on that variable. This method of imputation is a conservative procedure and reduces the variance of the distribution. The second method is random imputation, where the missing value is replaced by a value chosen randomly from the available values.

Sequential hot deck imputation technique adopts the process of arranging the whole data randomly, and then utilizes the value adjacent to the missing value as the imputed value. More sophisticated method of estimating missing value is the use of regression techniques. Here a regression model is constructed with other variables as independent variables and the variable with missing data as the dependent variable. The equation is derived from subjects without missing data and then it is used to predict the missing values from the remaining cases. This model based approach for handling missing values gives more accurate estimate of missing values but it is computationally complex. Modern approaches to imputation include maximum likelihood estimation and multiple imputation techniques.

5. DETECTING AN OUTLIER

An outlier is an observation that is dissimilar to the rest of the data. Our concern is to assess the extent to which the conclusion of a study is affected by the presence of outliers. Several questions may arise. Should they be kept or deleted from the data set for computing statistical summaries or drawing inferences? What causes some observations become very much different from the others? Do they indicate any special characteristics of the distribution of concerned variable(s)?

Towards handling outlier observations the first task is to identify the presence of it in a data set. Finding outliers in univariate data is relatively simple. There could be many possible reasons for the presence of outliers in a data set. It could be due to measurement error (data entry error, error in coding etc.), it could be resulting from an extraordinary event with an explanation or an extraordinary event without having any explanation. If it is caused by an extraordinary event with an explanation, it should be kept in the data set, as it may be a genuine data point. Otherwise, usually the outlier is deleted during data cleaning.

There are several methods of detecting outliers. One such method is based on upper and lower quartiles of the data set. Any value lying 1.5 (for a suspect outlier) or 3 (for an extreme outlier) times interquartile range below lower quartile or above upper quartile is considered an outlier.

Various graphs can also give some idea about the presence of possible outliers. Histograms provide a clear way to view the outliers, if any, in the data set, together with the central values, shape, range of values. It helps identify the outliers by eye inspection, which are the data points outside the range of expected values. Box plots also help in identifying the outliers. Box plots combine visual detection of outliers together with some other important summary statistics. Stemplots, dot plots are also useful for this purpose for relatively smaller data sets.

Another approach looks at how much each data point deviates from mean. The easiest way of doing this is to transform the data values into z-scores ($=\frac{x-\overline{x}}{s.d.}$). Each data point will then represents how far it is from the mean, below or above, in number of s.d. units. The z-score over 3 or below –3 is viewed with suspicion.

In a bivariate set up scatter plots can help identify bivariate outliers visually. The absolute standardized residuals from the regression line greater than 3 indicate the presence of outliers. It may be noted that there can be some outliers in this bivariate set up, even if there is no outlier in the data set on each of the two variables. In case of multivariate data it is difficult to visualize the outliers without the aid of statistical software. The usual measure of multivariate outliers uses Mahalanobis distance, which measures the distance of a case from the centroid of the data set, where the centroid is a point in space represented by the means of all the variables.

Mahalanobis distance of a point x is given by

$$D(x) = \sqrt{(x-\mu)'\Sigma^{-1}(x-\mu)}\,,$$

where μ is the mean vector and Σ is the variance-covariance matrix of the multivariate data set.

Estimated Mahalanobis distance of a point x is given by

$$\hat{D}(x) = \sqrt{(x-\hat{\mu})'\hat{\Sigma}^{-1}(x-\hat{\mu})}\,,$$

where $\hat{\mu}$ is the estimate of mean vector and $\hat{\Sigma}$ is estimate of the variance-covariance matrix of the multivariate data set. Usually $\hat{\mu} = \overline{x}$ (sample mean vector) $\hat{\Sigma} = S$ (sample variance-covariance matrix), and thus

$$\hat{D}(x) = \sqrt{(x-\overline{x})'S^{-1}(x-\overline{x})}\,.$$

Higher $D^2(x)$ value represents that the observation is farther from the bulk data set in the multidimensional space. In other words, whenever an observation has an unusual behavior, the Mahalanobis distance of the case from the bulk of the cases becomes significant.

It can be seen that if the data come from a *k*-variate normal distribution, then

$$\hat{D}^2(x) = (x - \overline{x})' S^{-1} (x - \overline{x})$$

can be represented as $\dfrac{(n-1)^2 kF}{n(n-k-1+kF)}$, where *n* is the number of independent observation vectors, and *F* is a central *F* random variable with *k* and (*n*-*k*-1) degrees of freedom. Finally, we get

$$F = \frac{(n-k-1)n\hat{D}^2(x)}{k(n-1)^2 - nk\hat{D}^2(x)} \sim F_{k,(n-k-1)}.$$

Using a conservative approach an observation *x* is considered an outlier if the observed *F* exceeds the critical value $F_{\frac{\alpha}{n},k,(n-k-1)}$. The drawback of this procedure is that it can verify if a data point in *k*-dimension is an outlier or not, but it cannot provide indication about which particular variable (or variables) is behind the high value of $\hat{D}^2(x)$.

An alternative approach is based on the fact that the estimated Mahalanobis distance

$$\hat{D}(x) = \sqrt{(x - \overline{x})' S^{-1} (x - \overline{x})}$$

follows a chi-square distribution with *k* degrees of freedom if the data come from a *k*-variate normal distribution. We can compute, for each sample in *k*-dimension, the value of $\hat{D}(x)$ and the 97.5% quantile ($Q_{0.975}$) in the chi-square distribution with *k* degrees of freedom. All samples with $\hat{D}(x) > Q_{0.975}$ will be considered an outlier.

Once outliers have been identified, the next question is what to do with them. Sometimes these outlier observations are real data points and represent a unique aspect of the population. They contribute to a complete understanding of the population. These outliers, of course, should be retained in the sample. Deletion of them may produce good results but the results might have lack of generalizability.

The outliers can be viewed as beneficial or problematic. An outlier is beneficial if it indicates a certain characteristic of the population, which could not have been noticed otherwise. An outlier is problematic if it is not representative of the population, and goes against the objectives of the study. No matter what, an outlier should always be evaluated in the context of analysis and information available. If most of the outliers, however, are due to the presence of one variable, it is then advisable to exclude that variable from the analysis.

If the outliers are retained to achieve more generalizability of the inferences drawn, then their values may be modified so that they would not be overly influential in dominating the results of the study. Outliers may cause a data set skewed. The influence of outliers on the results can be reduced by using transformation of data, as skewed distribution (non-normal) can be changed to normal using suitable transformation. Another option to reduce the influence is to run the analysis twice, once with outliers included and once without. Both the analyses are done with untransformed data and the results can be reported. Readers are referred to Barnett and Lewis (1994) for further reading on this issue.

6. HANDLING NON-NORMAL DATA

Another important issue in data analysis is handling of non-normal data. What strategies are to be adopted when the data do not appear to be normally distributed? Data transformation is useful for handing a number of distributional problems, such as lack of normality in distributions (univariate or multivariate), lack of homoscedasticity, nonlinearity etc.

Some distributions such as skewed or bimodal distributions are not well behaved, and data transformation may be useful to create symmetry in them. Sometimes the presence of extreme values in the data makes the data skewed, and data transformation helps in reducing their influence on the inferences drawn from the data.

In order to transform skewed, unimodal data, power transformation of the form X^q can be used. The X^2 (square-transformation) makes the negatively skewed distribution more symmetric. The cubic-transformation, X^3, reduces the extreme negatively skewed distribution to a relatively more symmetric distribution. The square root-transformation ($X^{\frac{1}{2}}$) and log-transformation ($\log_{10} X$) reduces the positive skewness in a data set. If the distribution differs moderately from normality and is positively skewed, then square root transformation should be tried first. If the distribution is substantially different from normal and is positively skewed, then logarithmic transformation is recommended. Logarithmic transformation is particularly good for stabilizing variances in a data set. Negative reciprocal root transformation, i.e., $-\frac{1}{\sqrt{X}}$ reduces extreme positive skewness in the data set. In a skewed distribution, values are closer to each other at one end of the distribution than the values at the other end. The values of power q greater than 1 are used to adjust for the problems of negative skewness, as they tend to change a distribution by shifting the area of the distribution to its upper tail. On the other hand, the values of q less than 1 change the problem of positive skewness in a distribution by shifting the area towards the upper tail.

It is possible that not by doing right transformation we may over correct the shape of the distribution. For example, when we apply a cubic transformation to a moderately negatively skewed data, it becomes a positively skewed data, and thus leave us no better off than where we started. A square transformation works much better in this case. So the question comes how to select the right power transformation. One should use trial and error for this purpose.

The biggest limitation of using data transformation is the possible difficulty in interpreting the transformed observations.

We can consider the following guidelines regarding the transformation of data: do not transform the data if:

- The deviation from normality and linearity is not too extreme
- The sample size is large, say, over 30
- The robustness of the statistic to be used is known.

Some other transformations used for different purposes are as follows (Roychowdhury, 2012):

1. ***z*-Transformation:** Transformed value = (original value – mean)/s.d.
2. **Min-Max Normalization Within (*a*, *b*):**

$$transformed\ value = a + (b-a) \times \frac{(original\ value - original\,\min)}{(original\,\max - original\,\min)}$$

3. **Logit Transformation:** $f(p) = p/(1-p)$, for data expressed in proportions.
4. **Box-Cox Transformation:** When a variable does not conform to the assumption of normality, but the data analysis method requires the data to come from a normal distribution, then one may use the following transformation, known as Box-Cox transformation, given by transformed value = $\{(\text{original value})^{\lambda} - 1\}/\lambda$, $\lambda > 1$ (Box and Cox, 1964).

7. VALUE MAPPING (OR CODING) AND DISCRETIZATION

For the purpose of analysis, sometimes, the ordinal variables described by letters or texts may be required to be converted to numbers. For example, the response of an employee working in an organization to a question regarding his or her job satisfaction recorded as low, medium and high may be replaced by the codes 0, 1 and 2. A nominal variable can similarly be handled, e.g.,'0' may indicate the absence and '1' may indicate the presence of a certain attribute, such as a subject is a male or a female, technical staff or not, permanent or contractual, etc. One should be careful about analyzing these coded data, since they are not actually numerical.

Similarly, sometimes for some statistical analysis, it becomes necessary to convert the continuous data into discrete values, or different categories. For example, 'age' is a continuous variable. By defining the variable as 'age on last birthday (l.b.d.)' we can make the continuous variable 'age' discrete. A continuous variable 'credit score' may be categorized as poor, average, good, excellent (ordinal). By converting continuous data into discrete we may lose information. But these conversions may be necessary in many situations. There are some techniques which are capable of processing only categorical data, and hence conversion of continuous data into discrete categories makes the data usable for these methods. When we wish to test if the salary has any effect on absenteeism of the employees, we can carry out a χ^2-test with a number of categories for salary ('high' if salary is more than Rs.1 lakh per month, 'medium' for 'between Rs.50,000-1,00,000' and 'low' for 'below Rs.50,000') and for absenteeism ('more than 5 days' in a month, 'between 3 and 5 days' and 'less than 3 days').

8. META ANALYSIS

Meta analysis is a different type of study, which is essentially a study combining many previous studies on the same subject. In other words, in meta-analysis researchers study that topic which has been the subject of study of previous many studies. It considers all previous studies as a combined group and try to find patterns that were not evident in the individual studies. It must be noted that for the purpose of meta analysis the populations of all individual studies must be same, and all the samples must come from that population. Meta analysis helps reveal even small relationships between variables, trends, which are otherwise hidden in individual studies. It can obtain more precise estimates of various relationships present in data. Different patterns across studies can also be detected in meta analysis.

Meta-analysis is an observational study in nature. It might bring the Simpson's paradox in the conclusion if not carefully analyzed. When data from several sources are combined, there is a possibility that some unreported variables (lurking variables) may cause a reversal of the findings. When the results of a meta analysis are interpreted, it is necessary to ensure that the Simpson's paradox (also called Yule-Simpson effect) is not affecting the conclusions. Below is a part of a meta analysis study, where we can see such reversal of findings.

In a study on survival rate of smokers and non-smokers, the following counts are obtained (see Table 4).

We find the survival percentage of smoker group as $\frac{443}{443+582}\times 100 = 43.2\%$ and that of non-smoker group as $\frac{502}{502+732}\times 100 = 40.68\%$. It is observed that the smoker group has more survival percentage. Does it not seem to be unusual?

Later we find that the data was a part of the whole data where the survival percentages for each age groups were studied (see Table 5).

Now we observe that the previous conclusion is reversed. It is now observed that, for most of the age groups, the survival percentages for non-smoker groups are higher. Here we observe that the effect of age is confounded when the age is not taken into account while making conclusion about the survival rates.

Table 4.

Smoker		Non-Smoker	
Survived	**At Risk**	**Survived**	**At Risk**
443	582	502	732

Table 5.

Age Group (Years)	Smoker			Non-Smoker		
	Survived	**At Risk**	**Survival Percentage**	**Survived**	**At Risk**	**Survival Percentage**
18-25	53	55	49.07	61	62	49.50
25-35	121	124	49.38	152	157	49.19
35-45	95	109	46.58	114	121	48.51
45-55	103	130	44.52	66	78	45.83
55-65	64	115	33.75	81	121	40.04
65-75	7	36	16.30	28	129	17.83
75 and above	0	13	0	0	64	0
Total	443	582	-	502	732	-

The reversal of conclusion when data are combined from several sources or groups is called reversal paradox or Simpson's paradox. It happens to the survival data given here. In this case the variable 'age' plays the role of lurking variable.

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Chapter 4
Application of Lens Model in HRM Research:
An Effective Tool for Measurement and Analysis

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ABSTRACT

The appropriate use of data-gathering tools and statistical analysis is a formidable challenge in several domains of HRM research. The application of Brunswik's lens mode offers an innovative strategy in this context. Brunswik's lens model is presented and its procedural application as suggested by Hammond in terms of social judgment theory is elaborated. A broad range of application domains including multiple-cue learning, cognitive conflict, policy formation and social issues is described. Studies carried out in Indian context are reviewed. The immense possibility of application in HRM domain is indicated. The idiographic-statistical elements are pointed out. It is asserted that the application of lens model in HRM research would pave the way for greater elegance and expansion of research.

INTRODUCTION

A basic problem in social and behavioral research concerns measurement and analytic tools. While measurement of relevant variables is generally carried out in the form of questionnaires, survey instruments and psychometric tests, the scientific rigor demands that two fundamental requirements be met. First, the tools must have culture-

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specific meaningfulness. Second, the measuring devices must have equivalence across groups or cultures. Cross-cultural investigators term it emic-etic dilemma.

The recent emphasis on globalization with its catchy slogan "think globally and act locally" has stressed scientific efforts to look for novel ways of dealing with this emic-etic dilemma. Egon Brunswik's lens model offers immense possibilities to meet challenges in this direction.

THE IDIOGRAPHIC APPROACH

In mainstream research, the basic objective is to compare groups with respect to one or more variables. This is termed nomothetic approach. In contrast, the idiographic approach examines the complexity of individuals trying to secure adaptation with an uncertain environment. While several cues are available in an environment and these cues can be utilized to maximize one's adjustment, people differ with respect to the extent of cue utilization. For example, an intelligent person may identify a wise person on the basis of cues such communication skill and analytical ability of the target person. On the other hand, a schizophrenic may identify a wise person on the basis of his or her dress and hair style. Similarly, a competent doctor may diagnose a disease correctly on the basis of cues that indicate main symptoms of the diseases. In contrast, a quack may handpick incorrect symptoms as cues and may lead to wrong conclusion. While examining, care is taken to make sure that the individual is utilizing cues consistently in statistical sense of the term. That's why the approach is termed idiographic-statistical approach.

Egon Brunswik (1952) gave a formal expression of probabilistic functionalism. It is concerned with nature of the organism's adaptation to its environment. Brunswik believed that the fundamental problem in behavioral science is that of studying how the organism comes to terms with an uncertain environment. He argued that it is wrong to seek general laws of behavior, rather it is appropriate to seek general description of behavior.

Another distinctive feature of Brunswik's methodology involves its representative design, not the systematic design. In representation design, the investigator attempts to find out whether or not the individual is utilizing specific cues consistently across a representative sample of tasks. The idiographic element looks into the consistency across trials whereas representative feature entails consistency across situations.

Egon Brunswik (1952, 1956) is a prominent cross-cultural psychologist. He introduced the concept of lens model as a way of conceptualizing the environment in general and cultural environment in particular. Later Kenneth R. Hammond (1966) proposed the empirical framework of social judgment theory with a view to expanding the application of lens model. An understanding of social judgment theory is a prerequisite for using lens model in applied research.

SOCIAL JUDGMENT THEORY

Hammond (1966) contents that humans learn, adapt and achieve in probabilistic circumstances. For instance, several parameters predict weather. It is also the fact that each of the parameters has a definite relationship with weather prediction. Yet, an individual is far from grasping the relative importance of each of the parameters in weather prediction. Individuals may identify wrong cues (parameters) as predictors of weather. The actual happenings (e.g, rain) may provide corrective feedback and the individual gradually alters his or her priority system. It is important to recognize that there is an objective (scientific) relationship between a cue (e.g., temperature) and weather (e.g., rain); there is also a subjective (perceived) relationship between the cue and the outcome (weather). The former is called achievement while the latter is known adaptation. It is possible to evaluate as to how an individual is moving from adaptation to achievement.

A similar example can be cited from another domain. A number of cues such as intelligence, knowledge, connectivity and technical skills may be objectively linked with leadership effectives. Yet different individuals might have learned differential priorities of these predictor cues. The importance attached may change across career span. But a legitimate scientific inquiry concerns the identification of an individual's priorities across these predictor cues. Social judgment theory essentially probes into this type of social adaptation of individuals.

Brunswik also maintained that, fundamental to the judgmental task is the distinction between cues that constitute the information available to a person making judgments and the criterion, the variable that the judgments are about. Brunswik viewed that, the relations between cues and criterion were to be considered probabilistic in real world judgment tasks because actual outcomes are always being affected by factors unique to a given prediction problem. Thus, predictability from a given set of cues common to many cases becomes less than perfect.

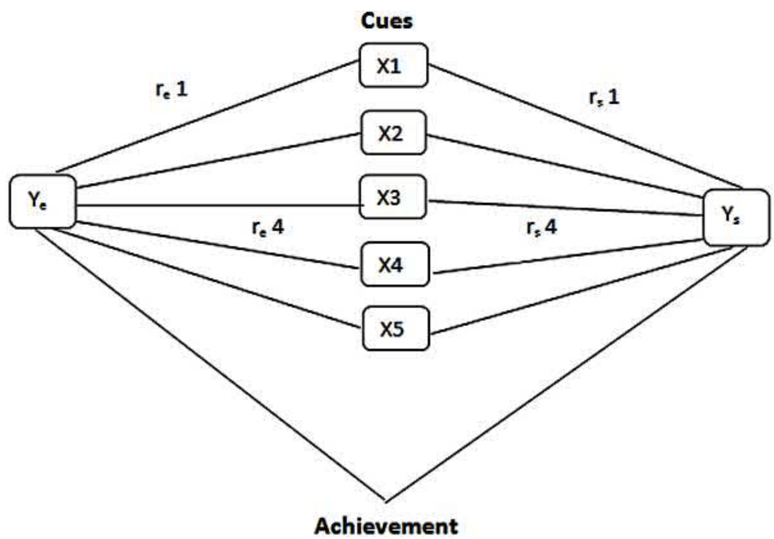
BRUNSWIK'S LENS MODEL

The lens model represents situations where individuals are expected to make decisions. It is obvious that any situation contains a number of cues. For example, a teacher encountering a student finds several cues such as students dress, eye glances, communication style and physical proximity. The task of the teacher is to delineate the most useful cues in predicting the adaptability of student (see Figure 1).

The lens model is a framework of depicting the relation between the environmental (situational) cues and prediction (behavior). According to Brunswik, people have their own pet theories linking environmental cues and outcomes. For instance, a person may hypothesize that an individual's clarity in expression is a stable and strong predictor of his or her wisdom. However, this initial assumption may be strengthened or revised by subsequent experiences. Accordingly, Brunswik believed that the examination of correlations (linkages), is not the group comparison, is the proper representation of the realities in the world.

The lens model is so called because it is depicted in the form of a convex lens. It is helpful to have an illustration. Suppose we are interested in the academic achievement of a student. Academic achievement depends on several parameters such as hard work, intelligence, attentiveness, class participation, and group work. These are the cues that are related to the outcome (academic attainment), but none of these cues does have one-to-one relationship with the outcome. Figure 1 shows the cues in the center of the diagram. During the process of judgment, the subject perceives different strengths linking cues (X_1 through Y_5) and the outcome (academic achievement). Obviously, some linkages (correlation) are perceived to be strong, while others are perceived weak. Once we generate all correlations, it is possible to identify which one is perceived to be a stable predictor.

Figure 1. Lens model



A functional relation exists between each cue and each Y. As indicated earlier, the linkage is expressed in terms of linear correlation between each cue and the judgment (e.g., r_s2) and also between each cue and the environment (e.g., r_e1). Further, the correlation between the judgment and environment is the achievement index (Ry_sy_s). in other words, greater is the match between a participant's judgement and actual dependent variable, higher is the level of achievement.

The examination of pattern of correlations between cues and judgment (the dependent variable), helps to identify important cues perceived by the judge. In the event that x_3 yields higher correlation with the judgment compared to the association between y_4 and judgment, it is the participant considers x_3 as more relevant than x_4 in predicting the outcome. For example, a student may judge and predict the effectiveness of a teacher on the basis of the cue of communication skill, not on the basis of scholarship.

The pattern of associations between cues and judgments may depict the difference across judges. For example, the first judge (say, a student) may show a strong association between hard work and judgment of academic attainment whereas a second judge (say, a professor) may show a smaller association between hard work and judgment of academic attainment. In contrast, this judge (professor) may indicate strong association between class participation and judgment of academic attainment.

AN ILLUSTRATION FROM HRM RESEARCH

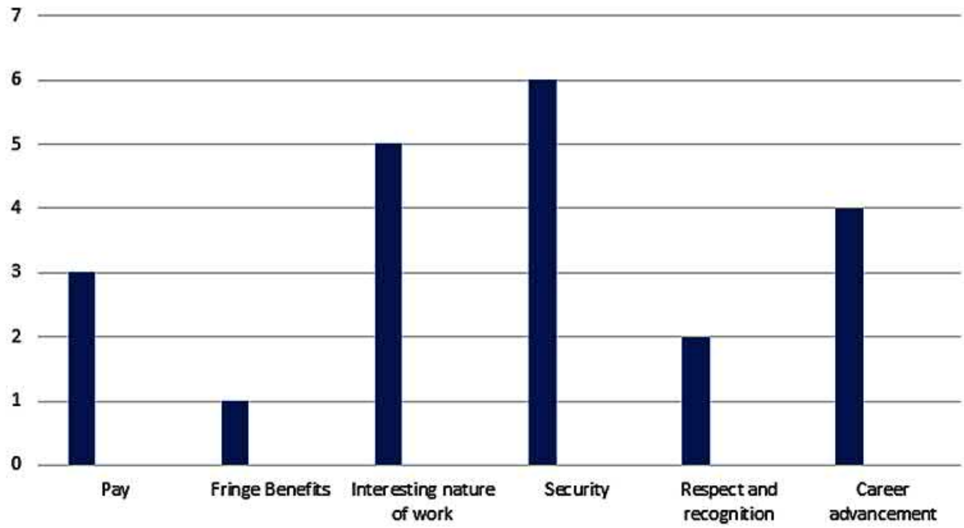
The application of lens model can best be demonstrated with illustration from HRM research. The case of job satisfaction is a typical situation. When employees anticipate job satisfaction several predictors (cues) enter the process. The cues may include magnitude of pay, fringe benefits, interesting nature of the work, security, respect and recognition, and career advancement. Employees take into consideration all these cues, yet weightages attached to each of the cues are different. With application of lens model, it is possible to identify the weightage system for each cue for each individual. In research, two types of profiles are used: pictorial and verbal.

Pictorial Profile Format

In this format, bar diagrams are presented. Each bar depicts a dimension (cue). The magnitude of a cue is indicated by the height of the bar. Different bars have differential magnitude (see Figure 2) across profiles. The following instruction is given for participants receiving pictorial profiles.

A number of pictorial profiles are presented. Each profile describes a job situation with certain characteristics. The extent of each characteristic is indicated by the

Figure 2. An illustrative pictorial profile



height of the bar. See through each profile and indicate the extent of job satisfaction you expect to derive in that condition. To help you to indicate your judgment, you are given a 20-point scale where a rating of '1' indicates least satisfaction and '20' indicates maximum satisfaction. Move forward from profile 1 through 35.

Verbal Profile Format

In verbal profile, similar instruction is given to subjects (participants). However, the magnitude of each cue is indicated verbally. For example, the previous profile can be stated indicated below:

Profile 1 represents a job condition where pay is *moderate*
fringe benefit is *negligible*
interesting nature of the job is *abundant*
security is *exceedingly high*
respect and recognition is *low*
and career advancement is *somewhat more*.

Please indicate the extent of your job satisfaction on a 20-point scale where a rating of '1' denotes least satisfaction and a rating of '20' denotes maximum satisfaction. Move forward from profile 1 through 35. Thank you for your cooperation.

Analysis

The verbal profile can be altered to suite description. The behaviorally-oriented description may take the following form:

The manager is

Rarely sincere
Never approachable
Almost always available
Sometimes dependable
Often helpful

The basic objective of the analysis is to identify significant dimensions of judgment. It is possible to compute product moment correlation between cue magnitude (for example, never =1, rarely = 2, sometimes = 3, often = 4, and almost always = 5) and outcome judgment (i.e., job satisfaction) across 35 profiles. It is important to note that there is nothing sacrosanct about 35 profiles; ideally a greater number of profiles are to be used. Similarly cue magnitude may be varied cross several levels (say, 10-point scale), not necessarily six-point and five-point scale as cited in the pictorial and verbal profile examples respectively. Furthermore, the outcome judgment may also a substantially spaced judgment scale, not necessarily 20-point scale. It is obvious that from the matrix of correlation it is possible to identify significant dimensions as well as non-significant dimensions of judgment.

The idiographic nature of the data imparts information regarding each individual separately. Of course, it is possible to generate nomothetic data from this idiographic information. For example, it is possible to determine whether or not male and female employees attach similar weightages to predictors (cues) of job satisfaction.

Group Comparisons and Analysis

Group comparisons are possible on the basis of lens model data. For examples, comparison across gender groups is possible with respect to weightages used for predictors of stress. Measures can be analyzed in terms of t-test or analysis of variance. However, it is important to note that judgment indices are correlation. Prior to using correlation data for group comparison (e.g., t-test or ANOVA), it is required that correlation data be transformed into standard scores by using Fisher's r to z transformations. with such transformations, parametric statistics can be applied to make group comparisons.

Domains of Application

The experimental nature of the lens model gives it a broad generality to study issues including cognitive studies, policy formation, social issues, and organizational setting. Recently, studies carried out in Indian sociocultural system document the application of lens model. The bulk of studies provides clear pointers for planning and undertaking investigations in HRM domain.

The Diversity of Application

The range of cultures, contexts and issues illustrates the broad generality of the use of lens model. An overview of studies clearly shows the contours of past exploration as well as future investigation.

Multiple-Cue Learning

It is almost axiomatic to state that many of the contemporary concepts we use are not monolithic, they are multidimensional. For example, the concept of *democracy* is a multi-dimensional one. Democracy entails freedom of press, equality in voting rights, economic justice, social justice, and gender equity. Yet different people may attach differential weights to these parameters. Similarly, different groups (say, national groups) may also attach varied priorities to these cues. American may consider a system democratic when freedom of press is essentially ensured. In contrast, Russians may view a system democratic when social justice is guarantee. Thus, the lens model can appropriately be used to map and identify "important cue" as perceived by an individual (or a group). Such as identification would be useful in three different forms. First, it could have a diagnostic purpose of delineating the importance attached. Second, the learners (subject) could be provided feedback with respect to other cues neglected / ignored by them. Third, the model could be used for conflict resolution. For example, the information obtained from the use of lens model may help to clarify as to why Americans and Russians differ with respect to their perception of democratic system.

A cross-cultural comparison was made by Gillis and Islam (1987) on the personality components of adjustments. The study was intended to determine whether advanced university students of India and the USA differ in judging how well-adjusted a person with a constellation of traits would be. The findings indicated that university students both in India and the USA do not differ, they attach similar priorities to traits such as intelligence and tolerance as the main components of adjustment.

Cognitive Conflict

One of the specific research paradigms employed extensively by Brunswikian social judgment theory researchers is interpersonal conflict. It is axiomatic to say that conflict arises because of the differences at several levels. There may be conflict because two different persons view different parameters as salient feature of a concept. For example, an individual may prioritize the price of a commodity as key element whereas another individual may view availability of the commodity as an essential feature. Obviously, this would lead to interpersonal conflict while taking the purchase decision. Similarly, a person may judge hardwork as the primary strategy for goal-attainment while another person considers social connectivity as an effective strategy. The resolution of conflict between persons will depend on learning each other's priority and on decentering one's own approach. When people are placed in lens model training situation and learn the value of other person's priorities the conflict is reduced to a substantial degree.

Similarly, lens model paradigms can be adopted to reduce inter-group conflict. Hammond (1975) noted that in addition to managing conflict, two significant aspects of transactions are learned. First, the comparison of decision making (judgment) brings to the awareness the role of the neglected parameters. Second, a person (or a group) learns about the other person (or group). The acquisition of information about others' personality preferences and strategies is very helpful in resolving conflict. Gillis and Moens (1974) used lens model to examine resolution of conflict in an Australian sample. Ten pairs of Australian University students participated in this study of conflict resolution. The researchers focused on the reduction of conflict across trails. They found that the participants progressively diminished their "policy" differences.

Policy Formation

Brunswik's lens model can readily be adapted to policy formation. The environment makes available a number of policy options with each option resulting in a number of effects. The policy maker has to judge the overall desirability of each option's effects and then select the option that will lead to the most desirable state of affairs. Brunswikian methodology can be extended to policy problems in order to improve the policy formation process by facilitating the selection of a policy option that maximizes achievement. For examples, there are several options for implementing population control. Yet, an application of lens model can identify the most effective option as perceived by relevant populations.

In an air quality management study (Mumpower, Veirs & Hammond, 1979), the model was used to describe the causal link between a number of potential interventions that make-up the policy options (controls on population growth, e.g.) and their projected effects. The result was the achievement of a set of policy options leading to the most desirable possible set of effects.

Study by Adelman, Stewart and Hammond (1975) applied social judgment theory to policy formation. The purpose of the study was to help participants develop an organizational policy for program evaluation, at an educational research institute.

Hammond (1975) reports a study involving handgun ammunition policy. Expert judgment models were used to generate the links between the technical characteristics of guns and resolution of conflict with regard to acceptance of the gun between police personnel and civil right activists. In a city there were frequent reports of hard crimes and there was public demand to curb the crime. In order to deal with the situation, police personnel wanted to have gone with greater firing power. But this was resisted by civil right activists. The law enforcement agencies wanted to find a solution to this conflict. They made use of lens model to find out the features of a gun that was maximally acceptable to both police personnel and civil right activists. Accordingly, they present different profiles of gun with each profile depicting varied intensities of gun characteristics. Police personnel were asked to examine each profile and indicate their acceptability on a 20-point scale. Similarly, civil right activists were presented with these profiles and their acceptability ratings were obtained. On the basis of cross-comparison, it was possible to determine a specific profile that was acceptable to both the parties. Thus, it was possible to solve the conflict and it was useful to procure guns of specific characteristics for use in that crime-prone city.

Social Issues

Doherty (1980) reviews studies dealing with fairness of social policies. In the first study on fairness in faculty salaries, Roose and Doherty (1978) first found out what objective cues (say, length of service and academic pursuits) were considered for determining the salary of a faculty member. Then members of the Salary and Promotion Committee were provided with hypothetical profiles of faculty members. Each profile depicted varied magnitude of cues such as academic pursuits and length of service. The participating members were asked to predict salary. The results revealed that there was modest degree of discrimination against women.

The second study was conducted on the fairness in admission policy. A complaint was received to effect that a physically challenged student has been discriminated against. Again, the situation seemed eminently suited to an analysis in the tradition of probabilistic functionalism. A set of 10 hypothetical applicant profiles was prepared. Each profile varied conditions including physical features. The admission committee members were asked to examine each profile and indicate admission suitability on a 12-point scale. The result of the study established that the committee did not discriminate.

While the application of lens model has been undertaken in cross-cultural contexts, a specific focus on studies carried out in Indian setting provides information regarding its cultural validation. Sahoo and his associates have extended the model to a variety of issues and concerns.

INDIAN CONTEXT

Sahoo and Bidyadhar (1992) used lens model to identify the subjective components of psychological well-being as perceived by different professional groups. A total of 100 professionals, 25 respondents in each individual group of doctors, teachers, engineers and administrators were the participants. The cues presented involved control, family support, social support, competence, depression, anxiety, and job alienation. Cue values ranged from 1 to 7 and outcome values ranged from 1 to 20. The weightages assigned to cues by each participant was determined by correlating magnitude of cues and outcome across trials (profiles). The results indicated that family support and social support were significant dimensions of well-being for all four groups. Similarly, depression emerged as a significant negative indicator of well-being for all groups. However, competence was given importance only by the groups of doctors and administrators.

In a different study, Sahoo and Bidyadhar (1994) attempted to generate critical factors of work-family harmony. The study was conducted in two sessions and 60 adults (30 males and 30 females) participated in the study. Session 1 presented 25 profiles in the form of bar diagrams. Each profile depicted say cues. The cues involved emotional support from spouse, child-maintenance facilities, relation opportunities, neighbor help, adequacy of friends, and clarity of division of duties. The magnitude of each cue varied across 25 profiles (e.g., different heights of each bar across 25 profiles). Similarly Session 2 presented 25 profiles depicting conflict-inducing factors. The factors included liabilities towards relatives, temperamental differences between spouses, aspirational gap between spouses, family demands and work demands. As with the first session, each conflict-inducing cue magnitude varied across trails. Each participant the asked to examine a profile and indicate the extent of harmony (session 1) and extent of harmony (session 2) separately on a 20-point outcome scale. The examination of linear correlation between cue magnitude and outcome judgement showed interesting results. Child-related support emerged was perceived to be relevant in the context of harmony whereas temperamental difference was relevant for conflict. Family demands and work obligations were found to be relevant only for females.

Sahoo and Palchoudhury (1994) applied lens model to assess priority ratings given to indicators of job involvement and job satisfaction. Sixty employees in three equal-sized groups (teachers, bank employees and industrial personnel) judged the possible extent of job involvement and job satisfaction separately on the basis of differing magnitude of some predictors. Data identified significant predictors (dimensions) of job involvement and satisfaction. Later the participants were asked to apportion 100 marks across the dimensions so that their priorities as consciously considered could be ascertained. Interestingly it was found that the participants were not aware of the basis of their judgment. In other words, the significant dimensions derived from lens model data and significant dimensions as shown by their conscious apportioning were not the same.

Sahoo and Chakraborty (1995) used lens model to delineate significant indicators of well-being in adolescents. Boys and girls from both science and humanities streams were involved. The results showed that all groups attached weightages to educational attainment as a predictor of well-being; similarly, all groups viewed job uncertainty as a negative predictor of well-being. However, girls viewed family support as a relevant dimension. Competence, control and peer support were considered relevant by girls of science stream only.

Sahoo and Patnaik (2001) examined the relevance of lens model as a social research paradigm. They used the case of judging teachers' effectiveness as an empirical context. Further they used both the pictorial format (bar diagrams) and verbal format to examine cross-validity of the method. One hundred college students participated in the study. Each participant was provided with 35 profiles. Each profile described a hypothetical teacher by varying six dimensions: support, direction, knowledge, communication, enthusiasm, and exhibition. Participants were asked to indicate, on a 20-point scale, the effectiveness of a teacher separately described in each profile. Results indicated that participants regarded enthusiasm, exhibition, and knowledge as significant indicators of teacher's effectiveness. Gender difference in weightages to different indicators was observed. The type of presentation format (bar versus verbal) did not differ significantly.

Sahoo (2007) studied happiness-promotive factors with the use of lens model. The study involved a factorial design where males and females of three different groups (pre-adults, adults, and the elderly) were sampled. There were 25 participants in each of the six cells. Participants were given 35 profiles, each profile depicting varying magnitudes of six indicators. The indicators were economic affluence, professional success, positive spousal relation, children's academic attainments, promising job prospect for children, and smooth social relation. Each participant was asked to judge happiness, on a 20-point scale, for each profile. While all adults identified children's academic attainment as a significant dimension of happiness, adult males showed economic affluence as a predictor of happiness. Adult females and preadult females revealed spousal relation as a significant dimension of happiness.

Similar procedure was adopted to identify significant dimensions of unhappiness. The cues used for unhappiness judgment involved economic hardship, professional reverses, family discord, academic failure of children, strained social relation, lack of opportunity for individual growth. it was shown that all participants regarded children's academic failure as a significant predictor of unhappiness. All adults revealed economic hardship as relevant whereas elderly males considered professional reverses as a significant dimension of unhappiness. Furthermore, elderly females indicated family discord as a relevant dimension of unhappiness.

Sahoo and Mohanty (2010) applied lens model to examine critical factors of effective leadership in IT and non-IT professionals of Indian organizations. On the basis of review of pertinent literature, seven factors were initially selected. These included vision, articulation of vision, uniqueness of strategy, rational intelligence, emotional intelligence, spiritual intelligence, and maintenance ability. One hundred twenty professional ITs participated in the study; half of them were from IT sector while the other half were from the non-IT sector. Each participant was shown a profile depicting seven cues of differing magnitude. Each participant had to judge the leadership effectiveness on a 20-point scale. The magnitude of each cue varied across 35 profiles. Correlations between each cue and outcome-judgment were computed for each individual across 35 profiles. The analysis showed these emotional intelligence and spiritual intelligence were considered significant predictor of effective leadership. Group comparison indicated that IT professionals attach importance to articulation and spiritual intelligence. In contrast, non-IT professional emphasize maintenance ability and rational intelligence as significant dimensions.

While reviewing empirical studies involving lens model, Sahoo (2011) has highlighted the possibility of its application in marketing research. Possible cases of application have been described with suitable examples.

Sahoo, Mohanty and Sahoo (2015) have carried an empirical investigation to identify significant dimensions of women's feminism as perceived by management students. The critical dimensions of feminism were carefully chosen. These included visionary, idealistic, public figure, influential, activist dauntless and assertive. Male and female management students were provided profiles differing in magnitudes of these dimensions. Participants were asked to rate feminism magnitude on the basis of each profile. The attribute of activist emerged as a significant dimension for both male and female students. In addition, males considered visionary and assertive as relevant dimensions while females viewed influential as a significant dimension of women's feminism.

More recently Sahoo and Sahoo (2017) attempted to derive significant predictors of achievement as perceived by management students. Seven dimensions were chosen on the basis of the current practice adopted in business schools. These include quiz (objective questions), thematic long questions, thematic short questions, individual project, group project, group presentation, and case analysis. Participating students were provided with pictorial profiles. Each profile depicted differing magnitudes of attainments on these dimensions. They were then asked to predict the level of their academic achievement. The examination of idiographic data showed that attainment on case analysis emerged as a significant predictor for both academic achievement as well as placement success. However, female students viewed individual project as an additional relevant factor of academic achievement. With respect to placement success, females viewed thematic questions and individual project as relevant dimensions whereas males considered thematic long questions and group discussion as relevant dimensions. Interestingly students were not aware of the basis of their judgment.

Taken together, the bulk of studies conducted in Indian settings evinces the broad application of lens model across a variety of issues and concern. Researchers intending to use it in novel areas can draw on these studies. Considering the fact that the present focus is on HRM research, certain illustrative application to HRM domain may be explicated.

THE FUTURE OF LENS MODEL IN HRM RESEARCH

It has been posited that Brunswik's (1952, 1956) lens model, empirically explicated through Hammond's (1965, 1966) social judgment theory, holds immense possibilities in behavioural research including HRM domain. The past research has already demonstrated its usefulness in areas of cognitive conflict (Gillis & Moens, 1974), interpersonal conflict (Brehmer & Hammond, 1975), policy formation (Brehmer, 1974; Rorbaugh & Wehr, 1978), clinical decision (Gillis & Moran, 1981) and organizational planning (Smith, 1975). The generality of application has been amply demonstrated (Beal, Gillis & Stewart, 1978; Browne & Gillis, 1982; Wolf, 2000, 2005).

With respect to HRM domains, several key questions may be brought under lens model procedure. The functional areas of recruitment and selection, promotion, training, leadership effectiveness, work-engagement, work-life balance, job satisfaction and organizational change and development are some potential areas of research. A couple of representative examples may be cited. The selectors in and organization make a use of a sample of parameters to choose their employees. These parameters do not have equal weightage system. Some of the parameters may be overemphasized whereas some other parameters are neglected. Prior to using objectively correct and appropriate parameters (predictor), it is useful to understand the strength and weakness of currently used parameters. For such an objective, lens model is an appropriate tool. Profiles can be easily generated through computers. Alternatively, paper-and-pencil materials can be prepared as profiles. The presentation of a number of profiles with currently used cues and selection-judgment on the part of selectors would provide useful data. It would clearly show which of the parameters are considered relevant and which of the parameters are neglected. In addition to the judgment process, it would be also possible to examine the achievement component (i.e., the correlation between cue magnitude and the actual success / productivity of the employee in the real setting).

Figure 3 illustrates a sample profile for an associate professor rated on five cues thought to be important for promotion decision. A number of profiles are presented where range of each cues varies from 0 to 5. Target population is asked to indicate possibility of promotion from 0 to 10. A sample profile may be represented as given in Figure 3.

Another illustration can be offered. Since effectiveness of reward and compensation is a key issue in organizational, the lens model can appropriately be extended to identify effective compensation mode in an organization. For examples, bar diagrams may depict different magnitudes of the components of the compensation modality. Figure 4 presents a sample profile a compensation modes. A number of profiles are to be presented. Potential employers and employees may be asked to indicate the adequacy of compensation on a 20-point scale with respect to each profile.

With the advent of computers, lens model procedure is easy to implement. A researcher or a policy maker can sit down at a computer to generate a large number of hypothetical profiles and use potential populations (subjects in the case of research and employees in the case of policy formulation) for immediate analysis.

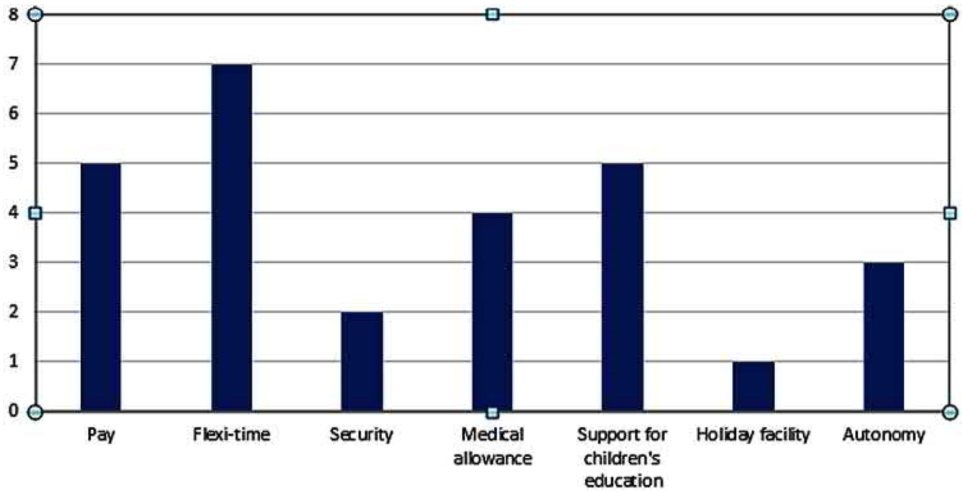
Figure 3. Sample verbal profile for judgment

Associate Professor has the following ratings on qualifications:

Seniority	**5**
Evaluation of teaching	**2**
Evaluation of University service	**3**
Refereed found publication	**4**
Conference participation	**1**

Would you recommend promotion to the level of professor for this candidate?
Indicate your outcome rating from 0 to 10.

Figure 4. A sample profile for judgment



It is possible to compare the relation between the cues and the judgment to the relation between the cues and the criterion. This can help to understand where the human is well and poorly calibrated in the environment. For instance, judges may show a strong association between scholarship and promotion, but criterion side may show a strong association between seniority and promotion. During Brunswik's time, the possibility of furthering the analysis in the form of multiple regression analysis was unknown. But this scope of taking the analysis forward through multiple regression analysis of cue-judgement relations is a significant value-addition to the existing procedure of lens model.

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KEY TERMS AND DEFINITIONS

Idiographic-Statistical Approach: The idiographic approach emphasizes individuals. Egon Brunswik, the noted cross-cultural researcher, highlighted the value of this perspective. The key element in this paradigm involves the identification of salient cues used by an individual to maximize his or her adaptation with the environment. Since the other key element looks into the consistency with while cues are utilized, this is known as idiographic-statistical approach. This is in sharp contrast with nomothetic approach where stress is placed not on individuals, but on the comparison of groups.

Lens Model: Lens model is an idea depicting the mode of adaptation of an individual with the surrounding environment. Egon Brunswik conceptualized the modality in form of a convex lens where several cues are objectively linked with a criterion in the reality. However, an individual makes use of differential linkages in his or her judgment. The model is helpful to identify significant dimensions of an individual's judgment process.

Pictorial Profile: In the lens model procedure, an experimental analog is created by presenting a number of pictorial profiles. Each profile contains bar diagrams representing different cues in different magnitudes. The individual examines each profile and makes a judgment with respect to an outcome (say, effectiveness of a manager). The examination of correlation between a cue magnitude and outcome judgment across profiles identifies significant predictor of an outcome as perceived by the individual.

Probabilistic Functionalism: Human adaptation do occur in a probabilistic environment. Although certain cues do have objective association with a reality outcome, people do not have such perfect knowledge. For example, a cue such as temperature may be having a mathematical relation with the weather (an outcome), yet the individual is unaware of this exact linkage. The individual considers several cues and selects a few cues to predict weather depending on perceived probability of functional relation between a cue and an outcome.

Social Judgment Theory: Drawing on Brunswik's concept of lens model, Hammond extended the lens model to a wide variety of social situations. In many situations of our social life, we are faced with the problem of making decisions. However, cues available in our environment are far from being adequate. Different individuals count on different cues to make decision. The application of social judgment theory is helpful to identify cues utilized by an individual. Accordingly such information can be used to understand, educate and reform the individual.

Uncertain Environment: This is a major assumption in the context of applying lens mode. Environment emits an infinite number of cues. The linkage between a cue and an outcome is far from being fixed. Since uncertainty is a basic property of the prediction process, behavioral scientists are urged to approach the issue by examining probabilistic functionalism (the most likely functional relation between cue and outcome).

Verbal Profile: Verbal profiles can also be used in lens model procedure. A verbal profile may depict different magnitude of a cue. For example, a teacher may be depicted as having moderate communication skill, somewhat interest in student, excellent scholarship and very good tolerance. An individual is asked to judge the effectiveness of teacher. Presentation of a number of verbal profiles depicting varying extent of cues provide the verbal mode of experimentation. The examination of correlation between cue magnitude and outcome provides information regarding the significant cues as perceived by an individual. Research shows that the use of verbal profile is as powerful as pictorial profile.

Chapter 5
Application of Statistics in HR Research

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ABSTRACT

Application of statistics in HR research has been briefly explained in our introductory chapter. It is now acknowledged, with statistics, we can ensure our HR research is more effective. Such research results can also help to take critical HR decisions at organization level. In this chapter, we have discussed on application of statistics in HR research in two critical areas, i.e., human resource planning (HRP) and performance management. Both in HRP and performance management, we can make extensive use of various mathematical, econometric, and statistical tools. Also, we have many established models. However, here our focus is restricted to only some of the simple statistical tools that can help in research in this two-critical human resource management areas. As the purpose of this chapter is to explain use of statistics in two major areas of HR research, it will cover only some selected areas of application. At the outset focus is on the specific research nitty-gritty, as these may help prospective researchers to get their basics clear, before they proceed for research in HRP and performance management areas.

HRP AND ITS STRATEGIC IMPORTANCE

HRP integrates all HR activities and the strategic plans of an organization to coordinate recruitment, succession planning, promotion, performance management systems and training and development. It is the primary level function of HR and it precedes all other functions of HR. HRP balances the demand and supply of

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manpower, aligning with the strategies and business plans of the organizations. Rothwell and Sredl (2000) observed HRP helps to analyze the environmental trends that may affect the HR supply chain and in the process, narrow the gaps between present human capital supply and the forecasted human capital demand. To ensure strategic alignment of HRP with the company's business plans, Rao and Rothwell (2005), recommended the need for developing a HR framework that can put more emphasis on results and measurable achievements. Rothwell and Sullivan (2005) also endorsed the similar views. In both the cases the use of balanced score card as a tool have been suggested.

For obvious importance of human resources, as the source of sustainable competitive advantage, now we also use the term human capital planning (HCP). HCP is a critical business process because of its transformational impact on the value the function delivers to the business (Brush and Ruse, 2005). HCP is used to identify the human capital needs of goals and objectives tied to the business strategy. According to Zula (2007), HCP involves the recruitment, selection, allocation, and retention of human talent (intellectual and knowledge resources), including the training and education of these resources, which are linked to critical business strategies; and goals and objectives to gain competitive advantage to earn above average return on investment (ROI). Brush and Ruse (2005) proposed a model of human capital planning based upon their work in industry. The model proposed by Brush and Ruse, detailed limited integration of multiple organizational systems to the alignment of human capital to business strategy. Zula contended HCP requires management support and participation; else it is not going to achieve success.

Human resources of an organization are no longer considered as important business constituent, it has now become almost inseparable from strategic and business planning issues. While the major part of human resource management issues focusses on its best optimization through practices, the process that starts after the acquisition of manpower; HRP or HCP issues are still not considered as critical, either for lack of knowledge or for unwillingness to invest time and money. Author's interactions with many top-level HR professionals (even in IT industry) were shocking; as organizations largely nurture lackadaisical attitude to HRP, people being available when they want them to hire. Their proclamation is partially true, as in many industry jobs are now fragmented and skill specific. Organizations now can also manage their manpower requirements through contingent workforce. But again, such trend is only up to specific nature of job and hierarchical level. A sudden change in top and middle level management takes the people of the organization through a cultural shock, and many prefer to quit for joining the rival organizations. Such organizational syndrome is evident from the corporate world across the globe.

Another reason for legitimacy of inclusion of HRP as part of the business and strategic plans of the organization is for the increasing complexities of business.

Business complexities are not only for globalization and intense competition, but for the internal pursuits of the organizations for frequent process changes through technology support, and for emulating the best business practices. Again, customers' expectations are changing. They want quality goods and services at a competitive price. Many business excellence models suggest us the ways and means to achieve this. But all these require availability of quality manpower, which are competent and flexible enough to take up this challenge.

Various other environmental constraints like; social, economic, and legal are also great influencers in HRP. We plan for business expansion, diversification, mergers and acquisition, or even for present business consolidation, but without HRP we are in haywire.

There are however organizations who are really concerned for HRP. These organizations consider HRP from a long-term perspective and align the same with their strategies and business plan (Burack, 1986). More relevant study by Doving and Nordhang (2010) on 3877 organizations across 21 countries, could identify the use of strategic human resource planning (SHRP) as an integral part of overall HRM strategies. However, HRP focus was found to be constrained by the resource support and the organizational endorsement. What is more astounding from their studies that organizations are unsure about the cost-benefit considerations for investment on HRP? Turner (2010) in his pioneering work published by CIPD, London suggests our renewed focus on manpower planning even in economic uncertainty from post 2008 period, changing its focus on organizational capacity planning. Turner argues HRP is increasingly becoming a compelling need for the organization to deal with both expected and unexpected events. HRP can also help the organization to contain cost by up-skilling without damaging its competitiveness. Obviously for such reasons, HRP needs integration with strategy and business plans, with flexibility to balance both the long-term and short-term business focus.

SHRP is now what we legitimately argue is a necessity for today's organizations. SHRP requires alignment of organizational HRP with their business and strategies, so that suitable manpower availability cannot become a deterrent factor in achieving the business results. Critical value of human resources in organizational sustenance and growth is now acknowledged. But such critical value can only be harvested when the flow of human resources is ensured through SHRP.

WHY HRP RESEARCH

The background information suggests growing importance of HRP research both for the academia and organizations. It is not just to perform this job as routine HR functions but a continuous process to ensure availability of quality manpower and even to manage the manpower redundancies as well. While the scope of academic research for HRP extends even to macro-economic issues, for organizations it may be restricted to specific areas to meet their requirements in alignment with their business goals and strategies.

At organizational level, HRP research involves activities like; forecasting of future manpower requirements, preparing inventory of present manpower, anticipating problems of manpower, and finally meeting manpower requirements. For all these activities, we require selection of appropriate research tools, including statistical tools (Bhattacharyya, 2007).

For doing HRP, HR managers follow certain steps like; doing job analysis to collect requisite information about a job. These require collection of job information from various sources and then relate the same with the specific nature of job of the organization. Even this also requires adequate research. Quite often organizations feel compelled to hire professional job analysts to chart the job content, without knowing even the person himself/herself or his/her supervisor can give better input. For technical jobs, technology vendors' product literatures also contain lot of information about the job. Scope of job analysis is just not limited to HRP, to take recruitment decisions; it also helps in other important HR decisions like; compensation management, job re-engineering, training and development, performance management and health and safety issues.

Succeeding steps of job analysis are job description and job specification. Job description is recording of duties, responsibilities and conditions needed for satisfactory performance of a job. For analyzing the job content (through job analysis), we need to create job family, grouping homogeneous nature of jobs. This helps to name a job (job description), which is the major role of HR manager. Even though operationally we use the terms job description and job analysis interchangeably, theoretically they are different. Job description denotes job content (conditions, tasks and responsibilities) and job specification defines the job requirements (i.e. qualities necessary) for satisfactory performance of the job. Thus, job specifications translate job descriptions into qualifications required for successful performance of a job.

HRP research also requires development of work rules, which are some pre-determined decisions about certain courses of action that may be taken when certain contingencies arise. Organizations develop such work rules in documented form and use the same as a control device to ensure predictability of behaviour. Starting and stopping of work, rest periods, time-keeping, insubordination, fighting or drinking on the job, smoking, report of injuries, etc. are normally incorporated in such work rules.

In HRP research, it is also necessary to understand various applications of industrial engineering techniques (work study, method study and work measurement techniques). These techniques provide opportunity for effective use of plant and equipment, effective use of human efforts, measurement of human work, better ways of doing things, developing pre-determined standard time etc.

Miscellaneous other factors in HRP research is layout plan, compliance with statutory requirements, shifts planning (including flexi-work issues), leave reserve etc.

Therefore, primary objective of HRP is to integrate planning and control of manpower with the organizational planning to ensure best possible utilization of all resources. This apart, HRP also facilitates in coordinating manpower policies of the organization, covering recruitment and selection, training and development programmes, placement and induction programmes, promotion and transfer policies, decisions on remuneration and rewards etc. Without proper coordination of manpower policies with each such decision, it is difficult to achieve the corporate objectives. Therefore, it is necessary to harmonize such objectives (corporate) with manpower planning system. Without co-ordination, company's plans may get frustrated for not having the right people in the right place at the right time. Other secondary objectives are; to achieve efficiency of work in all spheres of the organization, to ensure cost minimization, to eliminate all types of wastages including waste of time, to maintain required levels of skill and competency, matching present and future needs of the organization, etc.

For achieving all these objectives, it is important to undertake systematic HRP research.

HRP PROCESS

Basic HRP process compares the skill and competency gaps in the present manpower and accordingly develops plans for meeting such gaps for the future manpower (Bhattacharyya, 2012). HRP process ensures that required competency is maintained in line with organizational mission, vision and strategic objectives. HRP provides strategic basis for taking HR decisions, anticipating change. It is not merely concerned with manpower demographics, turnover projections, succession planning, etc. It helps to plan replacements and changes in manpower competencies in a systematic manner. Of late HRP has become an important enterprise-wide strategic function not only to achieve goals and objectives but also to sustain present level of achievement in organizations. Globally, skill shortages, competency gap, redundancies, rightsizing are the major issues in today's organizations. Such syndromes have become so acute that almost every day we find newspapers are carrying reports on job cuts or manpower redundancies. These phenomena have also changed the structure of employment relations.

There are many reasons for such manpower or human resource redundancy, although at corporate level, the only possible reasons attributed to such cause is skill obsolescence. Inadequate business planning, inflexibility of job descriptions, absence of training and development programmes are some identified causes for such problem. But the biggest problem lies with inadequate HRP.

Bramham (1994) has distinguished between HRP and manpower planning (MP). He has defined HRP as a process in which costs, numbers, control and systems interact and play a part. On the other hand, manpower planning is more concerned with the numerical elements of forecasting of manpower. However, other authors like; Bennison and Casson (1984), Thomason (1988) have discarded such perceptual differences, arguing that HRP and manpower planning (MP) is the same thing. For our purpose, also we have not considered any difference in HRP, MP and workforce planning and discussed the issues from a holistic approach.

To achieve any business goal, manpower requirement needs to be assessed, located and harnessed. HRP is not mere assessment of number of headcounts, it also categorizes manpower as per their knowledge and skills and so also to ensure their balanced allocation. Improper HRP or manpower planning may lead to over-staffing increasing direct cost (viz. salary), cost of training, amenities, apart from the cost of production. Under-staffing also affects production, morale and productivity.

Optimum HRP therefore aims at:

- Balancing demand, supply, distribution and allocation of human resources
- Controlling cost of human resources
- Formulating policy on transfer, succession, relocation of human resources

HRP is essential wherever production of goods and services are involved. This may be done either by external agencies (consultants, suppliers of plant and machineries) or internal agencies (HR Department, Industrial Engineering Department, Production Department etc.).

HRP RESEARCH AT ORGANIZATION LEVEL

Micro or organizational level HRP is a strategy for the acquisition, utilization and retention of human resource. It seeks to link policy and practice in day-to-day decision making. Thus, inter-relationships of HRP with other HR functions are established hypothesis, as evident from corporate practices. Micro level HRP follows four stages like; investigation, forecasting, planning and control of manpower and utilization. Each stage requires careful analysis by the researcher to ultimately decide the optimum manpower of the organization.

At investigation phase, the researcher, to start with, must develop awareness about detailed manpower, perform a SWOT analysis considering external environment, performance and productivity trends, working practices, operational and strategic plans. Scientific homework, at this stage itself can help to identify present and future skill gaps. For a better result, SWOT analysis can precede a cause-effect diagram (fish-bone diagram), which is simple to comprehend. While doing external manpower review, in the context of India, macro level issues need to be understood with due cognizance to the relevant literatures like; country specific Annual Economic Survey, Year Books on Labour, Survey of Industries, ILO International Year Book on Labour, various reports of Planning Commission on manpower, etc. Internal manpower review must be done with enterprise-wide current operational data, like; marketing, finance, performance data, current employment practices and methods, etc. Also, internal manpower review is done with a futuristic view with due cognizance to strategic plans and objectives.

In forecasting phase, the researcher assesses the demand and supply of manpower. We have different models of demand forecasting. Supply analysis is done considering both the internal and external supply. While doing internal supply analysis, career planning and development, training and development and succession plan aspects are considered along with corporate policies and procedures. For example 'promotion from within' as a corporate policy may or may not exist in a particular organization. Where it exist, it has to be understood for which levels it is applicable, is it a time-scale (seniority) promotion or promotion on merit, is there any policy on this, etc. Interestingly promotional decision is a prerogative of management, hence an employee, *prima facie* cannot contest such decision of management in a court of law, unless otherwise he or she can prove that such decision has prejudiced his or her interest. The onus of proving this lies with the employee concerned. Many organizations have their documented promotion policy, to address to the problem of personal bias in promotional decision. External supply analysis is done considering macro level issues to understand their availability. Since current employment practice is to employ people for a given time period, employment status also need to be assessed in terms of availability. Demand forecasting helps in identifying requirements of manpower for various positions at different point of time. What should be the status of employment (permanent, temporary, part-time contract labour, sub-contracting, etc.) will depend to some extent also on the nature of position. In many countries, we have the flexibility to hire for all positions from employee leasing companies on assignment basis. In some countries, however, scope of such engagement is limited to some specific jobs only. Moreover, people are by nature sensitized for contractual employment terms. This practice however, slowly catching up and since it is a total transition of attitude, it will take some time to settle down. May be 5-10 years time, job mobility will increase and people of new age will consider it as normal employment practice.

Planning and control of manpower translates forecasts of manpower into HR policies, encompassing HR issues like; recruitment, training and development, etc. While going for recruitment, it is necessary to understand the job descriptions, which precede job analysis. Also, it is necessary to document the status of recruitment, i.e. the time for which recruitment must be made. Most of the organizations have their own documented recruitment system. What should be best must be decided by the HR managers. Most of the organizations are besieged with the problem of restructuring. Hence extent and scope of internal hiring i.e. redeploying employees in restructured jobs also need to be understood. Similar efforts should be made in planning and documenting the training and development policies of the organization to address the problem of knowledge and skill obsolescence in the context of changing technology. Hence scope of redeployment through re-training also needs to be explored at this stage. While doing HRP, flexibility and interrelationships of all other policies also need to be considered. We must appreciate that manpower redundancy is not only for inadequate business planning but also for inadequate HRP, which among others, can be attributed to inflexible policies on redundancy, inflexible job descriptions (that restricts lateral job movement), inflexible employment conditions, absence of retraining and redeployment programmes, etc. Mere planning and documenting the policies cannot help. Control must be there to correct any observed deficiency in such plans. For example, offering voluntary or early retirement with additional benefits may transpire to be a costly decision than skill renewal of manpower through training and re-training. Similarly, outsourcing manpower through a body shopper may be costly than direct recruitment on contractual terms. Giving overtime to employees for sharing extra job load may be cheaper than recruiting extra hand (obviously if extra job load is seasonal). We can appreciate the need for control when manpower costs over shoot the budget.

Utilization is the final stage of micro level HRP process. At this stage, we measure success in terms of achievement trend, both quantitatively and qualitatively. While quantitative achievement is visible from productivity trend, manpower cost, etc. qualitative achievement is a subjective appraisal on achievement of organizational objectives. Reflection of qualitative achievement can also be studied in the context of prevailing industrial relations, level of motivation and morale, grievance pattern etc.

STATISTICAL AND QUANTITATIVE TOOLS FOR HRP

In HRP we make use of many statistical and quantitative tools and models. Some of these are; workload factor analysis, time series analysis, simulation, replacement, Markov Chain analysis, Cambridge Model, Renewal Model, etc. As the scope of this chapter limits its focus on some of the statistical tools, for HRP and performance management, we will restrict our discussions only on those statistical tools, which are popular and time-tested.

APPLICATION OF QUEUING THEORY IN HRP RESEARCH

Although queueing theory is classified under mathematics, it draws heavily from statistical theory. Hence using it as a statistical tool cannot be unwise here. Queuing theory is mostly applied in job scheduling. If we see the customer service operation of a retail bank, or a restaurant, maintenance services or even the scenario of inter-departmental coordination, the problem of queuing occurs, leading to customers' dissatisfaction and loss of business opportunities. In all these cases, the problem of queuing is attributable to improper planning for the human resources. Again, if we see these cases, companies cannot also over-recruit to solve these queuing problems, as the nature of the problems is time independent. What is important here is to optimize limited resources for best solution to such problems. Using the queuing theory, we can understand the queuing phenomenon and optimize our systems to manage the queue. With fewer queues we can increase the customer spread and gain in terms of productive use of resources.

To solve the queuing problem, first we need to design the queuing systems balancing the customers' services and optimization of our available resources. Accordingly, using the work breakdown structure (WBS), we understand various sub-systems or entities of queuing for different activities. WBS helps to identify the individual tasks in a job, which facilitates in understanding of tasks, and the time requirement. Also, it considers the resource requirement, and allocation of jobs.

Following information helps us to solve a queuing problem:

- Process of arrival of customers; say single arrival, arrival in group, etc.
- Probability distribution of arrival time
- Finite or infinite population

The process of arrival may be constant, i.e., time interval between successive arrivals would be same, or random. Customers' arrival at random shows a typical poisson distribution pattern, i.e., a situation where customers' arrival is time independent, or exponentially distributed. Also, we see the cases of scheduled arrivals, batch arrivals, etc.

The mechanism of services, i.e., the distribution of service time, availability of number of servers (separate or parallel), etc. need to be considered.

Similar consideration of queuing characteristics, i.e., first-in-first-out (FIFO), last-in-first-out (LIFO), first-come-first-served (FCFS), random, etc. is essential to solve the queuing problems. Queuing problems can be solved using the analytic methods, i.e., use of formulae, and computer based simulation. For example, to solve queuing problems for a busy airport, computer based simulation is the right choice. However, to solve the queuing problem of a restaurant, we can use analytic methods.

The symbols shown in Table 1 are used in solving analytic queuing model.

For application of queuing models, we consider four major types of flow as shown in Table 2.

A queue graph is quadratic for its obvious two times differentiation attributes at or near t_1.

Therefore, a queuing equation is as under:

$$\lambda_{(t)} = \lambda_{(t)} - \beta\left(t - t_1\right)^2$$

where β constant is represented by:

Table 1. Symbols in queuing model

$Q_{(t)}$	Length of Q at time t
$A_{(t)}$	Cumulative arrivals of customers to form the queue at time t
$D_{(t)}$	Cumulative departures of customers from the queue at time t
μ	The maximum possible service rate
$\mu_{(t)}$	The rate of service at time t
$\lambda_{(t)}$	Arrival rate at time t

Table 2. Major types of flow

Types of Flow	Importance
t_0	The point at which λ (t) equals to the maximum rate of service μ
t_1	At this point λ (t) is maximum
t_2	*At this point* λ *(t) is decreased to* μ
t_3	This is the final point where queue problem gets resolved, i.e., $\mu (t) = \lambda (t)$

$$\beta = -\frac{1}{2}\frac{d^2\lambda(t)}{dt^2}$$

where $t = t_1$

For small t - t_1; $t_0 < t < t_3$, i.e., t_0 and t_2 can be estimated by substitution as under:

$\lambda(t_0)$

$= \lambda(t_1) - \beta\left(t_0 - t_1\right)^2$

$$t_0 = t_1 - \left(\frac{\left(\lambda_{(t_1)} - \mu\right)}{\beta}\right)^2$$

$$t_2 = t_1 + \left(\frac{\left(\lambda_{(t1)} - \mu\right)}{\beta}\right)^2$$

The queue length is:

$$\begin{aligned} Q_{(t)} &= A_{(t)} - D_{(t)} \\ &= \int_{t_0}^{t}\left[\lambda_{(t)} - \mu_{(t)}\right]dt \end{aligned} \quad (1.3)$$

Using the substitutions, we can derive the substitution as under:

$$\begin{aligned} Q_{(t)} &= \int^{t}_{t0}\left[\lambda_{(t)} - \mu_{(t)}\right]dt \\ &= \beta_{(t-t0)^2}\left(\frac{t_2 - t_0}{2} - \frac{t - t_0}{3}\right) \end{aligned}$$

Let us discuss a simple queuing theory problem on manpower allocation. Suppose in a bank mean arrival rate (λ) of customers is 200 per hour. Mean service rate (μ) per customer is 0.3 minutes. Mean inter arrival time of customers is 1/λ, i.e., 1/0.3

minutes, i.e., 20 seconds. It means this bank can serve 3 customers in minute and 180 customers in an hour, resulting 20 customers to wait for the services. It requires allocation of more manpower for customer services during the customer service hour, which is possible by adjusting the back-office personnel for customer service jobs, because of skill interchangeability.

Let us take one more example:

A fast food centre in the heart of a business hub faces queuing problem during the lunch hours, while other time such queuing is almost absent. The shop does not like to lose customers, and asked us to suggest the optimum number of employment of service boys, based on the data of average number of customers' during lunch hours, i.e., the queue length, idle time of the service boys as percentage of their total working time. The shop owner is prepared to employ up to five service boys.

To help in our decision making, following information has been made available by the shop owner:

1. Mean time taken by the service boys to serve an order is 2 minutes, and the standard deviation is 5/4 minutes.
2. Because of the space availability, the fast food centre can accommodate any number of customers inside the shop.
3. Arrival of customers follows a Poisson distribution pattern with mean of 25 per hour.
4. The shop follows first come first serve principle of customers' service.

Solution

We can solve this problem using the steps below:

1. Calculate L_q and W as under:

$$r = \frac{\lambda}{\mu} = \frac{25}{30} = \frac{5}{6}$$
$$p = \frac{\lambda}{c\mu} = \frac{r}{c} = \frac{5}{6c}$$

L_q is the average length of queue
W is the percentage of service boys remaining idle.

2. Calculate Po (P represents number of orders per hour), L_q, and W to assess the idle time using the equation below:

$$p_o = \left(\sum_{n=0}^{c-1} \frac{r^n}{n!} + \frac{r^c}{c!(1-p)} \right)^{-1}$$

$$L_q = \frac{r^c p p_0}{c!(1-p)^2} = \frac{5^{c+1} p_0}{6^{c+1} c! c \left(1 - \frac{5}{6c}\right)^2}$$

$$W = \frac{1}{\mu} + \frac{L_q}{\lambda} = \frac{1}{30} = \frac{L_q}{25}$$

$$Idletime = 1 - p = 1 - \frac{5}{6c}$$

3. Get the results of these equations to find out number of service boys need to be engaged to optimize the resources.

Answer: Solving all the five equations, we can conclude that 1 to 2 service boys will be enough to ensure customer services without much queuing problem.

HRP IN MAINTENANCE FUNCTION

Maintenance is a time independent function. For a manpower planner, optimization of maintenance function is a big challenge. Presumably for this reason, many organizations try to outsource the maintenance function. However, for some criticality of maintenance jobs, companies need to maintain their own maintenance crew to avoid possible work stoppages. Maintenance manpower requirement is computed based on maintenance load analysis.

Let us assume a company has given us the following information, based on which we have been asked to suggest the optimum number of workers.

A machine breaks down at a mean rate (λ) of 0.4 per day. A worker can repair one machine per day, i.e., $\mu = 1$. The machine is such that repair time is proportionately reduced with the increase in the number of workers. However, the number of workers cannot be increased beyond 3, as logistic support is inadequate. If at any point of time, the company desires to increase manpower beyond 3, it is required to develop a second line.

Maintenance workers are paid \$ 300 per day, while the machine's idle cost is \$ 650 per day. Consider the optimum number of workers assuming no other cost is involved.

Solution

Let us now compute the mean of the broken machine as follows:

$$\frac{\lambda}{\mu - \lambda} = \frac{0.4}{1 - 0.4} = 0.66$$

Total cost of a repair, assuming one worker is deployed, would then be:

1(300) + 0.66(650) = 300 + 429 = 729

Assuming two workers are deployed, the mean rate of failure and the cost would be

0.4 / (2–.4) = 0.25

2(300) + 0.25 (650) = 762.5

Assuming three workers are deployed, the mean rate of failure and the cost would be;

0.4 / (3 – 0.4) = 0.15

3(300) + .15(650) = 997.5

It is therefore clear that the company benefits only when employing one worker, as the proportionate cost goes up with the increase in the number of workers. Hence, under the prevailing circumstances, the company should only use one worker for machine maintenance jobs.

STOCK AND FLOW MODEL

Manpower structure of any organization can be said as the dynamic system of stocks and flows. At a given time *t,* the workforce in an organization can be classified in terms of different attributes; age, hierarchical level, occupation, etc. Organizations categorize workforces based on such attributes and it represents stocks at time point t, if there are k categories, the stocks in category i at time t can be written as $ni(t)$, thus $n(t) = (n1(t); n2(t);\ldots nk(t))$ to represent the total stocks working in the organization at time point t. The nature of stocks is dynamic, as it moves from one-time period t to another time period $t + h$. Because of such dynamic nature of stocks, we need to supplement it by flows, i.e., movement of workforce from one stock to another. Flows are also represented by three components; promotions, wastages and recruitments. Promotions are upward movement of workforce between different categories within the organization. Wastages are the loss of manpower for various reasons such as death, resignation or retirement whereas recruitments are new induction.

Stock of the manpower can be represented as a non-homogeneous Markov chain $n(t)$ (stocks) with the transition matrix $P(t; 1)$ to represent recruitments and wastages (flows). For this reason, stock and flow model of HRP is called as the combination of Markov chain and renewal model.

PREDICTIVE STATISTICS IN MICRO LEVEL HRP

We have number of predictive statistical tools and techniques for organizational level manpower planning research. Some of the commonly used tools are discussed below:

REGRESSION ANALYSES

In HRP, information on number of people employed in other comparable organizations in similar nature of work may be of interest to us. For such purpose, we select the random samples of people and their level of productivity, and use the same as the means to predict the number of people required by us. This technique may not be foolproof as experience, performance levels, size of organization, salary and revenue, etc., play the important roles in manpower determination.

Regression analysis allows us to consider all these factors in deciding the requirement of manpower in an organization. Linear Regression allows us to make predictions of any dependent variable (y) based on any independent variable (x). Multiple regressions allow us to make predictions of any dependent variable (y) based on several independent variables (x).

Linear Regression

In linear regression, we first make use of straight-line model. This model makes use of variables plotting x value on the x-axis (horizontal line), and each y value on the y-axis (vertical line). Each x value and its related y value make up the coordinates of each point. After all the points have been plotted on a graph, the result is known as a scatter diagram. A scatter diagram helps us to visualize the relationship, if any, between the x and y variables. Since this relationship is linear (x and y) it is possible to predict values of y from various values of x. This prediction comes from finding the straight line that best fit the data.

Least-Squares Model

The least-squares method is used to find the straight line that best fits the data. It is based on the principle that a line of best fit, or one that describes relationships between two variables best, is a line for which the sum of the squares of the deviations or differences between values on the straight line itself and the actual values will be at a minimum. Only one line of the infinite number available may be drawn to meet this requirement. The line of best fit must be computed mathematically, and it will always pass through the average of the x and y data.

The equation for this line is best expressed as:

$$y = \beta_0 + \beta_{1x} + \beta$$

where, we can use this equation to predict any y value when we know the value of x.

One can visually approximate the position of a line of least squares through data plots by calculating the means of both axes. Regression lines always pass through these two means on any data plot.

Table 3.

Y	dependent variable
X	independent variable or predictor (used as a predictor of y)
β	random error or residual (actual y value – mean of y)
β_0	y-intercept
β_1	Slope

Line of Best Fit

The line of best fit is the line that produces the best estimate of y based on any given value of x. One way is to decide quantitatively how well a line fits the data points, and calculate the extent to which the data points deviate from the line. This deviation or error is the vertical distance between the data point and the line. If we take the deviation or error for each of the data points, square them, then add them together, we have a sum of squared errors (SSE). The line that produces the smallest SSE is the line of best fit.

The best-fit line is the line with the smallest SSE (sum of squares of the errors), which is a measure of the extent to which the data points deviate from the line.

How to Find the Least Squares Line

To find the least squares line for a set of data, we must find $\hat{\beta}_0$ and $\hat{\beta}_1$, which are least squares estimates of the population parameters μ_0 and μ_1. The fitted line is represented as:

$$\hat{y} = \hat{\beta}_0 + \hat{\beta}_1 X$$

The hats are read as estimator. In this case, $\hat{y}$ is the estimator of the mean value of y. $\hat{\beta}_0$ and $\hat{\beta}_1$ are estimators of μ_0 and μ_1.

Least-square estimates can be expressed mathematically as:

Slope: $\hat{\beta}_1 = \dfrac{SS_{xy}}{SS_{xx}}$

y-intercept: $\hat{\beta}_0 = \overline{y} - \hat{\beta}_1 \overline{X}$

It should be noted that the higher the correlation (r) between x and y, the better the line will fit the data. The purpose of regression is to extract all possible information from the data. The regression model should explain as much as possible about the underlying process. However, due to real world uncertainty, no model will explain everything. The information in the data that are not explained by the regression model is the error component called residuals.

All the above optimization techniques are useful for HRP research. But which one would be relevant for our organization, depending on our data availability, and its nature, must be decided by us only.

Some of the important operational difficulties for using statistics in HRP research are:

- Productivity or performance data cannot always be attributable to increased human effort.
- It is difficult to get units of output in same form for all jobs.
- Relationships between output and manpower may not be always straightforward.
- Effect of different factors may not always be linear.
- Uncertainty about the future can be a major problem for the manpower planner.
- Data on past workload factors may not be available.
- Integration of manpower plan with corporate plans may not exist in organization.
- Employees cannot always be related to output in a direct way.
- Human resource information systems (HRIS) may not exist in an organization.

Despite such operational difficulties use of statistical tools and analysis in HRP research can greatly help in decision making.

FUTURE RESEARCH DIRECTIONS ON HRP

Importance of HRP research has already been highlighted in preceding sections, primarily for its strategic significance. Although we have no empirical evidence to authenticate such importance in relation to the business performances of the organization at the micro level, and the economic development of the country at the macro level, we still can understand its significance. Ineffective HRP undoubtedly affects the bottom line, and ultimately cripple the organization to struggle for sustainability in the globally competitive market. Similarly, less developed and developing countries are not able to adjust with the pace of socio-economic changes, building human resource capabilities, obviously for their inability to visualize the changes in the skill and competencies of people for future employment. Such countries, on the one hand, are crippled with problem of unemployment, and at the same time the critical shortage in skill and competencies, leading them to depend on expatriate workers with specialized skills from developed countries. Developed countries are equally the victim of poor HRP, for their failure to align with various socio-economic dynamics, like; population planning and control, resulting their perennial dependence on expatriate workforce from less developed and developing countries, including the cloud manpower.

In future, macro or national level HRP research would be more sector specific, requiring longitudinal study with the involvement of team of professionals. Micro or organizational level HRP research would be more focused on optimization of future manpower requirements, building organizational capabilities through training, succession planning, redundancy planning, and redeployment, etc.

Performance Management Research

Performance management is an integrated process that sets objectives, appraises employees, translates objectives into individual key result areas (KRA), determines pay, and helps the organization to achieve its business goals. It is an important development tool for employees as it facilitates performance improvement, career development, and training.

Performance management involves both the managers and the employees in:

- Identifying and describing essential job functions and relating them to the mission and goals of the organization.
- Developing realistic and appropriate performance standards.
- Giving and receiving feedback about performance.
- Writing and communicating constructive performance appraisals.
- Planning education and development opportunities to sustain, improve, or build on employee work performance.

HR researcher needs to identify appropriate type of performance indicators, selection of which largely depends on organization specific needs. Some of the common performance indicators are:

- Cost
- Input
- Output
- Outcome

Developing performance standards is an important area for performance research. Important guidelines are:

- Relate performance standards to the employees' assigned work and job requirements (check job descriptions).

- Ensure quantitative measurement of performance data.
- When quantitative measurement is not possible, ensure in specific terms verifiable characteristics of performance quality.
- Relate performance standards to achievement of organizational objectives, like; cost control, improved efficiency, productivity, project completion, process redesign, and customer service.
- Prepare a detailed checklist for performance standards.

In performance management research performance metrics are used as standard measure to assess performance in an area. With performance metrics, organizations can develop performance matrix. Performance matrix is a construct of performance system, which sequentially illustrates decisions to be taken for improving performance systems in organizations. While we have many prescriptive performance models, many organizations at their level prefer to develop their own performance models. Effective performance model allows management to be confident that the end results are not guesswork but a summation of all the different activities and processes, given an attainable standard of performance. The requirements of performance model are:

- Relevant relationships
- Measurability
- Comprehensible
- Actionable
- Motivating
- Automation compliant

Research on Performance Measurement

Performance measurement is the act of assigning numbers to properties or characteristics. We measure performance to quantify a situation, to regulate, or to understand things we see. We measure with gauges and instruments or simply counting things. Managing performance is highly dependent on well-designed performance measurement system, which provides a clear linkage between strategy and human behaviour. Performance of the organization is completely dependent on the performances of its processes. In fact, in any organization, its performance is equal to the sum of the performance of its processes. Processes are the sequence of cross-functional activities performed by people and machines, which combine valuable resources to convert inputs into outputs. ISO 9000 documents define a process as interrelated and interacting activities to transform inputs to outputs.

These activities require allocation of resources such as people and materials. It is processes, which provide the linkage between organization level goals and the work performed by employees. Processes can be measured effectively. Measurements may be applied to many aspects and attributes of processes and the critical few are; time, quality, cost (financial), and scale.

Performance measures can help us understand and improve performance. It is exciting to measure, to benchmark, and to stretch to do better. It is important that performance measures be as direct as possible. To improve attendance, we need to measure attendance. To improve cycle times, we need to measure cycle times. The more directly we can measure, the better. There are two types of studies: enumerative and analytical studies. Enumerative studies are those that show how things are but have no value in predicting. Taking a census is an enumerative study. Analytical studies are used to study a process and show what that process can do in the future unless something changes that process. Shewhart (1931), a pioneer in statistical process control said a process consists of equipment, methods and materials, and people are blended to produce output in each environment. Hence to improve performance, better process measurement techniques are most important. Statistical process control helps to quickly detect the occurrence of assignable causes or process shifts so that investigation into the processes and corrective action there upon can be taken before any non-conforming units are manufactured. Assignable causes are those, which may occur due to improperly adjusted machines, operators' errors and defective raw materials or other inputs. This causes some variability in the quality characteristics. A process that is operating under assignable causes over and above change causes is said to be out of control.

In organizations following performance measurement techniques are used:

- Qualitative/Quantitative measurement
- Observation/subjective response
- Naturalistic observation of behavior, i.e., observing what is happening, where and when, and at what frequency
- Structured observations
- Questionnaire
- Interview
- Simulation
- Performance trials
- Fitting trials
- Observation on traces of behavior

Statistical Methods of Performance Measures

Statistical methods can help us in performance measures, if we broadly adopt the process approach as advocated by Shewhart (1931). Two main aspects of statistical methods deal with statistical distributions and statistical control.

Right at the outset, HR managers should understand statistical concepts on variation, including statistical distributions and statistical control. HR managers should also understand special causes, common causes, and control charting. In addition, they should clearly understand the concept of manipulation with a process.

Workers perform the operations in the system. Variation study demonstrates how workers in each process can perform. This natural pattern of variation shows what the process can do to improve the work performance. If the process is in control, then performance of workers would be in its natural capability, or else performance will be less than the expected levels or standards.

Use of Control Charts for Measuring Performance Variation

To measure the variation in performance, we can make use of statistical methods, developing control charts. The control chart is a tool for on-line process control, widely used for the detection of assignable causes of variation.

It is graphical display of a sample quality measure versus sample number (or time). The chart shows a centre line that represents the average value of the quality characteristic corresponding to the in-control state. Two other parallel horizontal lines, called the upper control limit (UCL) and the lower control limit (LCL), are also shown on the chart. Control charts compute control limits and values that fall outside the control limits (outside the UCL and LCL) are considered as signals of special causes and must be investigated. Good performance measures are also assessed using statistical methods for run charts. When the results are plotted, values are observed in relation to the center (median) line.

In any process, proper checks through control charts are exercised at strategic points. In the case of measurable quality characteristics, a pair of control charts; one for $\overline{x}$ to control the average level of the process, and the other for R to control dispersion, are used. Many quality characteristics are not measured on a numerical scale. In these cases, we may judge each unit of product as either conforming or non-conforming based on whether it possesses certain attributes, or we may count the number of non-conformities (defects) appearing on a unit of product. Control charts for number of defects or are used in such situations. If the points plot within the control limits, the process is assumed to be in control and no action is necessary. However, a point that plots outside of the control limits is interpreted as evidence that the process is out of control and investigative and corrective actions are required to find and eliminate the assignable cause or causes responsible for this behavior.

Control Charts for Measuring Performance Attributes

Similarly, for measuring attributes, attribute control charts like p, np, u, c, are also used. The Proportion Defective Chart (p-chart) is used to control the proportion of defective product in samples taken from a process. This chart is also referred to as the fraction nonconforming or fraction defective chart. The p-chart or fraction defective chart is defined as the ratio of the number of defective items in a population to the total number of items in that population. The sample fraction defective (p) is defined as the ratio of the number of defective units (d) in the sample to the sample size 'n', i.e., p = d/n, where 'n' is a sub-group size. If L.C.L. is negative, it is taken as zero.

The Number Defective Chart (np-chart) is an alternative chart that may be substituted for the p-chart. The underlying distribution for the np-chart is the binomial. In the case of the np-chart, the sample size must be constant. Rather than calculating the proportion of defective items in a sample for plotting on a p-chart, the np-chart allows the actual number of defective units to be plotted directly. This eliminates the need for one calculation (p) thereby decreasing the probability of an error. The np-chart also is somewhat easier to understand.

The c-chart or control charts for nonconformities are used to control the average number of defects in samples of fixed size. The inspection unit may be one item or multiple items. The underlying distribution for the c-chart is the Poisson. A defective (or non-conforming) unit is a unit of product that does not satisfy one or more of the specifications. Each specific point at which a specification is not satisfied, results in a defect or non-conformity. In this case each sub-group consists of a single unit and 'c' would be number of defects observed in one unit. It should be remembered that each inspection unit must always represent an identical 'area of opportunity' for the occurrence of defects.

The u-chart (sometimes referred to as 'rate' chart) deal with event counts when the area of opportunity is not constant during each period. The steps to follow for constructing a u-chart are the same as a c-chart, except that the control limits are computed for each individual quarter because the number of standard units varies.

All these control charts, one-way or the other helps us to measure the performance standards in quantitative terms.

These apart, histograms (for spread of data), Pareto Graph (80/20 rule, i.e., 80% improvement in performance can reasonably be expected by eliminating 20% of the causes of unacceptable quality or performance), process capability study etc. are also very effective for quantitative performance measurement.

A histogram is a graphic display of resource utilization and it is shown using coloured vertical bars to indicate over-utilization and underutilization of resources over a period. Pareto principles are based on 'a vital few trivial many'. This is because of interdependence and inter-relationships in motive strengths. HR managers can make extensive use of both Histograms and Pareto Graph in other HR research areas also.

Process capability denotes statistical measurement of process variability. The process capability index indicates specific tolerance for the process characteristic divided by the process capability. Process capability indices include the widely used C_{pk} and C_p. A process capability index can only be calculated from data collected while the process is in control. Hence when performance variability is within control, we can develop a capability index measuring process capability as $\overline{p}$, i.e., the average proportion defective produced by the process when it is operating in control. Therefore, if a $\overline{p} = 0.0016$ it indicates that on average 99.84 percent of the product produced by this process is in control, while 0.16 percent are defective.

Performance Measures Research Through Ranking and Rating

Performance measurement through rating and ranking system is again another important area for HR researchers. Ratings system measure worker's performance compared to some set standard. The rating is done listing desired objectives, skills or traits alongside a scale, which may be 1-5, 'poor to excellent' type. For making the ranking process simple, we normally make use of easy-to-read type of scale, keeping in view the basic scale construction norms. This, however, significantly depends on the judgment of the rater. Commonly we find use of subjective rating or observer rating scales. Subjective rating scales are psychophysical and it measures response to environment quantitatively. It is basically designed on ergonomic principles and developed through a process of empirical testing. Because of ordinal measurement of response, reliability and validity of such type of scales can be tested. Observer Rating Scales are used in real time for establishing a scoring algorithm for overall activity. This scale requires task analysis to break down task into components and assign scoring algorithms for each task component. To ascertain the degree of fit, one must obtain both an outside evaluation (observer rating) and a subjective evaluation (subjective rating).

Different types of scales, which are used for performance rating, are as under:

- **Graphic Rating Scales:** This is the single most common way of evaluating employees' performance. Here the manager or the rater can directly judge quality of performance of employees on a specific response scale. Response Scales may be a:

- **Continuous Scale:** Which computes score measuring the distance from one end of the scale.
- **Verbally Anchored Scale:** Where some discrete categories are anchored on either end of the scale with the range of abilities. Nature of verbal anchor scale varies with the specificity of the verbal anchors.
- **Numeric Scale:** Where verbal anchors with a numerical range within each category are shown.

Graphic Scales are simple to use, and allow for computation of scores to compare employees on overall job performance. However, problems with graphic rating scales are enormous. If such problems are not taken care of, the whole purpose of performance rating may be defeated. For not defining precisely the anchors, such scale may sometimes be ambiguous. Raters may use the scale in different ways, which may raise the problem of validity (when two employees are rated by different raters). However, such problems now a day is eliminated significantly using various behavior based scales, which help us to assess specific work-related behaviors. Some of the behavior-based scales are; behaviorally anchored rating scale (BARS), mixed-standard scale (MSS), etc. These scales can quantitatively measure performance criteria, using 360-degree feedback from multiple raters.

Ranking Systems

Ranking systems takes a markedly different approach by comparing employees against one another and then assign a rank order. This is like grading system in the classroom. Here we do not apply a set standard to all employees'; the best performer can determine where everyone else fits in. This system promotes healthy competition among employees and when reinforced by an effective incentive programme, it even develops cascading effect on productivity enhancement. There are various types of ranking, which is primarily decided based on the organizational need and nature of data.

- **Forced Distribution:** It divides the employees into categories; High Performance, Average Performance, and Low Performance. This distribution is known as forced as only a small percentage of employees can receive high or low rankings. The forced distribution helps to solve the problem of supervisors who like to rate most employees at the highest level.
- **Full Ranking:** Here instead of sorting employees into general categories, we do a complete rank ordering of all employees, so that no two employees are at the same level of job performance.

- **Paired Comparison Method:** This method arranges rank orders of employees by comparing each employee with the other, thus forcing the rater to make relative judgments. However, operational difficulty may be experienced in case we have more employees.

Which type of ranking method is more suitable in each situation will depend on number of factors. For example, degree of efforts, which HR managers may like to put for ranking and the intended usage of ranking results, are two primary factors to decide suitability of a ranking method. Forced distribution may be extremely necessary in cases where decisions like lay-off etc. need to be taken.

Comparing Job Performance Rating Systems

We really do not have any consensus on effectiveness of a job rating system. Despite its numerous flaws, graphic rating scale is still considered effective. Perhaps for this reason, psychological thought process of the individuals, while filling out the rating forms, has now become more important than the type of rating system. Many organizations use only a single measure of job performance. In such cases, it becomes difficult to find converging or diverging evidence to authenticate judgmental ratings. Therefore, using inter-rater reliability to estimate validity is considered more appropriate for measuring job performance. However, if we can define job performance very precisely, performance measures are likely to become more accurate. HR managers need to take guard against possible rating errors like; Halo, Leniency and Range distortion. Halo errors stem in general impression of the rater about the person being rated. Leniency errors may either result in rating all very high or very low. Range restriction errors fail to make fine distinctions between the performances of employees doing similar nature of job. These apart at times there may be memory distortions of the rater, in cases when a rater requires rating many employees. To take guard against all these problems, Schmidt, Hunter, McKenzie & Muldrow (1979) have suggested quantifying the value of job performance, using standard deviation as a measure. This method assesses the difference, in money terms, between the value of an average worker and the value of an exceptional worker

Multiple Raters/360-Degree Feedback

Multiple-rater and 360-degree feedback instruments are better performance assessment alternatives to eliminate errors in performance measurement. Multiple rater feedback is different from 360-degree feedback. 360-degree feedback collects and analyse inputs from the employees' immediate boss, peers, and direct reports, suppliers and customers (if applicable). Some organizations also do collect self-rating inputs from the employee concerned.

Multiple-rater feedback on the other hand consists of more than one rater, usually four or more. It is not necessary for the multiple raters to collect inputs from all sources, like what we do in 360-degree feedback. Numerous research studies like London & Beatty (1993). Pollack & Pollack (1996) have proved that multiple assessment tools are more reliable and valid for performance measurement.

Scales for Evaluation of Performance Management

Here we will be illustrating some of the practical means for performance research using rating and ranking system. Technical details of various validated scales have not been discussed here, rather discussions here is on scale constructions and measurement tools, which are more need based for correct evaluation of performance. Some of these are illustrated below:

- **Results-Based Scale:** For this scale, we need to develop a statement on the critical result, which helps us to get the expected output and then administer on the selected employees whose performance evaluation is done. Using a Yes/No type of statements, where 'No' indicates 1 and 'Yes' indicates 5, we calculate the average of critical results (CRs) and then compare the ratings on a 5-point scale.
- **Measurability Scale:** For this scale result/measure(s) are objectively quantified in terms of cost, quality, and timeliness using a 5-point scale, where 1 indicates 'not at all' and 5 indicates 'to a very great extent'. Performance rating is done based on the score assigned for each such identified measures.
- **Monitoring Scale:** This scale is used to track the work to ensure that it is accomplished. For example, in case of any critical results data, it is important for the rater to authenticate the source of the data, to understand whether it is just a sample or it needs to be collected, who will collect the data and who will receive it, etc. Here again a 5-point scale, starting from 'Not at all' to 'To a very great extent' is used.
- **Feedback Scale:** This 5-point scale measures performance feedback on the critical result areas to assess an employee.
- **Exceeds Expectations Scale:** The 'exceeds expectations' criterion assesses on a 5-point scale, whether employee's performance meets the expectation measure. This sale helps in understanding whether more efforts or skill are required on the part of employees, to achieve a high-performance score. This helps in better quantification of degree of efforts.

- **Linked With Goals Scale:** This scale evaluates the extent to which the result is valued by the organization. It compares the critical results and measures performance against organizational goals.

Using Z-Score Tests for Integrating Performance Management Systems of Two Organizations

In performance management research z-score tests is one of the important statistical tests, which can be used in contemporary business world. In mergers and acquisitions, we often face the challenge of due diligence in performance management systems. Two merging organizations' performance management systems may be different; hence they need to integrate. This is also important for integration of performance management systems with compensation and benefits plan. The z-score tests here can immensely help.

The z-score specifies how far a value lies from the mean of a normal distribution in terms of standard deviations. It is particularly helpful in comparing observations that come from different populations and from distributions with different means, standard deviations, or both.

It is calculated using the following formula:

z = (data value-mean)/standard deviation

Suppose a HR manager gets monthly salary of $ 98,000 while the mean is $ 85,000 and standard deviation $ 10,000. We can compute z-score as under:

(98,000-85,000)/10,000 = 13,000/10,000 = 1.3

We can interpret the results as under:

HR manager's salary is 1.3 standard deviations above the mean.

The z-score can help us to compare data sets, when same item is measured by two companies using different scales. When two organizations merge, we often face the challenge like; integrating compensation structure, or the performance management systems.

Here it is evident that Company-A uses a 5-point scale and Company-B uses a 7-point scale. In both the companies higher are the rank; the better is the performance. With z-score we can merge the performance management systems of both the companies.

Work sheet:

Table 4. Integration of performance management systems

Company-A				Company-B			
Rating	No. of Employees	%	z-Score	Rating	No. of Employees	%	z-Score
5	45	15	1.7	7	30	6	2.1
4	135	45	0.4	6	70	13	1.2
3	105	35	-0.9	5	230	44	0.2
2	15	5	-2,2	4	130	25	-0.7
1	0	0	-3.5	3	40	8	-1.6
Total	300	100		2	20	4	-2.5
Mean Rating			3.70	1	0	0	-3.4
Standard Deviation Rating			0.78	Total	520	100	
				Mean Rating			4.73
				Standard Deviation Rating			1.09

(5 x 45) + (4 x 135) + (3 x 105) + (2 x 15) + (1 x 0) = 1110. Mean is 1110/300 = 3.7

Steps are as follows:

Step 1: Find the mean.
Step 2: For each data point, find the square of its distance to the mean.
Step 3: Sum the values from step 2.
Step 4: Divide by the number of data points.
Step 5: Take the square root.

Let us assume Company-A has acquired Company-B, and now we need to convert 7-pont scale of Company-B to 5-point scale of Company-A. This can be done associating Company-B rating z-score for a given rating to the Company-A rating with the closest z-score. This is shown in Table 5.

SUMMARY

HRP integrates all HR activities and the strategic plans of an organization to coordinate recruitment, succession planning, promotion, performance management systems and training and development. It is the primary level function of HR and it precedes all other functions of HR. HRP balances the demand and supply of manpower, aligning with the strategies and business plans of the organizations.

Table 5. Merged performance management systems of Company-A and Company-B

B (Old Rating)	B z-Score	Closest A z-Score	A Rating	B New Rating
7	2.1	1.7	5	5
6	1.2	1.7	5	5
5	0.2	0.4	4	4
4	-0.7	-0.9	3	3
3	-1.6	-2.2	2	2
2	-2.5	-2.2	2	2
1	-3.4	-3.5	1	1

HRP is not a routine HR function but a continuous process to ensure availability of quality manpower and even to manage the manpower redundancies as well. While the scope of academic research for HRP extends even to macro-economic issues, for organizations it may be restricted to specific areas to meet their requirements in alignment with their business goals and strategies.

At organizational level, HRP research involves activities like; forecasting of future manpower requirements, preparing inventory of present manpower, anticipating problems of manpower, and finally meeting manpower requirements. For all these activities, we require selection of appropriate research tools, including statistical tools.

Organizational level HRP is a strategy for the acquisition, utilization and retention of human resources. It seeks to link policy and practice in day-to-day decision making. Thus, inter-relationships of HRP with other HR functions is now an established hypothesis. It follows four stages like; investigation, forecasting, planning and control of manpower and utilization. Each stage requires careful analysis by the researcher to ultimately decide the optimum manpower of the organization.

In HRP we make use of many statistical and quantitative tools and models. Some of these are; workload factor analysis, time series analysis, simulation, replacement, Markov Chain analysis, Cambridge Model, Renewal Model, etc.

For HRP research, the chapter discusses on application of queuing theory, stock and flow model, and regression analysis. The chapter also briefly summarizes future research direction on HRP.

This chapter also discusses on application of statistical tools for performance management research. Performance management is an integrated process that sets objectives, appraises employees, translates objectives into individual key result areas (KRA), determines pay, and helps the organization to achieve its business goals. It is an important development tool for employees, as it facilitates performance improvement, career development, and training.

In performance management research, performance metrics are used as standard measure to assess performance. With performance metrics, organizations can develop performance matrix. Performance matrix is a construct of performance system, which sequentially illustrates decisions to be taken for improving performance systems in organizations.

Statistical methods can help us in performance measures, if we broadly adopt the process approach. Two main aspects of statistical methods deal with statistical distributions and statistical control.

Right at the outset, HR managers should understand statistical concepts on variation, including statistical distributions and statistical control. HR managers should also understand special causes, common causes, and control charting. In addition, they should clearly understand the concept of manipulation with a process.

To measure the variation in performance, we can make use of statistical methods, developing control charts. The control chart is a tool for on-line process control, widely used for the detection of assignable causes of variation.

Performance measurement through rating and ranking system is again another important area for HR researchers. Ratings system measure worker's performance compared to some set standard. The rating is done listing desired objectives, skills or traits alongside a scale, which may be 1-5, 'poor to excellent' type.

In performance management research, a z-score test is one of the important statistical tests. In mergers and acquisitions, we often face the challenge of due diligence in performance management systems. Two merging organizations' performance management systems may be different; hence they need to integrate. This is also important for integration of performance management systems with compensation and benefits plan. The z-score tests here can immensely help.

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Chapter 6
Statistics for Recruitment and Selection

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ABSTRACT

Recruitment and selection processes focus on the acquisition of suitable human resources. Recruitment refers to the firm's efforts to attract the maximum number of minimally-qualified applicants while selection refers to the firm's efforts to choose competent and suitable candidates. The parameters for identifying minimally-qualified candidates come from job analysis. Statistical processes used in recruitment include summing the scores on different parameters; finding mean scores of applicants and rejecting candidates with scores below the cutoffs. The selection procedure focuses on designing tests that identify superior talent from the candidate pool. Statistical procedures used in selection include development of scales for capturing competencies, measuring the reliability of the scales, that is, how well they capture the underlying construct, measuring the validity of the scales, that is, how well the competencies relate to job performance and optimal combination of the selection instruments.

INTRODUCTION

Organizations are conventionally defined as a deliberately structured and coordinated activity systems linked to the external environment and consisting of a group of people who come together to achieve a common set of objectives (Daft, 2007). The organizations source inputs, both human and material, from the environment and exchange outputs, such as goods and services, with the environment. The human resource management function includes the sourcing of employees from

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the environment and developing them to meet the organizational objectives. The HRM function includes the processes of ascertaining demand for employees and acquiring, training, appraising, and compensating employees (Dessler & Varkkey, 2016). Ascertaining demand is the domain of human resource planning processes and acquiring employees from the external environment, or internally within the firm, falls under the recruitment and selection function.

The recruitment and selection processes of a firm usually follow the demand ascertainment or human resource planning (HRP) process. HRP is defined as the "systematic analysis of HR needs, so that the required number of employees with appropriate skill sets can be made available at times of needs" (Bhattacharyya, 2012). HRP processes can be divided into two broad categories – demand ascertainment and supply analysis. The demand ascertainment process aims to determine the change in the number of employees required, on an absolute basis as well as position-wise basis, to fulfill the firm's short-term objectives. It is linked to the firm's strategic planning. The supply analysis component of HRP analyzes the structure of the firm's talent base and aims to forecast the future distribution, by position, of the firm's current workforce. The gap analysis between demand ascertainment and supply analysis guides company's future behavior. If the gap is positive, it forms the basis of the targets for the recruitment and selection function. If the gap is negative it leads to downsizing.

STATISTICS FOR JOB ANALYSIS

The recruitment and selection process aims to select the required number of candidates for each position. Hence, job analysis is a pre-requisite for the recruitment and selection process as it helps define the work duties and employee competencies needed for that position. Job analysis is defined as "a purposeful, systematic process for collecting information on the important work-related aspects of a job" (Barrick, Field & Gatewood, 2011). The output of job analysis is normally divided into two components – job description or content of the job and job specification or the competencies (knowledge, skills and abilities) that are required to do the job. A candidate possessing the requisite job specifications is usually considered competent to do the job. Such a candidate is called a minimally-qualified candidate. A thorough job analysis should lead to the identification of relevant work behaviors and relevant competencies for performing the work behaviors.

There are no universally valid techniques to objectively identify relevant work behaviors and personal competencies. Hence, subject matter experts (SMEs) are usually consulted while performing a job analysis. As the job specifications establish the guidelines for selecting candidates they must be possessed by the candidate at the time of hiring. Certain rules of thumb for deciding upon the inclusion of work behaviors and competencies that have identified in a job analysis are mentioned below.

- A work behavior is included in the job description if
  - At least 67 percent of SMEs must indicate that they exhibit the behavior in their jobs
  - At least 67 percent of SMEs must acknowledge that an entry-level worker should be able to display these behaviors
  - The work behaviors must have an average importance rating of at least 2.0
- A competency is included in the job specification if
  - At least 67 percent of SMEs must rate the competency as necessary at entry-level
  - The mean rating given to the competency must be at least 2.0
  - The competency must be linked by the SMEs to at least one selected work behavior (as described above) with a mean linkage rating of at least 1.5.

The rating scale used is: 0 = Not important; 1 = Somewhat important; 2 = Important; 3 = Essential (Barrick et al., 2011).

Once the list of important work behaviors and competencies are listed, the next step is to sort them in terms of importance. After rank-ordering the work behaviors, the next step is to assign a percentage to each work behavior in terms of its contribution to the total work domain for an entry-level employee. Then each competency is assigned a percentage that measures the contribution of the competency in performing that behavior. The weighted average of each competency for all work behaviors is calculated. This weighted average reflects the importance of that competence in that job and is used while designing the selection process. The above-mentioned process is illustrated through the example of a job analysis of a safety officer in an oil company in India.

Example 1: Job analysis of the position of safety officer in an oil company in India.
Solution: The list of work behaviors and competencies for the job is mentioned below:

Work Behaviors and Responsibility

1. Responsibility to ensure health safety and environment standards in Drilling (WB1)

2. Organize regular safety education programmes and safety campaigns to promote safety awareness amongst persons employed in the mine (WB2)
3. Responsible for designing location entrance and exit (WB3)
4. Responsible for safety briefing to all at site and advising safe practices and hazards associated with the current jobs/task (WB4)
5. To update and abide by the instructions, advices, suggestions and recommendations made by top management and external statutory / regulatory bodies (WB5)
6. To arrange for safety meetings and monitor follow up actions required for improvement of safety standards (WB6)

Competencies

1. Knowledge on safety guidelines followed in the world and prescribed by government (C1)
2. Knowledge on emergency handling (C2)
3. Strong managerial skills (C3)
4. Strong mentorship skills (C4)
5. Strong communication skills (C5)
6. Efficient in operating computers (C6)

All the work behaviors (abbreviated as WB) and competencies (abbreviated as C) fulfilled the minimum criteria (67 percent or more of SMEs acknowledged them as denoting actual entry-level work behaviors/necessary competencies and gave each of the WBs and Cs a mean rating of 2.00 or more). Table 1 denotes the linkages between the WBs and the Cs[1].

The next step is to estimate the importance of each competency in the performance of the job. The matrix indicating the relationship between wok behaviors is rank-

Table 1. Linkage between work behaviors and competencies

WB	C					
	C1	C2	C3	C4	C5	C6
WB1	3	1	0	0	0	0
WB2	3	2	2	2	2	0
WB3	2	2	1	0	0	0
WB4	2	2	2	0	2	0
WB5	2	1	1	0	0	2
WB6	2	1	1	2	2	0

ordered by SMEs and each work behavior is assigned a percentage indicating it contribution to the total work content. Then the role of a competency in performing the work is estimated. Finally, the contribution of each competency to total work domain is calculated.

The percentage contribution of C1 to overall work performance is 54%

(1*0.3+0.5*0.2+0.2*0.15+0.4*0.15+0.3*0.1+0.2*0.1).

This suggests that C1 is by far the most important competency for performing the work (not surprising given that C1 reflects knowledge of safety guidelines and the job is that of a safety officer in an oil company) and hence maximum effort should be given to assess that competency. The next step is to select selection instruments that help measure each of the required competency and design a selection process that is in sync with the relative importance of each competency.

STATISTICS FOR RECRUITMENT

The recruitment and selection processes complement each other but have mutually opposite aims. Recruitment refers to the firm's efforts to attract the maximum number of minimally-qualified applicants while selection refers to the firm's efforts to choose competent and suitable candidates. Hence, recruitment is a process of attraction while selection is a process of evaluation. These differences inform the differential usage of statistics for these two processes.

For recruitment, the usage of statistics is related to the identification of minimally-qualified applicants and the development of effective recruitment programs. The identification of minimally-qualified candidates comes from the job analysis process.

Table 2. Weightage of each competency in executing work behavior

WB	Weightage of WB	C					
		C1	C2	C3	C4	C5	C6
WB1	30%	100%	0%	0%	0%	0%	0%
WB3	20%	50%	50%	0%	0%	0%	0%
WB4	15%	20%	30%	40%	0%	10%	0%
WB2	15%	40%	20%	20%	10%	10%	0%
WB5	10%	30%	0%	0%	0%	0%	70%
WB6	10%	20%	0%	0%	40%	40%	0%
		54%	18%	9%	6%	7%	7%

As discussed in the section on job analysis, a minimally-qualified candidate is one who meets the job specifications. As the input of SMEs is taken for determining the criteria for minimally-qualified candidates, it is important to ensure consensus among them. Hence, besides checking for the average rating of linkages of job specifications and the number of SMEs who identify the job specification as an entry-level necessity, it is also necessary to check for standard deviation (SD) among the SME scores. SD is a measure of the dispersion of the data points from the mean (Investopedia, n.d.). If the SD is small, it indicates consensus among the SMEs. On the other hand, a large SD indicates a lack of consensus. There is no objective rule to determine whether SD is large or small and hence judgment is required.

The concept of standard deviation is applicable for the entire population under consideration as well as for a sample taken from the population. The formula for population SD (σ) is

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(x_i - \mu\right)^2}$$

where N is the total number of elements in the population; µis the mean of the population and x_i represents an individual element from the population. For all practical purposes, it is impossible to gather all the SMEs for a occupation and hence we have to base our analysis based on the judgments of a sample of SMEs taken from the population. The corresponding formula for sample SD (s) is

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}\left(x_i - \overline{x}\right)^2}$$

where N is the total number of elements in the sample; $\overline{x}$ is the mean of the sample and x_i represents an individual element from the sample. The following example shows the calculation of SD for a sample in the context of recruitment and selection.

Example 2: Ten SMEs were consulted over the importance of a competency and the linkages between the competency and job behaviors. Seventy percent of respondents indicated the competency was necessary for entry-level employees. Only one job behavior was linked to the competency and the scores for linkages are 2, 3, 1, 2, 3, 3, 0, 2, 0, 3 where: 0 = Not important; 1 = Somewhat important; 2 = Important; 3 = Essential

Identify the suitability of inclusion of a competency in the list of job specifications of a minimally qualified candidate?

Solution: Mean rating of the linkages = (2+3+1+2+3+3+0+2+0+3)/10 = 19/10 = 1.9

Standard deviation of the sample = $\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(x_i-\mu\right)^2} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(x_i-\mu\right)^2}$

$= \sqrt{\frac{12.9}{9}} = \sqrt{1.433} = 1.197 \approx 1.2.$

The SD of the sample at 1.2 is quite large, especially when compared to the sample mean of 1.9 (coefficient of variation (CV) = $\left(1+\frac{1}{4n}\right)*\frac{s}{\bar{x}}$ where n is the number of observations (10) = $\left(1+\frac{1}{40}\right)*\frac{1.2}{1.9}$ = 0.647. As the CV is quite high, it indicates a lack of consensus among the SMEs about the linkage between the competency and the job description and hence it is prudent to avoid including the competency in the job specification.

The process of ascertaining job specifications after doing a thorough job analysis is quite costly in terms of time and resources. A sufficient number of SMEs must be convinced to partake in the exercise and the analyst have to engage with them over an extended period of time, using interviews and questionnaires, to gather all the job-related behaviors and competencies. Hence, in real-life situations, many organizations do not bother to scientifically ascertain the minimal qualifications required by a candidate and use academic qualifications as proxies for the minimal qualifications.

Once the qualities of a minimally qualified candidate have been identified, the next step in the recruitment process involves reaching the maximum number of potential applicants at the minimum cost, while meeting the firm's socio-legal obligations with respect to the demographic composition of its workforce (Barrick et al., 2011). For that purpose, a variety of recruitment sources are considered such as newspapers, employment agencies, universities, professional conferences and job boards. The parameters that needed to be considered are: cost of recruitment; amount of information given; predictability i.e. the certainty that the recruitment program will be able to attract a minimum number of candidates and the type of positions for which recruitment is being conducted (whether professional or non-professional) (Barrick et al., 2011). Normally, there is a trade-off between the different parameters i.e. low cost is likely to be associated with low predictability and access to non-professional employees. However, the increased use of online tools for recruitment is increasingly allowing recruiters to reduce the cost of operations while maintaining moderate levels of predictability and having access to professional employees.

Some of the metrics that can be used to gauge the effectiveness of recruitment measures include the recruiting cost ratio and recruiting efficiency. Recruiting cost ratio(RCR) includes the employee hiring costs and accounts for the costs associated with the new employee getting acquainted with the job i.e. the total compensation cost up to the period of induction and the cost of underperformance of the new employee for the first three to six months of learning. Mathematically, it is calculated as RCR= (Total hiring costs/ Total compensation up to the period of induction + cost of underperformance during the initial learning period) *100. Similarly, recruiting efficiency is measured in terms of the number of applicants for each vacant position.

Example 3: There are 10 vacant positions in an organization. There is a three-day induction period, for which the cost to company, is around Rs. 30,000 and the learning period for the job is estimated at 3 months. During the learning period, the cost of underperformance is estimated at 50 percent of monthly salary. The monthly salary is Rs. 70,000. The number of applicants was 200 and the cost of recruitment and selection was Rs. 2, 00,000. Assuming all positions are filled, calculate the recruiting cost ratio and the recruiting efficiency.

Solution: Recruiting cost per employee is Rs. 2, 00, 000/10 = Rs. 20, 000. Costs acquainted with induction and underperformance is Rs. (30,000 + 3*0.5*70,000) = Rs. 1, 45, 000. Therefore

$$\text{RCR} = \frac{20000}{145000} * 100 = 13.79.$$

Recruiting efficiency = Number of applicants/Number of open positions = 200/10 = 20.

STATISTICS FOR SELECTION

Selection can be broadly defined as the set of processes that enable the organization to select the best individuals from the available pool of candidates. Although recruitment and selection processes go simultaneously, they have different objectives with recruitment focusing on attraction and evaluation. The population of all minimally qualified candidates constitutes the applicant population and recruitment aims to ensure that the applicant pool i.e. the individuals who express interest in the job form a sizeable portion of the applicant population. Once a significant applicant pool has been created, the selection processes become more important and aim to hire suitable candidates from the applicant pool. Based on the demands of the job and the size of the applicant pool, the selection process can be a single step process or a multi-step process.

The selection process flows from the job analysis. The centrality of job analysis in human resource management rests on assuming three major inferential leaps – from work behavior to competencies; from competencies to selection instruments and from work behavior to performance. The selection process is concerned with the second inferential leap. Once the entry-level competencies for the work behavior have been identified, the next step is to identify the selection instruments that will be used to measure the competencies. Sophisticated statistical techniques have been developed to measure the amount of congruence between competencies and selection instruments and this process is less dependent on human judgment as compared to the linkages between work behaviors and competencies.

Competencies are normally classified as knowledge, skills and abilities (KSAs). Knowledge refers to a body of information, usually factual or procedural in nature that helps in the successful performance of a task (Barrick et al., 2011) while skill denotes the degree of competency or proficiency, usually expressed in numerical terms, achieved by an individual in performing a specific task (Barrick et al., 2011). The term ability refers to generic, relatively persistent trait or capability possessed by an individual before he or she first begins to perform a task (Schmidt, Ocasio, Hillery & Hunter, 1985). For example, knowing the laws of India constitute knowledge; typing speed is an example of a skill and having a higher than average score on the conscientiousness dimension of the Big Five personality constitutes an example of ability. Skills are conceptually related to tacit knowledge which refers to knowledge that is "rooted in action, commitment and involvement in a specific context" (Nonaka, 1994) and hence is difficult to formalize and communicate. Grant (1996) had identified tacit knowledge with knowing how and explicit knowledge with knowledge about facts and theories. Hence, knowledge as referred to in rest of the chapter deals with explicit knowledge that is easy to transmit through language (Nonaka, 1994).

The conceptual differences between knowledge, skills and abilities are manifested in the differences between the instruments used to measure them. Knowledge is usually measured through written tests while skills are measured through work samples. Abilities are psychological constructs that have no physical existence and are measured through psychometric instruments. As both knowledge and abilities represent non-physical entities, the instruments designed to measure them share certain similarities with respect to the problems of reliability and validity. However, while knowledge of candidates is usually judged by experts/machines, abilities are usually measured using self-reported questionnaires as only the candidate has access to his/her mental states.

Psychometric Properties of the Scales

As selection involves choosing candidates with the maximum score on the desirable attributes, measurement of attributes is central to the process. Measurement refers to the systematic application of rules for assigning numerical values to concepts that are representative of a person's attitudes or traits (Urbina, 2004). For measurement to be objective and meaningful, the application of rules should be context-independent and the rules should be objective. Measurement is useful only if people differ on the object of interest. A scale of measurement refers to how individuals are differentiated from one another on the variable of interest.

Based on their intrinsic properties, the scales used for measuring psychometric properties are classified as nominal, ordinal, interval and ratio. A nominal scale only classifies individuals into different, mutually exclusive categories. For example, gender-related questions are nominal scales as they classify the applicant pool into two exclusive categories without implying any ordering of the individuals. Ordinal scales rank order individuals but do not measure the magnitude-related individual differences with respect to the variable of interest. Supervisory ratings of subordinates are an example of ordinal scales. For example, if a supervisor has given ranks 1 to 5 to his subordinates with 1 implying best performance, we cannot conclude that the difference in performance between subordinates ranked 1 and 2 is equal in magnitude to the difference in performance between subordinates ranked 4 and 5.

Interval scales not only help rank-order the individuals but also use constant units of measurement thereby making the differences between the units meaningful. For example, job satisfaction is usually measured using interval ratio and hence we can conclude that the difference in job satisfaction between two persons scoring 3 and 4 respectively is equal to the difference in job satisfaction between two persons scoring 1 and 2 respectively. However, we cannot conclude that a person who scores 2 on the job satisfaction scale is twice as satisfied as a person scoring 1 as interval scales lack an absolute zero. Interval scores are useful for measuring psychological constructs (abilities) as most of these constructs lack an easily identifiable absolute zero (for example, what does zero job satisfaction mean?).

Ratio scales can measure the absolute magnitude of an individual's score on the variable of interest as well as the magnitude of differences between two individuals as they have a true zero i.e. the zero point of the scale reflects absence of that attribute. Tests of knowledge can theoretically be measured on a ratio scale as it is possible for a person to have zero knowledge about a subject. However, a proper ratio scale for a test implies that the test questions are a representative sample of the universe of questions about the subject and this condition is usually difficult to satisfy. A more pertinent example of a ratio scale is the number of units produced.

The selection procedures mostly use interval and ratio scales as most statistical analyses can be performed only with interval and ratio scales. Even means and standard deviations cannot be calculated for ordinal scales as equal differences in the scale need not represent equal differences in magnitude of the underlying construct. Hence, we cannot use multi-item ordinal scales for measuring underlying constructs as there is no procedure for calculating the mean score on a construct by averaging the scores of the different items measuring the construct. The use of multiple indicators per factor is recommended because it increases the probability of tolerably identifying the construct under study (Eisinga, Grotenhuis & Pelzer, 2012). The use of scales with less than three items has been considered problematic (Raubenheimer, 2004) and the use of single-item scales is considered admissible only if the underlying construct is narrow or unambiguous from the point of view of respondent (Wanous, Reacher & Hudy, 1997). Selection process is focused on selecting employees likely to be successful in the workplace and hence it is concerned with establishing relationship between criteria variables (which measure job performance) and predictor variables (which measure the competencies). As ordinal scales can only be single-item scales, the measurement of both criteria and predictor variables is likely to be error-prone. The errors in measuring these variables i.e. the loss of reliability is likely to affect the validity of the relationships.

Most underlying constructs are normally distributed when large number of observations is made. Hence, if the scores that we get from using an interval or ratio scale are normally distributed, we can be confident that the use of interval scale is appropriate. Table 3 summarizes the discussion about the scales.

Types of Scales

A variety of ratio and interval scales are used for measuring applicant competencies (knowledge, skills and attitudes). Some of the more popular scales are described briefly below with examples.

Table 3. Properties of measurement scales

Type of Scale	Scale Characteristics				Example in Selection Process	Typical Statistics	
	Classification	Order	Equal Magnitude	Absolute Zero		Descriptive	Inferential
Nominal	Yes	No	No	No	Classifying applicants by gender	Percentage, mode	Chi-square, binomial
Ordinal	Yes	Yes	No	No	Ranking subordinates	Median	Rank-order correlation
Interval	Yes	Yes	Yes	Yes	Employee scores of affective commitment	Mean, range, standard deviation	Product moment correlation, T-Test, Factor Analysis
Scale	Yes	Yes	Yes	Yes	Number of units produced per employee	Geometric Mean	Coefficient of Variation

Source: Bhattacharyya (2012), Sekaran (1984); Barrick et al. (2007).

Behaviorally Anchored Rating Scales (BARS)

They are useful for measuring behaviors and hence are used for measuring performance outcomes or skills. Normally, BARS are presented as scale points ranging from five to nine with each point being described by an actual consumer behavior. For example, an employee's customer interaction skills for a bartender can be measured with a BARS scale with 1 (lowest point) being defined as "Employee can be expected to remain silent until customer waves money" and 7 (highest point) being defined as "Employee can be expected to smile and greet a regular customer by name" (Barrick et al., 2007). BARS are difficult to design but provide benchmarks for rating behavior.

Likert's Summated Scales

Likert scales are the sum of responses on several Likert items. Likert items refer to statements that each respondent is asked to evaluate by giving it a quantitative value, with the most commonly used dimension being the level of agreement/disagreement (Jamieson, 2004). Mostly Likert items are about items and 5-point Likert scales are the most commonly used in literature. A sample Likert item is: I persevere in tasks delegated to me with 1 indicating "strongly disagree" to 5 indicating "strongly agree". Likert scales are among the most commonly used scales for measuring attitudes and research has indicated that they can be interpreted as interval scales even if Likert items are worded like ordinal scales (Norman, 2010) and can be used even if the underlying data is highly non-normal (Norman, 2010).

Thurstone's Equal-Appearing Intervals Scale

Thurstone developed three methods for developing a unidimensional scale: method of equal-appearing intervals; the method of successive intervals; and, the method of paired comparisons. All three methods are rated similarly by respondents even though their development processes are slightly different. For the equal-appearing interval scale, a set of final items are generated from a larger set of candidate items by considering the median and inter-quartile range of judges' ratings. The final items are rated on a binary (agree or disagree) scale with agree interpreted as 1 and disagree as 0. The number of items a person agrees with, convey his/her attitude towards the topic (Trochim, 2000).

Guttman's Cumulative Scale

The Guttman scale aims to identify a set of items on a one-dimensional topic in such a way that a person who agrees with any specific question in the list is likely to agree with all previous questions (Trochim, 2000). First a laundry list of items on the topic is generated and then the ordering of the items in the requisite manner is done using scalogram analysis (Trochim, 2000). In an ideal case, the total score of the respondent would enable the analysts to identify the exact items with which the respondent agrees. Put more formally, we would like to be able to predict item responses perfectly knowing only the total score for the respondent. For example, if there is an eight-item Guttman cumulative scale and respondent scores a four, it implies that the respondent agrees with the first four statements.

The Thurstone and Guttman scale are more complex to develop as compared to the Likert scale and hence the Likert scale is the most widely used measure for measuring attitude. BARS are also difficult to design but provide common reference points when rating behavior and hence their use might lead to increased inter-rater reliability.

Reliability

The selection instruments are used to measure the candidates KSAs. As the KSAs cannot be directly measure, it is imperative to ensure that the selection instruments are reliable indicators of the underlying constructs. In selection research and practice, variables are classified as criteria variables, which reflect job performance and on-job behavior, and predictor variables, which reflect candidate competencies. A good criteria variable must make sense to the company executives (recognizable), must be significant in determining employee performance (relevance) and should be measurable. A good predictor must have a logical relationship with at least one criterion variable (relevance) and should be measurable. A variable can be appropriately measured only if the scales measuring it are reliable. Hence, it is necessary to ascertain the reliability for both the criteria variables as well as the predictor variables.

Reliability is defined as the degree of dependability, consistency or stability of scores on a measure used in selection research (Barrick et al., 2011). For example, if a person's scores on a test do not change much on multiple attempts, the test is consistent. If the person has not changed much with respect to the variable of interest and the same is reflected in his/her test scores, the test score has stability. Dependability is a more abstract property and refers to the fact that the test is a good measure of the underlying construct i.e. the person's scores on the test are close to the person's true score on that attribute.

A fundamental assumption of measurement theory is that the measurement of any attribute consists of a true score component as well as error score component with the error arising due to systemic factors or random fluctuations. Systemic factors that can lead to the introduction of error in measurement include respondent's history; mode of administration of test and use of judgmental methods of scoring. If the error is systemic then it tends to bias the scores towards or away from mean (Atkinson & Nevill, 2000). Random errors do not distort the measurement in any direction and hence, in the absence of systemic error, the average of a large number of responses is likely to yield a score close to the true score. The lower the error component, the more reliable is the instrument. One measure of the amount of error is the standard deviation of scores obtained by repeated measurements (Bland, 1996).

The reliability coefficient of a measure and the true and obtained scores (obtained using that measure) are related by the equation $r_{xx} = r_{tx}^2$ (Gulliksen, 1950) where x stands for obtained scores; t stands for true scores; r_{tx} stands for the correlation between true and obtained scores and r_{xx} stands for the reliability coefficient of the measure. This equation suggests that reliability can be interpreted as the extent due to which individual differences in scores on the measures reflect true differences of individuals on the attributes.

Example 4: Two identical twins respond multiple times to two scales measuring the same underlying construct. The construct is almost completely genetics-based. For one twin, the scores were between 45 and 55 and for the other twin;

the scores were between 40 and 60. What can be inferred about the true score and the reliability of the instruments if the scores are normally distributed?

Solution: As the attribute is almost completely genetics-based, it is likely that the two identical twins will have the same score. The mean value for both twins is 50 which supports our contention. Hence, unless there is strong proof to accept the unlikely scenario that both the instruments are systematically biased to the same degree, it is prudent to assume that the measurement error is random and not systemic in nature and accept the average of the responses i.e. 50 as the true score. As the dispersion around the mean is greater for the second scale, the first scale is likely to have greater reliability.

Ascertainment of reliability is essential to ensure the usability of the scale. However, direct measurements of reliability are impossible as they require comparisons between the obtained score and true score, with lower spread indicating higher reliability, and the true score is not accessible. Hence, we must estimate reliability. Reliability is usually estimated by examining the relationship between two sets of measures measuring the same thing. Some of the indirect measures of reliability include test-retest reliability; parallel forms reliability; split-half reliability; Kuder-Richardson reliability; and Cronbach coefficient alpha reliability. Sometimes the rating cannot be done mechanically by use of a scale but instead involves the use of human judgment. In those cases, we focus on the inter-rater agreement between the different judges.

Test-retest reliability refers to the measurement of the same individuals using the same instrument over two periods of time. The assumption is that if the instrument used is highly reliable then the correlation between the two set of scores would be close to 1.00 as the underlying attribute is the same. Correlation coefficients range from -1.00 to 1.00. A correlation of 0.00 indicates zero reliability and suggests that the obtained scores are no better than any random number. Proper estimation of test-retest reliability is contingent on the test administration conditions; test scoring rules and respondents' mental and physical state being same in both states. As test-retest reliability is dependent upon the respondents' mental and physical state being unchanged they are unreliable if memory or learning is important.

Memory refers to the ability of respondents to remember their previous responses. It tends to artificially inflate the reliability estimates. The effects of memory can be reduced by increasing the number of items, increasing the complexity of time and maintaining a significant time-gap, of at least 8 weeks between the test and retest (Groth-Marnat, 2003). However, maintaining a significant time gap between the test and retest can lead to learning effects. Learning refers to any changes e.g. training programs or knowledge of answers that modifies respondents' responses to the questions. Due to differential learning by respondents, test-retest reliability decreases. Test-retest reliability also decreases when the underlying attribute is unstable.

Example 5: Professor X takes a test of 6 candidates. However, he misplaces the answer sheets. Hence, he re-evaluates the students on the same questions. The scores of the students are mentioned in Table 4. Calculate and comment on the test-retest reliability of the question paper.

Solution: Test-retest reliability is calculated using the Pearson correlation coefficient between the two set of data.

$$\text{Pearson correlation coefficient (r)} = \frac{n\left(\Sigma xy\right)-\left(\Sigma x\right)\left(\Sigma y\right)}{\sqrt{n\left[\left\{\Sigma x^2-\left(\Sigma x\right)^2\right\}\left\{\Sigma y^2-\left(\Sigma y\right)^2\right\}\right]}} = 0.94337.$$

As the Pearson correlation is very near to 1, it indicates high reliability.

Test-retest reliability of selection instruments is not always feasible due to the constraints of memory or learning or the inherent instability of the construct. To circumvent this problem, parallel forms of the same selection instrument can be developed and the correlation between the scores of a group of applicants who have been tested using two different forms can be calculated. To ensure parallel forms reliability, it is necessary to ensure that the two measures have the same number of questions of the same level of difficulty. Also, the means and standard deviations of the two set of measures should be the same.

Although multiple forms of the same measure are widely used in practice, it is practically difficult to ensure that all the three conditions that must precede the testing of reliability are met. Moreover, as the two sets of measures are designed to be as similar to each other as possible, the effects of learning on test scores cannot be eliminated. For example, if we are testing arithmetic ability and one set of measures has some questions on ratios then the other set also needs to include

Table 4. Test-retest scores of 6 students

Student Roll No.	Score on Test A	Score on Test B
1	7	8
2	6	7
3	8	8
4	5	7
5	4	5
6	3	4

similar questions. Hence, if the respondent develops his knowledge on ratios during the intervening period, the scores on second measure will be inflated leading to lowering of reliability. Also, multiple forms of the same measure may be difficult for psychometric tests measuring specific attitudes.

Given the problems in conducting parallel forms reliability, a potential solution is to divide the measure itself into two equal halves and check for the correlation between the two halves. This is called split-half reliability. The problems with split-half reliability include (1) difficulty of splitting a questionnaire with odd number of questions (2) existence of multiple ways of splitting the questionnaire (3) underestimation of actual reliability due to the reduction in number of questions and (4) spuriously high correlations for timed tests with rather easy questions.

Problem 1 is trivial and can be corrected by using measures with even number of items. Problem 2 limits the effectiveness of split-half reliability to those cases where all possible "splits" have similar correlation (highly implausible) or the split can be conceptually justified (e.g. similar questions are placed adjacent to each other in the original measure). To correct for the under-estimation of reliability, Spearman-Brown prophecy formula is used. The formula is:

$r_{ttc} = \dfrac{nr_{12}}{1+\left(n-1\right)r_{12}}$ where r_{ttc} is the corrected split-half reliability coefficient for the total selection measure; n is the number of times the test is split (usually 2) and r_{12} is the correlation between the two parts (1 and 2) of the selection measure. Assuming r_{12} is 0.7 and n is 2, gives r_{ttc} as 0.83. To avoid spurious correlations for tests where speed of answering rather than difficulty of questions is the main roadblock, it is necessary to avoid use of split-half reliability.

The possibility of dividing the measure into two equal halves in multiple ways, and the potentially different correlations between the different halves, limits the use of split-half reliability to special circumstances. To circumvent this problem, Kuder-Richardson reliability procedures can be used which solve the problem of dividing the measure by taking the average of the reliability coefficients that would result from all the possible ways of subdividing the measure equally. There are multiple Kuder-Richardon formulas and the most popular one is K-R 20. K-R 20 is used to determine reliabilities of dichotomous scales i.e. scales with two categories. The formula for computing K-R 20 $\left(r_{tt}\right)$ is:

$$r_{tt} = \frac{k}{k-1}\left\{\frac{\Sigma p_i\left(1-p_i\right)}{\sigma y^2}\right\}$$

where

k = number of items on the test
p_i = proportion of respondents getting each item (i) correct
$1 - p_i$ = proportion of respondents getting each item (i) wrong
σy^2 = variance of respondents' total score

Example 6: Calculate the K-R 20 reliability for instrument A. The responses of respondents are marked as 1 or 0 with 1 indicating correcting response and 0 indicating incorrect response.

Solution: The modified table for computing K-R 20 reliability is:

$$\text{K-R 20 reliability} = \frac{k}{k-1}\left\{\frac{\Sigma p_i\left(1-p_i\right)}{\sigma y^2}\right\}$$

Table 5. Data for computing K-R 20 reliability of instrument A

Applicant	Test Items							
	1	2	3	4	5	6	7	8
1	1	1	1	0	0	1	1	0
2	0	1	1	0	1	1	1	0
3	1	0	0	0	1	0	1	1
4	1	0	0	0	0	0	1	1
5	0	0	0	1	0	0	0	0
6	1	1	0	1	1	0	0	1

Table 6. Table for computing K-R 20 reliability of instrument A

Applicant	Test Items								Score of Applicant
	1	2	3	4	5	6	7	8	
1	1	1	1	0	0	1	1	0	5
2	0	1	1	0	1	1	1	0	5
3	1	0	0	0	1	0	1	1	4
4	1	0	0	0	0	0	1	1	3
5	0	0	0	1	0	0	0	0	1
6	1	1	0	1	1	0	0	1	5
Proportion correctly answering item	0.67	0.50	0.33	0.33	0.50	0.33	0.67	0.50	

$$= \frac{6}{5} * \left(\frac{\begin{array}{c} 0.67 * 0.33 + 0.50 * 0.50 + 0.33 * 0.67 + 0.33 * 0.67 \\ +0.50 * 0.50 + 0.33 * 0.67 + 0.67 * 0.33 + 0.50 * 0.50 \end{array}}{2.567} \right) = 0.87$$

K-R 20 is suitable only for measuring internal consistency only for dichotomized categories. However, most measures have provision for multiple responses and hence K-R 20 cannot be used for computing their reliability. If the responses are based on an interval scale, we can use Cronbach coefficient alpha (α), a generalized version of K-R 20 for computing the reliability (Cronbach, 1951). Cronbach alpha is widely used for computing the reliability of psychological constructs in the literature. The formula of α is:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\Sigma\sigma_{i^2}}{\sigma y^2}\right)$$

where

k = number of items on the test
σ_{i^2} = variance of respondents' total score on each item (i) of the measure
σy^2 = variance of respondents' total score

Cronbach's alpha is difficult to calculate manually and hence it is usually calculated with the help of software such as SPSS. Cronbach's alpha, K-R 20 and split-half reliability are all calculated based on a single administration of a measure and hence they are called measures of internal consistency. Increase in number of items usually leads to an increase in internal consistency and users need to account for the same while calculating reliability.

It is not always possible to systematically rate candidates on attributes using scales and other objective measures. In those cases, we have to rely on human judgment and we need to measure inter-rater agreement. The popular measures of inter-rater agreement include percentage of rater agreement and Cohen's kappa (κ). Cohen's kappa (κ) is calculated as $\kappa = \frac{p_o - p_e}{1 - p_e}$ where p_o represents the observed agreement among raters and p_e represents the probability of agreement by chance (Cohen, 1960). Interrater agreement is of two types: interclass correlation where two judges rate a series of individuals on attributes and intraclass correlation where three or more judges rate a series of individuals. Cohen's kappa (κ) is an example of interclass correlation. Intraclass correlation calculations are more complex and percentage of rater agreement is a good substitute in most cases.

Using Reliability Coefficients for Interpreting Individual Scores

A high reliability coefficient indicates that the error component of the obtained scores is low. However, as no measurement can be completely free of error, it is possible that differences in obtained scores may not reflect differences in true scores. Hence, it can be construed as unfair to discriminate between candidates based solely on their obtained scores. To rectify this, we can find the standard error of measurement $\left(\sigma_{meas}\right)$. The formula is: $\sigma_{meas} = \sigma_x\sqrt{\left(1 - r_{xx}\right)}$ where σ_x is the standard deviation of obtained scores on measure X and r_{xx} is the reliability of measure X. If the difference between the scores of two individuals is greater than two times the standard error of measurement, we can be 95 percent sure (assuming the underlying construct is normally distributed) that the two individuals differ in their true scores.

The standard error of measurement can be used to create bands of scores such that all applicants whose scores fall within the band are treated equivalently. Normally, the fist band is formed by taking the highest scorer as the upper bound and considered all scores that fall within two standard errors of measurement of the highest score as equivalent. The next band either starts from the highest scorer outside the first band (sliding band) or by considering the lower bound of the first band as the upper bound of the second band. Banding has been used in the United States of America (USA) to increase the representation of historically under-represented demographics and have been endorsed as a viable alternative to top-down selection by the Supreme Court (Cascio, Outtz, Zedeck & Goldstein, 2009). On the other hand, banding has been criticized as a logically flawed move (Schmidt, 1991). The assumption that standard errors of measurement are constant has also been criticized and alternate methods for computing bands have been proposed (Bobko, Roth & Nicewander, 2005). Despite the presence of multiple historically disadvantaged groups in India, banding has been rarely used in India and the Indian government has focused mostly on numerical quotas to secure representativeness in government service.

Validity

Validity is defined as the degree to which available evidence supports inferences made from scores on selection measures (Barrick et al., 2011). Selection measures help decide whether the candidate is expected to be a good performer or not. Hence, validation refers to the process of establishing relationship between the selection measures and performance attributes. Validity differs from reliability because reliability is an attribute of the measure while validity is an attribute of the inferences that we make based on the scores provided by the measure. For example, a scale of conscientiousness has reliability while the inference that people scoring high on conscientiousness perform better needs to be validated.

Validity usually involves determining the strength of relationship between the criteria and predictor variables. Hence, high reliability of the measures is necessary for establishing the validity of the inferences linking them. However, although reliability is a necessary condition for validity it is not a sufficient condition i.e. high reliability of the measures need not result in high validity of inferences linking them. The maximum empirically possible value of validity is given by $r_{xy} = \sqrt{r_{xx} r_{yy}}$ where r_{xy} = maximum possible value of validity i.e. maximum possible correlation between predictor X and criterion Y (the validity coefficient); r_{xx} = reliability coefficient of predictor X and r_{yy} = reliability coefficient of criterion Y. The square of the validity coefficient indicates the proportion of the individual variance in the criterion that is accounted for by variance in the predictor. Hence, higher the validity coefficient, the stronger is the inference that the predictor impacts the criteria.

Example 7: The reliability of a mental ability test is 0.7 and the reliability of supervisory rating of performance is 0.9. Find the maximum possible validity of the inference that mental ability is related to job performance.

Solution: In this case, the predictor is mental ability and the criterion is supervisory rating. Hence, reliability coefficient of predictor is 0.7 and reliability coefficient of criterion is 0.9. Therefore, maximum value of validity of predictor-criterion relationship is $\sqrt{0.7 * 0.9} = 0.7937 \approx 0.80$.

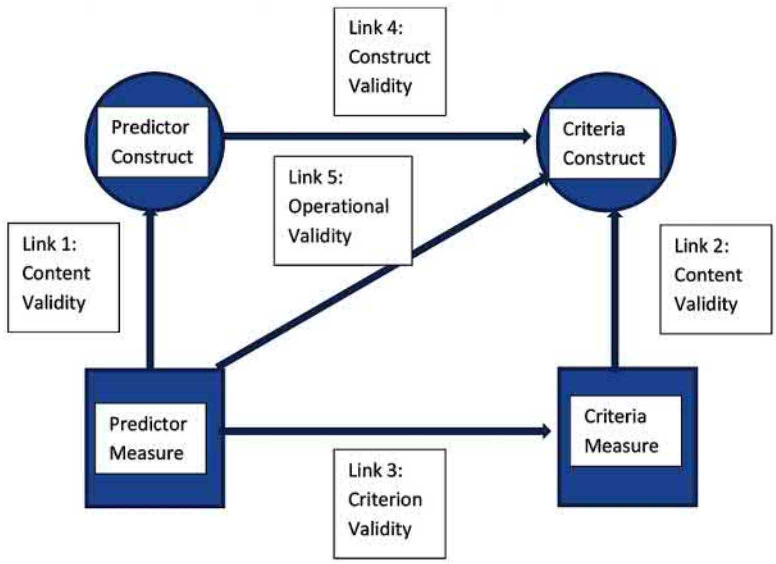
The validity of the inferences stating a correlation between the predictor and the criterion variables can be supported in at least three ways – (1) content validity (2) criterion-related validity and (3) construct validity. Content validity is based on an analysis of the content of the job and relies on the use of expert judgment. Criterion-related validity is based on an examination of the empirical relationship between the measures used to capture the predictor and criteria variable. It is of two types – concurrent validity and predictive validity. Construct validity is conceptually more complex and is used when both content validity and concurrent validity fail.

Content validity is based on job analysis that establishes the job content domain i.e. the expected work behaviors (job description) and required KSAs (job specifications). Content validity is established if the content of the measures reflects the job content domain. The content validity of predictors is established if they are representative of one or more job specifications and the content validity of criterion is established if they are representative of one or more expected work behaviors. The process of content validity is usually undertaken by a team of experts. The content validity of an item measure, either predictor or criteria, is determined using the Content Validity Ratio (CVR). CVR = $\frac{n_e - N/2}{N/2}$ where n_e is the number of judges rating the test item as essential and N being the total number of judges. If the CVR value is significantly different from what would be obtained by chance alone and positive in sign, the item is selected. Content validity of inferences can be established even if the number of applicants is small.

In criterion validity, the empirical relationship between the selection scores and criteria of job success are established. In concurrent validity, data about selection scores and job performance is simultaneously collected from current employees. On the other hand, in predictive validity data about selection scores are collected from applicants and data about performance is collected once the applicants have joined the job. As the design of concurrent validity studies is cross-sectional while that of predictive validities is longitudinal, predictive validity studies are methodologically more robust in demonstrating causality. Also, current employees may not give their best performance on selection measures as the real-life implications of the scores are limited. Thirdly, there might be substantial differences in the characteristics of applicants as compared to employees. All this suggests that predictive validity should be preferred wherever possible. However, if the organization hires relatively few people in a given time-period, it might be difficult to obtain requisite sample size for establishing statistical significance. Statistical methods like regression are used for establishing validity. Both predictive and concurrent validity suffer from the problem of attenuation as the performance of only selected candidates can be considered. Statistical methods and attenuation are discussed later in the chapter.

MacCorquodale & Meehl (1948) defined constructs as conceptual abstractions of directly unobservable phenomena such as psychological attributes. Construct validity is conceptually more complex and "…refers to the degree to which inferences can legitimately be made from the operationalizations in your study to the theoretical constructs on which those operationalization were based…" (Trochim, 2000). Construct validity is investigated whenever neither the criterion nor the universe of content has been accepted as entirely adequate to define the quality to be measured (Cronbach & Meehl, 1955). For selection process, construct validity is rarely used as it requires extensive research and is usually based on aggregation of results (Peter, 1981). Figure 1 summarizes the different types of validity

Figure 1. Representation of different types of validity used in personnel selection
Based on Viswesvaran, Ones, Schmidt, Le & Oh, 2014, p. 509.



Establishing Statistical Relationship Between Predictor and Criteria

Validity studies in selection should not only predict the expected relationship between predictors and criteria variables but they should also indicate how much a unit change in predictor scores is likely to lead to changes in the criteria scores. One of the most common tools used for establishing numerical relationships between predictor and criteria variables is regression.

Linear regression is a statistical technique for representing the relationship between predictors and criterion in form of a linear equation. It is of two types: simple and multiple. In simple regression, there is one criterion and one predictor. In multiple regression, there is one criterion and multiple predictors. The simple linear regression is expressed by $\widehat{Y} = A + BX$ where $\widehat{Y}$ represents the score of the criterion variable; a represents the intercept value of regression line; b is the slope of the regression line i.e. regression weight and X is the predictor variable. A unit change in X leads to b units' change in $\widehat{Y}$. The smaller the gap between Y, actual score on criterion variable, and $\widehat{Y}$, the predicted score, the more suitable is the regression equation. Regression equations are evaluated on two parameters: statistical significance of predictor (s) and the magnitude of variance in criterion explained by predictor(s) i.e. R^2. High statistical significance indicates that there is low probability that the results were achieved through chance. The formula of calculating a and b for simple regression is:

$$b = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{N\Sigma X^2 - (\Sigma X)^2}$$

$$a = \frac{\Sigma Y - b\Sigma X}{N}$$

where, N = Number of observations; X = value of predictor variable per observation and Y = value of criterion variable per observation.

In most practical cases, there are multiple potential predictors for each criteria of job success. As these predictors are correlated with each other, we cannot predict the cumulative effect of the predictors by adding the variances of all simple regression equations. Correlations between the predictors ensure that the combined predictive of the predictors (R^2 of the multiple regression equation) is less than the sum of their individual predictive powers. Hence, we have to run multiple regression equations i.e. regression equations with one criterion variable and multiple predictor values for finding the incremental validity of using an extra predictor. Multiple regression models are compensatory i.e. a low performance in one of the selection measures can be compensated by superior performance in others. The formula for multiple regression is:

$$\widehat{Y} = A + B_1 X_1 + \ldots + B_n X_n$$

The predicted values of the regression equation have important practical implications as far as it guides the choice of selection instruments to be used. Hence, it is necessary to measure the degree of accuracy of prediction. This accuracy can be measured with the standard error of estimate, which indicates how far the actual criteria variables are from the regression line. The formula for standard error of estimate for simple regression is: $sd_{yx} = sd_y \sqrt{1 - r_{xy}^2}$ where sd_{yx} is standard error of estimate; sd_y is standard deviation of criterion scores Y and r_{xy} is the validity coefficient of predictor X and criterion Y.

Accounting for Measurement Imperfections

The validity coefficients between predictor X and criterion Y might be affected by measurement error or range restriction. Range restriction of predictor(s) occurs because we have criteria measures only for current and past successful applicants and hence we can use predictor scores only for the same sample. As successful applicants are likely to possess higher average selector scores than applicants, collecting predictor scores only from them is likely to artificially restrict the range of selector scores.

Measurement scores can affect both predictor scores as well as criteria scores. However, research has mostly focused on accounting for measurement error in criteria scores as the relationship between predictor scores and criteria construct is "the crucial inference that is sought in validating assessments for selection" (Viswesvaran et al., 2014). Correcting for the measurement error in criterion scores, called as correction for attenuation, is done using the formula $\widehat{r_{xy}} = \frac{r_{xy}}{\sqrt{r_{yy}}}$ where $\widehat{r_{xy}}$ is the corrected validity coefficient; r_{xy} is the empirical validity coefficient and r_{yy} is the reliability coefficient of criterion. The corrected validity coefficient is always greater than the empirical validity coefficient.

The calculation of validity coefficient is dependent upon the variance in both the predictors and criteria scores. Due to certain reasons, the range of both predictors and criteria scores used in a study might be restricted. This problem is usually more pronounced for predictor scores. The formula for correcting range restriction is:

$$\widehat{r_{xy}} = \frac{r_{xy}\left(\frac{SD_{\mu}}{SD_{r}}\right)}{\sqrt{1-\left(r_{xy}\right)+\left(r_{xy}\right)^{2}\left[\left(\frac{SD_{\mu}}{SD_{r}}\right)\right]^{2}}}$$

with $\widehat{r_{xy}}$ representing the corrected validity coefficient; r_{xy} representing the validity coefficient obtained from the group with restricted range; SD_{μ} representing the standard deviation of the predictor scores from the unrestricted group and SD_{r} representing the standard deviation of the predictor scores from the unrestricted group.

Utility Calculations

A selection method, especially one that involves calculating validity coefficients measuring the relationship between a predictor and criteria variables, requires substantial time, effort and resources. Hence, there is always a need to prove the utility of a selection method to the organization. A good selection measure is likely to result in the hiring of employees with higher work productivity and this increased productivity is likely to result in increased value to the firm. These benefits have to be balanced with the cost of administering the program. The formula for calculating net utility of a selection method is:

Net monetary utility = $N_s r_{xy} SD_y Z_x - N_T\left(C\right)$ where N_s is the number of candidates selected; r_{xy} is the validity coefficient; SD_y is the monetary value of performance that is one SD above normal; Z_x is the average score of selected applicants in standardized format as compared to the applicant pool; N_t is the number of candidates assessed and C is the cost of assessing each candidate.

Example 8: A selection method assessed 1000 candidates and selected 80 of them. The validity of the selection measure with respect to supervisory rating is 0.6. Employees who score 1 standard deviation above the average on supervisory rating produce additional value of Rs. 100,000. The average scores of selected candidates on the measure was 50 and the average score of all applicants was 45. The standard deviation of the applicants' scores was 10. The cost of assessing 1 candidate was Rs. 500. Calculate the net utility of the selection measure.

Solution: In this case,

$$N_s = 80$$

$$r_{xy} = 0.6$$

$$SD_y = 100,000$$

$$Z_x = \frac{X - M}{\sigma} = \frac{50 - 45}{10} = 0.5$$

$$N_T = 1000$$

$$C = 500$$

Net utility = $N_s r_{xy} SD_y Z_x - N_T\left(C\right)$= Rs. (80*0.6*100000*0.5-1000*500) = Rs.19,00, 000

Combining Results of Different Tests

Candidates are tested on multiple competencies and most selection processes measure only a limited set of competencies. Hence, the testing body not only needs to establish the reliability and validity of each selection instrument but also the validity of the selection process as a whole Also, as the number of candidates increases it becomes costlier and time-taking to administer tests to all of them. Organizations may wish to test only selected candidates, thereby reducing their operational costs. All this requires proper sequencing of the selection process.

The collection and combination of predictor information can be either mechanical or judgmental (Barrick et al., 2011). Mechanical collection/combination refers to the collection and combination of applicants scores on various selection devices according to pre-established rules. On the other hand, judgmental collection/combination involves the use of human judgment in either collecting the data (example unstructured interviews) and/or combining the data (example using one's intuition to select a candidate based on his/her performance in interview and written test). Mechanical methods of combination are considered statistically more valid in predicting outcomes but are likely to be less helpful in novel situations where there is lack of enough past data to suggest rules for aggregating scores across tests. Different mechanical methods for combining test scores include multiple regression, multiple cut-offs, multiple hurdles and combination method.

Regression refers to a statistical technique that represents the relationship between the dependent (criterion) variable and one or more independent (predictor) variables in the form of a mathematical equation so that we can predict the magnitude or the change in the magnitude of the dependent variable based on the magnitude or change in magnitude of the independent variables (Minitab17 Support, n.d.). If the number of predictor variables is one, the regression technique is called simple regression else if the number of predictor variables is more than one, the regression technique is called multiple regression. Examples of regression equation include:

$$\widehat{Y} = A + BX$$
$$\widehat{Y} = A + B_1X_1 + \ldots + B_nX_n$$

$\widehat{Y}$ represents the predicted value of the dependent variable, B/B_n represents the coefficient weight of the independent variable(s) and X/X_n represents the independent variable(s).

For selection purposes, the criterion variable is usually job performance and the predictor variables are the scores on the selection tests. The job performance scores of employees are usually regressed on their scores in the selection tests to obtain the regression equation. A combination of selection instruments is deemed a good predictor model if the R^2, also called the multiple correlation coefficient, is close to 1 (Nagelkerke, 1991). R^2 is defined as the proportion of variance explained by the regression model i.e. the proportion of the variance in the dependent variable that is explained by the independent variables (Nagelkerke, 1991).

Example 9: The police department in a state decides to use regressions to recruit candidates. Based on a regression analysis of past data, the regression equation is estimated as

$$\hat{Y} = 7 + 0.8X_1 + 1.2X_2 + 0.7X_3 + 1.5X_4$$

where $\hat{Y}$ is the predicted value of job performance, X_1 is the score in physical test, X_2 is the score in legal test, X_3 is the score in general knowledge test and X_4 is the score in interview. The marks of four candidates in the four tests are mentioned. If only one of them is to be selected, identify the successful candidate.

Solution: The predicted scores for the different candidates are mentioned in Table 8.

Table 7. Candidate scores on various tests

Candidate Name	Physical Test	Legal Test	GK Test	Interview
Arnab	7	9	8	13
Ashwin	6	12	6	10
Aakash	8	11	5	11
Arindam	7	9	9	12

Table 8. Predicted performance using multiple regression

Candidate Name	Physical Test	Legal Test	GK Test	Interview	Predicted Performance
Arnab	7	9	8	13	48.5
Ashwin	6	12	6	10	45.4
Aakash	8	11	5	11	46.6
Arindam	7	9	9	12	47.7

Based on the predicted scores, Arnab should be selected for the post.

Although non-linear regression techniques are available, linear regression is the most preferred type of regression. It is compensatory in nature. Regression analysis can be done using standard statistical packages like SPSS, SAS and R. Linear means that the relationship between the dependent and independent variables can be represented as a straight line. Compensatory means that low values in one parameter can be compensated by high scores in another. Regression analysis is very flexible as it can be modified to handle nonlinear and nominal data. However, because of its compensatory nature it is not suitable for use in selection events where candidates need to possess a minimum level of scores for some competencies. For example, a police officer will require a minimum level of physical fitness and knowledge of law and this cannot be compensated by scores on other tests. Also, all candidates need to be tested using all selection instruments before predictions using the regression equation can made and this can increase the cost of the process.

The need for selecting candidates with certain minimum levels of competencies leads to the adoption of the multiple cutoffs approach. In this approach, a minimum level of score (cutoffs) in each test is deemed necessary and all candidates who score above the cutoffs are selected (Psychology dictionary, n.d.). For example, in the illustration regarding selection of police officers let the cutoff for the exams be: Physical test (7), legal test (10), general knowledge (6) and interview (10). Using the cutoffs, we see that none of the candidates are found suitable for the post.

The multiple cutoff approach has three major problems: it leads to selection of all minimally competent applicants; it does not solve the cost-related issues associated with testing all applicants and there is no specific method to determine cutoff scores. As all minimally competent applicants are hired, this approach can lead to excess hiring. The cutoff scores can be determined through expert judgments or by following methods like Ebel method and Angoff method (Livingston & Zieky, 1982), in case of written tests.

In the Ebel method, the questions are sorted using two parameters: ease of answering and relevance to the job. The ease of answering the items is based on an analysis of past responses and expert judgment while the degree of relevance comes from the job analysis. Example 10 illustrates the Ebel method.

Example 10: Based on job analysis and review of past data, the following table has been constructed for a 20-item test. For each cell, the expected probability of correct answers by a minimally competent candidate has been determined and is mentioned in brackets. The item numbers corresponding to each cell are also mentioned in the cells. Identify the cutoff score for the exam.

Table 9. Classification of problems based on importance and level of difficulty

Relevance/Difficulty	Easy	Medium	Hard
Essential	1, 6, 15 (95%)	7, 12, 18 (85%)	8, 17, 20 (75%)
Important	2, 5 (85%)	9, 14 (75%)	16, 19 (65%)
Satisfactory	3, 4, 10 (75%)	11, 13 (65%)	(55%)

Solution: There are nine possible combinations of the parameters. The table mentions each possible combination with the number of items in each combination and the probability for that combination. The cutoff score = Sum of (number of items*probability for that combination).

Hence, the cutoff score for the test is 16, rounded from 15.7.

The Angoff method does not sort the items into groups based on their relevance to the job. It determines, at an individual level, the probability of a minimally competent employee to answer each question based on a review of past data. The cutoff score for the test is the sum of all probabilities.

The multiple hurdles approach is a variant of the multiple cutoff approach in which candidates are tested sequentially. Only those candidates who successfully clear the cutoffs in the previous stage are tested in the subsequent stage. The multiple hurdles approach enables organizations to save costs by not testing all candidates. However, as results of a stage have to be announced before conducting the next stage, it may lead to an increase in the duration of the selection process.

Table 10. Illustration of Ebel method

Combination	Number of Items	Probability	Score
Essential-Easy	3	0.950	2.85
Essential-Medium	3	0.85	2.55
Essential-Hard	3	0.75	2.25
Important-Easy	2	0.85	1.7
Important-Medium	2	0.75	1.5
Important-Hard	2	0.65	1.3
Satisfactory-Easy	3	0.75	2.25
Satisfactory-Medium	2	0.65	1.3
Satisfactory-Hard	0	0.55	0
Total Score			15.7

CONCLUSION

Human resources have been identified as a major and sustainable source of competitive advantage (Lado & Wilson, 1994). The human resource department, which is concerned with the stewardship of the firm's human resources, plays an important role in the firm's effectiveness by sourcing talent from the environment, developing the talent and retaining the same. Recruitment and selection are core human resource activities as firms which are successful in hiring above-average quality of human resources at manageable costs are more likely to succeed in an increasingly competitive marketplace where quality of service and innovativeness are emerging as the differentiators. The process of sourcing talent is also linked with talent development as people differ in their ability to absorb training. As retention is linked to organizational commitment, which in turn depends upon employees' psychological traits and past experiences, a robust hiring and selection process can help organizations create a more loyal workforce. Thus recruitment and selection can be considered to be the key human resources function.

The importance of recruitment and selection to organizational effectiveness suggests that robust methods of appraising the effectiveness of the recruitment and selection process, in terms of cost and output, needs to be developed. However, statistically robust methods of appraising effectiveness are hindered by factors such as ignorance of relevant statistics, fragmentation of the process and lack of data. For example, the recruitment process aims to maximize the number of minimally competent employees. However, if the job analysis is not robust and the job descriptions and job specifications are ambiguous, it may attract many candidates who fulfill the mentioned criteria but are not actually minimally competent for the jobs. This can increase the workload of the selection personnel and lead to false positives i.e. hiring of non-competent persons. Even with a robust job analysis, the recruiting function's efforts to increase the number of minimally competent candidates can lead to an increased workload for selection personnel without any significant improvement in quality. Thus, there is a need to measure the effectiveness of the recruitment and selection process in an integrated manner and set goals for the recruitment and selection personnel accordingly.

The validity of selection tools suffers from the problems of data attenuation. For example, supervisor appraisal of job performance and training performance are two of the most widely used criteria for appraising effectiveness of selection tests. However, the data for these two variables are available only for previously selected candidates while the selection tests are used for all candidates. Hence, care needs to be taken to ensure that except for the measured parameters, the profile of the selected candidates is as close as possible to the non-selected candidates. It should also be remembered that most of the existing studies of reliability and validity have been carried out in Western European and North American countries during periods of relative stability. Hence, caution needs to be exercised while applying these findings to India and other developing countries, especially during periods of economic turbulence and skill obsolesce.

The importance of recruitment and selection functions in enhancing the effectiveness of organizations has led to the development of an impressive array of statistical techniques for gauging the effectiveness of the processes. However, issues like lack of well-defined parameters for judging effectiveness, data attenuation problems and generalization related problems limit the use of the statistical procedures. Hiring managers are well-advised to acquaint themselves with the statistical instruments while being cognizant of their limitations.

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ENDNOTE

[1] The linkages between the work behaviors and competencies are shown for illustrative purposes only. All further calculations are based on author's assumptions and are included for illustrative purpose only.

Chapter 7
Methodological Considerations for Research in Compensation Management

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ABSTRACT

Compensation and Benefits continues to be the most researched field with more than thousand academic studies. Given the extensive research on Compensation in academia, there has been evolution in approaches to explore and keep pace with recent trends along with research methodology and technology. As a Research Scholar, I began to realize that while dominant literature on Compensation and Benefits favoured quantitative research to study its impact on organizational outcomes such as performance, turnover, job satisfaction, commitment, etc., both qualitative and quantitative research are needed to be able to study and explore unexplored areas of the said field. The book chapter will elaborate the specific applications of qualitative and quantitative statistical applications in Compensation Research with relevant basic examples. I am hopeful that the book chapter will be of use to academics, researchers and students focusing their studies and research on Compensation and Benefits.

INTRODUCTION

For management research to progress, it is important for researchers to assess the methods they employ. The impact of management studies depends upon the appropriateness and rigor of the research methods chosen. Design choices about

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instrumentation, data analysis, and construct validation, and more may affect the types of conclusions that are drawn (Sackett & Larson, 1990). Given such concerns, an examination of the use of research methods is needed to investigate possible patterns emerging over the last two decades of the 20th century. Examination of such patterns may provide some insights into the possible future development of research methodology. Although we recognize that differences in researchers' training may affect their research design choices, we present a framework within which many areas of management research can be discussed. It seems clear that choices about the settings of organizational studies, research designs, and analyses have important implications for the accumulation of knowledge over time.

Following the categorizations developed in Werner & Ward (2004)'s seminal work and further review of work done during last decade, it is found that Compensation research reviewed has been largely quantitative and empirical, reflecting the dominant methods currently in management (Scandura & Williams, 2000). It was found that the primary type of data analysis was mostly carried through Univariate and multivariate analyses of variance and covariance and t-tests were considered analysis of variance techniques. Linear regression analyses included simple, multiple, hierarchical, moderated, and mediated regression. Correlation techniques, meta-analysis, and linear techniques for categorical dependent variables (for instance, logistic regression analysis) were found. Factor analytic and clustering techniques included confirmatory factor analysis, multidimensional scaling, and discriminant analysis. Structural equation modeling and path-analytic techniques were combined.

In the next part, relevant quantitative techniques will be discussed along with its calculation in SPSS. A suitable example is also given for better understanding.

PART 1: RELEVANT QUANTITATIVE DATA ANALYSIS TECHNIQUES AND ITS APPLICABILITY

Before understanding the application of some of the frequent used above mentioned techniques along with its applicability, it is important to understand the meaning of multivariate research methods. Broadly defined, multivariate research methods involve the inclusion of more than one outcome in a singular analysis. The multivariate approach allows the researcher to analyze the data in a way that is most reflective of the actual research context and environment.

In Compensation area, research scenarios involve using multi-dimensional concepts such as pay satisfaction, attitude to money and multiple outcomes such as self-efficacy, attitudes, and behavior, or performance. Hence, multivariate analysis is always called for as it can extend to include models such as those specific to testing structural validity of instruments designed to measure latent constructs such as pay satisfaction or predicting intention to quit. In other words, multivariate research methods are warranted in most situations where multiple-dimensional dependent variables are being considered in the same research scenario. They are developed for analysis of data which has more complex, multi-dimensional, dependence/ interdependence structures.

Mostly, ANOVA, Multiple Regression, Correlation Techniques, Factor Analysis, Discriminant Analysis and SEM are the popular and mostly used analytical procedures. Thus, these selected techniques are briefly discussed along with the relevant examples of certain compensation research as illustrations.

Correlation Analysis in Compensation Research

The correlation is one of the most common and most useful statistics. A correlation is a single number that describes the degree of relationship between two variables. A quantitative correlation design was the most effective method for the research study as it offered a non-obtrusive approach to the inquiry and resulted in identification of significant relationships between study variables (Creswell, 2009). Correlation in social science research talks about relationships and association between variables. In simple words, Correlation is existence of patterned relationship or connection or association between variables.

In pursuing correlation analysis, both strength and direction of the relationship is also considered. The extent to which two variables co-vary i.e. move in tandem represents strength of the relationship. According to Creswell (2009), strength of correlation is the extent to which changes in one variable are reflected in changes in the other. It is expressed with the help of size of the coefficient of correlation which can range from 0 (no connection between variables) to 1 (perfect connections between variables). Correlation Coefficients are also expressed as positive or negative numbers (-1 to +1). This positive or negative number denotes the direction of the correlation. A positive correlation denotes a relationship in which values of the variables are moving together in the same direction. A negative correlation means a relationship in which values of the variable are moving together but in an opposite direction of each other.

It is pertinent, however, to note that Correlation is not causality. Correlational data do not indicate cause-and-effect relationships. When a correlation exists, changes in the value of one variable reflect changes in the value of the other. The correlation does not imply that one variable causes the other, only that both variables somehow relate to one another.

Example

The purpose is to assess the relationship between salary, rewards, indirect compensation and performance in an organization. The process of analysis will be carried out in SPSS. Let us consider a hypothetical table showing correlation among these factors. This table shows the correlation analysis of the variables salary, rewards, indirect compensation and employee performance. The relationship among these variable is given in Table 1.

- The table shows the moderate positive relationship among salary and rewards. It means that if there is an increase in salary then rewards will also increase moderately. So, there is a direct relationship among these variables.
- The table shows the weak positive relationship among salary and indirect compensation. It means that if there is an increase in salary then indirect compensation will also increase weakly. So, there is a direct relationship among these variables.
- The table shows the weak positive relationship among salary and performance. It means that if there is an increase in salary then the Performance will also increase but increase will be minor. So, there is a direct relationship among these variables.
- The table shows the weak positive relationship among rewards and indirect compensation. It means that if there is an increase in rewards then the indirect compensation will also increase but increase will be minor. So, there is a direct relationship among these variables.
- The table shows the negative relationship among Rewards and performance. It means that if there is an increase in rewards then the performance will be decreased. So, there is an inverse relationship among these variables.

Table 1.

Correlations

		Salary	Rewards	Indirect Compensation	Performance
Salary	Pearson Correlation		.499**	.271**	.072
	Sig. (2-tailed)		.000	.000	.314
	N		200	200	200
Rewards	Pearson Correlation			.269**	-.048
	Sig. (2-tailed)			.000	.500
	N			200	200
Indirect Compensation	Pearson Correlation				.095
	Sig. (2-tailed)				.180
	N				200

**. Correlation is significant at the 0.01 level (2-tailed).

- The table shows the weak positive relationship among indirect compensation and performance. It means that if there is an increase in indirect compensation then performance will also increase but increase will be minor. So, there is a direct relationship among these variables.

Coefficient of Determination (r^2): After calculating the strength of the relationship a step further can also be taken to calculate the coefficient of determination (r^2) to find out the amount of variation in the dependent variable which explains its relationship with the independent variable in percentage terms, due to the amount of variation in the independent variable.

Step by Step Calculation in SPSS

Step 1: To run a bivariate Pearson Correlation in SPSS, click Analyze > Correlate > Bivariate.
Step 2: Transfer the variables salary, rewards, indirect compensation and performance into the Variables box by dragging-and-dropping them or by clicking on them and then clicking the arrow button.
Step 3: Click the "Pearson" check box if it isn't already checked. Then click either a "one-tailed" or "two-tailed" test radio button.
Step 4: Click the Continue button. You will be returned to the Bivariate Correlations dialogue box.
Step 5: Click the OK button. This will generate the results of Pearson's correlation.

Establishing relationships and associations between variables is the starting point for all the complex analyses to take place. Correlation provides the base for regression for predicting the values of the dependent variable based on the known relationship that exist between the independent and the dependent variable. Correlational research plays an important role in the development and testing of theoretical models. Once the nature of bivariate relations has been determined, this information can then be used to develop theoretical models that paves the way for factor analysis, path analysis and structural equation modelling (Duncan, 1966).

Correlation still remain a very important tool in social science research and its techniques almost inevitable especially in quantitative studies involving variables.

Multiple Regression Analysis in Compensation Research

Multiple regression is used to predict the value of a variable based on the value of two or more other variables. When using multiple regression in psychology, the variable to be predicted is called the dependent variable (or sometimes, the outcome, target or criterion variable). The variables that is used to predict the value of the dependent variable are called the independent variables (or sometimes, the predictor, explanatory or regressor variables).

Having more than one predictor variable is useful when predicting human behaviour, as human's actions, thoughts and emotions are all likely to be influenced by some combination of several factors. Using multiple regression, we can test theories (or models) about precisely which set of variables is influencing our behaviour. For example, you could use multiple regression to understand whether retention of employees can be predicted based on total rewards strategy, employee engagement, job embeddedness, need satisfaction and attitude to money.

Multiple regression also tells that how much of the variance in the dependent variable can be explained by independent variables. It also determines the statistical significance of the results, both in terms of model and the individual independent variables (Pallant, 2005). For example, we might want to know how much of the variation in employee retention can be explained by preferences of components of total rewards, employee engagement, need satisfaction, embeddedness and attitude to money "as a whole", but also the "relative contribution" of each independent variable in explaining the variance.

This statistical tool is used to develop the equation that represents the relationship between the variables. A simple regression analysis can show that the relation between an independent variable and a dependent variable is linear, using the simple linear regression equation. Multiple regression analysis provides an equation that predicts dependent variable from two or more independent variables. In other words, it can be said that multiple regression involves a single dependent variable and two or more independent variables, while simple regression model involves one dependent variable and one independent variable.

Example

An example might help. Suppose the researcher is interested in predicting the impact of the independent variables (salary, rewards, indirect compensation) on dependent variable (employee performance)[1]. Multiple regressions allow using the independent variables as a predictor for dependent variable. Therefore, it is appropriate for this kind of study. The regression model of the study is:

Y= a+B1x1+B2X2+B3X3+.............BnXn

Y= Dependent variable (Employee Performance) and is a function of n independent variables, x_1, x_2, ..., x_n

a= constant
B= Regression Coefficient
X= independents (salary, rewards, indirect compensation)

Using the above mathematical illustration, the regression model can be written as:

Performance (Y) = a + B_1 Salary + B_2 Rewards + b_3 Indirect Compensation

Let there be a hypothetical table showing the coefficients of the independent variables wherein, it will be easy to interpret the result and understand the model.

Each of the coefficients in front of the above independent variables determines how much that independent variable contributes (holding all other variables constant) to the overall regression equation in determining performance. In order to find the contributions of each independent variable to dependent variable included in the model it has to be noticed that the value of standardized coefficient (Beta) is considered. The greater value of beta and less value of significance level ($p < .05$) of each independent variable will show the strongest contribution to dependent variable (Pallant, 2005). Thus, the largest beta coefficient for EM is .468 at significance level 0.000 ($p<.05$), meaning that extrinsic motivation (independent variable) makes the strongest unique contribution to explaining employee engagement (dependant variable) as compared to intrinsic motivation.

Regression Equation:

Employee Performance = 3.659+ 0.096 Salary - 0.081 Rewards + 0.085 Indirect Compensation

Further, the strength of relationship between one dependant variable and one or more independent variables is determined by coefficient of determination r^2 (also called regression coefficient). The regression coefficient varies between -1

Table 2.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.659	.316		11.578	.000
	Salary	.096	.073	.109	1.317	.189
	Rewards	-.081	.052	-.129	-1.566	.119
	Indirect Compensation	.085	.063	.100	1.351	.178

a. Dependent Variable: Performance

and +1. -1 represents complete negative relationship while +1 represents perfect relationship (Saunders, 2012). For example, if the dependent variable is “Employee Performance” and the independent variable is “Compensation” and $r = .9$, then $r^2 = .81$. And that means that Compensation “explains” 81% of the variation in Employee Performance. Rest of 19% is explained by other factors which is taken care it the analysis is done “multiple regression” analysis. If the value of r^2 is between “.5 to 1.0,”, it is a stronger and better value explaining the variation.

Step by Step Calculation in SPSS

Step 1: Click Analyze > Regression > Linear... on the main menu. The Linear Regression Dialog Box will open

Step 2: Transfer the dependent variable into the dependent box and the independent variables, into the Independent box, using the arrow buttons (all other boxes can be ignored).

Step 3: Click the Statistics button. You will be presented with the Linear Regression: Statistics dialogue box.

Step 4: In addition to the options that are selected by default, select Confidence intervals in the –Regression Coefficients– area leaving the Level(%): option at “95”.

Step 5: Click the Continue button. You will be returned to the Linear Regression dialogue box

Step 6: Click the OK button. This will generate the output.

Regression analysis is one of the most important statistical techniques for business applications. It’s a statistical methodology that helps estimate the strength and direction of the relationship between two or more variables. Regression analysis is an indispensable tool for analyzing relationships between variables.

ANOVA in Compensation Research

ANOVA analysis is normally used to compare the mean scores of more than two groups or variables. It is also called analysis of variance because it compares the variance between groups (Pallant, 2005, p. 214). Essentially, ANOVA is used as a test of means for two or more populations. The F ratio or F statistic represents the variance. If the F ratio is large and probability is less than 0.05 then it is termed statistically significant (Saunders et al., 2012). A significant F test indicates that we can reject the null hypothesis and accept alternate hypothesis, stating that the population means are equal (Pallant, 2005, p. 214).

Why ANOVA and Not T-Test?

1. Comparing three groups using t-tests would require that 3 t-tests be conducted. Group 1 vs. Group 2, Group 1 vs. Group 3, and Group 2 vs. Group 3. This increases the chances of making a type I error. Only a single ANOVA is required to determine if there are differences between multiple groups.
2. The t-test does not make use of all of the available information from which the samples were drawn. For example, in a comparison of Group 1 vs. Group 2, the information from Group 3 is neglected. An ANOVA makes use of the entire data set.
3. It is much easier to perform a single ANOVA then it is to perform multiple t-tests. This is especially true when a computer and statistical software program are used.

Example

Suppose, we want to investigate the influence of pay satisfaction and length of service on organizational citizenship behavior among executives working in an IT firm in Bengaluru. Thus, we want to understand that: (1) Are those executives who are satisfied with their pay exhibit organizational citizenship behaviour more than those who are not? (2) Do executives who have been in IT sector for longer period exhibit organizational citizenship behaviour more than those who have been in the job for short period? So, there are 2 levels of pay satisfaction: satisfied and not satisfied. Similarly, length of service has 2 levels: long period and short period. There will be 2 null hypotheses to be tested which can be done through ANOVA that are as follows:

- There will be no influence of satisfaction with pay on organizational citizenship behavior.
- There will be no influence of length of service on organizational citizenship behavior.

This will be a case of 2-way ANOVA because 2 factors viz. pay satisfaction and length of service are involved. Let us consider the table showing means ($\bar{x}$) of pay satisfaction and length of service.

The table of mean ($\bar{x}$) shows that bankers who are satisfied with their pay had a higher organizational citizenship behavior mean score of 75.6 than those who are not satisfied with their pay, they had a mean score of 57.11. The result also showed that bankers who had been on the job for a shorter period of service had

Figure 1.

Length of service		Pay Satisfaction: Satisfied	Pay Satisfaction: Not satisfied
	Short	$T_{11} = 2283$ $n_{11} = 40$ $\bar{x}_{11} = 57.11$	$T_{12} = 2667$ $n_{12} = 42$ $\bar{x}_{12} = 63.5$
	Long	$T_{21} = 1512$ $n_{21} = 20$ $\bar{x}_{21} = 75.6$	$T_{22} = 1128$ $n_{22} = 18$ $\bar{x}_{22} = 62.70$

Table 3. Analysis of Variance (ANOVA) summary

Source of study	Sum of squares	d/f	Mean square	F	P
Row (Pay Satisfaction)	1566	1	1566	10.92	< .05
Columns (Length of Service)	212	1	212	1.480	> .05
Interaction (pay & Length)	1864	1	1864	13.00	< .05
Within cells	16630.07	116	143.40		
Total	20272.07	119			

more organizational citizenship behavior mean score of 63.5 than old entrants' mean score of 62.70.

The ANOVA result indicated that mean differences between the bankers who are satisfied with their salary and those who are not were statistically significant, $F(1, 116) = 10.92$, $p < .05$. Therefore, the hypothesis that there will be an influence of satisfaction with pay on organizational citizenship behavior was accepted. Moreover, the result showed that the mean score differences between bankers who have been on the job longer and those who are new on the job was not statistically significant, $F(1, 116) = 1.480$, $p > .05$. Based on that, the hypothesis that stated that there will be an influence of length of service on organizational citizenship behavior was rejected. The interaction effects for pay satisfaction and length of service on organizational citizenship behavior was significant, $F(1,116) = 13.00$, $p < .05$.

Step by Step Calculation in SPSS

We choose Univariate to analyze just one dependent variable, regardless how many independent variables are there.

Step 1: Select Analyze > General Linear Model > Univariate

Step 2: Select one variable as the dependent variable, and select one factor say (factor_A) and other factor say (factor_B) as the fixed factors

Step 3: Click on Model and select Full factorial to get the 'main effects' from each of the two factors and the 'interaction effect' of the two factors. [It is possible to build a Custom model, if you prefer]. Click Continue.

Step 4: Click the "Plots…" button. In the Profile Plots window, select one factor for the horizontal axis and one for the separate lines (the treatment means will be on the vertical axis). Be sure to click "Add" and then click "Continue"

Step 5: Click the "Post Hoc…" button, select the "Tukey" procedure, enter "factor_A" (Number of Coats) and "factor_B" (Batch) as the Post Hoc Tests variables, and click "Continue".

Step 6: Click the "Options…" button, select "Homogeneity tests", enter 0.05 for the significance level (95% CI corresponds to a 5% (0.05) significance level). Check the result of Levene's test for a p-value (Sig.) > 0.05, so that similar variances for each group of measurements can be assumed (otherwise the ANOVA is probably invalid). Click "Continue". Now click the "OK" button in the main Univariate window.

Factor Analysis in Compensation Research

Factor analysis is usually adopted in social scientific studies for the purposes of: (1) reducing the number of variables; and (2) detecting structure in the relationships between variables. The first is often referred to as common factor analysis, whereas the second is known as component analysis when both variables are operated as statistical techniques. While factor analysis expresses the underlying common factors for an entire group of variables, it also helps researchers differentiate these factors by grouping variables into different dimensions or factors, each of which is ideally uncorrelated with the others.

In social science studies, researchers often face a large number of variables. Factor analysis reduces the number of variables to a smaller set of factors that facilitates our understanding of the social problem. It provides such functions to determine the "common factors" of these independent variables. Each of these common factors should be the best representative of certain independent variables, and every factor should be, theoretically, independent from the other factors. Researchers substitute these factors for the variables because the factors can explain a similar degree of variance on the dependent variable but are simpler in terms of the number of independent variables. In most cases, factors found in an analysis may not provide a complete description of the relevant independent variables, but these factors should be the most important factors, the best way of summarizing a body of data.

In Compensation research, factor analyses are used to test the reliability and validity of the questionnaire developed to understand and to investigate the relationship between the total rewards and employee engagement or any other comes.

There are mainly three types of factor analysis that are used for different kinds of research and analysis.

- Exploratory factor analysis
- Confirmatory factor analysis
- Structural equation modeling

Exploratory factor analysis is used to measure the underlying factors that affect the variables in a data structure without setting any predefined structure to the outcome. Confirmatory factor analysis on the other hand is used as tool in market research and analysis to reconfirm the effects and correlation of an existing set of predetermined factors and variables that affect these factors. Structural equation modeling hypothesizes a relationship between a set of variables and factors and tests these casual relationships on the linear equation model. Structural equation modeling can be used for exploratory and confirmatory modeling alike, and hence it can be used for confirming results as well as testing hypotheses.

Factor analysis will only yield accurate and useful results if done by a researcher who has adequate knowledge to select data and assign attributes. Selecting factors and variables so as to avoid too much similarity of characteristics is also important. Factor analysis, if done correctly, can allow for market research and analysis that helps in various areas of decision making like product features, product development, pricing, market segmentation, penetration and even with targeting.

Example

If there is an effort to develop understanding of the total reward factors required to attract and retain bankers. In this case data will be collected through questionnaire and will be analysed using descriptive statistics and factor analysis[2].

The first questionnaire was developed using principles of the Hay model and the WorldatWork total rewards model, and was designed to determine which of the total rewards elements respondents deemed most important when deciding whether to stay with or leave their current organisation (Hay Group, 2002; Pregnolato, 2010). Responses were recorded on a five-point Likert-type response scale where 1 represented 'Not at all important' and 5 'Very Important'. The scale comprised 20 questions covering six total rewards elements, namely: (1) quality of work, (2) work-life balance, (3) future growth opportunities, (4) tangible rewards, (5) inspirational values and (6) environment. The outcomes of Questionnaire 1 were analysed using descriptive statistics and exploratory factor analysis.

Exploratory factor analysis was performed to establish the underlying factor structure of the questionnaire that was based on the Hay Group total rewards model as well as the WorldatWork total rewards model (Questionnaire 1). Factor analysis is used to discover patterns amongst the variations in values of several variables. This is done through the generation of factors that correlate highly with several of the real variables and that are independent of one another (Babbie, 1995). In order to conduct a factor analysis the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy should be greater than 0.6 and the Bartlett's test of sphericity should be significant. The KMO measure of sampling adequacy for the factor analysis was 0.83 and the Bartlett's test of sphericity was significant ($p < 0.01$). These results therefore indicated that it was appropriate to conduct an exploratory factor analysis on this data.

In order to determine how many factors should be extracted, only those factors with an eigenvalue greater than 1 were selected (the so-called Kaiser criterion). Most of the strategies that have been proposed to determine the number of components that account for the most variation in a principal components analysis of a correlation matrix rely on the analysis of the eigenvalues and on numerical solutions. Cattell's scree test is a graphical strategy with a non-numerical solution to determine the number of components to retain. Like Kaiser's rule, this test is one of the most frequently used strategies for determining the number of components to retain (Pallant, 2004). Using both Kaiser's rule and an inspection of the scree plot, using Catell's scree test, confirmed the presence of three factors.

The inclusion criteria used for the factor analysis were that factor loadings needed to be greater than 0.400; if the difference in factor loadings across factors was less than 0.25 then the item was considered to have cross-loaded. If an item did not meet these criteria it was excluded, and thereafter a new round of factor analysis was conducted. Considering the inclusion criteria, after the first round items Q11 ('The opportunities offered to you by your company for training within your current job, e.g. skills training'), Q1 ('Recognition provided to you by your employer, e.g. financial recognition such as a cash, paid travel'), Q20 ('The provision of recognition via non-financial means, e.g. certificates of recognition') and Q16 ('Your employer's provision of employee health and wellness programmes, e.g. employee assistance programmes, counselling services, fitness centres) were removed as they did not meet the inclusion criteria. After the second round Q10 ('Having supportive and like–minded colleagues') was deleted.

The third round of exploratory factor analysis was accepted as the final factor structure. Table 8 summarises the items within the scale that loaded on three factors and explained 56.56% of the total variance: factor 1 (eigenvalue = 5.11) explained

34.12% of the variance, factor 2 (eigenvalue = 1.78) explained 11.89% of the variance and factor 3 (eigenvalue = 1.47) explained 10.51% of the variance. The factors were labelled: job-related factors, remuneration-related factors and work-life–related factors.

Step by Step Calculation in SPSS

Step 1: Click Analyze > Dimension Reduction > Factor
Step 2: Transfer all the variables you want included in the analysis into the Variable box by using the arrow button
Step 3: In the Descriptives window, you should select KMO and Bartlett's test of sphericity. KMO is a statistic which tells whether you have sufficient items for each factor. It should be over 0.7. Bartlett's test is used to check that the original variables are sufficiently correlated. This test should come out significant ($p < 0.05$) — if not, factor analysis will not be appropriate. Click on Continue.
Step 4: In the Extraction window, you can select the extraction method you want to use (e.g. principal components, etc.). Under Analyze ensure that Correlation Matrix is selected (this is the default). The default is also to extract eigen values over 1 but if you want to extract a specific number of factors you can specify this. Click on Continue.
Step 5: In the Rotation window, you can select your rotation method (as mentioned above, Varimax is the most common). The researcher can also ask SPSS to display the rotated solution. Once it is selected, click on Continue.
Step 6: In the Scores window, you can specify whether you want SPSS to save factor scores for each observation (this will save them as new variables in the data set). Under Method choose Regression. You can also ask SPSS to display the factor score coefficients. Click on Continue.
Step 7: OK

Structural Equation Modeling and Path-Analytic Techniques

SEM is a multivariate technique that considers and estimates the linear and/or causal relationships between multiple exogenous (independent) and endogenous (dependent) constructs through a simultaneous, multiple equation estimation process. SEM is a procedure for estimating a series of dependence relationships among a set of concepts or constructs represented by multiple measured variables and incorporated into an integrated model.

In compensation research, a scholar wants to answer a set of interrelated questions. Fox example, what variables determine employee turnover? How does Total Rewards influence employee engagement and turnover? How does satisfaction with total rewards influence intention to quit? Such interrelated questions cannot be explored with the use of single statistical technique. To answer such questions in a unified and integrated manner, SEM is required to test the proposed theoretical relationships by using a single technique. SEM is a very general, largely linear, typically cross-sectional statistical modelling technique. A primary feature of management research is that several of the constructs in management theories, for example employee motivation and job satisfaction are not directly observable (Hughes, Price and Marrs, 1986). It has thus been difficult to test many of these theories using standard statistical tools. In response to this, several statistical tools (SEM included) have emerged to test in particular the relationship between theoretical constructs that are not directly observable.

SEM examines the structure of these interrelationships which are expresses in a series of structural equations that model all the possible relationships among constructs, dependent as well as independent. The constructs are unobservable or latent factors that are represented by multiple variables. On the contrary, observed variables are known as manifested or measured variables. In SEM, dependent variables are known as endogenous construct that are latent and multi-item or multi-dimensional in nature. Exogenous constructs are also latent and multi-item equivalent of independent variable. It is determined by factors outside the model and it cannot be explained by any other construct in the model. In SEM, the measurement error is the degree to which the observed variables do not describe the latent constructs in question. Overall, SEM is a causal modelling technique that aims at determining whether a certain model is valid rather than finding a suitable model.

The SEM can be divided into two parts. The measurement model is the part which relates measured variables to latent variables. The structural model is the part that relates latent variables to one another. Path analysis can be viewed as a special case of structural equation modeling (SEM) – one in which only single indicators are employed for each of the variables in the causal model. Other terms used to refer to path analysis include causal modeling, analysis of covariance structures, and latent variable models. Simply, Path analysis is used to evaluate causal models by examining the relationships between a dependent variable and two or more independent variables. Using this method, one can estimate both the magnitude and significance of causal connections between variables.

Using path analysis, one can create a diagram that charts the relationships between age and autonomy (because typically the older one is, the greater degree of autonomy they will have), and between age and income (again, there tends to be a positive relationship between the two). Then, the diagram should also show the relationships between these two sets of variables and the dependent variable: job satisfaction. After using a statistical program to evaluate these relationships, one can then redraw the diagram to indicate the magnitude and significance of the relationships. While path analysis is useful for evaluating causal hypotheses, this method cannot determine the direction of causality. It clarifies correlation and indicates the strength of a causal hypothesis, but does not prove direction of causation

Example

The researcher wants to examine the relationship between total rewards and organizational performance. So the purpose is to test a structural equations model (SEM) that links total rewards and the performance of Swedish real estate firms. It specifically seeks to find if a statistically significant link exists between total rewards and performance in the Swedish real estate sector. The researcher collected data through questionnaire survey of Swedish real estate firms[3].

Step 1: modeling begins with a specification of a causal relationship between unobservable constructs represented by latent variables, which are empirical measures of the constructs. Each latent variable is measured by one or more observable indicator variables. These indicator variables are assumed to be measured with error. The actual LISREL model that is used to test a theory consists of two parts:

- The measurement model which specifies how the latent variables are linked to the (observable) indicator variables and
- A specification of a relationship between the latent variables, reflecting the hypothesised link between the theoretical constructs (the structural equation model)

Step 2: One can assess the validity of the specified LISREL model on a number of different levels: the entire model (nomological validity), extent of separation between the constructs (discriminant validity) and the homogeneity of the constructs (convergent validity). Garver and Mentzer (1999) suggested two approaches of testing overall fit: selecting fit indices representing various classes of such indices; or specifying restrictive yardsticks and selecting fit indices that best measure up to them.

Step 3: Based on these criteria, Garver and Mentzer (1999) recommended the non-normed fit index (NNFI); the comparative fit index (CFI), and the root mean squared approximation of error (RMSEA). Therefore, the commonly applied fit indices are NNFI and CFI (>0.90 indicates good fit), RMSEA ((<0.08 indicates acceptable fit), and commonly used $\chi 2$ statistic ($\chi 2$ / d.f. ratio of 3 or less). Chi-square ($\chi 2$) is the most common method of evaluating goodness-of-fit. A low $\chi 2$ value, indicating non-significance, would point to a good fit. This is because chi-square test is used to assess actual and predicted matrices.

With respect to the probability estimate the ρ-value of the model should be 0.05 or higher to indicate a non-significant distance between the model and the data at the 5% level.

Step 4: Three estimates allow an assessment of discriminant and convergent validity: coefficients, t-values and R2-values. The coefficients normally referred to as factor loadings, reflect the strength of the relationship between two variables (Bollen, 1989).

The factor loadings in this analysis are very important. These factor loadings reflect the correlation between the indicator and the factor. The loadings are measured on a scale from -1.0 to 1.0. Hair et al. (2010) gave the following criteria for determining the significance of factor loadings: Factor loadings in the range of $\pm$.30 to $\pm$.40 are considered to meet the minimal level for interpretation of structure. Loadings $\pm$ .50 or greater are considered practically significant. Loadings exceeding $\pm$ .70 are considered indicative of a well-defined structure and are the goal of any factor analysis. The KMO is the common measure used to analyze the significance of factor analysis. A KMO measure from 0.90-0.99 is measured as outstanding, from 0.80-0.89 as very good, from 0.70-0.79 as average, from 0.60-0.69 as tolerable, from 0.50-0.59 as miserable, and below 0.49 as unacceptable (Hair et al., 2010).

Step 5: Construct validity: Four indicators constitute operational definitions of total rewards. The first concerns whether or not the respondent firm uses any kind of variable pay scheme. The second concerns whether the firm gives out discretionary in-kind benefits to non-managers (given that increases the likelihood managers also receive it). The third is a proxy for the quality of the work environment – the frequency of performance appraisals per year. The last indicator for total reward is the variety of training programmes in each company.

Table 4. G

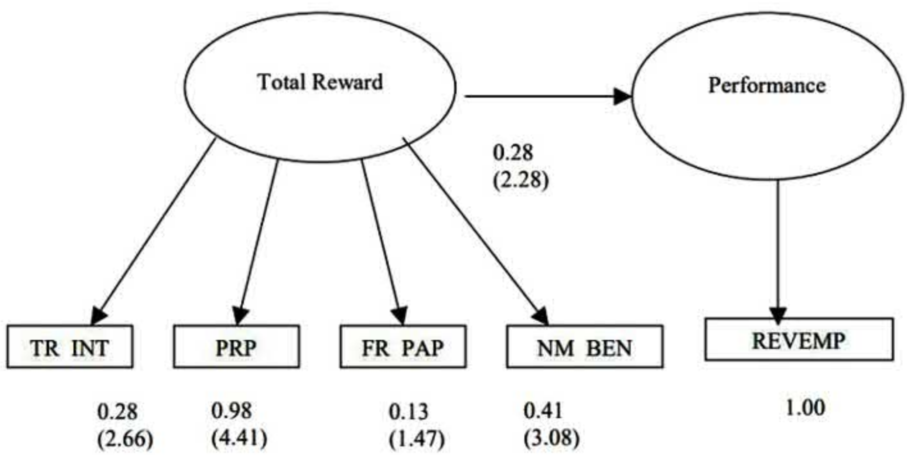
Construct/indicator	Code	Factor loading	t-value	R^2 value
Total reward				
Does the firm use any form of variable pay plan?	PRP	0.98	4.41	0.95
Do non-managers have any form of discretionary in-kind benefit?	NM_BEN	0.41	3.08	0.17
How many times per year does the firm carry out performance appraisal of it employees? Scale: 4 steps from monthly to quarterly to biennially to annually	FR_PAP	0.13	1.47	0.027
Number of training programmes organised or sponsored by the company	TR_INT	0.28	2.66	0.11
Performance				
Revenue per employee. Scale: 7 classes from 0 to 100 000	REVEMP	1.00		1.00

With the exception of the performance appraisal frequency indicator, the factor loadings, t-values and R2 are reasonable for this construct to be convergent. The performance construct is a single item construct measured by revenue per employee. Revenue per employee is grouped into seven classes from 0 to 100 000.

The empirical results of the hypothesised structural model are depicted in Fig.1 below. The overall fit of the model is good as all the indicators fall within an acceptable range. In other words, the model is nomologically valid. The Model χ 2 1.49 with 5 df with a pvalue of 0.914. A Chi-square/df ratio of 3 or less is good. Both NNFI and CFI must be 0.90 or more to be acceptable, and they both are. The GFI is 0.99 and the RMSEA is 0.00. Recall that RMSEA values less than 0.05 indicate a good fit. One indicator of the total reward construct, namely the frequency of performance appraisals is, however, insignificant. All the t-values, with the exception of the performance appraisal indicator, are greater than 2.28.

Figure 2 shows that combined investments in human resources in the form of variable pay, discretionary benefits, learning and development programmes as well as the work environment does translate into performance. The hypothesised relationship between total reward and performance is thus supported. This lends a measure of empirical support to the role of total rewards as a tool in a general talent management policy in driving employee performance, the primary hypothesis of this paper. The total rewards approach appears diverse and versatile enough to provide motivation in ways that address the diversity of the modern workplace.

Figure 2.



Discriminant Analysis and Its Application in Compensation Research

Discriminant Analysis allows a researcher to study the difference between two or more groups of objects with respect to several variables simultaneously, determining whether meaningful differences exist between the groups and identifying the discriminating power of each variable. Discriminant analysis (also known as discriminant function analysis) is a powerful descriptive and classificatory technique developed by R. A. Fisher in 1936 to (a) describe characteristics that are specific to distinct groups (called descriptive discriminant analysis); and (b) classify cases (i.e., individuals, subjects, participants) into pre-existing groups based on similarities between that case and the other cases belonging to the groups (sometimes called predictive discriminant analysis). The mathematical objective of discriminant analysis is to weight and linearly combine information from a set of p-dependent variables in a manner that forces the k groups to be as distinct as possible.

Specific descriptive questions that can be answered through discriminant analysis include the following: (a) In what ways do various groups in a study differ? (b) What differences exist between and among the number of groups on a specific set of variables? (c) Which continuous variables best characterize each group, or, which continuous variables are not characteristic of the individual groups?

While every effort was made to conceptually differentiate near-identical or overlapping constructs, it was essential to make the same discrimination operationally as well. It was for this purpose that discriminant validity tests were carried out such that the operationalization of one construct was different from that of another construct. In social science research in general, and OB/HR research in specific, there are quite a few constructs that would appear synonymous in lay terms. To establish construct difference definitionally, it is therefore practically advisable to carry out a discriminant validity analysis and ascertain the precise connotation of that construct – both, conceptually as well as mathematically.

Simply, Discriminant analysis is a multivariate tool that shows the relationship between several predictors (independent variables) and one dependent variable (criterion), and determines the extent to which each of the independent variables is predictive of the dependent variable. Discriminant analysis usually has a descriptive objective (to assess the adequacy of classification, given the group memberships of the objects under study) or a predictive objective (to assign objects to one of a number of (known) groups of objects).

Example

There was a study that was conducted with the aim of discovering the factors which maximally discriminate between those employees who intend to leave the organization and those who intend to stay with the organization. Discriminant analysis, though a non-parametric tool, is the most suitable choice for such analysis. Most of the extant research on retention is based on multiple regression analysis, which gives only the factors predicting intention to leave/stay, whereas discriminant analysis goes a step ahead and produces a discriminant function and a classification matrix. The results thus obtained would help in identifying those factors which are strong predictors of intention to stay, so that employees who intend quitting the organization are identified in advance and remedial measures are taken to retain them, especially if they are key performers.[4]

Step 1: A questionnaire covering several aspects relating to employee retention was designed and distributed amongst a sample of 100 employees chosen through incidental sampling.

Step 2: Data thus collected was subjected to factor analysis, which yielded seven factors: Goal Clarity, Autonomy, Employee Engagement, Affective Commitment, Organizational Culture, Compensation and Benefits, and Normative Commitment. KMO measure of sampling adequacy to be carried is which should be significant (greater than 0.5) and Bartlett's test should also be significant, which means that the variables are correlated highly enough to provide a reasonable basis for factor analysis.

Step 3: Discriminant analysis was done on these seven factors to identify the best predictors of employees' intention to leave or stay, by creating a discriminant function. Wilks' Lambda is one of the multivariate statistic calculated by SPSS. Wilk's lambda is used to test for significant differences between groups. Wilk's lambda is between 0 and 1. It tells which variables contribute a significant amount of prediction to help separate the groups. The statistical significance of the discriminant function is revealed from Wilk's lambda and the probability value for the F-test.

Group centroids, that is, the average discriminant scores for employees in the two groups was calculated. The mean discriminant score for group 1 (intention to leave) is 20.409 and the same for group 2 (intention to stay) is 0.565. This means the midpoint of these two is 0.078. This is clear when we plot the two means on a straight line and locate their midpoint, as shown in Table 1. This gives us a decision rule for classifying other employees. If the discriminant score of any employee falls to the right of the midpoint, we classify that employee as "not intending to leave";

and if the discriminant score of an employee falls to the left of the midpoint, we classify him/her as "intending to leave".

Step by Step Calculation in SPSS

1. Analyse >> Classify >> Discriminant
2. Select 'dependent variable' as your grouping variable and enter it into the Grouping Variable Box
3. Click Define Range button and enter the lowest and highest code for your groups
4. Click Continue.
5. Select your predictors (IV's) and enter into Independents box and select Enter Independents Together. If you planned a stepwise analysis you would at this point select Use Stepwise Method and not the previous instruction.
6. Click on Statistics button and select Means, Univariate Anovas, Box's M, Unstandardized and Within-Groups Correlation
7. Continue >> Classify. Select Compute From Group Sizes, Summary Table, Leave One Out Classification, Within Groups, and all Plots
8. Continue >> Save and select Predicted Group Membership and Discriminant Scores
9. OK.

PART 2: RELEVANT QUALITATIVE DATA ANALYSIS TECHNIQUES AND THEIR APPLICATIONS

In-depth qualitative research always provides rich data about a particular phenomenon which is sometimes not captured through quantitative research. Although qualitative research would not be expected to be prevalent in a well-established field (Wright, Lane, & Beamish, 1988), it is believed that qualitative research can contribute to even well-established fields.

In compensation research, eminent scholars like Gomez-Mejia & Welbourne (1988); Heneman & Judge (2000) in their seminal works have also suggested over the years that the field would benefit from comprehensive case studies, interviews, and participant observation. Werner & Ward (2004) believed that qualitative research could be very useful in theory building and "a viable contributor along with quantitative research in addressing important compensation issues (Ibid: 23-25)" that has been failed to come to the surface or has failed to capture the hidden patterns responsible for organizational outcomes such as impact of attitude to money on job tenure and organizational citizenship behaviour. Further, quantitative research always aims at obtaining "unstructured data" meaning data that had not already been coded or categorized due to small number of cases (Atkinson & Hammersley 1998) thus bringing out underlying patterns and relationships for further theory building. Thus, Qualitative Research aims at exploring the nature of the behaviour and thought process in an organizational setting. One can gain a deeper understanding of dynamic yet important reactions of employees towards any strategies or functions per se through more qualitative methods such as exploration, unstructured interview. The importance of analysing data qualitatively lies in the fact that qualitative methods push the boundary of re-questioning and developing new theories.

In the second part of the book chapter, the author discusses about some of the qualitative approaches used in data analysis in compensation setting along with suitable research examples.

Content Analysis and Coding

Content analysis is a widely used qualitative research technique. Content analysis is a research technique used to make replicable and valid inferences by interpreting and coding textual material. It is the study of the content with reference to the meanings, contexts and intentions contained in messages. By systematically evaluating texts (e.g., documents, oral communication, and graphics), qualitative data can be converted into quantitative data. A number of definitions of content analysis are available. Broadly content analysis may be seen as a method where the content of the message forms the basis for drawing inferences and conclusions about the content (Nachmias and Nachmias, 1976). Kerlinger (1986) defined content analysis as a method of studying and analyzing communication in a systematic, objective, and quantitative manner for the purpose of measuring variables. Simply, it comprises a searching out of underlying themes in the materials being analysed and can be discerned in several of the studies referred to earlier, such as Eby et al. (2005)

Example

One of the most frequent uses of the content analysis is to study the changing trends in the theoretical content and methodological approaches by content analyzing the journal articles of the discipline (Loy, 1979). For instance, using this approach, Vijayalakshmi et al. (1996) analysed a stratified random sample of 194 research articles published in the Indian Journal of Social Work from 1971 to 1990 to identify characteristics of authors, and document the trends in empirical content, and subject areas.

Steps in Doing Content Analysis

Step 1: Content Analysis begins with a specific statement of the objectives or research questions to be studied.
Step 2: Selection of communication content and sample
Step 3: Developing content categories: What classification would most efficiently yield the data needed to answer the research questions raised?
Step 4: Finalizing units of analysis
Step 5: Preparing a coding schedule (survey questionnaire), pilot testing and checking inter coder reliabilities
Step 6: Analyzing the collected data

Narrative Analysis

Narrative inquiry is a means by which we systematically gathering, and analysing the past work or stories done, and representing them in a synchronised and meaningful manner. Analysis occurs throughout the research process rather than being a separate activity carried out after data collection (Gehart et al., 2007). While being involved in the process of synchronizing, researchers take in what is being said and compare it with their personal understandings, without filling in any gaps in understanding with 'grand narratives', but rather inquiring about how pieces of the stories make sense together. Thus, the process of 'data gathering' and 'analysis' therefore becomes a single harmonious and organic process.

A number of data collection methods can be used, as the researcher and the research subjects work together in this collaborative dialogic relationship. Data can be in the form of field notes; journal records; interview transcripts; one's own and other's observations; documents such as school and class plans, newsletters, and other texts, such as rules and principles; and pictures. For instance, using this approach, Werner & Ward (2004) analysed 396 research articles published in 20 top journals from 1996 – 2002. These compensation-related articles were grouped into 12 categories. Upon synthesis of these articles, linkages across these categories were developed and suggested areas for future research.

Example

For instance, in Compensation Research, there were narrative reviews of pay satisfaction research conducted by Heneman & Schwab, 1985; Heneman & Judge, 2000. In their narrative review, Maertz and Campion (1998) concluded that, although the links among attitude, perceived alternative, search, and turnover are consistent but weak, many other meaningful topics have been neglected.

In one of the seminal studies, Judge et al. (2001) qualitatively reviewed 7 models that characterize past research on the relationship between job satisfaction and job performance. In light of the qualitative review, an agenda for future research on the satisfaction-performance relationship was provided. First, we qualitatively review past research on the job satisfaction-job performance relationship. In this section, we briefly summarize previous reviews of the literature and then consider various conceptualizations of the satisfaction-performance relationship. In order to locate studies containing relationships between individual job satisfaction and job performance, the PsycINFO electronic database (1967-1999) was searched. The primary focus was on locating published studies, unpublished doctoral dissertations, and cited but unpublished manuscripts and research reports from government agencies. The bibliographies from previous qualitative and quantitative reviews were also thoroughly reviewed.

Steps for Identifying Articles for Narrative Analysis

Step 1: Literature search and criteria for inclusion
Step 2: Identify the tiered journals
Step 3: Prepare the list journals and articles identified for the analysis
Step 4: Finally, briefly summarize previous reviews of the literature and then consider various conceptualizations of the theme that has to be explored.

CONCLUSION

The author reviewed the current state of methods used in Compensation Research and provides holistic view of the data analysis techniques with a particular focus on two important aspects of conducting compensation research: (1) appropriateness of quantitative data analysis and steps to be followed in SPSS; and (2) appropriateness of least used qualitative data analysis and steps to be followed. Considering the value of developing novel theoretical perspectives and advancing the field, there is a need to go beyond the debate related to the use of methods and consider undertaking more of quantitative research backed by qualitative validation and vice versa to be able to find plausible theoretical answers to research questions. The examples and step by step calculations presented here will help the researchers conduct and evaluate high quality qualitative and quantitative methods research. The book chapter hopes to be a launching pad for those students and research scholars who wish to do research in Compensation and apply relevant techniques for a fruitful and more meaningful analysis.

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ENDNOTES

[1] Refer to Impact of Compensation on Employee Performance (Empirical Evidence from Banking Sector of Pakistan) by Hameed et al. (2014)

[2] Refer to Total rewards: A study of artisan attraction and retention within a South African context By SCHLECHTER et al. (2014)

[3] Please refer to Rewards and Performance of Swedish Real Estate Firms by Azasu (2009)

[4] Refer to "Who stays with you? Factors predicting employees' intention to stay" by Ghosh et al. (2013)

Chapter 8
Measuring the Different Facets of Diversity Using Quantitative Methods

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ABSTRACT

The aim of this chapter is to provide quantitative techniques and guidance for analyzing different problems related to the measurement of diversity and inclusion practices present in organizations. The example of only one dimension of diversity; viz Gender diversity is given in this chapter. However, these Quantitative tools can be used to explore other facets of diversity as well. In this way, this chapter shall seek to provide a basic understanding of how to analyze and study the data collected for research on Diversity and Inclusion practices in organizations.

INTRODUCTION

A wise scholar has said, "Research consists in seeing what everyone else has seen but thinking what no one else has thought."

Research is a continuous and rigorous process to study a particular topic as meticulously as possible. It calls for inquisitiveness, perseverance, commitment and hard work for a quite a number of years. The decision to start on this difficult journey should be made after careful consideration. A good institution and the support of its research community, matter a lot in this journey.

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Mostly this chapter will adhere to University level students or doctoral scholars who have embarked on their research journey. However, researchers affiliated with different organizations too can benefit from the methodology described here.

The chapter shall deal with quantitative methods to measure different facets of diversity. Throughout the chapter, as an example, a study conducted by a researcher on gender diversity and the glass ceiling phenomenon in organizations shall be highlighted. This example shall help readers to understand better, the different statistical methods that can be used to conduct research on diversity.

Gender Diversity is a dimension of workplace diversity, which we shall be taking as an example in our chapter. Similarly, other dimensions of diversity too can be researched and analyzed using the tools given in the chapter. With the help of these methodologies and tools, researchers need to find their own unique approach to the study of management of diversity or analysis of diversity dimensions in an organization.

The layout of the chapter is as follows. In the first section, a general introduction to the chapter is given; in the second and third section, the topic of workforce diversity is explained with special emphasis on gender diversity in the workforce; in the fourth section, the researcher's induction into the research journey is highlighted; the third section talks about framing the research question and identification of the research population. The fourth section talks about how to approach research on diversity. The fifth section talks about framing the research Question and formulating the hypothesis. The sixth section discusses identification of the population while the seventh section talks about the different Sampling Methods that are used by researchers. The eighth section, follows up on this, by discussing data collection tools and techniques and the ninth section talks about ways to frame a basic questionnaire. The tenth section talks about certain basic quantitative methodology to analyze the collected data and the eleventh section takes this further by touching upon the different parametric and non-parametric tests used by researchers in their studies. Finally, the twelfth section sums it all up by providing a guideline on how to write the complete research report on the study conducted. Through these different sections, this chapter tries to give an overall view of some of the quantitative methods that may be used for analyzing research data on diversity.

WORKFORCE DIVERSITY

What Is Diversity?

In simple words, diversity is the individual quality which differentiates a person or group from others around them. Some of these differences like race, gender and age may be visible and distinguishable among different individuals while some others like educational levels, sexual orientation, opinions, beliefs, etc. may be invisible. Cox (1993) defines diversity as "a mix of people in one social system who have distinctly different, socially relevant group affiliations." Other researchers have defined diversity as organizational efforts which don't focus on any one particular group but rather on all employees for the overall benefit of the organization (Fraser-Blunt, 2003). Researchers like Hill, Lorbiecki and Jack and Mor Barak define diversity as efforts which move beyond tolerance to celebration of a heterogeneous workforce in an organization. According to them, diversity exists not because some groups are underrepresented but rather for celebrating plurality of the heterogeneous workforce so that everyone must be included while at the same time honoring the 'difference' that exists among individuals (Hill, 2009; Lorbiecki and Jack, 2000; Mor Barak, 2000)

Workforce diversity is considered to be extremely important in today's world. Researchers have pointed out that diversity helps an organization to increase acquisition of resources and marketing, creativity, problem solving and flexibility (Cox and Blake, 1991). Research on diversity has also found that having a workforce that is culturally diverse can help organizations make better quality decisions (Cox, 1994; McLeod et al., 1996), help to improve performance in an organization (Leonard et al., 2004) and lead to an increase in organizational creativity (Jackson, 1992). Due to all these benefits, organizations today are aggressively supporting and promoting different dimensions of diversity in the workplace, including gender diversity.

Certain researchers advocate the origin of diversity as a topic of organizational studies to the US (e.g. Ashkanasy et al., 2002; Ivancevich and Gilbert, 2000; Lorbiecki and Jack, 2000; Lorbiecki, 2001). In the year 1964 in the US, the civil rights act was enacted. This act made it illegal for US companies to discriminate on the basis of race, color, religion, sex or nationality. Similarly the EEOC (Equal Employment Opportunity Commission) and other acts such as the Age Discrimination in Employment Act of 1967, the Rehabilitation Act of 1973, the American with Disabilities (ADA) Act of 1990 and the ADA Amendment Act of 2008 all guaranteed the protection of worker's rights at the workplace, and prohibited discrimination so as to create a culture of diversity at the workplace.

Researchers advocating diversity have suggested that organizations needed to break away from their narrow definition of equal representation in employment as propagated by affirmative action programs and instead use broader concepts that capture individual differences and celebrated all the ways in which people can differ (Mor Barak, 2000)

Diversity as a term got impetus in the management discussion in the 1987 Hudson Institute report, 'Workforce 2000' (Ivancevich and Gilbert, 2000; Lorbiecki and Jack, 2000). This report predicted that the US workforce was going to get extremely diverse as women, blacks and Hispanics would make up about 85 percent of the workforce by the year 2000. Although this report was not accepted by the entire research community, it had given birth to the idea that the US workforce would soon be a heterogeneous one. In fact, researchers began to predict with the advent of the US economy more and more individuals would soon find themselves working with people who were demographically different from them in age, race, ethnicity, etc (Tsui et al., 1992). By the late 1970s and early 1980s, private companies in the US even began to realize that the legal mandates were not enough to effectively manage diversity in organizations and they themselves began to offer training and evaluation programs for promoting and managing diversity in the US workforce (Herring, 2009). It was also during this period that researchers started to suggest the different benefits that diversity provided to organizations. This included the ability to retain and attract the best talent in the market, reduced costs due to lower turnover and fewer lawsuits, increased market understanding and marketing ability, increased innovation, increased problem-solving and idea generation, better decision making, and better overall performance. (Cox, 1993; Cox and Blake, 1991; Cox, 1991). Due to these varied benefits, organizations in the US started making diversity a part of their internal DNA so as to keep themselves abreast in the changing global economy.

A Note on Diversity Policies in India

India is a founding member of the ILO and has been a permanent member of the ILO governing body since 1922. The establishment of the International Labour Organization in 1919, its conventions and recommendations, influenced considerably the labor laws which were formulated in India. Consequently, laws were passed which not only regulated the hours of work but also contained provisions for health, safety, welfare and equal treatment of workers irrespective of gender, race, religion, etc.

The Constitution of India also supports and promotes equality in the workplace. The term diversity, when used in the Indian context mostly, encompasses regional, linguistic, religious, cultural, socio-economic status and educational diversity as compared to diversity as understood in the western context which includes other dimensions like race, gender identity, gender choice, etc. One of the approaches that the Indian government has taken for managing diversity in its workforce was to give ‘reservation’ quotas to its historically discriminated groups, the Scheduled Castes (SCs), the Scheduled Tribes (STs) and the Other Backward Castes (OBCs).

India is a booming economy with a big middle-class population having a high spending potential. It is a very attractive destination for foreign investors from all over the world. Many multinational companies have opened operations in India. They have brought along different ethnocentric diversity assumptions of their host country culture into the Indian workplace (Nishi and Ozbilgin, 2007). MNCs have also brought more awareness to the diversity aspects like gender diversity, age diversity, LGBT diversity, etc., in their Indian operations. Indian employees have assimilated these western perspectives of diversity into their eastern values of equality and fraternity (Cooke and Saini, 2010). Thus, with the phenomenal growth of the Indian market and the globalization of the Indian workplace, 'diversity' has also become an important part of the Indian workforce.

GENDER DIVERSITY

WHO or the World Health Organization defines "gender" to be "the socially constructed characteristics of women and men – such as the norms, roles, and relationships that exist between them." Gender roles are "the set of arrangements by which a society transforms biological sexuality into products of human activity, and in which these transformed needs are satisfied" (Reiter, 1975). In other words, society sets some expectations and standards which influence the work done by each sex. Women do certain activities based on their gender while men do some other activities based on the fact that they are men. Having gender diversity in the workforce means that both men and women in the workforce will have equal work opportunities, compensation, growth options, and fairness in the organization

According to Kochan et al., 2003, women need to be provided equal job opportunities in the workplace as it helps in improving the performance of employees in an organization. Furthermore, a study by Wentling and Palma Rivas (2000) shows how organizations that have diversity in their workforce provide better services to their customers because they can understand their customers better. Certain other studies have talked about how hiring woman employees will help organizations tap niche markets globally (Kundu, 2003). Professor Klaus Schwab, Founder and Executive Chairman of the World Economic Forum (WEF, 2010) has said that women constitute approximately one-half of the potential talent base throughout the world and therefore, over time a nation's competitiveness in the global forum will depend on how much it educates and utilizes its female talent in the workforce.

As more and more women enter the workplace, organizations have started embracing diversity and inclusion practices to create a gender-neutral workspace. However, women are still largely under-represented and undervalued at work. Across managerial levels, they are inequitably employed and face discrimination. Women face a number of workplace barriers which cause many of them to take career breaks or leave their jobs. These barriers also become a deterrent to other women who seek to join the workforce. At the same time, different initiatives have been taken up by organizations to make the workplace more gender inclusive. In the ideal inclusive workplace, all employees would feel valued rather than just being represented. Such an organization would have fairness and equal opportunities for all its employees.

A Note on Gender Diversity and Equality Policies in the Indian Workplace

Article 39 of the Directive Principles of State Policy states that all citizens, men or women, have the right to an adequate means of livelihood while article 42 of the directive principles of state policy state that the state shall make provisions for just and humane conditions of work and maternity relief. Keeping these principles in mind, the government of India formulated the following acts for the working women in Indian organizations.

The Equal Remuneration Act which was passed in 1976, emphasized that men and women shall be paid equally for equal work done by them and that no discrimination shall happen in the workplace based on gender, physical ability, caste, religion, etc except where employment of women is prohibited or restricted by the law. The government also passed the Equal Opportunities, Protection of Rights and Full Participation Act in 1995 for equal treatment of all workers, including women, employed in an organization. Similarly, the Maternity Benefits Act passed in 1961 and amended again in 2008 and recently in 2016, provides all women employees with a maternity leave of 26 weeks and certain other benefits which have made a better place for the working mother in the Indian workforce. All these laws and acts are regularly monitored by the Central Ministry of Labour and Central Advisory Committee of the Government of India.

For safety of women at the workplace, the historical case of the supreme court of India (Hon'ble Supreme Court in Vishaka and Others Vs. State of Rajasthan and Others (JT 1997 (7) SC 384)) held that the sexual harassment of women in the workplace amounts to violation of the rights of Gender Equality and should be punishable by law. In the year 2013, the Sexual Harassment of Women at the Workplace (Prevention, Prohibition, and Redressal) Act, was passed which created a safer and more secure workplace for the working women in the Indian workforce. All these acts are constantly evolving and becoming more flexible and diverse with the changing times and the changing role of women in the modern Indian economy.

Now that we have provided a brief idea about the field of workplace diversity and of gender diversity, in particular, let us look at how a researcher shall begin her journey, be it in the field of gender diversity or any other diversity dimension of her choice. Starting with deciding on a research question to conducting a survey to collecting and analyzing the data and finally making a report using quantitative methodology, this chapter shall explain the different steps that are involved in the journey to conducting a good research.

DOING RESEARCH ON DIVERSITY

Once the course work had finished, scholars should totally concentrate on reading and broadening their spectrum. They should try to read various articles, books, blogs, dissertations, magazines, etc., related to their area of interest. These books and articles will help researchers in all the steps of their research journey. They say books are a student's best friend. In this Ph.D. journey, books shall certainly be one's best friend and reading is certainly the best exercise one can do.

The first step in this journey is to find a topic of interest. Choosing a topic ought to be one's own decision as otherwise, it will lead to a lack of motivation in the long run. It is recommended to read extensively and identify a topic of interest which is important to the researcher and which she can be passionate about. Identifying a potential supervisor and writing a research proposal usually comes next. Usually, students choose supervisors among those who have worked previously in this field or who have an interest in the topic of choice. In certain cases, students correspond with their guides well in advance and enter the Ph.D. program at a certain University with the topic and guide in mind.

Reading is an exercise which needs to be continuously taking place during the research program. Some supervisors might insist on a research proposal before they agree to work with you. Keep in mind while submitting the research proposal, that it should not be overly ambitious or impractical. Often a considerable time is spent in writing a research proposal and then it might need to be altered completely or at least funneled down to reduce the scope. The research proposal should refer to a subject, the scope of which is neither too broad nor too narrow so that the work can be completed within the typical timeframe of a doctoral program, that is, around 3-4 years.

Once the supervisor has been fixed and a broad reading of the literature in your field of interest is done, the next crucial task is to find out the research question. It needs an enormous study on the area of interest along with a considerable amount of time to find a gap in the existing literature. Many books and articles from different sources have to be read and a thorough review needs to be done by devoting sufficient time before deciding the research question. Students may first start with a rough notion about a researchable topic, based on their educational background, personal and professional experience and personal interest in that area. Next, they may explore a variety of sources to understand the broad area and develop the research question. They may also need to write a complete review of the literature in their field and show how they have developed the research question from gaps left in the literature. Some universities insist on the literature review as part of the doctoral coursework, others do not. But ultimately, doing a review of the literature is beneficial as it helps researchers be aware of the past and present debates concerning their research area.

Students should attend all kinds of seminars and workshops, along with University coursework during this period. The most important characteristic that should be present in a scholar is patience and readiness towards new possibilities. Also, scholars need to be innovative and tentative towards every possible aspect of the journey. Research is a process of personal growth where scholars need to be open-minded enough to welcome unexpected results.

Reading, writing, listening, and thinking constitutes important skill areas for early-career researchers to develop. The importance of reading has already been highlighted in the chapter. Writing stimulates thinking, imagination, and learning and helps the researcher pen down her thoughts on paper. Moreover, academic writing needs intensive practice and it is only by trying again and again that students can become good academic writers. The skills of listening are known to be important in any form of communication. It assumes importance in research because communication is involved in many stages of the research process. Hence to be good researchers, we need to be good readers, we need to be good writers and we also need to be good listeners.

It is important for researchers to have and follow a timetable for deadlines in their research work. This timeline should be further revised and updated as they proceed further along the research journey. This timeline helps researchers keep track of the progress that they have made and also keeps them from falling back or procrastinating on their research journey.

FRAMING THE RESEARCH QUESTION AND FORMULATING THE HYPOTHESIS

Having a broad research area is good as it serves as a starting point for researchers, but specific research questions need to be developed from here. In our example on gender diversity, our student decides to concentrate more on barriers women face in the workplace at upper levels of management after researching on the broad overall topic of gender diversity in organizations. She feels the glass ceiling is a phenomenon she would like to look at. This becomes her research problem. This research problem should have a clear sociological angle and the scope of the research question should not be too broad or too narrow. A few sub-questions need to be framed which the student shall explore in her research journey. In our example, the student may come up with the following research questions with regard to her area of interest on glass ceiling in organizations:

1. Does the glass ceiling exist in organizations? Is it specific to any particular sector?

2. Do women in middle management perceive a glass ceiling at the top?
3. Does this perception of the glass ceiling effect their organizational commitment?
4. Are women leaders in organizations able to cross over to the other side of the glass ceiling?
5. Do these women leaders continue to face such barriers in the top management?
6. Does this crossover effect their organizational commitment?

This may be a broad list of the research questions that the student has thought of. These questions may be more or less, depending on the depth of the subject and the scope of the research.

Another way to approach the research problem is to have a theoretical construct and let the thesis be guided by findings and developments, instead of beginning with a specific hypothesis and trying to prove and disprove it.

The research question should ultimately be such that it helps to make some kind of contribution to the field of study, however big or small.

In statistical data analysis, we first decide on a hypothesis. A hypothesis is a proposition or an assumption which the researcher wants to test through her research. A null hypothesis is a statement that the effect or the relationship that we are looking for is absent. The question that we need to find an answer to, through our research is whether according to the data we have collected and analyzed is the null hypothesis true. If it is true then we reject the alternate hypothesis and if it is false, then we accept the alternate hypothesis.

So, in our example, the null hypothesis would be that the glass ceiling does not exist in the Indian IT sector. We mostly reject the null hypothesis if the confidence level is 95 percent i.e we only reject the null hypothesis if we can be 95 percent sure that the association is a real association, In other words, we can say with 95 percent confidence that the glass ceiling does exist in Indian industries. We call this acceptance of the alternate hypothesis.

There are two types of errors which can be made with regard to acceptance or rejection of the null hypothesis:

Type 1 Error: The null hypothesis is rejected, when in fact it is true
Type 2 Error: The null hypothesis is accepted, when in fact it is untrue.

IDENTIFICATION OF THE POPULATION

After conducting the literature review and deciding on the research question, we come to the identification of the population. In our example, the student has conducted a literature review on the topic of gender diversity and has formulated her research questions on the glass ceiling in organizations. Now she needs to decide upon the population that she wants to study and decide what sample design should be used to draw a sample from the total population. These two terminologies, the population and the sample may be defined as:

Universe or Population: The total group of people of interest to us whom we wish to study for our research. E.g. All women managers in India.

Sample: A segment of the total population which we have chosen to study for our research purpose. The sample should ideally be representative of the population.

In our example, the researcher might have an in interest in the Indian IT sector as she may have previously worked in that sector or have acquaintances in that sector or may have read literature on the topic which would have created in her an interest to understand whether the glass ceiling is present in Indian IT organizations. So, the total number of women in the Indian IT Industry becomes her population and it is from them that she will draw a sample since it is about them that she wants to draw inferences from her research.

SAMPLING METHODS

It is obviously not possible to administer the research on the entire population because the number of women in the Indian IT Sector is huge. So, a sample needs to be drawn. The sample is a segment or subset of the population.

Non- biased sample or probability sample is when each and every unit in the sample has a known chance of being selected. An example is a simple random sample, which can be likened to something as simple as pulling names out of a box; every article in the sample has an equal and fair chance of getting chosen.

In stratified random sampling, the articles in the population are divided into different clusters and then a simple random sample is drawn out of each stratum. This ensures better representation of each cluster within the population.

Multi-stage sampling is when the researcher goes through different stages of simple random sampling to arrive at the final sample.

Similarly, there are other methods of probability sampling which are preferred by researchers so as to get a non-biased sample for their study. But during research on cross-cultural or diversity management, many researchers prefer to use non-probability sampling.

Non- probability or biased samples are those when one or more parts of the population are favored over others. Examples of biased samples are Convenience samples, Voluntary response sample, Snowball sample etc.

A convenience sample is a sample which is administered by the researcher on people whom the researcher can more easily approach or on participants who are easily accessible; hence it is not a fair sample.

A voluntary response sample is a sample where people who choose to include themselves in the sample, become part of the sample. People with a strong interest in the research topic will usually respond to such a sample. Hence it is a biased sample.

Snowball sampling is a sampling technique when one study participant participates in the research and then refers another participant for the survey. This participant, in turn, refers another participant for the sample and so on, thus leading to a snowball of respondents. However, since these respondents are all socially connected, they may have some variable in common, which may interfere with the research findings.

Judgmental sampling is when the researcher judges and decides which of the people are to be included in the sample. So, it is up to the judgment of the researcher on who should be part of the sample and hence there is no randomness in the sample.

When samples are not random, there may be a confounding variable which may become a part of the study unintentionally. Thus, these samples may not be a true representative of the population.

Let's say that the student researcher that we are considering in this chapter, conducts her survey and collects data on women managers in Indian IT organizations, by using snowball sampling which is a non-probability sampling method. The student may call up her old colleagues or acquaintances and mail them the questionnaire. Similarly, she may look up women leaders and managers in organizations and mail them the questionnaire. She may then ask these colleagues or acquaintances for contact information of other women managers and forward them the questionnaire. This way her sample size keeps increasing and the depth of her sample also widens.

DATA COLLECTION TECHNIQUE

Data collection can be done in two parts. We can collect primary data or secondary data. Primary data are original sources of data, collected firsthand by the researcher. Secondary sources are when the data has already been collected by some other researcher and we are simply using the data for our research purpose. This can be published and unpublished data. The benefit of secondary data is that they are readily available and do not need to be collected again but the disadvantage may be that they may not help the researcher in their particular research need.

Now that the student has decided on the population and the sampling technique that she will use to reach to her respondents, she needs to decide how she will collect the data. There are a number of ways by which she can do that. She can interview respondents face to face or over the telephone or the internet, send them a questionnaire, observe them in their natural or specified settings or have a focus group interview or discussion. The interview, questionnaire, and other data collection tools may further be structured, unstructured, semi-structured, in depth, etc. Further, the questions may be open-ended, close ended or both. Each of these methods has its own defects and merits and it is up to the researcher to decide what tool is ideal for their research. Two or more methods may be mixed up. There are no hard and fast rules for collecting data. Whatever method is best for your research, should be adopted by you to conduct your study. Neither are there any black and white lines between quantitative and qualitative data analysis. Students may adopt a combination of both in their research to get desirable results. For the purpose of this chapter, we are focusing on quantitative data analysis.

Quantitative Questions used in Questionnaires, Surveys, Interviews, etc., are of three kinds and generate three types of data – Nominal, Ordinal and Continuous. In nominal or category type questions, participants choose from two or more options, given to them. For e.g., Questions on Gender (1 for male and 2 for female) or Questions on Ethnic origin (1 for African American and 2 for Indian). In Ordinal type of questions, there is a relationship between the different variables or some kind of order or ranking between them. For e.g., Age (1 for 20-30 years of age, 2 for 30-40 years of age, 3 for 40-50 years of age, 4 for 50-60 years of age). Continuous questions are those which are identified by a number and this number defines the intensity or frequency of a particular occurrence. For e.g., how many women have had promotions in the past three years in your organization?

Designing the Questionnaire

From our continuing example of the scholar who wants to understand whether women managers in organizations, face the glass ceiling and what are the reasons for such barriers, let's have a look at the steps that she takes to design a questionnaire for this purpose.

The researcher needs to decide how the questionnaire shall be administered. For the purpose of our research, and because we want to reach out to a large number of people, we decide to use online questionnaires. The method of administration affects the type of questions that shall be asked and should be decided in light of needs and resources.

Questionnaire structure is very important. A good questionnaire should be interesting, easy to answer and respectful. It should have an informative title and description, so that the respondent knows why the data is being collected and for whom. The questions should be such that through them, we are able to find answers to the research objectives we have in mind.

The questionnaire should always be pre-tested or pilot tested. Focused groups, cognitive interviewing, split ballot experiments, field testing and many other methods exist for pre-testing of the questionnaire and determining its reliability and validity.

Once the questionnaire results are out, these need to be computed. There are two ways of calculating and analyzing the results. One way is using quantitative methodology and the other is using qualitative methodology. In this chapter, we shall be focusing on quantitative methodologies that can be used.

A Sample Questionnaire

This is a sample questionnaire handed out to employees working in different management positions in the IT sector of India:

Name of the Employee:
Gender (1 for Male and 2 for Female): _______
Age (1 for 20-30 years of age; 2 for 31-40 years of age; 3 for 41-50 years of age; 4 for 51-60 years of age; 5 for 61 years and above): ____________
Your position in the organization (1 for junior manager; 2 for middle manager; 3 for senior manager; 4 for Senior Executive roles):
Your Salary (1 for below Rs 40,000; 2 for 40,001-70,000; 3 for 70,001 to 1,00,000; 4 for 1,00,001 to 1,30,000; 5 for 1,30,001 to 1,60,000; 6 for 1,60,001 and above)

Kindly answer questions with a response from 1 to 5

1 – Strongly agree
2 – Agree
3 – Neutral
4 – Disagree
5 – Strongly disagree

1. Women and men are equally respected in my workplace: ____________
2. Women and men are rewarded/ promoted based on their performance, in my workplace: _____
3. An employee who can travel for work and work on weekends or night shifts, when required has a better chance for promotion in my organization: ______
4. Women must perform better than a man to be promoted in my organization ______
5. There are sufficient opportunities in my organization for women to advance into leadership roles _______
6. In my organization, women are usually employed in support roles _______

7. Men have their own networks at work which limit a woman's chances of growing in the organization _______
8. Sufficient guidance and mentorship is given to women who are trying to move up the corporate ladder in my organization ________
9. In my organization, there are a number of women leaders who are inspirations to the other women in the workplace ______
10. My organization inculcates a sense of diversity and inclusion in the workforce culture by regular diversity awareness seminars, diversity and inclusion workshops, training and/or other methods ________

ANALYSIS OF DATA

When talking about statistics, we refer to two types - Descriptive and Inferential.

Descriptive Statistics: Statistics which describe the sample or summarize it. An example would be if we say that 85% of the population agrees that glass ceilings exist in organizations. This would be descriptive statistics since this is a fact which is describing the population.

Inferential Statistics: Statistics which make inferences about the larger population using the results of the sample data given. Inferential statistics uses statistical analysis and interpretation to infer the data. Statistical tests and significance tests are then used to check the degree to which we can rely on the sample to make inferences about the population

For a quantitative study, we need to further summarize and describe the responses that have been generated through our research. For category type and ordinal type questions, like gender and age, we can count the number of responses and determine their frequencies. Further by using percentages, bar charts, and pie charts, we can report our findings. For eg, in our research, we shall count the frequency of the employees who are females (for the nominal variable of gender) or frequency of women who are above 30 years of age in the organizations (for the ordinal variable of age), and represent them via pie charts or bar graphs in the analysis.

Let's say from our questionnaire, we collect data which looks like that shown in Table 1.

For representation of continuous data, however, we can use measures of central tendency. In day to day language, this is called average or more academically – the mean, the median, and the mode. For example, if we want to understand what is the average earnings of a woman in a particular organization, we should find out the mean of the group of women working in the organization. This figure would then give us an idea about the average earnings of a woman working in that organization.

Table 1.

Gender	Age	Salary per Month
Male	35	40,000
Female	28	32,000
Female	32	38,000
Female	36	38,000

The formula for the mean is

Mean, $\overline{x} = \frac{\sum x}{n}$

So in our example, the average salary of the woman would be 32000+38000+38000 = 108000 and we will divide this by the number of woman i.e. 3. Hence the mean salary for a woman in the organization would be 36000.

If we want to understand the distribution or dispersion of the salary in this group of women, we would have to find out the range of their salaries. This can be done by simply subtracting the largest salary amount from the smallest one, i.e., finding the difference between the smallest and the largest responses. Similarly, we can also use the standard deviation method, to get a more accurate idea of the dispersion. In our example, the range of the salary for women would be 38000-32000 = 6000

Variance is a measure of how spread out is the distribution. It gives an indication of how close an individual observation clusters about the mean value. The variance of a population is defined by the following formula:

$$\sigma^2 = \sum\left[x_i - x\right]^2 \Big/ N$$

where σ^2 is the population variance, x is the population mean, x_i is the i^{th} element from the population mean and N is the number of elements in the population. The variance of a sample is defined by a slightly different formula:

$$s^2 = \sum\left[x_i - x\right]^2 \Big/ n - 1$$

$$s = \sqrt{\left(\sum\left[x_i - x\right]^2 \Big/ n - 1\right)}$$

where s^2 is the sample variance, x is the sample mean, x_i is the i^{th} element from the sample and n is the number of elements in the sample. The formula for the variance of a population has the value '*n*' as the denominator. The expression *'n−1'* is known as the degrees of freedom and is one less than the number of parameters. Each observation is free to vary, except the last one which must be a defined value. The variance is measured in squared units.

All this looks too complicated, so let's understand with the help of our example. As per our example, the average salary of the women in the organization is 36000.

Now the next step is taking every value that we have, subtract it from the mean, square the result and add all such results formed. So as per our example, the equation would look like

(32000-36000)^2+(38000-36000)^2+(38000-36000)^2

4000^2+2000^2+2000^2

16000000+4000000+4000000 = 24000000

24000000 /2 (3-1) = 12000000

To make the interpretation of the data simple and to retain the basic unit of observation, the square root of the variance is used. The square root of the variance is the standard deviation (SD). The SD of a population is defined by the following formula:

$$\sigma^2 = \frac{\Sigma\left(X_i - X\right)^2}{N}$$

$$\sigma = \sqrt{\sum\left[x_i - x\right]^2 / N}$$

where σ is the population Standard Deviation, x is the population mean, x_i is the i^{th} element from the population and *N* is the number of elements in the population. The Standard Deviation of a sample is defined by a slightly different formula:

$$s = \sqrt{\sum\left[x_i - x\right]^2 / n - 1}$$

where s is the sample Standard Deviation, x is the sample mean, x_i is the i^{th} element from the sample and n is the number of elements in the sample.

Hence the standard deviation of our sample is simply the square root of the variance of the sample calculated i.e. the square root of 12000000 which is 3464.10162

All these statistical methods are called univariate i.e. dealing with a single variable. This is because they look at only one question or variable at a time. A univariate is an individual fact about one particular data group. It simply states a fact about the sample, there is little to contextualize that fact or draw inferences from it. For e.g. 320 women managers have been promoted last year in the organization. This is an example of univariate data.

A more useful way of looking at descriptive statistics is to look at two or more variables at a time. This is called bivariate analysis of data and it allows us to draw some hypothesis or conclusion and infer some kind of relationship between these variables. Bivariate analysis helps us to explore whether the variation in one variable brings about any significant change in the other variable. For e.g. if the number of men who got promoted last year was 640 and the number of women who got promoted was 320, then we can say that the number of men who got promoted last year was double of the number of women who got promoted.

When Bivariate data is represented graphically, like a pie chart or a bar graph, they show a picture of how much the two variables differ. Such a representation can be very insightful and important. For e.g., a bar graph or pie chart showing how many more men are in top management positions when compared to women in top positions, shows the glass ceiling phenomenon being exhibited at higher rungs of the management.

In bivariate analysis, we look at pairs of questions and find how they interact or are different from each other. For e.g., we may find out how the nominal and ordinal data of age and gender are related to each other in the data that we have collected. Through bivariate analysis, we can find out the number of individuals in the bracket of age 30-40 who are females. A stacked bar chart helps to graphically present this data.

Figure 1. Management representation

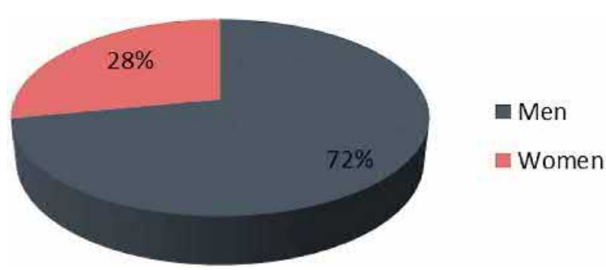
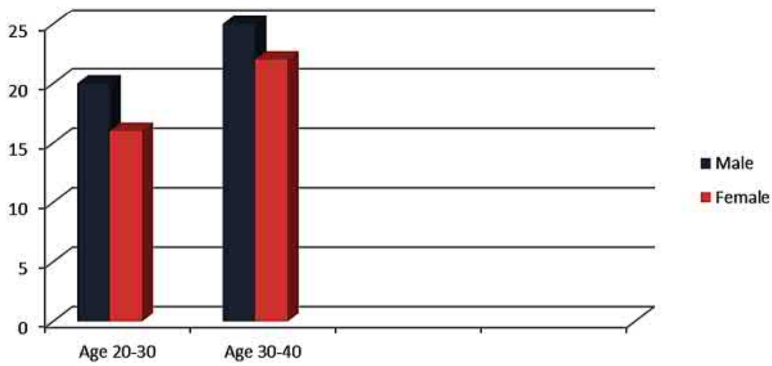


Figure 2. Stacked bar chart of management representation



Similarly, bivariate analysis can be used to find the relationship between a nominal and continuous data, for e.g. we may try to find how many individuals who have had any promotions in the last five years are women. In statistical terms, this is simply a comparison of means of the two kinds of data. We first divide our questionnaire into two parts - male and female, then we calculate the mean and standard deviation of people who got promoted in the last five years, for just the data of females. Then we compare the mean and standard deviation of the people who got promoted in the last five years for just the data of males and then we compare these results. This helps us to understand the relationship between the two variables.

Coefficient Correlation

However just showing variables side by side, only shows that there is an association between 2 variables, it doesn't tell us the strength of that association. If we need to understand the intensity of that association, there are a number of statistical tools which we shall need to apply. A way to understand this strength is to go for correlation. Correlation is a measure of the strength and direction of association between two variables. When measuring correlation, we use a correlation coefficient, most commonly known as R or r. This correlation coefficient will always be on a scale from -1 to +1 with 0 in the middle showing no association. -1 is a perfect negative correlation and +1 is a perfect positive correlation. An easy way to demonstrate correlation graphically is to use a scatter plot. This places one variable on each axis and visually demonstrates the relationship between the two. Strong positive correlation means that as one variable increases, the other increases in the same way. Strong negative correlation means that as one variable increases, the other decreases. The nearer to zero lies the coefficient, the lesser the relationship between the two variables.

An example would be finding the correlation between organizations which have women in higher positions and organizations which have gender diverse policies at work. It may be seen from our analysis that there is a strong correlation between organizations which have gender diverse policies and organizations who have women leaders in top management i.e (a value close to +1). This shall help in making correct inferences about the association between these two variables.

The line of best fit is a straight line drawn through the center of a group of data points plotted on the scatter plot. The steepness of the line indicates the strength of the relationship between the variables and the direction of the line indicates, whether it is a positive or negative correlation. Correlation doesn't however always imply cause and effect. There may be a third variable which may be related to these two variables and which may be the reason for the effect. Similarly, through correlation, we are not able to know the direction of causality i.e which variable is causing the change in the other.

The level of significance is the confidence level which is required to make sure that the findings can be generalized to the population. Usually, 95 percent confidence level is preferred for scientific studies i.e. one should have 95 percent credibility in their research findings.

What Is Normal Distribution?

Most variables usually cluster around a single central value, with either positive or negative deviation from that value. The standard normal distribution curve is a symmetrical bell-shaped curve. In a simple normal distribution, 68 percent of the scores are within one standard deviation of the mean, 95 percent of the scores are within 2 standard deviations of the mean and 99 percent of the scores are within 3 standard deviations of the mean.

Figure 3. Correlation

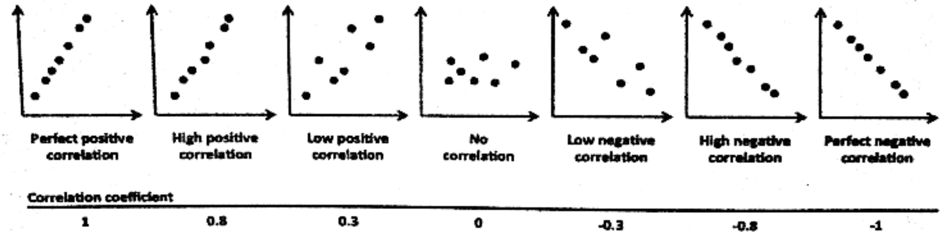
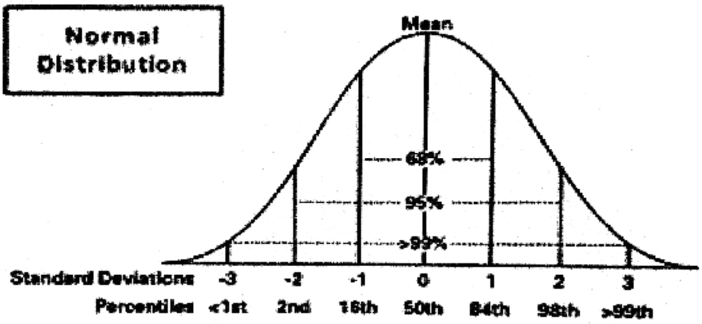


Figure 4. Normal distribution



What Is a Skewed Distribution?

A skewed distribution happens when the data collected is asymmetric about the mean or central value. If most of the data fall to the right of the central value, then it is a negatively skewed distribution having a longer left tail. On the other hand, if most of the values fall to the left of the central value, then it is a positively skewed distribution with a longer right tail.

Probability is a measure which states how likely it is that an event will occur. Probability is quantified as a number between 0 and 1 (0 indicates that the chances of the event occurring is impossible and 1 indicates that the chances of the event occurring is certain). The numerical value between 0 and 1 is called the *P* value or calculated probability.

This *P* value helps researchers to reject or accept the null hypothesis. If the P value is less than the significant level, the null hypothesis is rejected else it is accepted.

Figure 5. Skewed distribution

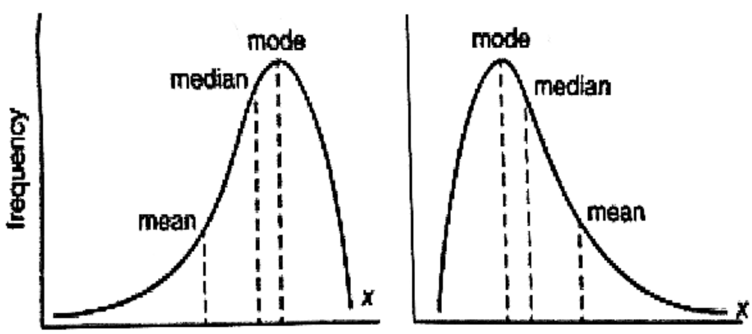


Table 2.

P value	Result	Null Hypothesis (H0)
< 0.01	Highly Significant	Reject H0
>= 0.01 but <0.05	Significant	Reject H0
>= 0.05	Not Significant	Do not reject H0

PARAMETRIC AND NON-PARAMETRIC TESTS

Parametric tests are those that assume that the data to be analyzed is on a numerical scale with a normal distribution. All variables collected have the same variance i.e., they there is homogeneity in them. The sample is randomly drawn from the population and observations within the sample are independent of each other. In those conditions, parametric tests are used.

Here we consider two most commonly used parametric tests, T-Test, and ANOVA.

T-Test

The t-test is used to test the mean value between two groups. There are three types of T-Test:

One Sample T-Test

One sample T-Test is used to check if the sample means differ significantly from the population mean.

The formula for one sample *t*-test is

$$t = \frac{X - U}{sE}$$

where *X* = sample mean, *u* = population mean and SE = standard error of mean

Unpaired T-Test

The unpaired T-Test is used to test whether the population means of two different and independent populations differ significantly from each other.

The formula for unpaired *t*-test is:

$$t = \frac{x_1 - x_2}{sE_{x_i - x_2}}$$

where $X_1 - X_2$ is the difference between the means of the two groups and SE denotes the standard error of the difference.

Paired T-Test

Paired T-test is used to test whether the population means estimated by two dependent samples differ significantly from each other.

Usually, a situation where a paired T-Test would be used is when measurements made on the same subject both before and after a particular phenomenon are compared.

The formula for paired *t*-test is:

$$t = \frac{d}{sE_d}$$

where *d* is the mean difference and SE denotes the standard error of this difference.

ANOVA (Analysis of Variance)

The T-Test cannot be used for comparison of more than two groups. Anova helps to compare the means of two or more groups and find any significant differences.

In ANOVA two group variances are studied – between group variability and within group variability.

The within group variability, known as the error variance, is a variation that cannot be accounted for in the study design. It is based on random differences present in the sample.

The between-group variance or the effect variance is the result of the treatment of the researcher. These two estimates of variance are compared on random differences present in the sample.

These two estimates of variances are compared using the *F*-test.

A simplified formula for the *F* statistic is:

$$F = \frac{Ms_b}{Ms_w}$$

where MS_b is the mean squares between the groups and MS_w is the mean squares within groups.

Non-Parametric

When the distribution of variables in the distribution is skewed to one side or the assumptions of normality are not met and the sample means are not normally distributed, parametric tests can lead to errors. In such cases, non-parametric tests are used. Non-parametric tests are usually used to analyze ordinal or categorical data. As is done for parametric tests, the non-parametric tests also compare the test statistic with known values of the sampling distribution leading to acceptance or rejection of the null hypothesis.

The most commonly used non-parametric test is the Chi Square Test.

Chi Square Test

We use this test when we want to compare bivariate data. For e.g. we may want to understand whether men and women in similar job roles in an organization have the same salary or not. The Chi-square data compares the data of the job roles of men and women employees in an organization to the data of the salary that they receive. The null hypothesis would be that male and female employees in similar roles would have the same salary while the alternate hypothesis would be that they do not receive the same salary.

The Chi-square test compares the frequencies and tests whether the observed data differ significantly from that of the expected data if there were no differences between groups (i.e., the null hypothesis). It is calculated by the sum of the squared difference between observed (*O*) and the expected (*E*) data (or the deviation, *d*) divided by the expected data by the following formula:

$$x^2 = \sum \frac{\left(0 - E\right)^2}{0}$$

The Research Report

After we have interpreted and analyzed the data that we have collected through our report, we need to write the finished report. The last step in the research process is the presentation and preparation of the research report. If the report is not well written, all the effort in preparing, gathering and analyzing the data shall be of little value. Hence to write a good report, the following points need to be kept in mind:

1. Write in clear and lucid English which is grammatically correct. Have the distinguishing touch of your own style of writing. Avoid plagiarism at all costs.
2. Write in a language which your intended audience shall be able to understand. For example, if your audience does not understand technical jargons, try to avoid technical language as much as possible.
3. Be objective in stating the aim of your research and presenting your findings in a clear and concise manner
4. Present your arguments, data, and findings in a clever, logical and ordered way.
5. Although there is no particular format for presenting a research report and it differs according to the study and the researcher, we present here a general outline of the research report

The Title of the Report

The title should explain the purpose or intent of the study and should be brief yet should sound interesting and catchy to the readers of the report. For our research, the title of the paper can be "The Glass Ceiling: Does it really exist in the Indian IT Sector?"

Table of Contents

The table of contents sequentially lists the different sections of the report along with their page references, for the ease and comfort of the readers.

The Objective

This section talks about the objective of the report. It defines the aim of the report and gives an idea about the focus of the study. It helps the readers to get a clear idea about the scope of the research.

Have an Outline

Outline helps to visualize how your essay will look. Outline can be a flowchart of ideas or a concept map. It helps the researcher as well as the audience to understand how the report shall present the ideas that have been generated through research.

Introduction

Introduction may include the literature review of the field of study and explain how the gaps left in previous literature, has led to the present study take place. It also explains why the present study is important or required. The researcher should get to the point and the target audience should be identified. The introduction should be clear and interesting so as to capture the attention of the researcher.

Background

Background helps to present the setting of the research being conducted. The problem statement behind the research should be highlighted in the background. The reason why the problem is important should also be explained in this section. Finally, the motivation behind the research question should be emphasized here. All this should be covered as a preface to the main research problem.

The Body of the Paper

In the body, we give literature for backing up the research statement. Each paragraph in the body should have the main statement and the ensuing paragraph should explain that statement. In this way, the body is linked to the thesis statement. In the body statement, we also specify the methodology that we shall be used for obtaining data for the research. The purpose of the methodology section should be to used to explain the research design, the data collection, and analysis design. It would explain to the readers whether the design is exploratory or conclusive. Basically, the body of the paper helps in understanding the nature of the research problem and explains the methods that shall be used to solve this problem.

Results and Findings

The bulk of the research report talks about the research findings which should be organized around the main research question and objective of the research. The data that has been found should not be written as a haphazard series of tables or figures, rather it should be categorized and presented in a manner in a logical manner which should be both interesting and insightful to the readers.

Limitations

It is obviously not possible that your research will not have any shortcomings. All research has certain limitations, which needs to be communicated to the readers clearly and concisely. Whatever gap is identified in the research should be written in this section. This does not mean that the research is being belittled but rather it enables the researcher to judge the validity of the results and be truthful to their audience.

CONCLUSION

This section summarizes the major findings of the research and provides the final thoughts of the researcher on the topic. It basically states the take away from the research conducted. The researcher may also make any recommendations to the research question that they have arrived at, after a complete analysis of the research findings.

Bibliography

The bibliography section helps to list the publications or sources that have been consulted for the purpose of the research. MLA, APA and Chicago are the most common styles to be used for referencing of an article. Moreover, the font size, the font type etc are other things to be kept in mind while writing the bibliography.

After finishing of writing of the report, we need to analyze the report for accuracy and precision. It is a good idea to read the report from an outsider's perspective. We need to ask ourselves whether the flow of the report is logical and whether it is lucid enough to be understood by someone, who is reading the paper for the first time.

All these steps provide a basic guideline on how to conduct research on diversity using quantitative methods. The quantitative tests and statistical techniques given above, attempt to assist researchers in conducting research on different facets of diversity. It is hoped that through these methods, students and researchers shall be encouraged to conduct a quantitative study on different diversity dimensions and contribute to the growing research in this field.

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Chapter 9
Driving Employee Engagement Through Data Analytics:
Helping Leaders Make Better People Decisions

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ABSTRACT

Employee engagement refers to a condition where the employees are fully engrossed in their work and are emotionally attached to their organization. An "engaged employee" is one who is fully involved in, and enthusiastic about their work, and thus will act in a way that furthers his/her organization's interests and productivity. There is a clear and mounting evidence that employee engagement keenly correlates to corporate performance in areas such as retention, productivity, customer service and loyalty. This timely treatment provides a comprehensive framework, language, and process that genuinely connects People Strategy with Business Strategy. Aimed at HR Professionals and People Managers, this chapter offers a complete, practical resource for understanding, measuring and building engagement with the use of data. Grounded in engagement theory and an understanding of psychology combined with practical tools, techniques and diagnostics this will help professionals make better and more informed decisions across the Engagement, Retention and People Satisfaction space.

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INTRODUCTION

With recent focus in data-driven analytics, and the resultant improved capabilities in working with huge datasets, strategic planning has become more complex for business units, and subsequently for the People function. Today well-intentioned 'textbook' ideas that are not rooted in data to support their value have no place in modern People Practices.

Over the last couple of years, "Data Analytics" has become a huge buzzword in the business world. Whether this data comes from social networks, analyzing purchase histories, web browsing patterns or surveys, the vast amount of consumer information that brands can gather and analyze has allowed them to improve and personalize their customers' experiences.

But for all the attention "Data Analytics" has received, many organizations tend to forget about one application of it: "Employee Engagement".

Employee Engagement has become an engaging notion – we get excited by it, we get involved in it, we're willing to invest time and efforts in it and we get proactive about pursuing it.

More and more organizations are looking at Employees as "Customers". Similar to "Customer Experience", organizations are focusing on "Employee Experiences". An experience that does not stop at providing consumer grade applications to employees, but looking at employees in a completely different light, as enablers of business success.

Just as how customers generate data, when they demand a particular service, particular product and express their preference through a LIKE or DISLIKE, a formal feedback or switching over to a competitor, employees also generate data, in the way they interact within and outside the organization.

Organizations world over spend hundreds of millions, annually, conducting surveys, feedback sessions, behavioral assessments and collecting vast data to study emerging themes that measure people engagement values. Interestingly, only 8% (Bersin by Deloitte 2016) of organizations world over are able to fully use the data to make advanced people decisions.

So the question is, when we extensively use the most miniscule piece of data to predict customer behaviors and choices why don't we use data in relation to employee engagement?

This chapter emphasizes how data can help HR Professionals and People Managers make better and more informed decisions across the Engagement, Retention and People Satisfaction space.

DOES EMPLOYEE ENGAGEMENT REALLY MATTER

You can buy a man's time, you can buy a man's physical presence at a certain place, you can even buy a measured number of skilled muscular motions per hour or day. But you cannot buy enthusiasm, you cannot buy initiative, you cannot buy loyalty; you cannot buy the devotion of hearts, minds, and souls. You have to earn these things. (Clarence Francis, 1950)

This famous employee engagement quote by a business executive in the early 1950s continues to resonate with HR professions even today. 'Increase Employee Engagement' continues to be a key agenda for CEOs, HR Leaders and People Managers year on year. Yet global employee engagement continues to remain at abysmally low levels. According to Gallup, on an average the number of employees who are ranked as 'disengaged' globally remains in the range of 70%. Of the total, some 15 to 17% are actively disengaged. Presumably, that means that they are so alienated that they have stopped connecting either with their employers or their work.

Disengaged employees cost organizations anything between $450 and $550 billion annually (The Engagement Institute). Therefore, it's clear: higher the number of engaged employees, greater will be the impact on the bottom line of any business, the ultimate success metric.

So are employees to blame for low level of engagements?

Nope.

A glimpse into any workplace and you sense:

Organizations are keen to maximize the contribution of each individual toward corporate imperatives and metrics. Individual employees, meanwhile, need to find purpose and satisfaction in their work.

If employee engagement has been on the leadership radar screen for all these years and engagement levels continue to be low, what's missing?

Most engagement strategies are slapdash efforts plagued with check in the box activities, conventional management values and lack linkages between business issues and people issues.

The solution to create an engaged workforce, therein leading to an increase in organization performance and productivity lies in 'Strategic Engagement' - one based on the collaboration of employee needs and the overall business agenda.

An engaged workforce plays an essential role in the success of any organization. As per the Aon model of engagement: The employee engagement construct, refers to the psychological state and behavioral outcomes that lead to better performance. Engagement is thought to include a combination of several constructs widely accepted in academic literature such as affective and continuance commitment, motivation, and organizational citizenship behaviors. Practically speaking, this means engagement involves a combination of rational thought, emotions, intentions, and behaviors required for optimal performance and productivity.

The model therefore, operationalizes employee engagement as a construct of six items composed of three observable facets of "SAY, STAY, and STRIVE".

This clearly reflects, when you're engaged, it infuses everything you do with purpose, energy, and enthusiasm.

HERE ARE SEVEN REASONS WHY EMPLOYEE ENGAGEMENT IS VITAL TO YOUR COMPANY

Engaged Employees Are More Productive

Engaged employees feel a deeper connection with the organization and are more committed and willing to work harder in order to reach the overall business goal. According to research from SHRM, employees with the highest levels of commitment perform 20% better than employees with lower levels of commitment. Similarly, research from the Hay Group found that engaged employees may boost office productivity by as much as 43%.

Engaged Employees Help Increase Profits

Engaged employees lead to increased profits. This impact is largely indirect. Through improving retention, customer loyalty, productivity, quality delivery and safety; organizations are able to keep their bottom line healthy while engagement strengthens all of these factors. Higher profits mean higher shareholder returns. Companies that increase their number of talented managers and double the rate of engaged employees achieve, on average, 147% higher earnings per share than their competition (Gallup).

Figure 1.

Engaged Employees Are Less Likely to Leave

Nearly $11 billion is lost due to annual employee turnover. A happy employee is less likely to start looking for a new opportunity elsewhere. If you are working to make each employee feel that they are valued and that the role they play significantly contributes to the overall organization success, they are going to be content to stay where they are. The attrition rate of disengaged employees is 12x higher than highly engaged employees over the period of a year (Glint).

Engaged Employees Increase Customer Satisfaction

Happy Employees = Happy Customers

It's not just speculation, these two elements really are deeply connected. Here is a sampling of studies that support this conclusion:

- Customer retention rates are 18% higher on average when employees are highly engaged (Cvent)
- The Gallup State of the American Workplace study found that companies in the top quartile of employee engagement experience 10% higher customer ratings.
- A study conducted by Washington State University determined that customer satisfaction is directly linked to employee satisfaction and that financial success is directly linked to customer satisfaction. Therefore, employee engagement is indirectly, yet importantly, linked to financial performance.
- Bain & Company studies indicate that employee behavior and attitude is one of the most significant drivers of customer satisfaction. Engaged employees not only spread their enthusiasm to customers, but they also are more dedicated to providing the best product and service to customers. For example, as Bain & Company explains, the "key ingredient" to JetBlue's high customer ratings is that "JetBlue employees treat customers' problems as their own."

Engaged Employee Impact the Overall Work Environment

The more connected your employees are to the business; the more positive they are about working to make it successful each day. They share that boost in morale with each other which means they help create an atmosphere of excitement, energy and drive within the organization.

Engaged Employees Are Your Greatest Brand Ambassadors

When your employees care about your company, they are ready to engage in effective communication with their peers, leaders, clients and potential partnerships. They will give valuable feedback and go out of their way to start stimulating conversations and engagements within and outside. They are out there championing your brand; ready to recommend your business, products and services to anyone they meet. They are excited about the company they are a part of and they want to make others excited too. You can spend millions on marketing but having real people out there who are talking positively about your offerings is transcendent to even the best marketing campaigns.

Engaged Employees Drive a Culture of Innovation

In today's ceaseless quest to stay ahead, a prized attribute for any organization is innovation. There is a close relationship between innovation and employee engagement. Engaged employees deliver high performance combine with passion and interest, which often leads to innovation in the workplace and if you foster innovation in your organization, you'll probably find that your engagement levels benefit too. As highly engaged employees feel they have a real stake in the organization, they strive to efficiently create new products, services and processes. Collaboration in the workplace amongst engaged employees and top management also leads to overall organizational growth.

While there is no such thing as a rulebook for creating an engaged workforce. What works for one may completely backfire for another organization, but here are somethings you can do to increase engagement levels:

- Have a meaningful vision of the future
- Understand what motivates each employee and match tasks to skills
- Create a sense of purpose
- Don't be afraid to empower
- Communicate effectively
- Leverage technology and cut out the excess
- Give employees a sense of purpose
- Create role models at the senior levels
- Get managers to own engagement agendas
- Celebrate victories no matter how small

There's a lot at stake. The impact of high employee engagement pervades every aspect of the company culture, impacts the financial bottom line, and can catalyze customer loyalty. So treat each employee like you would treat a customer or a shareholder and you will see the results with or without the engagement survey.

WHAT ARE EMPLOYEE ENGAGEMENT DRIVERS?

So what drives employee engagement?

People's motivations are strongly driven by a combination of internal and external factors. Understanding what drives their actions and how this translates into productivity, performance and loyalty to the company, is the first step in acting towards employee engagement, rather than just talking about it.

Several theories have been deduced that focus on the rational and emotional aspects of engagement. However, over the years, these drivers have changed and shifted priorities, reflecting geographical and economic conditions, generational changes and overall workplace trends.

While there is no 'one size fits all' methodology for leveraging employee engagement, there are some broad drivers that are common across organizations world over.

Relationship With the Manager

It's true, employees leave managers, not companies. Popularly known as the chief emotional driver at the workplace, the attitude and actions of the immediate manager can enhance employee engagement or can lead to total disengagement.

Given the direct management relationship, it's extremely critical that middle -managers are competent, effective and role models for their teams. While CEOs and other senior leaders set the overall strategy for the organization, great managers consistently engage their teams to achieve outstanding performance. They create environments where employees take ownership, feel valued and contribute to productivity and profitability. A Gallup research shows that managers account for as much as 70% of variance in employee engagement scores.

Yes, every manager can learn to become a people manager. But without the raw natural talent to individualize, focus on each person's needs and strengths, boldly review his or her team members, rally people around a cause, and execute efficient processes, the day-to-day experience will burn out both the manager and his or her team. This basic inefficiency in identifying the right people managers can cost organizations billions of dollars annually.

Therefore, identify the right people managers through behavioral assessments, Invest in New Manager programs, Leadership enhancement sessions, Coaching & Mentoring sessions, Manager connects and best practice sharing across the people manager community.

Organization Culture

Culture leads to performance and not the other way around. The impact of a high-trust culture extends far beyond an organization's performance and bottom line, and addresses the core of what people desire and long for in a work environment: a place that thrives on trust and transparency, collaboration, learning and pride. After all, if over a third of our lives are spent at work, our businesses ought to be places that accommodate basic individual desires for positive relationships.

It's imperative that organizations focus on increasing transparency, encourage more one-on-one discussions rather than just an annual engagement survey, listen to employee, accept change and empower individuals at the workplace.

Job Enrichment and Professional Growth

When top performers leave a company, the most popular comment they make is, "I just didn't see the right opportunities here." Or 'I'm leaving for a better opportunity"

According to a Deloitte report, 42% of respondents who have been seeking new employment believe their job does not make good use of their skills and abilities. Furthermore, surveyed employees who are planning to switch companies cited the lack of career progress (37 percent) and challenge in their jobs (27 percent) as the two top factors influencing their career decisions.

The millennial workforce is restless and is constantly looking for either a horizontal or vertical growth every year. Organizations need to create effective job rotation opportunities, skill development programs and fast track movements more frequently to support this demand.

Skill Development. This is especially true in the case of today's millennial workforce – the ever changing needs of the market and self -development aspirations make it even more challenging. Today, skill and knowledge enhancement is not just important for the employee but providing a learning culture is essential for organizations to remain relevant in the constantly changing business landscape.

Focus on creating Individual Development plans rather than simple organization focused goal sheets, find out what kind of projects keep your employees engaged, and invest in internal initiatives, structured job rotation programs, promotion evaluations, capability and competency development.

Make Them Feel Valued

Employees need to know you care, the challenge is they want to hear this every single day. Ensuring that an organization's action reiterates this emotion is a key driver for employee engagement. Individuals who feel personally meaningful will be motivated to give 110% at work.

- Entrust them with information that is critical for their role
- Provide constant feedback and mentorship
- Recognize and reward
- Trust & Empower
- Flexibility and Benefits
- Communicate, Communicate, Communicate

Job Security

A sense of security at the workplace is critical. Coming to work not knowing whether you will have your job at the end of the day doesn't benefit the individual or the organization, what it actually does is acts as a big deterrent to productivity levels. Security is not simply a matter of whether an employee is permanent or temporary/on contract. The environment can have a huge impact on how secure an employee feels in his or her job role. For example, being understaffed or having knowledge of other employees being laid off can make an employee feel threatened in his or her own job role. Unless these issues are properly addressed by management, then this can become a huge barrier to employee engagement. Creating employee feedback loops is an effective way that managers can create a dialogue with their direct reports to better understand what may be impacting an employee's sense of security.

Relationship With Co-Workers

"Do you have friends at work' is a question that features in almost all engagement surveys. It might sound trivial when you see it on the questionnaire, but response patterns impact engagement levels.

Positive relationships with co-workers can foster a sense of loyalty, camaraderie, and moral support among employees. These bonds may boost overall results and productivity as employees are more likely to want to avoid disappointing their teammates and to remain a cohesive team, especially when faced with adversity.

Employee Wellness and Benefits

Employee benefits have seen a significant change over the last couple of years. Benefits have moved beyond just medical and food coupons.

Several studies reveal that workplace wellness has the potential to deliver quantifiable benefits by creating a thriving, engaged, and productive workplace. Programs that go beyond mundane reviews, performance metrics and revenue targets are a key engagement driver especially for the millennial workforce. If you can make the workplace like home, they'll never want to go home!

Fun at work activities, annual health checkups, yoga and meditation camps, free food, work-life balance programs, facilities like day care centers & gymnasium, leave benefits, work flexibility, Knowing that family plays an important role in everyone's life –extend certain benefits even to family members - Family day, health benefits. Also, an employees' decision to stay or leave an organization is a family decision rather than just one individual – engage with the family through family days, newsletters, Family –work days.

Although these are some of the key employee engagement drivers identified in recent years, there are a number of other drivers that are equally important, such as organization policy, organization performance and external markets. It's important that each company analyze their own internal engagement drivers that stem from their unique cultures, ways of working and business goals.

An effective employee engagement strategy can only be designed and implemented after these particular drivers have been identified and understood.

EMPLOYEE ENGAGEMENT SURVEYS: REAL DATA ANALYSIS OR A PROCESS COMPLETION?

Featuring on the top 3 initiatives for the year on any HR plan, is the famous 'Employee Engagement Survey'.

Most businesses operate in a digital culture, and the way we measure employee engagement is largely reliant on an annual survey where a series of questions are skewed in a certain direction, and employees can decide whether to answer honestly or not at all. Unfortunately, the survey process cements an unequal power relationship between employees and the organization.

HR teams spend hours organizing the annual event; then spend a lot of money getting the data analyzed by expert firms, and then spend hours drilling down into the information. The question is what happens when the drilling is done. They often read and see information they don't want to see or hear about, and then find excuses for why they got these results.

If logic is to follow, the engagement score should typically be indirectly proportional to the attrition numbers, yet, despite high engagement scores - employees attrite, retention is a challenge and turnover costs high.

Why?

Because, there is likely nothing more frustrating for employees who complete surveys in good faith, provide honest feedback and then just never hear back or experience any change. The better option is to find a workplace that matches their professional needs instead.

If you've spent time collecting data and defining what "engagement" means in your organization (through linking it back to your overall business strategy and HR strategy), then you should conduct a key driver analysis to understand which factors in the survey have the biggest positive influence on your measure of engagement, and include them in your business plan.

Here are 5 core steps in delivering an employee engagement survey which makes a positive difference. From bottom to top of the pyramid;

Accept Change

You need to be open to the survey and embrace the chance to learn about what your employees think and feel. Welcome the opportunity to change for the better. Ask yourself why your organization is thinking about an engagement survey. If you can get the answer to each of these questions in turn, you'll be in a good place and have a goal to aim at.

For example:

- Why did we conduct a survey?
- How are we going to use the results?
- How quickly will we be able to introduce change within the organisation?
- Does this have a buy in from senior influencers?
- How are we going to measure change?

The quicker the organization change, the more worthwhile the investment on conducting the engagement survey will be.

Take Key People Issues Into Consideration While Designing the Survey

From design to conducting, Employee Engagement surveys usually becomes an HR agenda. The questionnaire is designed on what the leadership and management believe they want answers to, few surveys take into consideration what employees want to respond to. A lengthy survey with complementary questions that don't cover what your employees care about is an absolute waste.

You simply have to have some way of ensuring that the content of your questionnaire meets 2 key goals.

1. Do our employees think the topics and questions in this survey are important in their jobs here (irrespective of whether they are happy or disgruntled about the issues at hand)?
2. Are we as an organisation able and/or prepared to take action against any one of the issues that are covered by the survey (if they are identified as strategically important)?

Drive Genuine Participation

Surveys sometimes become a check in the box activity. HR teams publish participation rates, incentivize participation, giveaways and run a series of programs to increase the percentage of completion. But you need people to take part for the right reasons and share feedback on real issues. They have to trust that you will do something with the survey results to want to share honest feedback.

Analyse Your Survey Results

Survey responses and results usually reflect engagement levels across 4 levels (Disengaged | Not Engaged | Nearly Engaged | Engaged). Organizations usually combine engaged and nearly engaged % to feel good, but forget to combine the disengaged and not engaged % when they evaluate overall disengagement. That's not the best way to analyze engagement responses.

At the top-level, frequency count analysis of the proportions of people who agree/disagree with questionnaire statements are an excellent starting point. But they should be just that. A starting point.

If your survey is only generating hundreds of (albeit nice looking) charts which show percentage scores comparing different parts of the business or benchmarking you against a list of 1000 other organizations, then you are missing something big.

You need to dig a little deeper and examine the links between the survey items, verbatims and feedback that you receive on the ground and implement a plan that takes into account real people issues and challenges rather than people priorities defined by the leadership.

Result to Action Plan

The value of any employee engagement survey is not in just the questionnaire design, high response rates, insightful analysis or clear and concise feedback.

The Added Value of Any Survey Is From the Action Which Happens as a Result of the Analysis

Research suggests that organizations that conduct structured action planning exercises after conducting an employee survey are more likely to move towards their goal of creating and sustaining a great workplace culture

Though there is no single, definitive approach towards action planning, here are some guidelines which make action planning successful.

Step 1: Communicate the Findings

When an organization conducts an engagement survey, its employees expect the feedback to be acknowledged. Acknowledgement is the key to encouraging continuous and constructive feedback. Therefore, the first step of an effective action planning exercise is to share the survey findings with all employees.

Step 2: Identify Root Causes and Action Areas

Acknowledgement is incomplete till your employees feel that their feedback is being used to steer things in a positive direction. A good action planning exercise is one where the organization identifies key action areas based on the assessment findings and spends time to understand the underlying reasons of employee perception.

Step 3: Involve Employees in Implementation

How many people should be involved in the action planning exercise? In addition to the senior leaders owning the key action areas, involving employees across teams and levels is a key success factor for successful implementation. Best workplaces ensure that their employees have the opportunity to be a part of teams driving various action plans across the organization.

Step 4: Define a Review Mechanism to Track and Share Progress

Institute a review mechanism to monitor the efficacy of action plans. Hold "update" meetings throughout the year to report on progress to your employees. It is vital to celebrate the achievement of milestones while implementing action plans.

The custodians of action planning are often tempted to rush towards execution without enough preparation or research. Organizations that are successful in implementing action plans, communicate and collaborate with their employees and celebrate milestones at each stage.

While the overall proposition, frequency and confidentiality of the employee engagement survey continues to be a debatable topic; for now, it's important that HR and management are open to feedback, design a structured and measurable action plan and are willing to implement change immediately because the more we procrastinate, the more complex the problem at hand will be.

These are real people with issues, stories, passions, concerns and aspirations that deserve and require human reaction in every organization immediately. It's time to evolve out of the Junk Science paradigm that has made HR weak and ineffectual in so many organizations and that has reduced employee loyalty practically to zero.

WHAT IS PEOPLE ANALYTICS AND HOW DOES IT IMPACT CASE STUDIES?

Human analytics is about analyzing organizations' people problems. For example, can you answer the following questions about your organization?

- How high is your annual employee turnover?
- Do you know which team's engagement level is going to be at the highest this year?
- Do you know how many employees are expected to leave your organization within this year?
- What % of future leader will you be able to groom internally?

While the response to the first question is easy, responding to the remaining three requires you to analyze HR data in depth.

Interestingly all HR teams are sitting on a gold mine of data – employee background,, performance information, past experience information, education background, yet, According to Accenture's 2016 outlook *How Well Do You Know Your Workforce,* "Many companies are struggling just to get basic reporting right.

They may not even know exactly how many people work for them, in what jobs and in what regions. And many still rely on first-generation spreadsheets to manage HR data."

As soon as organizations start to analyze their people problems by using the data already available with them, they are engaging in People analytics.

In other words, it is using data to make more effective people decisions.

Analytics is the science of extracting patterns, trends, and actionable information from large sets of data to radically improve the way we make decisions today. It has a lot of potential, Cloud-sized chunk of information that, with the right algorithms and filters – can be turned into actionable insights. Big data, hyper personalization, customer experience analytics have become essential buzzwords at board room discussions across the globe.

So, if business is using it so extensively, what's stopping HR from adopting People Analytics to make better people decisions?

Today, the majority of HR departments focus on reporting employee data. This doesn't suffice in today's data-driven economy. Just keeping records is often insufficient to add strategic value. The goal is to turn data into information and information into insights

In the pre-big data days, businesses had a tendency to sideline problems with intangible solutions. Culture management was one such issue. How do employees behave? Do they reflect the company values in their actions? Is there a positive work culture? More than 80 percent of companies say they conduct employee satisfaction surveys, according to the Society for Human Resource Management, but "many admit that they don't understand how to interpret the results nor what to do to improve survey scores." How do we change this?

Say you want to measure the impact of employee engagement on financial performance. To measure this relationship, you need to combine your annual engagement survey with performance data. This way you can calculate the impact of engagement on the financial performance of different teams across different regions. Or imagine you can predict which new hires will become your highest performers in the next two years. Or that you can predict which new hires will leave your company in the first year. Having this information will help you make better and proactive decisions while hiring, selecting and retaining.

However, only few organizations are capable of producing predictive models for HR. According to Deloitte's Global Human Capital Trends (2016) report, only 8% of the organizations worldwide had this capability in 2015. This number only doubled compared to the year before.

And the most sophisticated form of analysis is about using data in a predictive way, eg to pose future scenarios and conduct various forms of workforce planning.

Applying predictive analytics to specific HR areas can yield impressive results. This is clearly reflective in organizations that consider people analytics as an important trend, for example:

Google Uses People Analytics to Identify the Right Talent

In his book, Work Rules! (2015), Laszlo Bock, Senior Vice President of People Operations (HRM) at Google, writes that the most important instrument of Google's People Operations is statistics. The questions interviewees get asked in Google's hiring process are all fully automated, computer-generated and fine-tuned in order to find the best candidate.

On top of that, Google estimates the probability of people leaving the company by applying HR predictive analysis. One of Google's findings through analytics is that a new sales person, if not promoted within four years, is much more likely to leave the company.

Facebook Leverages Analytics on Personal Profile Pages to Understand Personality Traits

Do you checkout the Facebook page of a potential candidate? If you are not doing it, maybe it's time to rethink. A 2012 study revealed that it is possible to predict someone's personality and future work performance based on their Facebook profile (Kluemper, Rosen & Mossholder, 2012). In this study, a number of participants gave hire ability ratings based on Facebook profiles. These ratings predicted 8% of manager-rated job performance for these people. 8% is not that much. For instance, a standard personality test has a higher predictive value for performance compared to looking at someone's Facebook profile. However, the literature shows time and time again that the best predictive models for future job performance combine various predictors, such as IQ tests, structured interviews, and personality tests together. Looking through a Facebook profile could be an additional instrument to scan candidates.

Wikipedia Identifies Contributors Through the Use of Analytics

Wikipedia editors, or Wikipedians, create and edit articles to keep the world's largest encyclopedia up-to-date. Each day, over 800 new pages are created and 3,000 edits are made on the English Wikipedia alone. However, with the use of data, Wikipedia is able to predict who of its 750,000 editors is most likely to stop contributing.

Analysis of Employee Engagement Responses at Best Buy Has Led to Increased Profits

A leader in HR predictive analytics- Best Buy, can accurately predict how employee engagement impacts the performance of their stores. A 0.1% increase in employee engagement results in an increase of over $100,000 in the store's annual income. The enormous impact of engagement prompted Best Buy to make its engagement surveys quarterly instead of annually.

A US Telecom Giant Uses Analytics to Understand Patterns of Absenteeism

Take the case of a communications company that set out to understand the drivers of employee absenteeism at its call centers as a means of improving overall call center productivity. One hypothesis was that a major cause of absenteeism was the distance between an employee's home and the center. As it turned out, a much more important factor was the employees' family obligations, including caring for aging parents or young children. The finding was critical. If the company had based changes in hiring policies or employee support programs on the original hypothesis, it could have wasted money, constricted the hiring pool and even increased rather than decreased absenteeism.

Knack Uses a Combination of Gamification and Analytics for Hiring

Knack uses games to help identify recruits with a higher probability of becoming successful employees. Recruiters use the games to look at a variety of capabilities and traits, from cognitive ability to creativity to learning to decision making. One of them, "Wasabi Waiter," asks the player to assume the role of a waiter at a sushi restaurant. Players take orders and then analyze customers' facial expressions—such as "happy," "angry" and "sad"—to decide how to proceed. How applicants play the game indicates how well they read social and emotional signals. Performance is benchmarked against the top performers among a company's current employees to help identify the most promising recruits.

An Asian Life Insurance Company Used Talent Analytics to Make Better Decisions About Employee Recruiting and Retention

The company began working with an HR outsourcing provider, primarily to improve the efficiency of its recruiting and onboarding processes. As the relationship progressed, however, the company asked the provider to help with a more serious business problem: retaining people in one of its most critical workforces—managers at its affiliated agency locations. The company was experiencing 100 percent turnover among these employees, with many leaving after only six months—a situation that was impeding overall corporate growth.

Executives had several hypotheses. Perhaps it was about compensation, or maybe it was an issue with the quality of life at the locations. The provider was able to use predictive analytics to determine the actual predictors of success in terms of the performance and retention of these workers. Among the insights: Educational requirements for incoming managers had set false expectations about the kind of work actually involved. The company had been requiring that all new managers have MBAs. In fact, the analysis showed that these recruits were often among the company's poorest performers. This data enabled the company to alter the job profile, which also opened up the position to a broader group of candidates.

An important lesson of the company's experience is that the results of an initial talent analytics program need to be revisited over time to continue to validate the findings. One point of comparison had been between managers working at branches within their home state and those working in a state other than where they had grown up. An initial analysis seemed to indicate that managers who had moved around frequently and had previously been forced to establish new networks were performing better. A year later, a more complete analysis of the parameters found that the reverse was actually true: Managers working within their state were outperforming the outsiders. Six months after the company changed its hiring profile, new-hire performance shot up by more than 100 percent and new-hire attrition went down by 50 percent.

The data space can be overwhelming and enchanting all at the same time, but, the results of this people analytics programs are impressive when implemented correctly. HR has all the data, we just need to begin using it beyond mundane dashboard and headcount reports.

It takes the guesswork and gut feeling out of employee management and is therefore the future of HR. Or, to put it in the words of Edwards Deming: "Without data you're just another person with an opinion".

The Bersin by Deloitte Talent Analytics Framework clearly explains all of the elements of talent analytics and spells out the % of organizations adopting various forms of talent analytics.

WHY YOU NEED TO EMBRACE 'ANALYTICS' TO DRIVE EMPLOYEE ENGAGEMENT

People analytics can mine through volumes of information and previous employee development experiences to guide users to the most effective information to meet their business needs. It's not about ditching the intangibles altogether. HR is all about humans—different people behaviors, skills, capabilities, competencies, and mindsets, you can't simply quantify the entire people agenda. But analytics can do a whole lot of the heavy lifting. You just have to know how to use it.

People analytics gets to the root causes of engagement issues and enables you to develop better action plans, which are grounded in fact-based insights about employee dynamics. Your engagement survey results, whether annual or "pulsed" throughout the year — are only one of many data points to take into consideration.

People Analytics Uses Data in Management Decisions

It looks across all the hundreds of employee attributes (taken from all your different HR systems) to answer the WHY and HOW questions like:

Figure 2.

- Why does a specific team or role or demographic have an issue with engagement?
- What is the connection between engagement and performance or retention?
- How can we measure the results of HR programs designed to drive engagement and, ultimately, business outcomes?
- Is engagement driving resignations or absenteeism in a way that impacts business performance?

It Has the Capacity to Be a Powerful Descriptive Tool to Evaluate Performance

It looks through past performance and employee information to drive change. Josh Bersin's example on the use of Big Data explain how.

A large financial services company, operates under a belief system that employees with good grades who come from highly ranked colleges will make good performers. So their recruitment, selection, and promotion process is based on these academic drivers.

They performed a statistical analysis of sales productivity and turnover. They looked at sales performance over the first two years of a new employee and correlated total performance and retention rates against a variety of demographic factors.

The results were astounding

An ideal candidate for the role would be: (Must haves)

- An accurate, grammatically correct resume
- Having completed some education from beginning to end
- Having successful sales experience in high priced items
- Demonstrated success in some prior job
- Ability to work under unstructured conditions.

What did NOT matter:

- Where the candidate went to school
- What GPA they had
- The quality of their references.

The data showed that old indicators (such as GPA and education) were far less critical to performance and retention than factors like experience selling big-ticket items, for instance. When the data was implements into the recruiting process, the company grew by $4 M in the very next fiscal period.

Advanced Software Algorithms Can Identify Talent and Match It to an Organization's Needs

It can evaluate collaborative interactions that occur within the organization and automatically identify subject matter experts in the organization that can mentor other team members. Effective and timely coaching and mentoring can be a key ingredient to improving employee morale and engagement.

It's an Incredible Predictive Tool

Attrition turnover being the greatest hit on bottom line, organization use analytics extensively for predicting attrition. By analyzing the skills and attributes of high performers in the present, it enables organization to build engagement plans, high potential programs, predicts attrition metrics and helps design proactive retention strategies. Analytics in certain cases has also helped identify low performers and successfully aided in creating the right development programs reducing cost and increasing job security for the employee. One company reduced its retention bonuses by $20 million - as well as its employee attrition by 50% - all thanks to predictive behavioral analysis.

Helps Determine Factors That Contribute to Maximum Employee Productivity

One organization has begun to experiment with using smart badges and has gathered data that suggest offices with more natural light and inter-company collaboration experience higher rates of productivity and lower rates of employee attrition and turnover.

Helps an Organization Become More Agile

Beyond the experiential, people analytics can also have practical applicability in helping to optimize spending and investment in talent programs. Using a combination of analytics and data visualization tools, many organizations are investing in short-term, deep-dive projects to identify millions of dollars in unnecessary talent spending. For example, these projects might identify areas of payroll leakage due to inefficient pay practices. They might simplify organizational structures that have become overly complex and costly to maintain as the business has grown. Or they might evaluate core HR functions such as total rewards, learning & development, and recruiting with an eye toward reducing duplication and adding efficiency while improving outcomes.

It's Growing

The market for corporate talent management software grew by 17% in 2013, and is now over $5 billion in size. Gartner predicts that the market for Big Data and analytics will generate $3.7 Trillion in products and services and generate 5.1 million new jobs by 2018

There is significant revolution taking place in human resources and talent development departments around the world. Faced with a growing need for meaningful insights into the workforce, companies are beginning to recognize the enormous, untapped potential in what they already know, and what they could know, about their own people. 'People Analytics' is changing the way companies think about everything from attracting and developing talent to employee engagement and retaining talent.

IS YOUR ORGANISATION READY TO ADOPT PEOPLE ANALYTICS?

Analytics, thus is going to see a marked shift towards focusing on the individual employee rather than focusing on overall organization. The "drill down" will become "roll-up".

This is an enormous shift from focusing on organizational metrics, trying to identify compliance, and to satisfy that, trying to collect and cleanse the data.

As per an Accenture study, these are a few important lesson that are further along in their people analytics journey.

- There is no such thing as 'perfect' data. Start with what you have and approach the complexities and problems with data as you go along.
- Start small. Identify two or three issues the organization is facing and begin a pilot to prove the value of the longer-term people analytics enterprise.
- Align with business strategy. Driving people analytics in silos will have zero impact on bottom line, productivity and business-people issues.
- Analytics is not the traditional HR function. You will need data scientist to help you mine and analyze data appropriately.
- Don't forget the people. No matter how effective your insights are, HR is about dealing with humans and will always require social interventions.

For years, the human resources function has managed people and taken people decisions based on feelings, emotions, and behaviors. Talent analytics can change all this—revolutionizing not only the practice of HR but also how insights about workforce performance can be derived and applied to achieve real improvements in business performance.

In the "war for talent" to come, the companies that use people analytics as the key to unlock the masses of data in their HR systems will win.

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Chapter 10
Organizational Well-Being:
A New Theoretical Model and Recommendations for Future Research

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ABSTRACT

The aim of this paper is two aspects: to provide an overview of organizational wellbeing (OW) research; to present a new model of OW focusing on successful outcomes and its operationalization of the construct and the recommendations for future. A summary literature review of the OW literature, focusing on organizational well-being and its possible consequences. The literature is used to develop and propose a new model of OW and its success indicators. Testable relationships are proposed between these indicators. The research model has not been tested empirically. It is an external representation, is a new and untested concept in the OW literature. The paper provides a model that leaders, managers and newcomers may find useful to successfully establish the OW process. The model proposed is novel and raises the important issue of appropriate OW success indicators. New propositions are made regarding relationships between antecedents and output variables.

INTRODUCTION

Well-being plays an important role in a variety of ways. It impacts an employer's approach to traditional benefits and HR policies. But just as important, making employee well- being a priority will have a positive return on the organization's workforce availability and performance, labor-related costs, and output — including

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innovation, customer service, and quality of products and services. Research undertaken in various social science disciplines supports the adoption of well-being — in all its many dimensions — as a concrete, achievable employer goal. Creating a future-ready approach to employee well- being requires a vision of the end-state and a strategy. It should start with an analysis of the employer's expectations and needs and objectives to identify areas of greatest need and the corresponding effort required for success. Using an opportunity analysis enables an employer to prioritize and plan actions that will produce the best return on investment by using all parameters of wellbeing. To implement wellbeing in the workplace, employers must first understand the nature and process of well-being. First, an individual's experience at work obviously affects the person while she or he is in the workplace. In addition, these experiences also "spill over" into non-work domains. Workers almost spend one-third of their waking hours at work, they don't necessarily leave the job behind when they leave the work site. Indeed, the overlap between non-work and work leads to the observation that a person's work and personal lives are interrelated and intertwined. Second, there is a growing awareness that certain elements in the workplace pose risks for workers. Unsafe work practices, sexual harassment, disturbing supervisor-subordinate relationship, and uncontrolled aggression are such potential threats. Third, health problems adversely affect outcomes. Workers experiencing poor health may be less productive, make lower quality decisions, exhibit higher absenteeism and make consistently diminishing overall contributions to the organization. The need for regulating new business growth is usually prompted by social and psychological perception of the employees. We need to understand the key predictors and the process of well-being.

Now there is a greater awareness on the role of employee's wellbeing in the business organization. But there is less attention has been paid to its ramifications for employee wellbeing. Current research is now demonstrating the benefits of organizational wellbeing which is a strong criterion for business success.

The pursuit of wellbeing is an important goal for many organizations. Few scientific researches have focused on the question of how wellbeing can be increased and then sustained. In the pursuit of happiness, empirical evidence suggests that the ability to be happy and contented with life is a central criterion of adaptation and positive mental health. Lyubomirsky and her colleagues recently complied evidence showing that happiness has numerous positive byproducts that appear to benefit individuals, families, and communities (Lyubomirsky, King, & Diener, 2004; Fredrickson, 2001). Furthermore, Lyubomirsky et al.' analysis revealed that happy people gain tangible benefits in many different life domains from their positive state of mind, including larger social rewards (higher odds of marriage and lower odds of divorce, more friends, stronger social support, and richer social interaction; e.g., Harker & Keltner, 2001; Marks & Fleming, 1999; Okun, Stock, Haring, & Witter, 1984), superior work outcomes (greater creativity, increased productivility, higher quality of work, and higher income, e.g., Estrada, Isen, & Young, 1984; Staw, Sutton, & Pelled, 1995) and more activity, energy, and flow (e.g., Csikszentmihalyi & Wong, 1991).

ORGANIZATIONAL WELLBEING

With the growth of companies, in terms of employee numbers, and in terms of service quality and complexity, they provide the human factor which has become a prime competitive advantage on the market. Organizational wellbeing is a holistic concept. It can be operationalized from multiple variables. It requires the congruence between the needs and values of employees and the organization and enabling conditions include providing a safe and supportive environment for shared meaning-making effective boundary management, and engaging, invigorating and inspiring employees.

A study run by Gallup on 5000 employees proves that individual wellbeing now produces long-term effects on the organization, in year 1 and 2 after the investments, in terms of enhanced engagement at the workplace. These individuals tend to see their workplace as positive, productive and engaging. Moreover, managers will collect the results stemmed from investments in wellbeing in terms of an open organizational culture that challenges and engages employees and will, most keep them loyal to their company. There is a greater need for research in this area.

So, what factors play a role in enabling organizations to thrive in today's world? There is a growing body of literature on the importance of organizational health (Cooper & Cartwright, 1997; Grawitch, Ledford, Ballard & Barber, 2009). Most of research focuses on underlying conditions including programs, policies and practices through which a workplace can be psychologically and physically healthy for employees. There is some philosophical debate about the considerable overlap between health and wellbeing (Ryff &Singer,1998). In support of this view, the WHO (2010) suggests that mental health should be conceptualized as a state of well-being in which an individual realizes his or her own abilities can cope with the normal stresses of life can work productively and can contribute to his or her community.

SCOPE OF WELLBEING

Chronic Happiness Level

Our primary focus is on a person's characteristic level of happiness during a period in his or her life, which is known as chronic happiness level. It is difficult to alter one's happiness level at a moment or on a day. Operationally, one might define a person's chronic happiness level in term of his or her retrospective summary judgments regarding his or her mood and satisfaction during some recent period. People, however, may vary in their "hedonic profiles".

Determinants of the Chronic Happiness Level

There are three primary types of factors that affect the chronic happiness level, namely, the set point, life circumstances and intentional activity. These three factors distinction addresses several important issues and paradoxes. Existing evidence suggests that genetics account for approximately 50% of the population variation and circumstances account for approximately 10% (Argyle, 1999; Diener et al., 1999). This leaves as much as 40% of the variance for intentional activity, supporting our proposal that volitional efforts offer a promising possible route to longitudinal increases in happiness. In other words, changing one's intentional activities may provide a happiness boosting potential that is at least as large as and probably much larger than, changing one's circumstances. Individual's chronic happiness level is in part determined by her or his set point, which is defined as the central or expected value within the person's set range. It is genetically determined and is assumed to be fixed, stable over time, and immune to influence or control.

It is assumed that twin studies (Lykken & Tellegen, 1996; Tellegen et al., 1988), Long-term panel studies (Headey & Wearing, 1989), and studies of the effects of life events on well-being (Brickman et al., 1978) all indicate substantial long-term stability in happiness. For example, Lykken and Tellegen (1996) assessed well-being in twins at 20 years of age and then again at 30 years of age. The cross-twin, the cross-time correlation for the happiness of monozygotic twins was 40 (or 80% of the test retest correlation), suggesting that the heritability of the "stable" component of happiness is approximately .80. In contrast, the cross-twin, cross-time correlation for dizygotic twins was close to zero (.07). Monozygotic twins exhibit considerably more similar patterns of happiness change than do dizygotic twins, providing converging support that the variance in adult happiness is in large part determined genetically.

So far as the implications of the set point is concerned, the preceding analysis implies that one's chronic happiness during a life period can be increased, but not by changing one's set point, because it is constant. In other words, although it is possible that future scientists will learn how to alter people's basic temperaments and dispositions, at present it appears that focusing on the set point is not a fruitful avenue for happiness increase. Nongenetic factors also influence a person's chronic happiness level, helping to determine whether the person falls in the lower or upper portion of his or her potential range at a time.

Circumstantial factors also include the individual's personal history, that is life events that can affect his or her happiness, such as having experienced a childhood trauma, being involved in an automobile accident, or winning a prestigious award. These factors also include status variables such as marital status, occupational status, job security, income, health and religious affiliation.

Intentional Activity

Individuals are very active creatures, with innumerable behaviours, projects, and concerns to which they devote energy. Intentional activity refers to people can choose to engage may have become habitual. It also assumes that intentional activities require some degree of effort to enact. There is a critical distinction between the category of activity and category of life circumstances. Circumstances happen to people, and activities are ways that people act on their circumstances. This intentional activity can influence well-being.

The research also suggests that the impact of adopting new behaviour on longitudinal wellbeing. For example, faithfully engaging in a new exercise program positively boosts people's mood and vitality and can even maintain the boosts for if 6 months (Stewart et al., 1997). Recent work is also indicating positive effects of prompting people to proactive positive psychological "virtues" such as gratitude (Emmons & McCullough, 2003), hope and forgiveness (McCullough et al., 2000). It suggests that cognitive activity offers many excellent possibilities for happiness interventions (Fordyce, 1983).

After behaviours and cognitions, the third type of intentional activity, recent longitudinal studies have focused specifically on is volitional activity as a producer of enhanced well-being. In such studies, students are asked to pursue self-generated personal goals over the course of semester. High levels of goal progress or attainment consistently predict increased well-being. That means it enhances high positive affect and life satisfaction and decreases negative mood.

Hedonic adaptation can constrain the happiness inducing effect of intentional activities. Sheldon and Lyubomirsky (2004) recently conducted several short term longitudinal studies in which participant's wellbeing (positive affect, negative affect, and life satisfaction) was measured at Time 1, and positive circumstantial and activity based life changes were measured at Time 2. Well-being was then measured twice more, at Time 3 and 4, These investigations found consistent support for a path model, in which both positive circumstantial change and positive activity change predicted enhanced life satisfaction and positive affect at Time3, but only positive activity change predicted and maintained happiness gains at Time 4, with positive circumstantial change dropping out of the model. In other words, consistent with the present model, only activity based well-being change lasted; circumstance based happiness change did not.

Sheldon and Lybomirsky (2004) randomly assigned participants to report on either activity-based positive changes or circumstantially based positive change in their lives. Relative to those in the circumstantial – change group, those in the activity – change group reported a weaker sense of "having gotten used to the change such that it does not give the same boost as before" and more strongly endorsed the statement "the change is something that varies over time, that is something that adds variety to my life" That means the activity changes are characterized by less hedonic adaptation than circumstantial changes.

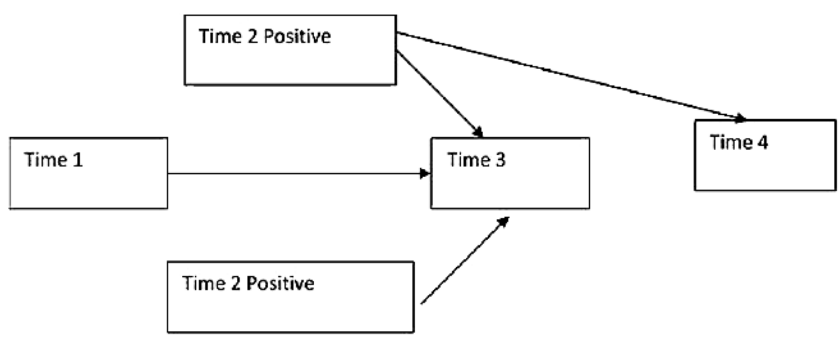
Intentional Activity Is Episodic

One feature of activities is that they are episodic and transient. People cannot spend all their time doing one thing. So, it suggests that individual may adapt less readily to new activities than to new circumstances. The episodic nature of activity also suggests that an additional way maximize the impact of activity. Thus, people should strive to discover the optimal timing for each activity, that is, a frequency of engagement that allows that activity to remain fresh, meaningful, and positive for a person.

Intentional Activity Can Be Varied

Another important parameter of behavioural, cognitive and volitional activities is that people can continually vary them, both in their foci and in the way they engage in them. If the person counting his blessings varies the domains of life in which he or she counts them in relationships, in work, in health, or in most recently successful domain, then the strategy may remain "fresh" and meaningful and work indefinitely. Supporting this notion, past research suggests that people tend to seek variety in

Figure 1. Longitudinal Path Model
Adopted from Lyubomirsky, Sheldon & Schkade (2005) Review of General Psychology, 9 (2), 111-131.



their behaviour, perhaps because change – both in thoughts and actions- is innately pleasurable and stimulating.

Intentional Activity Can Directly Contract Adaptation

Another advantage of intentional activity is that it can directly tackle the problem presented by adaptation. For example, the cognitive practice of pausing to savor the good things in one's life can directly counteract the effects of hedonic adaptation to one's constant circumstances by drawing attention to the features that produced the initial happiness boost and helping to keep them from being taken for granted. For example, practiced mediators frequently report renewed appreciation of the ordinary as a result of their intentional reencounters with the world.

The fact about intentional activity is that it can directly tackle the problem presented by adaptation. It can directly counteract adaptation and hedonic treadmill helps shed further light on the distinction between life circumstances sand intentional activities. The crucial question raised with respect to well-being is whether one exerts intentional effort with respect to the circumstantial category. For example, an individual can engage in a number of intentional activities with respect to the circumstantial category "marriage"; A husband can have the goal of making his marriage work (a volitional activity), he can make the effort to appreciate his wife's positive qualities (an attitudinal activity), and he can try to remember to bring her flowers (a behavioural activity). A person who performs these activities would probably best counteract adaptation to this particular circumstances and derive the most benefit from it. In contrast, a husband who is not intentionally engaged in his marriage, his demographic circumstance would essentially become a background factor. That' why, intentional activity appears to offer the best prospects for increasing and sustaining happiness.

In conclusion, happiness-increasing strategies can be initiated and effectively pursued only with concerted, consistent, commitment and effort.

IMPLEMENTING HAPPINESS-INCREASING STRATEGIES

The strategic issues proceed from the question of how to choose a particular happiness boosting activity to the question of how such activity may be initiated and the question of how the activity can be maintained over time to produce a sustained increase in the chronic level of happiness. The main strategic issues are the role of person activity fit, the role effort, role of habitual activity and the impact of short term versus long term considerations.

Choosing an Activity: The Role of Person Activity Fit

Any repeated activity will not help the person become happier. People have enduring strengths, interests, values, and inclinations that undoubtedly predispose them to benefit more from some strategies than others. For example, extraverts may benefit most from activities that bring them into regular contact with other people, and people high in nurturance motivation may benefit most from activities that afford them opportunities to take care of others. The fit of an activity with a person might be conceptualized in a variety of ways, for example, with respect to individual's motive dispositions, basic needs, core values, signature strengths, personal resources, hedonic profiles, or other individual difference characteristics. There are also a variety of ways that fit might be operationlized, such as in terms of self-reported fit, in terms of consistency between implicit and explicit measures of activity relevant motives, or in terms of informant-rated-person-activity fit.

Role of Effort

Engaging in an activity requires at least two different kinds of effort. First, the effort required initiating the activity and second, the efforts required to carry out and maintain the activity. For example, exercising in the morning, making time to work on at least one important project during the day, or pausing to count one's blessings at the end of the day can have significant benefits, but only if the person can "get off the hurdle" of remembering to do them and overcoming any obstacles to initiating them. This kind of self-regulatory effort requires considerable self-discipline and will-power. In Muraven and Baumesister's (2000) terms, self-regulatory will is like a "muscle" that has limited capacity in each unit of time and must be used strategically to avoid fatigue. Some activities will appear intrinsically more appealing and will be easier to jumpstart which is one advantage of selecting an activity that fits one's personality.

Maintaining an activity is the second type of effort. If an activity is to yield sustained happiness change, the person must keep performing the activity over the long term. For effective happiness - enhancing activities, the task will probably be inherently interesting or rewarding and thus will probably be "autotelic" in nature (Deci & Ryan, 2000). That is self-reinforcing and self-sustaining. The person always shifts attention among several projects at work, explores new trials in the state park etc. This is known as "flow" experiences (Csikszentmihalyi, 1990).

By emphasizing the importance of one's intentional activity, it does not mean to imply that people should seek out only "fun" activities. Sometimes choosing to endure boring or even aversive experiences in the short term can have considerable positive effects on chronic happiness in the long run. For example, a naval officer candidate is playing a short-term cost to receive a longer-term benefit (a career as an officer).

Role of Habitual Activity

Habits appear to present a conundrum for our model. We assume that hedonic adaptation occurs only with respect to particular experiences, and not with respect to the decisions that give rise to those experiences. Thus, making a habit out of deciding to initiate an activity is not problematic but may instead help people to keep getting "over the hump". Sometimes it is problematic when people make a habit out of how they implement the activity. When this happens, the flow experience produced by such a habit is likely to remain relatively constant.

Impact of Short-Term vs. Long-Term Considerations

We assume that happiness originates from two sources. First, people make global well-being judgments in part regarding emotions associated with their recent experiences (Kahneman, 1999). If they can recall number of recent affectively positive experiences, then they report being very happy (Sheldon & Elliot, 1999).

Accumulations of need-satisfying daily experiences over time (such as competence, relatedness, and autonomy; Deci & Rayn, 2000) lead to enhanced global well-being at the end of that time. Furthermore, Sheldon and Lyubominsky (2004) found, in their comparison of the sustained effect of circumstantial changes and activity changes on changes in well-being among students, that the more enduring activity-based effects on happiness were mediated by the greater feelings of competence and relatedness associated with activity changes during the semester.

It is meaningful and important to pursue happiness and it is also crucial to find out how this can be accomplished. Simply, happiness seekers might be advised to find new activities that fit their values and interests. They should make a habit out of initiating the activity while at the same time varying their focus and timing in terms of the way they implement the activity. People might be advised to avoid basing their happiness on the acquisition of particular circumstances or objects because they will tend to habituate to such stable factors. Again, one can deter, or delay, such adaptation to positive circumstantial changes by engaging in intentional effort and activity with respect to them. Only life changes involving intentional activity can be expected to lead to sustainable changes in well-being.

In sum, happiness-increasing strategies can be initiated and effectively provided with consistent, commitment and effort. In addition to the construct of intentional activity, another framework that has been developed in the context of employee happiness involves the model of flow experiences.

THEORETICAL FRAMEWORKS

The purpose of our paper is to find out a series of human resource management policies and practices to improve wellbeing of employees who work in project based organizations, which is a neglected research topic in the field of project management. To achieve the research purpose, firstly we review related theories to explain employee wellbeing and project based organization.

While a number of factors have been identified as correlates of subjective well-being a basic research gap exists with respect to specific theoretical framework. Of course, a few researchers have directed their alternation to integrate empirical findings with the help of a theoretical construct. Although all the diverse findings cannot be accommodated within the scope of a single theory, their relative relevance requires a close examination. Psychological theories related to happiness are telic theories, pleasure and pain, activity theories, top-down versus bottom-up theories, associationistic theories and judgment theories.

Telic Theories

Telic or endpoint theories of subjective wellbeing maintain that happiness is gained when some state, such as goal or need, is reached. One theoretical postulate offered by Wilson (1960) is that the "…satisfaction of needs causes happiness and conversely, the persistence of unfulfilled needs causes unhappiness…"

Alternatively, the theories derive from different origins of the striving. In need theories, there are certain inborn or learned needs that the person seeks to fulfill. The person may or may not be aware of these needs. Nevertheless, it is postulated that happiness will follow from their fulfillment. In contrast, goal theories are based on specific desires of which the person is aware. The person is consciously seeking certain goals, and happiness results when they are reached (Michalos, 1980). Goal and needs are related in that underlying needs may lead to specific goals. Needs may be universal, such as those postulated by Maslow (1954) or they may differ markedly from individual to individual such as those proposed by Murray (1938).

Goals and desires are usually thought of as more conscious than needs. Most individuals had the experience of feeling happy when they achieve some important goal. However, a key question is whether goal fulfillment leads to long-term differences in SWB between persons rather than just short-term mood elevations.

According to telic approaches, there are several things that can interfere with SBW. First, individuals may desire goals that bring short-term happiness but have long-term consequences that are deleterious to happiness because they interfere with other goals. Second, people's goal and desires may be in conflict and thus it is impossible to satisfy them fully. Third, individuals could be bereft of happiness because they had no goals or desires. Finally, people may be unable to gain their goals because of poor conditions or skills.

There are several shortcomings to the current telic approaches. They have rarely been formulated in a clear way and then tested. Many of these approaches are not falsifiable. Needs or goals are sometimes described in a circular way, depending on the observations. Clear measures of needs and goals are needed and longitudinal methodologies would help indicate whether achieving the goals actually heightens SBW.

Pleasure and Pain

The idea that gaining goals or needs leads to happiness raises a theme that is pleasure and pain are intimately related. An individual only has goals or needs to the extent that something is missing in that person's life. One assumption in these approaches is that the greater the deprivation (and hence unhappiness), the greater the joy upon achieving the goal. According to the present formulation, if an individual's desire and goals are totally fulfilled, it may be impossible to achieve great happiness.

Another theory that suggests pleasures and pains are intimately connected is the opponent process theory of Solomon (1980). According to this formulation, the loss of something good leads to unhappiness and the loss of something bad lead to happiness. In addition, specific predictions are made about the magnitude of affect. A person will habituate to a good or bad object and thus it will bring happiness or unhappiness with repeated exposure. However, the crucial component of the theory is that opposing affect when the object is lost will be greatest after habituation. This is an addiction type of model which states that with repeated exposure, good items lose their power to produce happiness, but after repeated exposure their loss will produce unhappiness. Initial studies on this theory of happiness have not been supportive (Sandvik & Diener, 1983).

Activity Theories

Activity theories maintain that happiness is a by-product of human activity. Aristotle was a major proponent of one of the earliest and most important activity theories. He maintained that happiness comes about through virtuous activity, that is, from activity that is performed well. According to Aristotle's theory, there are certain human abilities and happiness arises when these are performed in an excellent manner. In contrast, activity theory in modern gerontology refers to activity in more global terms. For example, hobbies, social interaction and exercise are all considered to be activities.

One frequent theme in activity theories is that self-awareness will decrease happiness and there is some empirical evidence for this (Csikszentmihalyi & Figurski, 1982). This is consonant with the popular idea that concentrating on gaining happiness may be self-defeating. According to this approach, one should concentrate on important activities and goals and happiness will come as an unintended byproduct. These ideas have not yet been rigorously formulated or empirically tested.

The most explicit formulation about activity and SWB is the theory of flow (Csikszentmihalyi, 1975). Activities are seen as pleasurable when the challenge is matched to the person's skill level. If an activity is too easy, boredom will develop; if it is too difficult, anxiety will result. When a person is involved in an activity that demands intense concentration and in which the person's skills and the challenge of the task are roughly equal, a pleasurable flow experience will result. Surgery and mountain climbing are offered as prototypes of this pleasurable experience. Unlike goal theorists, activity theorists propose that happiness arises from behavior rather than from achieving endpoints. However, the two ideas are not necessarily incompatible and thus could possibly be integrated.

Top-Down vs. Bottom-Up Theories

Bottom-up theories maintained that happiness is simply the sum of many small pleasures. According to this view, when a person judges whether his or her life is happy, some mental calculation is used to sum the momentary pleasures and pain. A happy life in this view is merely an accumulation of happy moments. In contrast, the top-down approach assumes that there is a global propensity to experience things in a positive way and this propensity influences the momentary interactions an individual has with the world. In other words, a person enjoys pleasure because he or she is happy, not vice versa. In the top-down approach to happiness, global features of personality are thought to influence the way a person reacts to events. For example, a person with a sanguine temperament might interpret a large number of events as positive.

Associationistic Theories

Many theories are based on memory, conditioning or cognitive principles that can be subsumed under the broad rubric of associationistic models. Cognitive approaches to happiness are in their infancy. One cognitive approach rests on the attributions people make about the events happening to them (Schwarz & Clore, 1983). It might be, for example, that good events bring the most happiness if they are attributed to internal stable factors. Another possibility is that events that are perceived as good lead to happiness, regardless of the attributions made.

One general cognitive approach to happiness has to do with associative networks in memory. Bower (1981) has shown that people will recall memories that are affectively congruent with their current emotional state. Research on memory networks suggests that persons could develop a rich network of positive associations and a more limited and isolated network of negative ones. In such persons, more events or ideas would be happy ideas and affect. Thus, a person with such a predominantly positive network would be predisposed to react to more events in a positive way.

A related type of theory is based on a classically conditioned elicitation of affect. Research has shown that affective conditioning can be extremely resistant to extinction. Thus, happy persons might be those who have had very positive affective experiences associated with a large number of frequent everyday stimuli. Zajonc's (1980) contention that affective reactions occur independently or / and more rapidly than cognitive evaluation of stimuli is compatible with a conditioning approach to happiness.

There is some evidence that a person can give conscious direction to the affective associations in his or her life. Fordyce (1977) offered evidence that a conscious attempt to reduce negative thoughts can increase happiness. Kammann (1982) found that reciting positive statements in the morning leads to a happier day. Goodhart (in press) has found that positive thinking similar to that recommended by Norman Peale is correlated with SWB. Thus, explicit conscious attempts to avoid thoughts and to think of happy ones may to some extent increase happiness.

Certain individuals may have built up a strong network of positive associations and learned to react habitually in positive ways. These individuals are characterized as possessing a happy temperament. A person with a Pollyanna approach to life is perhaps the prototype of a person who has formed positive associations to the world. Several studies have found a relationship between happiness, a cognitive bias towards positive associations and high Pollyanna personality scores.

Judgment Theories

Judgment theories maintained that happiness results from a comparison between some standard and actual conditions. If actual conditions exceed the standard, happiness will result. In the case of satisfaction, such comparisons may be conscious. However, in the case of affect, comparison with a standard may occur in a nonconscious way. Although judgment theories usually do not predict what events will be positive or negative, they do help to predict the magnitude of affect that events will produce.

In social comparison theories, proximal others are usually weighted heavily because of their salience. Will (1981) showed that downward comparison with less fortunate persons can increase SWB. Kearl (1981-1982) found that believing others live in poor circumstances can enhance one's life satisfaction. Easterlin (1974) argued that the amount of income that will satisfy people depends on the income of others in their society. One shortcoming to social comparison theories is that they do not make clear when a person will need to make comparisons with others..

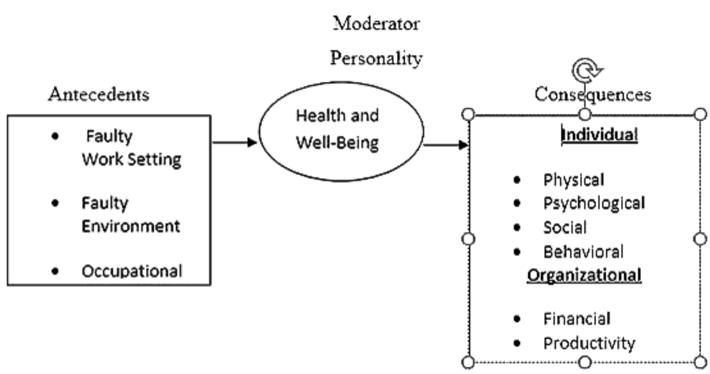
One popular form of judgment theory is aspiration level, which maintains that happiness will depend on the discrepancy in a person's life between actual conditions and aspiration

The concept of well-being is the broader and more encompassing construct. Specifically, well-being is viewed as comprising the various life/non-work satisfactions enjoyed by individuals (satisfaction with self, family life, social life, recreation, spirituality, and so forth), work/job-related satisfactions, and general (psychological) well-being. General health/well-being is a state of equilibrium at the physical, mental, social and spiritual domains (World Health Organization).

The Wellness Councils of America (WELCOA, n. d.) reports that 81% of companies with over 50 employees have implemented at least some kind of health promotion program. These programs range from comprehensive wellbeing programs to smoking cessation, back care programs, stress management, exercise, and nutrition programs. For some companies, over half of the company profits are spent toward employee health care expenses.

At the operational level, behavioral scientists have stressed three aspects of the construct definition. First, well-being includes total life satisfaction. It provides an overall assessment of person's subjective well-being. Second, well-being denotes "feel good" component. Majority of Psychologists view that frequent experience of moderately positive affects (emotion) is a more reliable indicator of well-being compared with infrequent experience of strong positive emotions. Third, satisfaction in several domains of life (such as work, family, social relation, and so forth) is also an essential component. A comprehensive measure includes an integrated composite index of these three components.

Figure 2. An organizing framework or model



MEASUREMENTS

Well-being is not a unitary construct. There are several components of subjective well-being (SWB): life satisfaction (global judgment of one's life), satisfaction with important domains (e.g., work satisfaction), positive affect (experiencing many pleasant emotions and moods), and low levels of negative affect (experiencing few unpleasant emotions and moods).

In early research on well-being, researchers studied only a single self-report item for measurement. For example, Andrews and Withey (1976) asked participants about the feeling of life as a whole on 7-point scale ranging from delighted to terrible. Current measure of well-being includes multiple items. For example, the *PANAS (Positive and Negative Affect Scale)* assesses both positive and negative affect, each with ten affect items. The gap score between positive affect experience ratings and negative affect experience rating is indicative of wellness or illness.

In the past, researchers have used additional types of assessment to obtain a better gauge of long-term feelings. One such measure in *Experience Sampling Method (ESP).* Considering the view that one-time self-report life satisfaction scale is inadequate, ESM measures life satisfaction and memories of positive and negative life events.

On the basis of World Value Survey –II (World Value Survey Group, 1994) three components of well-being have been recognized: life satisfaction, pleasant affect, and unpleasant affect. The life satisfaction score is based on respondents' answers to the question: "all things considered, how satisfied you are with your life these days?" This was used with the help of number from 1 (dissatisfied) to 10 (satisfied). Later many researchers have adopted this format, but have usually included multi-item scales.

Other physiological measures, reports by informants, memory and reaction time measures are included in order to make measurement complete. Though each of these measures has its limitations, the merits of different kinds of measures are complementary to each other. For example, in the memory measure, participants are asked to generate as many positive and negative events from their lives as they can during a short span of time. With the help of this method, researchers can measure individual difference in the relative accessibility of memories for good and bad events and structure of respondent's recall of their lives.

Diener argues that the frequency count of intense positive emotion is not proper indication of well-being. He viewed that how much of the time a person experiences well-being is a better predictor than positive emotional intensity of how happy the person reports being. Intense positive moments are rare even among the happiest individuals. Instead, happy individuals report mild-to-moderate pleasant emotions most of the time whether they are alone or with others, at work or in free time.

Few other researcher view quality of life (QOL) is an aggregate of objective and subjective components. Each component is divided into 7 domains:

1. **Material Well-Being:** Measured by income, quality of house and possessions
2. **Health:** Measured by number of disabilities and medical consumptions
3. **Productivity:** Measured by activities in work, education and leisure
4. **Intimacy:** Contact with close friends, availability of support
5. **Safety:** Perceived safety of home, quality of sleep, worries
6. **Place in Community:** Social activities, responsibilities, being asked for advice
7. **Emotional Well-Being:** Opportunely to do/have things wanted, enjoyment of life

Overall QOL is measured by using a point system. Objective QOL uses simple scores and subjective QOL uses satisfaction with domains. Finally, all these scores are added. But limitations of these remain as sum scores fail to give justice to the functional relationships between qualities of life. The value of environmental opportunities depends on personal capabilities. When human capacities fit environmental demands, these needs are satisfied. This manifests in good mood and a satisfaction with life as a whole. So, well-being is both merits in itself and indicative of good of life chances.

In sum, there are various approaches to measurement. The contemporary researchers are adopting multi-measure approach. For example, Sahoo (2006) has developed a multi-measure technique that comprises mainly three parts. The first part denotes overall life satisfaction (global judgment of total life satisfaction). The second part measures domain- specific satisfaction. The third part determines positive affect experience minus negative affect experience. A composite picture of well-being is derived based on these three interrelated scores.

APPLICATION OF WELLBEING IN HRM RESEARCH

The First Research Challenge in HRM is to establish Link between external and internal fit of the organizations. Then deciding on the model of HRM and determining sources of information. The Second Research Challenge is Measuring Outcomes that includes focus has been mainly on performance or output. In the case of performance, need to distinguish proximal and distal outcomes need to broaden to consider a stakeholder perspective. The third research challenge is to understand and explore the implementation of HRM. There are three elements involve in implementations: extent of implementation, influences on implementation, key actors in implementation. Next, we choose qualitative research type and case study research method to collect data.

Gallup scientists have been exploring the demands of a life well-lived since the mid-20th century. More recently, in partnership with leading economists, psychologists, and other acclaimed scientists, we began to explore the common elements of wellbeing that transcend countries and cultures. So, to construct a comprehensive measure of individual wellbeing, Gallup designed an assessment composed of the best questions we have asked over the last 50 years. Upon completion of the research, five distinct statistical factors emerged. These are the universal elements of wellbeing that differentiate a thriving life from one spent suffering. They describe aspects of our lives that we can do something about and that are important to people in every situation we studied. These elements are the currency of a life that matters. They do not include every nuance of what's important in life, but they do represent five broad categories that are essential to most people.

- The first element is about how you occupy your time or simply liking what you do every day: your Career Wellbeing.

Figure 3. Essential elements of well-being
Source: Rath & Harter, 2010.

- The second element is about having strong relationships and love in your life: your Social Wellbeing.
- The third element is about effectively managing your economic life: your Financial Wellbeing.
- The fourth element is about having good health and enough energy to get things done on a daily basis: your Physical Wellbeing.
- The fifth element is about the sense of engagement you have with the area where you live: your Community Wellbeing.

While 66% of people are doing well in at least one of these areas, just 7% are thriving in all five.

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KEY TERMS AND DEFINITIONS

Design/Methodology/Approach: A summary literature review of the OW literature, focusing on organizational well-being and its possible consequences.

Findings: The literature is used to develop and propose a new model of OW and its success indicators. Testable relationships are proposed between these indicators.

Originality/Value: The model proposed is novel and raises the important issue of appropriate OW success indicators. New propositions are made regarding relationships between antecedents and output variables. This testable model is a valuable resource for researchers. Further, for human resource managers, the model provides a framework for considering what they are aiming to achieve and how they might experience it. Most employees assume wellbeing or happiness is a state of mind. But it is not. There is substantial amount of research to show that the meaning of wellbeing shifts in very systematic ways over the due courses and even throughout the day.

Practical Implications: The paper provides a model that leaders, managers and newcomers may find useful to successfully establish the OW process.

Purpose: The aim of this paper is two aspects: to provide an overview of organizational wellbeing (OW) research; to present a new model of OW focusing on successful outcomes and its operationalization of the construct and the recommendations for future.

Research Limitations/Implications: The research model has not been tested empirically. It is an external representation, is a new and untested concept in the OW literature.

Chapter 11
Six Sigma in Human Resources:
Application in the Domain Function

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ABSTRACT

HR business partner, Business Excellence are some buzzwords in the industry nowadays. Profitability and efficiency are being driven through various strategic initiatives aligned to the vision of the organization. Customer satisfaction is now being replaced by customer delight. Organizations are taking steps ahead of voice of customer. The consumer insights are thoroughly analyzed and interpreted. Data analytics is not restricted to only finance and operation functions but are widely used across the support functions along with line functions. Human resource is now considered as an asset. Organizations are also trying to find out ways to capitalize the full potential of human asset. Various tools and methodologies are paving its way to bring efficient human resource management practices. Six Sigma is one of the tools, which is booming into the application space of Human Resource Management. Six Sigma is being considered as a business process and is helping the in shaping and improving their bottom line by designing and monitoring various activities to reduce the defects.

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SIX SIGMA

HR business partner, Business Excellence are some buzzwords in the industry nowadays. Profitability and efficiency are being driven through various strategic initiatives aligned to the vision of the organization. Customer satisfaction is being replaced by customer delight. Organizations are taking steps ahead of voice of customer. The consumer insights are thoroughly analyzed and interpreted. Data analytics is not restricted to only finance and operation functions but are widely used across the support functions along with line functions. Human resource is now considered as an asset. Organizations are also trying to find out ways to capitalize the full potential of human asset. A most recent human resource ROI has been identified, which is return on intangibles.

Intangible assets are difficult to imitate and thus it becomes a strong competitive advantage of an organization. Metrics enabling the calculation of such intangible asset will provide the organization exact estimation of its competitive advantage in form of intangible assets. The last two decades have seen a shift in the source of market value to intangible assets like human capital, customer capital, brand equity etc. Thus, a situation arises of challenges and opportunities for HR functions. Major challenge is the strategic hiring, and talent management enabling the talent retention in the organization. This also brings a challenge to define talent for an organization. The organization has to decide whom its talent is and where to invest on the talent.

HR function like other line functions forecasts and achieves its target in the form of recruiting expense, turnover, training, employee engagement and compensation.

But unlike most of the functions HR function does not have objective parameters to show its contribution.

In India, there are some models of HR accounting (Sinha & Gahlot, 2000) which were being used in organizations like ONGC, BHEL, SPIC, VSNL. The focus is on the Human capital and not Human resource function. Some of the HR accounting models in the Indian market place are:

- Hermanson’s Adjusted Discounted future wages model
- Likert’s socio-psychological model of Human Resource valuation
- Flamholtz’s Model of Human Resource Valuation: A stock process with service rewards
- Morses model of Human Resource valuation as assets and capitals
- Jaggi and Lau’s model of Human Resource Valuation on career movements of the employees
- Freidman and Lev’s measure for the firm’s investment in Human Resources
- Myers and Flowers’ five-dimensional model of human resource valuation

- Pekin and Organ's model of Human Resource valuation for professional service organizations
- Lev and Schwartz compensation model of Human Resource Valuation

The Lev Schwartz model has been used by Infosys technologies in India. The model is based on the economic concept of human capital. Capital is defined as a source of income over a period of time, and its worst is the present value of future incomes discounted by a certain rate (Lev & Schwartz model).

Economic Value Added (EVA) is another metric used for Human Capital accounting and has a performance perspective that is micro. Essentially, it has a reward and incentive based performance measure. Indian organizations like, TCS, HLL; TVS Motors; Godrej soaps, Satyam computers etc. are implementing Performance based EVA, while, some of the multinationals which are practicing EVA model are Coca cola; Siemens; Bausch and Lomb; Dun and Bradstreet etc. The advantages with EVA are that managers, act, think and behave like owners and there is no ceiling on the kind of investment that they can carry home.

HRD Audit is a method for measuring the effectiveness of the HR function through audit of systems and their functioning. It focusses on Core Competency of the organization and evaluates the commitment of the organization to drive the culture. HR audit addresses issues like top management commitment and involvement to HR processes, aligning the business goals to the individual goals and other aspects like TQM. HRD Audit is essentially a checklist, which is to be ticked off for its presence. The ISO certification also gives an assurance of presence of strong system while the need of HR function now is a tool, which is more scientific, strategic, has rigorous measurement and soft processes. HR Score card finds a challenge in its measurement effectiveness. Hence HR Six Sigma has emerged as a superior tool.

In the 1980s, Motorola developed a methodology for process improvement based on the Scientific Method called Six Sigma. Prior to Motorola's coining of the term "Six Sigma", companies for centuries had experimented with and implemented process improvement strategies. However, it is Motorola that is given credit for designing Six Sigma as a process improvement mechanism because Motorola was the first company to advertise its savings (in the millions) using Six Sigma methodology. Six Sigma's focus is on eliminating statistical variation in a process to strive towards a goal of 3.4 defects per million opportunities (I Six Sigma, n.d.).

In statistical terms, sigma represents the standard deviation; a measure of the variability within a population around the mean. Six Sigma represents the population that falls within +/- six standard deviations from the mean. If you apply Six Sigma to a payroll process for instance, and are calculating the acceptable number of defects allowable per million payroll calculations, then to fall within Six Sigma parameters, there would only be 3.4 defects per million allowed. See Table 1.

Table 1. Sigma level defects per million opportunities

Sigma Level	Defects per Million Opportunities
1	690000
2	308000
3	66800
4	6210
5	230
6	3.4

Dow Chemical's HR resource center saved $3.2 million in financial benefits through Six Sigma implementation (Heuring, 2004). Ford reports more than $ 1 billion saved since 2000, as a result of Six Sigma initiatives. HR practitioners at Ford Europe and Intel have significantly improved their internal processes based on such initiatives (Bhatnagar & Pandey, 2005). Six Sigma denotes the organizational mindset in which people make decisions based on data, look for root causes of problems, define defects based on external or internal customer, and seek to control variation, track leading indicators of problems to prevent them from happening. Six–sigma is organized around individual projects with finite timelines; each project begins by forming the team that identifies the customer needs.

SIX SIGMA IN HR

Six Sigma is one of the tools, which is booming into the application space of Human Resource Management. Six Sigma is being considered as a business process and is helping the in shaping and improving their bottom line by designing and monitoring various activities to reduce the defects and wastage. At any point in time Six Sigma restricts the compromise of voice of customer and consumer insights. It has been a part of the corporate strategy of the organization. Various organization are in strive to bring the six-sigma culture to core DNA of the organization.

Application of Six Sigma in HRM can be viewed in two different aspects. One way is to see the HR function as facilitator of Six Sigma culture across the organization. Organizations formulate strategies for profit and growth. The strategy is driven down through action plans across the organizations. Most strategies fail to get down to the floor level and get lost in the middle layers of management, but HR can help execute the profit and growth strategy through the use of Six Sigma. The HR department interacts with and influences every employee; therefore, it's the department best suited to facilitate management change. HR can integrate the

Six-sigma methodology with balance scorecard to bring out profitability and growth. HR involvement in achieving corporate growth and profitability must be defined. The HR should support leadership and departmental activities provide feedback, and intellectually engage employees in achieving their personal and corporate objectives. HR experts are initially involved in processes and projects within a company. Human resource professionals are able to efficiently identify the critical factors in order to increase employee satisfaction. As a result, the HRD is able to contribute greatly to the company by defining and designing the metrics.

Role of HR in Driving Six Sigma

We have seen various steps that HR can take in order to bring transformation across the organization through Six Sigma. Broadly HR can drive the change by being the change agent.

Selection and Retention of Black Belts

It is very important to understand the role played by professionals in implementation of this powerful tool. According to Mary Federico, Six Sigma has a naming convention for its professionals similar to martial arts. Leaders and Champions usually receive high-level training on the technical aspects of Six Sigma, especially how to lead an initiative. At the "belt" level, each candidate is assigned an initial "training project" that he/she will work on during the formal training period.

Right people in the Black Belt role is critical to the success of Six-sigma initiative. And it becomes important for an organization to invest in the training and development of such people. Black belts are visible "face" of Six Sigma. They encourage and motivate others to be a part of the initiative and drive the change. A competency model can be built for such employees, which will help to identify candidates with the right mix of technical, team, leadership skills and abilities. Upon identification of such candidates comes about the deliverables, clarity of their expectations and expectations out of them. Thus, the job description has to be in line that helps the candidates fully understand the position and expectations prior to signing on.

Retention of black belts are very critical for any organization. Their specialized skills make them valuable in the market hence their ability for being poached also increases. With the focus shifting to data driven style of management these people become valuable in the market and their small number makes it difficult to chase them. So, the retention strategy has to be carefully designed. They should be provided with ample scope of rotation so that organization recoups its investment in training and development.

Rewards and Recognition

Employees driving the six-sigma initiative join the project from various places in the organization. They carry it along with their allotted routine jobs whereas black belts are likely to have leave and join new places. Rewarding and recognizing Black Belts and Six Sigma teams is more complex than it may appear. It is very critical to determine appropriate adjustment in levels and compensation as all these individuals are in the same role. Compensation structure has to be revised in alignment with existing structure and arrangements that will support the Six Sigma initiative. Non-Monetary rewards can be designed and brought into existence. However, the when it comes to Sales force non-monetary rewards have to be reviewed.

Project Team Effectiveness

Six Sigma projects are usually driven by a project leader who is a black belt and team members who are green belts. They follow the methodology of DMAIC. HR can improve the effectiveness of such team by ensuring the adequate training on "coaching and mentoring" for the black belt, "conflict management, communication, dealing with difficult team members" to the team members.

Creating a Six Sigma Culture

Many Sponsors, Champions and Leaders look to Six Sigma as a way to change an organization culture to one that is more based on data, proactive, decisive, and customer oriented. But they have no experience to initiate this change. HR professionals can help these executives approach a culture change to achieve goals without creating organizational resistance. HR professionals can work to identify elements of the culture that might hinder the achievement of Six Sigma goals. Different cultural elements need specific set of action plan for their acceptance and implementation. Thus HR can find such elements and suggest the necessary action plans.

Change Management and Communication

Introduction of Six Sigma brings uncertainty to the current system and anxiety among the employees. Various stakeholders are observed to have new behavior towards it. Some view it as competitive edge, while some view it as a source attention of senior management and organizational power. Some view it as indictment of past performance while some are still confused about how Six Sigma fits with large number of other ongoing organizational initiatives. HR professionals can help to bring clarity in such circumstances. They can draft a change management communication plan and address the people issues of such initiatives. They can create a "Case for Change", including reasons for Six Sigma and its benefit. They can provide counselling to the professionals about their behavior and its impact. HR professionals shall be champions in making change happen by owning the change process, customising the change model and guiding the business through the change process. HR professionals as change agents, helping their businesses to meet new objectives should consider taking the following steps:

1. Identify key success factors for building capacity for change
2. Provide the extent to which these key success factors are being managed
3. Identify the improvement activities for each success factor
4. See the review of the key factors as an iterative process, not an event
5. Thus, HR can help the organization digest the change named as Six Sigma

Driving Six Sigma in HR Function

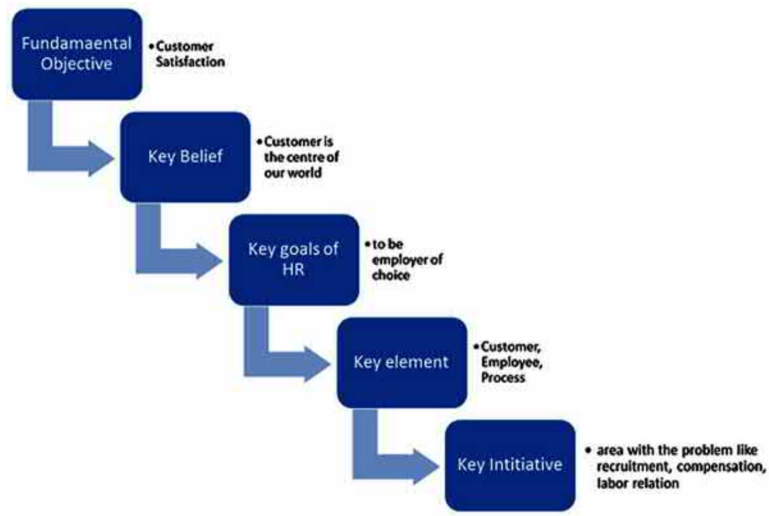
HR has been a support function essentially a cost center with an internal focus. Six Sigma can assist in identifying areas that have an impact on the external customer. These projects may concentrate on such aspects as leadership selection and training, enabling employees to focus on the external customer by decreasing their non-value-added time, and organizational development to promote an effective Six Sigma culture. When reviewing human resources function of an organization, it becomes clear that a number of business processes have an impact on the effectiveness of employee efforts in delivering services or products to customers. An effective HR organization can balance the financial needs of the company while attracting and retaining the most appropriate personal to become part of the organization.

HR can implement Six Sigma in its day to day process. Right from defining its objectives to getting feedback and taking proactive action for customer satisfaction, HR department can use this tool to the maximum benefit. The various steps that are followed by HR function for implementation of Six Sigma are lined below.

Voice of Business

Any industry attributes its existence and profit to the customer and they are the driving power of any business. The approach to drive the function can be characterized as customer-focused with the right skill sets and technical knowledge to interact directly with the target customer's organization in order to develop relationships and business insight. Senior Management plays a leading role and personally makes direct customer contacts, spending time with customers and also follow-up during industry conferences and seminars. Combination of approaches to listen to and

Figure 1.



learn from customer through various touch points and are to be well coordinated to ensure quick response and customization, matching the end-usages. Thus, it is all about listening to the customers. HR function should have clear roadmap of the methods of listening to its customers. They can identify various stages to listen the customers like If a policy is going to be executed, then pre- implementation stage, execution stage, post execution stage then understanding the customer by listening to them. They can also identify various channels through which they will listen the customers and point the actionable information. These initiatives to listen to the customer can be done periodically and the frequency can be mentioned.

With the increasing cost of raw materials and Labor, to remain competitive in the market, the cost of production has to be reduced. Hiring cost of middle management and senior management contributes a significant amount to the Cost of Production as admin and overhead expenses. In order to reduce the admin cost the hiring cycle has to be optimized.

Key Process Issue

In any business there can be many blind spots and points of failures but few of them contribute to the maximum loss. The Pareto principle (also known as the 80/20 rule, the law of the vital few, or the principle of factor sparsity) states that, for many events, roughly 80% of the effects come from 20% of the causes. When reviewing human resources of organization, it becomes clear that a number of business processes have an impact on the effectiveness of employee efforts in delivering services or products to customers. An effective HR organization can balance the financial needs of the company while attracting and retaining the most appropriate personal to become part of the organization. HR can look into its various functional divisions like compensation and benefits, labor relations, organizational development, etc., where they need to assess critically the key issues of processes. For example, Hiring Cost of General Managers in 36 Business units contribute to 20% of admin expenses. The hiring cycle has to be optimized by process improvement and right hiring. This can be the key process issue of talent acquisition team. Hiring cycle and Cost of hiring are the business effects slowing down the effectiveness of the customer as well as increasing the cost of production for business.

To identify the key Process issue a though data analysis and brainstorming session has to be conducted. It is important to involve the senior management team in this process. It boosts of the morale and brings confidence among the team driving the process.

Voice of Customer

The "voice of the customer" is a process used to capture the requirements/feedback from the customer (internal or external) to provide the customers with the best in class service/product quality. This process is all about being proactive and constantly innovative to capture the changing requirements of the customers with time. The "voice of the customer" is the term used to describe the stated and unstated needs or requirements of the customer. The voice of the customer can be captured in a variety of ways: Direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, complaint logs, etc. This data is used to identify the quality attributes needed for a supplied component or material to incorporate in the process or product.

Listening to Current Customers

The approach to marketing can be characterized as customer-focused with the right skill sets and technical knowledge to interact directly with the target customer's organization in order to develop relationships and business insight. Senior Management plays a leading role and personally makes direct customer contacts, spend time with customers and also follow-up during industry conferences and seminars. Organisation should use a combination of approaches to listen to and learn from customer through various touch points and are well coordinated to ensure quick response and customization, matching the end-usages. It should maintain close contact and relations with them. Various listening methods across the Customer engagement and life cycle stages for all products & segments are shown in Table 2.

Table 2. Listening methods

Engagement Stages	Listening Methods	Frequency	Actionable Information
Pre-Sales	"Top-to-Top" meetings with each key customer account	Quarterly visits by CEO/CFO and Senior Management	Understand long term plans/ goals and high-level issues/concerns
	Customer Visits	Customer Contact Visit Plan	Understanding Quality, Price, Delivery needs, enquiry responses
	Joint volume planning meetings	Annual	Volume planning and future projections (MOU)
During Execution	Customer Visits	As and when required	Contract Progress Review
Post-Sales	Customer Visits	Continuous	Understanding our product usage and performance
	Complaint Resolution	As and when received	Addressing the concerns & resolution of complaints/ grievances
	Customer Satisfaction and Dissatisfaction	Yearly	Process based and competitive ratings, Feedback/ Suggestions
Common to all Stages & Segments	Company website and web-mails, e-mails, telephone, fax	As and when required	Enquiries, suggestions and feedback from customers, Updates on enquiries/orders, production/ deliveries
	Aluminum Association of India	Yearly	Development of Industries using Aluminum and increment of Aluminum Consumption in India

Listening to Potential Customers

Organisation should ensure regular customer visits at various forums to obtain information from potential and prospective customers, pertaining to product, service and delivery requirements, competitive factors, strategic direction, future requirements and relative importance of purchasing decisions resulting in value-sharing opportunities. There is a lot of emphasis during prospective customer visit to understand key differences in their current buying pattern, technical requirements, financial requirements etc. which is then deliberated internally to provide them time, place and product utility.

Customer Satisfaction and Engagement

Organisation should conduct customer satisfaction survey once in two years by third party with emphasis on product, services and customer focus. Efforts are made to capture perception and feedback of all the customers on SSL Jharsuguda contract performance. Feedback from customers are taken on yearly basis. Customer feedback process, aims to:

- Measure and monitor customer satisfaction
- Obtain regular feedback from customers on business performances
- Understand the importance of various factors governing customer relationship
- Help us monitor our processes and continually improve process

Customer Dissatisfaction

Organization should measure customer dissatisfaction by gathering information on customers who may have tried our products and then not purchased it again. Various causes of dissatisfaction, methods of measurement are as below:

- Few Examples of VOC in HR Function:
  - Minimum Vacant Manhours
  - Higher Retention rate of Middle Management

Figure 2. Feedback process

Figure 3. Customer dissatisfaction

Causes of Dissatisfaction	Forum/Method to obtain Feedback
Quality Issues	Complaints, Service Level Agreement, Formal meetings, Feedback survey
Logistics	Communication through telephone, e-mails and visits
Responsiveness	Feedback survey, Communication through telephone, e-mails

- Trained Hires
- Lower Turnover rate
- Increased Employee engagement activities
- Automated Performance Management system

Critical to Quality

TQs are the internal critical quality parameters that relate to the wants and needs of the customer. They are not the same as CTCs (Critical to Customer), and the two are often confused. CTCs are what is important to the customer; CTQs are what's important to the quality of the process or service to ensure the things that are important to the customer.

A quality function deployment (QFD) or CTQ tree relates the CTQs to the CTCs. For instance, car door sound when closing might be a CTC, while the dimensional tolerances and cushioning needed to produce those conditions are CTQs for the automaker.

- Few examples from HR function:
  - Minimum Vacant Manhours
  - Higher Retention rate of Middle Management
  - Lower Turnover rate

Problem Statement

Upon identification of the CTQ parameters now it's the time to identify the problem statement. This statement answers the question of why we are doing this project. It addresses the gains of project and its effect on business. It's a very important part of the project charter. It's a very simple statement which talks about the problem and benchmarks it's against the target. It charts out the benefits exclusively.

For Example: Minimum Vacant Man-hours- Improving the Hiring Cycle

SIX SIGMA METHODOLOGY

Define Phase

During the define phase of a Lean Six Sigma project, a work unit would decide which process to focus on to define the scope of the project. The define phase focuses on the scope of the project and uses tools such as voice of the customer, brainstorming and value stream mapping. Brainstorming is used to determine which processes to focus on improving. The voice of the customer should drive the process of deciding what to work on first. Once a process has been identified, value stream mapping consists of listing the steps of the process in order and assigning a time to each step of the process. This is especially useful when trying to improve service processes, where timeliness is generally a key metric. A value stream map can also make it easier to determine where bottlenecks exist in the process (periods of waiting that hold up the process), and it provides a visual for a project team to develop a list of quick hit items where the solution is obvious. Once the scope of the project is defined, the project team is refined to ensure that all sides of the process have a voice – those responsible for day-to-day tasks, customers, management and representatives from any departments that might be effected by the change. HR is involved in the project planning process from the beginning, so that knowledge of the integration of different departments within the company can be a huge asset during the team selection process. The project team then sets goals and time limits for the project. Goals should be measurable, Process Improvement, Human Resources and Lean Six Sigma 6 attainable, verifiable and realistic. Project timelines can be anywhere from two weeks to six months, depending on the scope and the frequency of the information. A baseline chart representing something that can be measured in the current state of the process is also created. The baseline is established prior to making any changes to the process.

The various stages of the define phase are

1. VOC/VOB Analysis
2. Project Charter
3. Process Map (Level 1)
4. SIPOC
5. Stakeholder Analysis

Cost-Benefit Calculation

Cost benefit analysis is a systematic approach to estimate strength and weaknesses of the project. In CBA, cost and benefits are expressed in monetary terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their net present value. CBA has two main purposes:

- To determine if an investment/decision is sound (justification/feasibility) – verifying whether its benefits outweigh the costs, and by how much;
- To provide a basis for comparing projects – which involves comparing the total expected cost of each option against its total expected benefits.

Figure 4. What is there for us in the project?

	Loss if project is not done	Gain if project is done
Short term	Lot of effort will be put in which may or may not give desired results	Knowledge will be gained
Long Term	Personal growth will be stalled	Work will be easier

The cost benefit calculation has to be carried on the project and can be approved by the finance departments. It gives a financial dimension to the project and management is transparent about the loss and gain out of the project. This calculation gives the information on the cash flow out of the project and hence can boost the potential of the project. Both direct and indirect cost involved in the project should be included in the calculation. An example is provided in Table 3.

SIPOC

The Supplier, Input, Process, Output, Customer diagram gives a clear understanding of the various agents involved in the project. A SIPOC diagram is a tool used by

Table 3. Financial benefit calculation for reducing a hiring cycle

Item	Qty	UOM
No of Days required for Hiring	40	Days
After improvement	35	Days
Days Saved	5	Days
Cost of Hiring per days	100000	Rs
Cost of Hiring days (saved)	500000	Rs
No of Hiring Cycles in year	12	Nos.
Total amount saved	6000000	Rs

a team to identify all relevant elements of a process improvement project before work begins. It helps define a complex project that may not be well scoped, and is typically employed at the Measure phase of the Six Sigma DMAIC (Define, Measure, Analyze, Improve, Control) methodology. It is similar and related to process mapping and 'in/out of scope' tools, but provides additional detail.

The tool name prompts the team to consider the suppliers (the 's' in SIPOC) of your process, the inputs (the 'i') to the process, the process (the 'p') your team is improving, the outputs (the 'o') of the process, and the customers (the 'c') that receive the process outputs. In some cases, requirements of the customers can be appended to the end of the SIPOC for further detail.

The SIPOC tool is particularly useful when it is not clear:

- Who supplies inputs to the process?
- What specifications are placed on the inputs?
- Who are the true customers of the process?
- What are the requirements of the customers?

Process Mapping

The process mapping gives a detailed view of the process which helps in identifying the steps of process which are leading to the problem identified. Business process mapping refers to activities involved in defining what a business entity does, who is responsible, to what standard a business process should be completed, and how the success of a business process can be determined. The main purpose behind business process mapping is to assist organizations in becoming more effective. A clear and detailed business process map or diagram allows outside firms to come in and look at whether or not improvements can be made to the current process. Business process mapping takes a specific objective and helps to measure and compare that objective alongside the entire organization's objectives to make sure that all processes are aligned with the company's values and capabilities.

Figure 5.

The Major Steps of Process Improvement Using Process Mapping

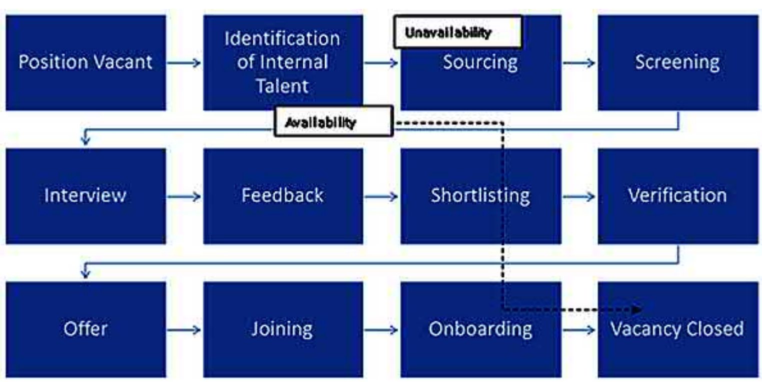
1. **Process Identification:** Identify objectives, scope, players and work areas.
2. **Information Gathering:** Gather process facts (what, who, where, when) from the people who do the work.
3. **Process Mapping:** Convert facts into a process map.
4. **Analysis:** Work through the map, challenging each step (what-why?, who-why?, where-why?, when-why?, how-why?)
5. **Develop/Install New Methods:** Eliminate unnecessary work, combine steps, rearrange steps, add new steps where necessary
6. **Manage Process:** Maintain process map in library, review routinely, and monitor process for changes

Measure Phase

Measure Phase is a stage of double check. The system selected is measure again and tested for its validity and integrity. The double check can be a manual process, or could be another computer system through which information is gathered. This double check is important because it shows management that the information gathered is consistent and reliable. This is especially important if you are attaching savings to that information.

In this stage in DMAIC model, the various parameters that are critical to quality and critical to process are listed out. Then data collection starts on the processes and sub processes. For example, while measuring the hiring cycle the whole hiring cycle across the months is important and the data for each hiring done in the last

Figure 6.



twelve months is also required. While measuring single hiring cycle, the time spent in each sub process like sourcing, screening, interview, feedback is recorded.

Data Collection

Data collection takes time from operators and management and can be viewed as a burden. Finding the balance to get as much information as possible that is proven reliable while not consuming excessive resources is key to success in this phase.

This data collection will often encounter resistance and can lead to gatherings taking the easier route and rounding off numbers, or otherwise skewing and creating inaccuracies. Education, awareness, rule setting, and up-front discussion with all stakeholders (not just team members) is ideal to get the most cooperation and validity in data collection. A model of data collection for hiring cycle is shown in Tables 4 and 5.

Table 4. Hiring cycle per month (2015-2016)

Months	Requirement Raised	Hiring Cycle
Jan	2	85
Feb	3	56
Mar	0	0
Apr	1	62
May	0	0
Jun	1	60
Jul	0	0
Aug	2	80
Sep	0	0
Oct	1	48
Nov	3	65
Dec	2	**35**
Jan	1	49
Feb	0	0
Mar	1	64
Average	**1**	**40**

Current Hiring Cycle- 40 days
Last Year Best – 35 Days
Target- 35 days

Table 5. Stages of hiring cycle

Employee Hire Serial	Sourcing	Screening	Interview	Feedback	Shortlisting	Verification	Offer	Joining	Onboarding	Hiring Cycle
1	6	12	10	1	2	15	5	3	30	84
2	3	10	5	1	2	10	2	2	30	65
3	1	0.5	0.25	0.25	0.5	1	1	0.5	30	35
4	4	8	2	1	1	1	1	1	30	49
5	3	8	2	1	1	1	1	1	30	48
6	1	0.5	0.25	0.25	0.5	15	5	3	30	55.5
7	3	9	5	1	2	10	2	2	30	64
8	1	7	5	1	2	10	2	2	30	60
9	4	10	10	1	2	15	5	3	30	80
10	1	0.5	0.25	0.25	0.5	15	5	3	30	55.5
11	1	0.5	0.25	0.25	0.5	1	1	0.5	30	35
12	1	7	5	1	2	10	2	2	30	60
BEST	1	0.5	0.25	0.25	0.5	1	1	0.5	30	35

Measurement System Analysis

Measurement system analysis (MSA) is an objective method to assess the validity of a measurement system and minimize the factors contributing to process variation that is actual stemming from the measurement system.

The first goal of MSA is to quantify the:

- Process variation
- Appraiser variation
- and the Total measurement system variation.

Secondly, minimize the measurement system variation and its impact on the Total Variation so the amount of Process Variation can be understood as precisely as possible.

The following components of measurement error need to be studied and quantified before establishing process capability and making decisions from the data.

- Accuracy / Bias
- Resolution / Discrimination
- Linearity
- Stability
- Repeatability & Reproducibility (Gage R&R)

The MSA is often a very time consuming component of the project and can slow the team's quick progression through the process.

Continue to focus on low hanging fruit that may be momentum "sustainers" and work vigorously through the MSA process. Most of this work can be done by the GB/BB outside of the team meetings.

Accuracy/Bias

The difference from the true value and the value from the measurement system. Accuracy represents the closeness to a defined target. Precision is different than accuracy and is covered in Gage R&R under Repeatability.

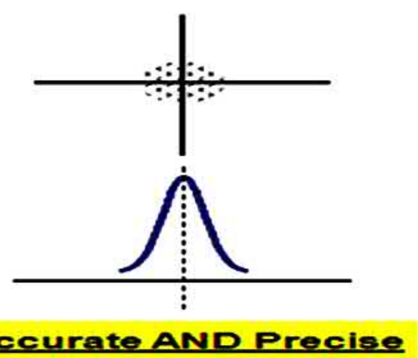
For best accuracy of the data:

1. Accept all data as it is collected. Assigning special cause and scrutinizing data comes later.
2. Record the data at the time it occurs.
3. Avoid rounding off the data (rounding can create resolution problems).
4. On the data collection plan, record as many details around the data such as the exact source, machine, operator, conditions, collector's name, material, gage, and time. Record legibly and carefully.

The data should be screened for misplaced decimal points, duplicate data entries by mistake or improper recording procedure, missing date points if frequency is important, and other obvious non-representative data.

5. Verify the gage is accurate. If using a weigh scale, verify it with a known and calibrated weight. Use gage blocks for calipers or micrometers. Use hardness blocks to verify hardness testers.

Figure 7.



Resolution/Discrimination

The goal is to have at least 5 distinct values or categories of readings.

Adhere to the 10-bucket rule. If your measurement system requires measurements to the hundredths (x.xx), then divide that by 10. Collect and record the data to the nearest thousandths (x.xxx). The measurement system shall be sensitive to change and capable of detecting change.

The lack of resolution will not allow a measurement system detect change. If you are measuring the downtime and using measurement to the nearest hour and most downtime is less than an hour then most of the reading will either be a 0 (for 0 hours) or a 1 (for 1 hour).

However, using a stop watch and recording data to the nearest minute will provide 60x more resolution and allow better distribution of data points, more variety of data, with fewer repeat measurements. You could have 60 different readings. Actually, recording the nearest 6 minutes would satisfy the 10-bucket rule, but it is a guide to help ensure resolution in the measurement system. This part of the MSA is usually the easiest to fix such as finding a micrometer, caliper, hardness tester that can capably read to the next nearest decimal.

Linearity

When gathering data only collect with the acceptable limits where there is proven linearity. This is a test to examine the performance of the measurement system throughout the range of measurements. Linearity represents the change in accuracy through the expected operating range of a measurement device.

For example, does the bathroom scale perform the same when weighing a pet of 10 lbs. to a man of 250 lbs.? The scale has an operating range of 0 lbs. to 300 lbs. but the accuracy of the scales may change at various levels of measurement.

Sources of linearity error may come from age, wear, or calibration error, or there may be known linearity error. If there is known error then there may be a calculation to account for it and various ranges of measurement.

Stability

Stability (also referred to as "drift") of a measurement system can be analyzed using control charts. Ensuring the measurements taken by appraiser(s) for the process indicate stability and consistency over time. Each appraiser should measure the same way every time over a long period of time and each appraiser should measure the same way as all the others.

Stability is the total variation (spread and shape of the data distribution) of the measurements using the same parts, measured using the same gauge over a long period of time. SPC Charts use a variety of tests to determine stability. Many software programs will have these as options when analyzing data and will even indicate the point(s) and test that each failed.

Some of the corrective measures once again include Standard Operating Procedures and re-calibration. Sometimes the gauge will have wear from use over a long period and this cannot be repaired or re-calibrated. Other times, there may be a buildup of dirt, dust, or contamination.

Reproducibility

Ability of one appraiser to get the same result and another appraiser or the ability of all appraisers to get the same results AMONG each other.

To optimize reproducibility in ATTRIBUTE Gage R&R:

1. Create visual aids, templates, definitions, or other specific criteria for each to meet a certain rating, value, or appraisal. Pictures of good, bad, in the middle, and colors, will help each appraiser standardize their response, improving the reproducibility.

Note: If these corrective actions are needed to pass the Gage R&R, it should be instituted as a formal work instruction and everyone involved throughout the company or plant should adhere to same instructions.

To optimize reproducibility in VARIABLE Gage R&R:

1. Create a Standard Operating Procedure with visual aids and definitions. When using humanly subjective “touch” devices such as micrometers and calipers it is important that all appraisers “squeeze” the same amount. Too little or much pressure at higher levels of resolution can be enough to alter the Gage R&R.
2. Visual aids also help. When using an optical comparator to get a higher resolute data point there is subjectivity where to place the template or the starting and end point(s) on the shadow. Pictures of acceptable and non-acceptable will help reduce this variation. Templates of complex figures or shapes also help reduce subjectivity and improve R&R.

Repeatability

This describes the ability for an appraiser to repeat his/her measurements each time when analyzing the same part, unit, etc. In destructive testing (such as tensile testing) these reading will not be possible and some statistical software programs have options to select for destructive testing.

The goal is to have an appraiser repeat unit readings at least three times. The person administering the test should randomize the sequence each time to prevent and patterns and bias (the appraiser may remember or try to remember what a measurement was and tend to alter real measurements to get the Gage R&R to pass). It is important for the administrator to record carefully to ensure readings correlate the correct part/unit each time.

Avoid writing down measurements and then typing them into a statistical program. The fewer times measurements are recorded and copied the lower the risk for human error to add even more variation and possibly fail (or pass) the Gage R&R when it shouldn't have.

Precision is the ability to have the same repetitive result (or appraisal in this case). Visually, it means that all your shots of an arrow are very close to one another. It does not mean that they are near the bullseye. In other words, it does not mean that your shots are accurate.

If your shots are accurate and precise, then they are tight circle centered around the target. It is also possible to be accurate without being precise. For example, there may be several shots all around the bullseye (target) but they may be scattered all around it in a large diameter cluster (area).

If you take a look at the group the center (mean) may be on the bullseye but the shots are not in control or precise. In other words, there is a lot of unpredictability or variation. This would represent a set of data with an acceptable mean (on target) but too much variance (high standard deviation).

This is the essence of Six Sigma. The methodology focuses on Variation Reduction as primary goal and then with the inputs under control, the mean can be shifted if it is necessary. It is not possible to shift the mean with sustainability without having process control (control over sources of variation).

ANOVA

Analysis of Variance is another technique to analyze sources of variation of measurement error (and for any sources of variation - hence the name).

With statistical software, the method has the advantage over the "average and range" technique since it provides more information, such as interactions between the parts being measured and appraisers.

The variation can be distinguished between four categories:

1. Appraisers (those that are measuring)
2. Parts or item being measured
3. Interaction of Appraisers and Parts
4. Replication error from the gauge

Analyse Phase

The analyze phase aims at finding the root cause of the undesired quality level. This phase is the beginning of the statistical analysis of the problem. The practical problem was created earlier. This phase statistically reviews the families of variation to determine which significant contributors to the output are. The various tools that can be used to find the root cause are Cause and Effect diagrams, Hypothesis testing, YY analysis etc. The statistical analysis is done beginning with a theory, null hypothesis. The analysis will "fail to reject" or "reject" the theory. Brainstorming sessions with the team can be used to find the factors with potential to make positive changes in the process.

An example is provided in Table 6.

The processes identified for the optimization in first round (in descending order) were

1. Verification
2. Screening
3. Interview

Improve Phase

The goal of the Improve phase is to identify a solution to the problem that the project aims to address. This involves brainstorming potential solutions, selection

Figure 8.

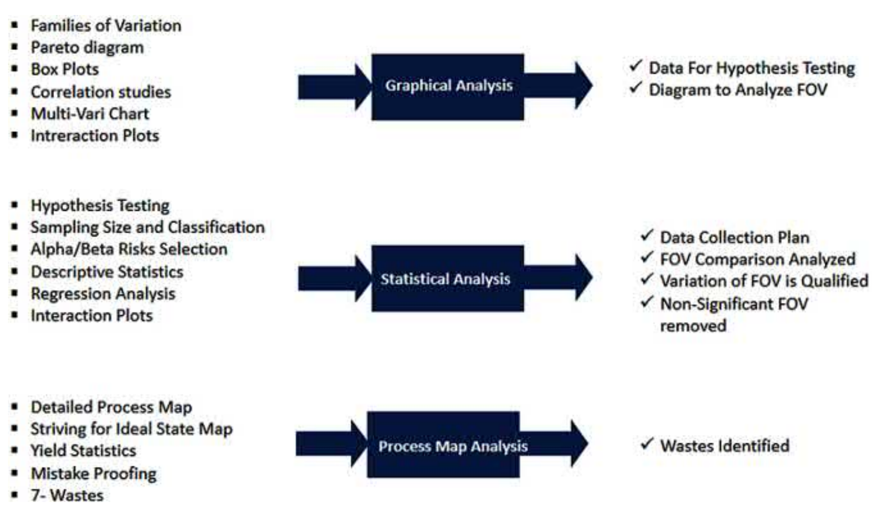


Table 6. Example of analysis of hiring cycle

Employee Hire Serial	Sourcing	Screening	Interview	Feedback	Shortlisting	Verification	Offer	Joining	Onboarding
1	6	12	10	1	2	15	5	3	30
2	3	10	5	1	2	10	2	2	30
3	1	0.5	0.25	0.25	0.5	1	1	0.5	30
4	4	8	2	1	1	1	1	1	30
5	3	8	2	1	1	1	1	1	30
6	1	0.5	0.25	0.25	0.5	15	5	3	30
7	3	9	5	1	2	10	2	2	30
8	1	7	5	1	2	10	2	2	30
9	4	10	10	1	2	15	5	3	30
10	1	0.5	0.25	0.25	0.5	15	5	3	30
11	1	0.5	0.25	0.25	0.5	1	1	0.5	30
12	1	7	5	1	2	10	2	2	30
BEST	1	0.5	0.25	0.25	0.5	1	1	0.5	30
Average	2	6	4	1	1	9	3	2	30
Difference	-1	-6	-4	-1	-1	-8	-2	-1	0

solutions to test and evaluating the results of the implemented solutions. A pilot implementation should be conducted prior to a full-scale rollout of improvements.

Identifying Potential Solutions

In the first stage of Improve it is important to include the people who are involved in performing the process. Their input regarding potential improvements is critical, and this step should not be completed by the project team alone. In fact, it is wise to maintain communication with those who work on the process throughout any Six Sigma quality improvement project.

A variety of techniques are used to brainstorm potential solutions to counter the root cause(s) identified in Analyze. Encouraging participants to challenge rules and assumptions, ban excuses and think like small children can be very effective. For those who prefer a more structured brainstorming exercising, specific techniques are available, but often participants are more than able to produce a substantial list of ideas on their own.

It is important during this stage that ideas not be judged nor eliminated. Even an outlandish idea that couldn't possibly be implemented as first suggested may lead to a related idea that is an ideal solution. Similar to other aspects of a Six Sigma project, assumptions about what can or can not be accomplished should not be accepted without confirmation.

Selecting Solutions to Implement

As in the prior step, it is a good idea to involve the people who work on the process that is being improved, be included in the decisions regarding which potential improvements to implement. With their help, the project team establishes criteria for evaluating the proposed improvements in an objective manner. Criteria usually include time line for implementation, financial cost, the extent to which root causes are likely to be countered and the overall ease of implementation. Some teams consider other factors such is the amount of buy-in that already exists for each possible change.

Implementing Improvements

Planning the implementation is largely a matter of basic project management. The team needs to plan the budget and time line of the implementation, determine roles and responsibilities, and assign and track tasks. Tools for planning include Gantt charts, planning grids and flowcharts. A deployment flowchart can be created for the implementation process itself, as well as for the new process that will be followed as a result of the improvements being implemented.

A data collection plan should be created similar to the one used during Measure, and the same data should be collected. After the data is collected the team will compare the before and after data to determine if the key metrics show improvement.

It is often beneficial to use Failure Modes and Effects Analysis (FMEA) before implementing improvements to identify and address potential problems that may arise using the improved process. With this tool, the team lists risks and potential issues, and estimates the likelihood and severity of each one. Then the most critical are identified and the team establishes a plan for minimizing each risk.

One aspect of implementing improvements that is often overlooked is the impact of change on the people that are involved in and affected by the process. Basic change management procedures should be followed to smooth the way: communication, seeking input, and ensuring the necessary level of commitment from key players.

During the implementation itself, the team should be monitoring the process and act to address any issues that arise. In addition, the data should be reviewed periodically to ensure that appropriate data collection procedures are being followed.

Evaluating Improvements

For some DMAIC projects, it is appropriate to pilot the improvements before proceeding to a full roll out. The most common piloting options include either making changes only in one group or department or making changes for a limited time period. The benefit of a pilot test is that the project team can ensure the changes result in the desired improvements before a full roll out. In addition, the team can gain insights to allow a more effective implementation during the full roll out.

Whether evaluating the pilot results or the full roll out results, a variety of techniques are important for assessing the extent of improvement. Perhaps the most important is recalculating the process sigma, so that it can be compared to the baseline process sigma established earlier.

Also common are frequency plots or Pareto charts to show before and after data. And the hallmark tool of DMAIC improvement projects, the control chart, is often employed to show the reduction in variation and improvement in performance. Both before and after data are plotted on the same chart, and the control limits are calculated and depicted separately for the two stages. In all cases, statistical tests are typically used in addition to graphs and charts. The same tests that were used in Analyze can be used in Improve; ANOVA, regression and chi-square testing are common.

Wrapping Up the Improve Phase

By the end of the Improve phase, the project team has demonstrated that the solutions implemented do in fact counter the identified root causes and thus result in substantial improvement in the CTQ metrics. The new process is in place and the team is ready to create a plan to maintain the gains and close out the project.

Control Phase

Standardizing and Documenting the Improvements

The first step of the Control phase is to document and standardize the improvements that were rolled out during Improve. This takes several forms. The process map of the new process that was created during Improve should be reviewed and updated as necessary to reflect any modifications that may have occurred during roll out. It will be used for training and reference so that the new process will be clear. If many individuals or groups are involved in the process, a deployment flowchart should also be developed to clarify roles and tasks.

While a process map is a key component of the documentation of the new process, it is usually also beneficial to have a user guide, which spells out the steps of the process and provides rationale. This is particularly important if multiple improvements were made and if the new process is substantially different from the original.

Finally, the project team will ensure that everyone involved in the process receives proper training and that effective communication occurs. Training may involve actual classroom learning or may consist simply of distributing the process documentation. This is a great opportunity to confirm that the process map and user guides are effective.

Creating a Process Monitoring Plan

Perhaps the most critical aspect of Control is establishing a plan to monitor the new process and act when results are not up to spec, so that the project gains will be maintained. It is this component of Six Sigma projects that tends to distinguish them from basic project management methodology, whereby the project is closed out once the improvement is confirmed. The monitoring plan clarifies how the process performance will be continuously monitored, who will be notified if there is a problem and how that will happen and what response is required.

The first part of the monitoring plan specifies the metrics that will be tracked to summarize process performance, as well as specifying how and how often they will be tracked. Also, be sure to clarify who is responsible for doing it; usually it falls to the process owner. Typically, the metrics used during Measure and Improve and established as Critical To Quality (CTQ) measures during Define are appropriate.

The monitoring plan also indicates what constitutes satisfactory performance and what should be considered a red flag indicating possible problems. The team should brainstorm potential issues and appropriate responses for each. Again, be sure to specify not only what needs to be done but who is responsible for making it happen.

A control chart should be continuously updated so that the process owner can watch for process shifts or other signs that there may be a problem with process performance. If the process owner is not well versed in interpreting control charts, the project team should create a reference sheet indicating what the process owner should be looking for. If possible, use an automated process to flag the process owner when performance becomes questionable.

Finally, since further change in the process environment is inevitable, the project team should develop a process for updating the new procedures when required. The update process will include updating the process map and user guides, communicating the changes to all involved, and modifying the monitoring plan if necessary to reflect the changes. Common changes that the team should plan for include shifts in employee roles, changes in customer specs and replacements for existing technology.

Wrapping Up the Control Phase

By the end of the Control phase, the project team has successfully standardized and documented the new process, created training and reference materials and established a plan for ongoing process monitoring. The improvements are fully established and a plan exists for updating the process in response to changes in the environment. The team is now ready to close out their Six Sigma DMAIC project and hand the process off to the process owner.

Closing Out the Project

The five phases of DMAIC have been completed. The Six Sigma project team has:

- Established the customer requirement (CTQ)
- Measured the process against that requirement
- Clarified the problem that had to be addressed
- Confirmed one or more root causes of that problem
- Identified one or more solutions to counter the root causes
- Demonstrated that the solutions implemented result in substantial improvement in the CTQ metrics
- Rolled out the new process
- Standardized and documented the new process
- Created a plan for monitoring the process and responding to performance problem.

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