Organizational Commitment of Information Technology Professionals: Role of Transformational Leadership and Work-Related Beliefs
Priya Chandna and Venkat R. Krishnan

E-Services in Bank- Solution for Better Tomorrow
Dr. R.K. Uppal

Validating Metrics on the basis of Object Oriented
Gurvinder Kaur and Vijay Singhal

A Simulation-Based Approach To Software Release And Support
Vikram Singh

Knowledge Management: Tools, Techniques and Technologies
Dr. K.P. Singh

Automatic Tuning of Oracle SGA Parameters – An Overview
Praveen Kumar Gupta and Hitesh Kumar Sharma

Measuring Return On Investment (ROI) In ERP Implementation – A Management Perspective
C. M. Maran

Book Review

Book Review
TECNIA INSTITUTE OF ADVANCED STUDIES
(Approved by AICTE, Ministry of HRD, Govt. of India and affiliated to GGS Indraprastha University, Delhi)
Institute is rated as Best Business School by Latest AIMA –Business Standard Publication &
Business India survey and Rated amongst Top 100 B-Schools and IT Schools in India by Dalal Street Investor Journal

A Centre of Excellence providing

professionally oriented quality education in

Management, Information Technology and Mass Communication.

The Vision

To emerge as one of the world's leading institute through
continuing education to the highest academic standards, by developing strong
industry-academia bond and playing a pioneering role in research and development,
so as to serve society by way of shaping professionals to conquer the
present and future challenges to the socio-economic fabric of our society by
dissemination of relevant knowledge through structured learning system.

Mission

To build & nurture a new generation of well-rounded professionals who can
work as positive change agents in the new millennium by helping
the Indian industry attain and sustain global leadership. It will be our endeavour to
assimilate and disseminate practical strategies to future professionals and to encourage
their understanding of strategic perception to fulfill the mission of the organisation
in the fast changing global business environment and to make a significant contribution by
providing an opportunity to the deserving candidates of society to have world class professional
education and to inculcate among them the feeling of fraternity and patriotism
From The Editor’s Desk

I take this opportunity to thank all contributors and readers for making *Tecnia Journal of Management Studies* an astounding success. The interest of authors in sending their research-based articles for publication and overwhelming response received from the readers is duly acknowledged. I owe my heartfelt gratitude to all the Universities and management institutes for sending us their journals on mutual exchange basis, and their support to serve you better.

We are happy to launch the seventh issue of our academic journal. The present issue incorporates the following articles:

- Organizational Commitment of Information Technology Professionals: Role of Transformational Leadership and Work-Related Beliefs
- E-Services in Bank - Solution for Better Tomorrow
- Validating Metrics On The Basis Of Object Oriented
- A Simulation-Based Approach To Software Release And Support
- Knowledge Management: Tool, Techniques And Technology
- Automatic Tuning of Oracle SGA Parameters – An Overview
- Measuring Return On Investment (ROI) In ERP Implementation – A Management Perspective

My thanks to the authors Priya Chandna and Venkat R. Krishnan, Dr. R.K. Uppal, Gurvinder Kaur, Vijay Singhal, Dr. K.P Singh, Praveen Gupta, Hitesh Sharma, Vikram Singh and C.M. Maran who have sent their manuscripts in time and extended their co-operation particularly in following the American Psychological Association (APA) Style Manual in the references.

I, extend my sincere thanks to our Chairman Sh. R. K. Gupta, who has always been a guiding light, encouragement and prime inspiration to publish this journal. I am grateful to Dr. A.K. Srivastava, Director, for his continuous support to bring out the Journal in a proper form. I also appreciate Editorial Committee Members for their assistance help, advice and suggestion in shaping up the Journal. My sincere thanks to our distinguished reviewers Mr. Vijay Singhal & Mr. Praveen Gupta and all team members of Tecnia family for their untiring efforts and support in bringing out this bi-annual Journal.

I am sure the issue will generate immense interest among corporate practitioners, policy-makers, academicians and students.

Dr. Nirmal Singh
Editor
## Contents

1. **Organizational Commitment of Information Technology Professionals: Role of Transformational Leadership and Work-Related Beliefs** ........................................... 1  
   *Priya Chandna and Venkat R. Krishnan*

2. **E-Services in Bank- Solution for Better Tomorrow** .......................................................... 14  
   *Dr. R.K. Uppal*

3. **Validating Metrics on the basis of Object Oriented** .................................................... 28  
   *Gurvinder Kaur and Vijay Singhal*

4. **A Simulation-Based Approach To Software Release And Support** ......................... 41  
   *Vikram Singh*

5. **Knowledge Management: Tools, Techniques and Technologies** ............................ 47  
   *Dr. K.P. Singh*

6. **Automatic Tuning of Oracle SGA Parameters – An Overview** ............................ 57  
   *Praveen Kumar Gupta and Hitesh Kumar Sharma*

7. **Measuring Return On Investment (ROI) In ERP Implementation – A Management Perspective** .............................................................. 64  
   *C. M. Maran*

8. **Book Review: Mr. Vijay Singhal** .................................................................................. 71

9. **Book Review: Dr. Nirmal Singh** .................................................................................. 71
General Information

- Tecnia Journal of Management Studies is published half-yearly. All editorial and administrative correspondence for publication should be addressed to the Editor, Tecnia Institute of Advanced Studies, 3 PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-110085.

- The received articles for publication are screened by the Evaluation Board for approval and only the selected articles are published. Further information on the same is available in the “Guidelines for Contributors”.

- Annual subscription details with the format for obtaining the journal are given separately and the interested persons may avail the same accordingly.

- Views expressed in the articles are those of the respective authors. Tecnia Journal of Management Studies, its Editorial Board, Editor and Publisher (Tecnia Institute of Advanced Studies) disclaim the responsibility and liability for any statement of fact or opinion made by the contributors. However, effort is made to acknowledge source material relied upon or referred to, but Tecnia Journal of Management Studies does not accept any responsibility for any inadvertent errors & omissions.

- Copyright © Tecnia Institute of Advanced Studies, Delhi. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior permission of the Publisher.

- Registration Number : DELENG/2006/20585

- International Standard Serial Number (ISSN) : 0975 – 7104

- Printed & Published by : Tecnia Institute of Advanced Studies, Madhuban Chowk, Rohini, Delhi-110085.

- Printed at: Rakmo Press Pvt.Ltd., C-59, Okhla Industrial Area, Phase-I, New Delhi-110020.
One of the biggest challenges that Information Technology (IT) organizations have been facing over recent years is the ability to attract and retain quality human resources. Several surveys have shown high staff turnover rates in the IT industry. The highest turnover rates were reported in India (16 percent), China and Switzerland (14 percent), the U.S. and Canada (10 percent) (Pastore, 2000). Industry attrition rates are highest amongst employees having between one and five years of experience. With the fast pace of technological development in the sector, there are new technologies coming up all the time. If the current firm does not provide the wherewithal to learn these, employees job-hop to another firm that does. The mobility is more because higher numbers of jobs are available at this level of skill and experience. As a result, the Indian IT industry, especially for employees at the lower end of the software skill spectrum, faces an employee turnover rate of as high as 25 to 30 percent.

Employee turnover is affected largely by employees’ organizational commitment. An assessment of Meyer and Allen’s (1991) three-component model of organizational commitment by Jaros (1995) showed that an employee’s affective commitment to the organization was the most important component of organizational commitment in predicting turnover intentions. Jaros (1995) claimed that each component of commitment is significantly and negatively correlated with turnover intentions and an employee’s affective commitment to the organization is the most important component of organizational commitment in predicting turnover intentions. Lee and Mowday (1987) found that organizational commitment explained a significant proportion of incremental variance in intention to leave.

In this age of accelerating attrition rates, leaders are more important than ever. An effective leader can enhance an employee’s organizational commitment. Over the last two decades, considerable literature has accumulated on transformational leadership (Bass, 1998). The present organizational focus on revitalizing and transforming organizations to meet competitive

**Abstract:** Impact of transformational leadership and five work-related beliefs (work ethic, Marxist, organizational, leisure ethic, and humanistic) on affective, continuance, and normative commitment was studied using 34 manager-subordinate pairs from information technology (IT) and 44 pairs from manufacturing organizations in India. Analyses of variance show that normative and continuance commitment, transformational leadership, and three beliefs—work ethic, Marxist, and organizational—are less in IT than in non-IT sector. Continuance and normative commitment continue to be lower even after controlling for beliefs. Transformational leadership appears to have no direct effect on commitment in non-IT and no effect at all in IT sector.
challenges ahead has been accompanied by increasing interest among researchers in studying transformational leadership. Such leadership is necessary for optimal subordinate satisfaction, commitment, and performance. There exists a relationship between transformational leadership behaviors and various outcomes measured at the individual and organizational level. In addition to transformational leadership, work beliefs of an individual could also affect his or her organizational commitment. Studies have shown a positive relationship between work beliefs and commitment (Finegan, 2000; Oliver, 1990).

We report in this paper a comparative study that looked at individuals’ organizational commitment in the IT and non-IT sectors. This study analyzed the impact that a transformational leader has on employees’ commitment to the organization and hence their willingness to continue to work in the organization. In addition, it took into account the work-related beliefs typical to every individual and analyzed how these work beliefs were related to organizational commitment and transformational leadership. The impact of transformational leadership and work beliefs on the organizational commitment of employees was analyzed separately for the IT and non-IT sectors.

**Theory and Hypotheses**

With the increasing importance of knowledge as a corporate asset in today’s dynamic environment, it is becoming imperative for organizations to be able to increase the level of commitment and attachment that employees feel toward their organization and to be able to retain the all important human asset in the organization. This is especially true for the IT sector where the attrition rates are one of the highest.

**Organizational Commitment**

According to Porter, Steers, Mowday, and Boulian (1974: 604), commitment is a “strong belief in and acceptance of the organization’s goals and values, a willingness to exert considerable effort on behalf of the organization, and a definite desire to maintain organizational membership.” Researchers have recommended restricting the definition to the attachment resulting from, or based on, an employee’s compliance (conformity driven by rewards and punishments), identification (a desire for affiliation), and internalization (individual’s congruence with organization’s goals and values) (Hunt & Morgan, 1994). Also important in conceptualizing organizational commitment is the advocacy of multiple commitments view. According to Reichers (1985: 469), “organizational commitment can be accurately understood as a collection of multiple commitments to various groups that comprise the organization.”

**Components of commitment.** Until recently, commitment has typically been defined as a one-dimensional concept (Meyer, Allen, & Smith, 1993). O’Reilly, Chatman and Caldwell (1991) recognized the multidimensional nature of commitment. Meyer and Allen (1991) presented compelling evidence to suggest that commitment comprised of three distinct components—affective, normative, and continuance. “Affective commitment refers to an employee’s emotional attachment to, identification with, and involvement in the organization.... Normative commitment reflects a feeling of obligation to continue employment” (Meyer & Allen, 1991: 67). Continuance commitment develops “as employees recognize that they have accumulated investments ... that would be lost if they were to leave the organization, or as they recognize that the availability of comparable alternatives is limited” (Meyer et al., 1993: 539).

**Antecedents of organizational commitment.** Finegan (2000) illustrated that the best predictor of commitment was the employee’s perception of the work environment. Pearson and Chong (1997) on studying 286 nursing staff of a large Malaysian hospital reported that the task content properties of identity, significance, and autonomy as well as the interpersonal task attribute of dealing with others were significant contributors of organizational commitment. Becker (1992) said that the foci of commitment (the individuals and groups to whom an employee is attached) were important determinants of commitment to an organization. Hunt and Morgan (1994) showed that global organizational commitment was a key mediating concept and several constituency-specific commitments such as commitment to top management and commitment to supervisor have important outcomes for organizations because they lead to, bring about, or result in global organizational commitment. Luthans, Baack, and Taylor (1987) showed that demographics, such as age, education, and tenure, had a significant impact on organizational commitment. They also found that the more a leader structured a situation, the more committed employees were to the organization.

**Effects of organizational commitment.** According to
Meyer et al. (1993: 67), “employees with a strong affective commitment remain with the organization because they want to, those with a strong continuance commitment remain because they need to, and those with a strong normative commitment remain because they feel they ought to do so.” Finegan (2000) claimed that with all three types of commitment, the employee is committed to the organization but for different reasons, and accordingly, each type of commitment produces different effects. Affective commitment is associated with more positive work attitudes (Allen & Meyer, 1996) and a greater likelihood of engaging in organizational citizenship (Meyer & Allen, 1991). In contrast, studies have found either no relationship between continuance commitment and performance, or a negative one (e.g., Konovsky & Cropanzano, 1991).

Siders, George, and Dharwadkar (2001) found that commitment to an organization was positively related to objective job performance that is rewarded by the organization, more specifically to sales volume. Wong, Hui, and Law (1995) found that commitment predicted both satisfaction and turnover intention. Organizational commitment has a direct bearing on the employees’ intention to leave the organization. Keeping in mind the high attrition rates in the IT sector, we hypothesized:

**Hypothesis 1.** Organizational commitment would be lower in the IT sector than in the non-IT sector.

**Transformational Leadership**

Burns (1978: 20) defined transformational leadership as occurring “when one or more persons engage with others in such a way that leaders and followers raise one another to higher levels of motivation and morality.” Transformational leaders thus serve as an independent force in changing the makeup of followers’ motive base through gratifying their motives. Bass (1985) built on Burns (1978) work and described transformational leadership in terms of the impact that it had on followers; followers felt trust, admiration, and loyalty towards the leader. Transformational leaders motivated followers to do more than the latter originally expected to do. Transformational leaders also changed the organizational culture (Bass, 1985).

**Factors of transformational leadership.** Transformational leadership consists of four interrelated factors—charismatic leadership, inspirational leadership, intellectual stimulation, and individualized consideration (Bass, 1998). Charismatic leadership could be further divided into two factors—attributed charisma and idealized influence behavior. Charismatic leaders provide subordinates with more meaning for their work and arouse enthusiasm, excitement, emotional involvement, and commitment to the group’s objectives. Inspirational leader behaviors include action-orientation, confidence building, and inspiring belief in the cause, which often leads followers to be committed, involved, loyal, and ready to exert extra effort. Intellectual stimulation helps employees emphasize rational considerations and challenge old assumptions. Individualized consideration implies developing employees and coaching them.

Authors have been using the terms transformational leadership and charismatic leadership as synonyms or as identical twins (Conger, 1999). According to Conger and Kanungo (1998), charismatic leaders critically evaluate the existing situation or status quo and keeping in mind the environment, they formulate a strategic vision and then articulate it such that it motivates the followers. Shamir, House, and Arthur (1993) theorized that charismatic leadership transforms followers’ self-concepts and thereby motivates them. Shamir, Zakay, Breinin and Popper (1998) found that a leader’s emphasis on collective identity was related to subordinate’s level of identification with the leader.

According to Hater and Bass (1988), transformational leadership factors added to the prediction of work group performance (the performance of the group of subordinates directly reporting to the manager) beyond that of transactional leadership factors. Kuhnert and Lewis (1987) claimed that transformational leaders held a sense of moral obligation to the organization as an end value, which in turn was also adopted by subordinates. Pillai, Schriesheim, and Williams (1999) found that leaders foster organizational commitment through the fairness of procedures they employ.

**Context and transformational leadership.** While transformational leadership is potentially applicable to most organizational situations, the emergence and effectiveness of such leadership may be facilitated by some contexts and inhibited by others (Pawar & Eastman, 1997). Waldman, Ramirez, House, and Puranam (2001) found that CEO charismatic leadership enhanced performance only under conditions of perceived environmental uncertainty. Shamir and Howell (1999) argued that charismatic leadership...
leaders are more likely to emerge and be effective when the tasks of organizational members are challenging and complex and require individual and group initiative, responsibility, creativity, and intense effort; and when performance goals are ambiguous and extrinsic rewards cannot be strongly linked to performance.

In the IT sector, telecommunication technologies provide managers with easy means of monitoring and controlling their subordinates’ behaviors. Thus, they may strengthen the organizational situation, and reduce the scope for the emergence of transformational leaders. Furthermore, the IT sector uses technologies which may be seen as introducing more distant and cold means of communication between leaders and potential followers, thereby hindering the identification, trust-building, and emotional processes involved in charismatic leadership (Shamir & Howell, 1999). Hence, we hypothesized:

Hypothesis 2. Transformational leadership would be lower in the IT sector than in the non-IT sector.

Transformational leadership and organizational commitment. Bycio, Hackett, and Allen (1995) studied 4000 registered nurses and found that transformational scales had positive relationships with affective commitment that were significantly larger than those involving continuance commitment or normative commitment. Moreover, inspirational aspects of transformational leadership enhanced affective commitment but not the other facets of commitment. They showed that higher levels of transformational leadership were associated with subordinates’ organizational commitment, irrespective of the commitment measure used. Barling, Weber, and Kelloway (1996) used a pretest-posttest control-group design and found that training managers in transformational leadership enhanced the organizational commitment of their subordinates. We therefore hypothesized:

Hypothesis 3. Transformational leadership would be positively related to organizational commitment.

Work-Related Beliefs

Authors have used the two terms work values and work beliefs interchangeably. Work values, according to Dose (1997: 227-228), “are evaluative standards relating to work or the work environment by which individuals discern what is right or assess the importance of references.” Zytowski (1970: 176) defined work values as “a set of concepts which mediate between the person’s affective orientation and classes of external objects offering similar satisfaction.” Work values are goals that one seeks to attain to satisfy a need; the needs may be satisfied by more than one kind of activity or occupation. Organizational researchers use the term work values to encompass a variety of notions ranging from business ethics to work preferences. Dose (1997) proposed that work values vary along two dimensions: (a) whether the value held exhibits a moral element, and (b) the degree of social consensus regarding the importance or desirability of the particular value. Elizur (1984) used smallest space analysis to analyze work values, and argued that two basic facets were needed to describe the domain of work values: modality of outcome (the importance of various work outcomes to the individual) and system performance contingencies (the importance of performance-reward contingencies and system rewards to the individual). Work values have been investigated as preferences for the type of work or work environment individuals would like or consider important in job decisions (Dose, 1997).

Work belief systems. Buchholz (1997: 571-572) stressed on the existence of five belief systems—work ethic, organizational, Marxist, humanistic, and leisure ethic. First, work ethic is considering work as being good in itself and as bestowing dignity upon a person. Second, organizational belief system is where “work takes on meaning only as it affects the group or organization for which one works and as it contributes to one’s status and rise in the organizational hierarchy.” Third, Marxist-related beliefs implied that “productive activity or work is basic to human fulfillment.” Fourth, humanistic belief is that work should be taken seriously as the way in which individuals discover themselves and fulfill themselves as human beings. Lastly, leisure ethic is considering work to have no meaning in itself and claiming that meaning could only be found in leisure.

Antecedents of work beliefs. Niles (1999) conducted a study to examine the structure and relative importance of work-related beliefs in contrasting cultural and religious settings. The results showed that most religions and most cultures had a common concept of a work ethic when it was defined as a commitment to hard work and to excellence. Hard work was seen as an end in itself and even as morally right. However, what did not appear to be universal seemed to be a belief that there was a direct relationship between hard work and success.
According to Shome, Ratan, and Bhardwaj (1997), the strength of the organizational belief system also depended on the individual’s understanding of the organizational ethos.

Effects of work beliefs. Pryor and Davies (1989) claimed that there existed a moderate relationship between work beliefs and general work preferences. In addition, Shome et al. (1997) found that people with a stronger work ethic were more willing to compromise and hence this denoted a positive and healthy environment in the organization. Studying 90 managers from a public sector undertaking, they found that middle level managers showed a stronger organizational belief system as compared to junior managers. Saks, Mudrack, and Ashforth (1996) found that work ethic was indirectly related to intentions to quit and turnover in the case of temporary service employees.

Organizational commitment and work beliefs. Oliver (1990) conducted a study in an employee-owned firm in the United Kingdom, and found that both organizational rewards and work values showed significant relationships to commitment. The study revealed a direct impact of work values on the level of commitment. Participatory and instrumental values made the most impact on the commitment index. According to Finegan (2000), affective, normative, and continuance commitment were each predicted by different clusters of values. It was found that the greater the similarity between personal values and organizational values, the greater the affective commitment. Individuals who valued obedience, cautiousness, and formality are more likely to be normatively committed. Shamir et al. (1993) argued that charismatic leadership would make followers see work as intrinsically valuable, since work provides an opportunity for them to express themselves. It is by first affecting work ethic that transformational leadership would enhance commitment indirectly. Hence, we hypothesized:

Hypothesis 5. Transformational leadership would be positively related to the work ethic of follower.

Hypothesis 6. The relationship between transformational leadership and organizational commitment would cease to exist after controlling for work beliefs.

Method

Questionnaires were distributed to employees of two organizations in the IT sector and one organization in the manufacturing sector. One of the organizations in the IT sector specializes in delivering high-quality, cost-effective solutions for businesses with intensive information processing needs and employs over 3,900 IT professionals at ten development centers in India and multiple customer locations in the U.S. and Europe. The second IT sector organization is the software division of one of the leading iron and steel companies of India. The organization surveyed in the manufacturing sector is located in a major industrial town in Eastern India. The organization is a 50:50 joint venture between an automobile manufacturer, and a U.S.-based company that manufactures fuel-efficient, low emission, environment-friendly diesel engines. It has over 900 employees consisting of around 125 managers and over 750 associates.

To minimize the risk of relationship inflation due to common source biases, data about leader behavior was obtained from a different source than that for data about subordinates’ beliefs and attitudes. Hence, a leader-follower dyad was used where the superior completed the questionnaire on transformational leadership and his or her immediate subordinate completed the questionnaires on work beliefs and organizational commitment. The respondents from the
IT sector were project leaders and their immediate subordinates. In the manufacturing sector, managers and their immediate subordinates, the associates, were chosen as respondents. Respondents were not asked to give any form of identification. It was made clear to the respondents that all responses will be anonymous. The questionnaires measured transformational leadership of the leaders, work beliefs of the followers and the followers’ commitment to the organization.

Demographic Details of Sample

The final sample for the study comprised 78 pairs of leaders and followers—34 from the IT sector, and 44 from the manufacturing sector. The median age of the respondents in the superior category was 31 years and they had on an average 11 years of work experience. On the other hand, the median age of the subordinates was 26 years and their tenure in the organization was 3 years on an average. More than 50% of the superiors were graduates. Out of the 55 subordinates who provided data related to academic qualifications, 36 were graduates and 12 had completed their post graduation and the remaining had professional diplomas. Most of the subordinates had been working under the same superior for two years.

Measures

Organizational commitment. Affective, normative, and continuance commitment were measured using Meyer, Allen, and Smith’s (1993) 18-item commitment scale. This scale has been widely used in the field and has median reliabilities (assessed using coefficient alphas) across many studies of .85 for affective commitment, .73 for normative commitment, and .79 for continuance commitment (Allen & Meyer, 1996). A detailed discussion of the construct validity of this scale is found in Allen and Meyer (1996).

Work beliefs. The belief system questionnaire as developed by Buchholz (1977) was used to measure the intensity of five types of work-related beliefs held by the follower. The five types of work beliefs are work ethic, organizational belief system, Marxist-related beliefs, humanistic belief system, and the leisure ethic. The respondents were asked to judge how strongly they agreed or disagreed with each statement in the questionnaire, using a seven-point scale (1=Strongly disagree; 2=Disagree; 3= Somewhat disagree; 4=Neither disagree nor agree; 5= Somewhat agree; 6=Agree; 7=Strongly agree). The leisure ethic scale was not found to be reliable and hence an item (“the trend towards more leisure is not a good thing”) was deleted, which led to an increase in reliability and a resultant alpha of 0.51.

Transformational leadership. The most widely used scale to measure factors in transformational leadership is Multifactor Leadership Questionnaire (MLQ). The Bass and Avolio (1991) version of the MLQ was used to measure transformational leadership of the supervisor. Five factors of transformational leadership—attributed charisma, idealized influence behavior, inspirational leadership, intellectual stimulation, and individualized consideration were measured. Respondents were asked to answer the MLQ by judging how frequently they displayed the behaviors described in the questionnaire, using a five-point scale (0=Not at all; 1=Once in a while; 2=Sometimes; 3=Fairly often; 4=Frequently, if not always). There was a significant positive correlation between the five transformational leadership factors, the correlation being not less than 0.70 (p < 0.001). The mean of the five factors was taken as the score for transformational leadership.

Results

Table 1 presents descriptive statistics (means and standard deviations) for and correlations between all variables in the study—three types of organizational commitment, five types of work beliefs, and transformational leadership. It also presents reliability coefficients for all the variables. Each variable was constructed by computing the mean of the items comprising the scale. The table also presents the correlations between transformational leadership and the three dimensions of commitment after controlling for all the five work beliefs.

Analysis of variance was done to test if means of the variables are different across IT and non-IT sectors. The results are given in table 2. Normative and continuance commitment were significantly less in the IT sector as compared to the non-IT sector. There was no significant difference in affective commitment across the two sectors. Hence, our hypothesis 1 was partly supported. The mean of transformational leadership in the IT sector was 4.05 as compared to the non-IT sector where it was 4.39 (F=10.65, p < .01, from table 2). Hypothesis 2 which said that transformational leadership would be lower in the IT sector as compared to the non-IT sector was hence supported.
We did an analysis of covariance to see if continuance commitment and normative commitment varied across the IT and non-IT sectors after controlling for transformational leadership and the five types of beliefs, taking one at a time. Analysis of covariance assumes that the slope of the covariate by independent variable is the same for all levels of the independent variable (Scheffe, 1959). We tested for heterogeneity of slopes by modeling continuance commitment and normative commitment separately against each of the six covariates (transformational leadership and the five beliefs), sector, and the product of sector and covariate. Except in the cases of continuance commitment modeled against leisure ethic, continuance commitment modeled against transformational leadership, and normative commitment modeled against work ethic, there was no significant difference in the covariate by sector relationship as a function of sector. We therefore did the analysis of covariance excluding those three cases. Least squares means of continuance commitment were significantly lower for IT professionals than for non-IT employees, after controlling for work ethic, Marxist-related beliefs, organizational belief system, and humanistic belief.

Table 1
Descriptive Statistics and Correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>s.d.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Affective commitment</td>
<td>4.80</td>
<td>.92</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.54</td>
</tr>
<tr>
<td>2. Continuance commitment</td>
<td>4.59</td>
<td>1.29</td>
<td>-.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.82</td>
</tr>
<tr>
<td>3. Normative commitment</td>
<td>4.99</td>
<td>.84</td>
<td>***.42</td>
<td>***.56</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.56</td>
</tr>
<tr>
<td>4. Work ethic</td>
<td>5.57</td>
<td>.92</td>
<td>-.24</td>
<td>***.54</td>
<td>***.43</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.61</td>
</tr>
<tr>
<td>5. Marxist-related beliefs</td>
<td>4.55</td>
<td>.82</td>
<td>***.44</td>
<td>***.71</td>
<td>***.33</td>
<td>***.58</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.67</td>
</tr>
<tr>
<td>6. Organizational belief system</td>
<td>5.85</td>
<td>.63</td>
<td>.15</td>
<td>***.52</td>
<td>***.61</td>
<td>***.42</td>
<td>***.39</td>
<td></td>
<td></td>
<td></td>
<td>.66</td>
</tr>
<tr>
<td>7. Leisure ethic</td>
<td>4.10</td>
<td>1.09</td>
<td>***.37</td>
<td>**.34</td>
<td>.12</td>
<td>**.35</td>
<td>***.52</td>
<td>*.28</td>
<td></td>
<td></td>
<td>.51</td>
</tr>
<tr>
<td>8. Humanistic belief system</td>
<td>6.05</td>
<td>.54</td>
<td>-.05</td>
<td></td>
<td>.14</td>
<td>**.31</td>
<td>.18</td>
<td>***.51</td>
<td>*.28</td>
<td></td>
<td>(.79)</td>
</tr>
<tr>
<td>9. Transformational leadership</td>
<td>4.24</td>
<td>.48</td>
<td>-.21</td>
<td>***.42</td>
<td>**.32</td>
<td>***.43</td>
<td>***.44</td>
<td>**.29</td>
<td>***.32</td>
<td>***.37</td>
<td>(.96)</td>
</tr>
<tr>
<td>10. Transformational leadership</td>
<td></td>
<td></td>
<td>-.01</td>
<td>.18</td>
<td>.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after controlling for work beliefs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a n=78. Alphas are in parentheses along the diagonal. † p < .10. * p < .05. ** p < .01. *** p < .001.

Table 2
Analysis of Variance across IT and Non-IT Sectors

<table>
<thead>
<tr>
<th>Variable</th>
<th>IT Sector (N = 34)</th>
<th>Non-IT Sector (N = 44)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>s.d.</td>
<td>Mean</td>
</tr>
<tr>
<td>Affective commitment</td>
<td>4.84</td>
<td>1.11</td>
<td>4.76</td>
</tr>
<tr>
<td>Continuance commitment</td>
<td>3.74</td>
<td>1.19</td>
<td>5.25</td>
</tr>
<tr>
<td>Normative commitment</td>
<td>4.62</td>
<td>.95</td>
<td>5.28</td>
</tr>
<tr>
<td>Work ethic</td>
<td>5.00</td>
<td>.84</td>
<td>6.01</td>
</tr>
<tr>
<td>Marxist-related beliefs</td>
<td>4.00</td>
<td>.63</td>
<td>4.97</td>
</tr>
<tr>
<td>Organizational belief system</td>
<td>5.50</td>
<td>.63</td>
<td>6.12</td>
</tr>
<tr>
<td>Leisure ethic</td>
<td>3.75</td>
<td>.92</td>
<td>4.36</td>
</tr>
<tr>
<td>Humanistic belief system</td>
<td>5.97</td>
<td>.55</td>
<td>6.12</td>
</tr>
<tr>
<td>Transformational leadership</td>
<td>4.05</td>
<td>.43</td>
<td>4.39</td>
</tr>
</tbody>
</table>

† p < .10. * p < .05. ** p < .01. *** p < .001.
system one at a time. Similarly, normative commitment was significantly lower for IT professionals than for non-IT employees, after controlling for Marxist-related beliefs, leisure ethic, humanistic belief, and transformational leadership one at a time.

Transformational leadership was significantly positively related to continuance commitment and to normative commitment (from table 1). However, it did not show a significant relationship with affective commitment. Separate correlations by sector were calculated and the results are reported in table 3. Transformational leadership did not show any significant relationship with organizational commitment in the IT sector. In the non-IT sector, transformational leadership was related negatively to affective commitment and positively to continuance commitment and normative commitment. Therefore, hypothesis 3 was supported only in the case of normative and continuance commitment, and only in non-IT sector.

Though not hypothesized, some correlations were also seen between the other work beliefs and commitment. In the IT sector, affective commitment was related negatively to Marxist belief and positively to organizational belief. Continuance commitment was positively related to Marxist belief and organizational belief. Normative commitment was positively related to organizational belief. In the non-IT sector, affective commitment was negatively related to Marxist belief and leisure ethic. Continuance commitment was positively related to work ethic, Marxist belief, and leisure ethic. Normative commitment was positively related to work ethic, Marxist belief, and organizational belief.

There was a significant positive correlation between transformational leadership and all the five work beliefs for both sectors together (from table 1). Looking at each sector separately, transformational leadership did not show any significant relationship with any of the work beliefs in IT sector (from table 3).

Transformational leadership was significantly positively related to all the five work beliefs. This showed that hypothesis 5, which related transformational leadership and work ethic, was supported only in the non-IT sector.

For testing our hypothesis 6, we controlled for the five work beliefs and looked at the relationship between transformational leadership and organizational commitment. The results of the partial correlation are also included in table 1 (for both sectors together) and table 3 (for each sector separately).

<table>
<thead>
<tr>
<th>(N=78)</th>
<th>Affective commitment</th>
<th>Continuance commitment</th>
<th>Normative commitment</th>
<th>Transformational leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IT</td>
<td>Non-IT</td>
<td>IT</td>
<td>Non-IT</td>
</tr>
<tr>
<td>Work ethic</td>
<td>-.32</td>
<td>-.20</td>
<td>.14</td>
<td>***.54</td>
</tr>
<tr>
<td>Marxist related beliefs</td>
<td>-.42</td>
<td>**.*.64</td>
<td>.38</td>
<td>***.73</td>
</tr>
<tr>
<td>Organizational belief system</td>
<td>**.44</td>
<td>.12</td>
<td>*.36</td>
<td>**.29</td>
</tr>
<tr>
<td>Leisure ethic</td>
<td>-.22</td>
<td>**.*.53</td>
<td>-.14</td>
<td>***.52</td>
</tr>
<tr>
<td>Humanistic belief system</td>
<td>.06</td>
<td>-.17</td>
<td>-.07</td>
<td>.22</td>
</tr>
<tr>
<td>Transformational leadership</td>
<td>-.09</td>
<td>**.*.34</td>
<td>-.01</td>
<td>***.56</td>
</tr>
</tbody>
</table>

† p < .10. * p < .05. ** p < .01. *** p < .001.
Analyzing sector-wise, it was found that in the non-IT sector, the zero order correlations between transformational leadership and commitments that were significant ceased to be significant after controlling for all the five work beliefs. In the IT sector, the relationship between transformational leadership and organizational commitment remained non-significant before and after controlling for work beliefs. Hence, hypothesis 6 was supported in the case of only the non-IT sector.

We used regression analysis with forward option with the three types of organizational commitment as the dependent variables, and the five work beliefs and transformational leadership as the independent variables. This was done separately for the two sectors. Regression analysis with the forward-selection technique (Judge, Griffiths, Hill, Lutkepohl, & Lee, 1985) begins with no variables in the model. For each independent variable, it calculates F statistics that reflect the variable’s contribution to the model if it is included. The variable that would produce the largest F statistic is added to the model. The evaluation process is repeated with the variables remaining outside the model. Once a variable is entered into the model, it stays. Thus, variables are added one by one to the model until no remaining variable produces a significant F statistic.

The regression analysis with forward option revealed that in the IT sector, increasing the intensity of organizational belief system would best predict affective commitment. Affective commitment would be further enhanced if Marxist-related beliefs were decreased. Continuance commitment on the other hand would be best predicted by Marxist related beliefs and could be further increased by increasing organizational belief system. For normative commitment, organizational belief system was the best predictor. In the non-IT sector, affective commitment could be increased by reducing Marxist-related beliefs. Increasing Marxist-related beliefs as well as transformational leadership would result in increased continuance commitment. For increasing normative commitment, one would have to enhance work ethic. Increasing organizational belief system and reducing humanistic belief system would also enhance normative commitment in the non-IT sector.

**Discussion**

The results of this study reveal that employees’ commitment to the organization varies across sectors. Employees in the manufacturing sector, which was used to represent the non-IT sector, exhibit a higher organizational commitment as compared to employees in the IT sector. Another interesting finding is that transformational leadership also varies sector-wise. A transformational leader appears to have an insignificant role to play in the present IT scenario. In addition, the results demonstrate that, in both the sectors, organizational commitment is best explained by the work beliefs. Hence, by targeting work beliefs one can change the organizational commitment of the employees. Transformational leadership does not directly enhance organizational commitment in either of the two sectors and can do so only by suitably modifying the work beliefs. The relationship between organizational commitment and work beliefs is therefore, of paramount importance.

This study has direct implications for today’s industrial world. Turnover rates are skyrocketing, and employees are moving from one organization to another in rapid succession taking with them the entire organizational learning. To curtail this huge loss of human capital, it is necessary for an organization to know which work beliefs to tap to increase employees’ attachment to the organization and the motivation to work for the organization. The human resource management professionals have a daunting task ahead of them.

In the IT sector, the organizational belief system plays a significant role in predicting an employee’s organizational commitment. Enhancing the organizational belief system can increase affective commitment. Employees feel more emotionally attached to and involved in the organization if steps are taken to ensure that they perceive that their work affects the organization. Increasing their sense of ownership and empowering them can therefore help in this case. In addition, they should feel that if their work serves the group’s interest it will result in their own success. Hence, a reward system with a transparent performance-reward relationship should be put in place, such that the employee’s work would contribute to their status in the organization and rise in the organizational hierarchy. Moreover, to increase the feeling that working in a group is best, organizations can make use of symbols. In addition, a sense of identification with the organization can be cultivated if employees are given stock options. These measures will increase the intensity of affective commitment that employees feel towards the
organization. Affective commitment can also be impacted positively by modifying Marxist-related beliefs such that employees feel that they are being able to fulfill themselves as creative and social individuals and are not being exploited.

Increasing Marxist-related beliefs can enhance continuance commitment. Employees need to be made to feel that they would have a lot to lose if they leave the organization. Moreover they should feel that all their past investment and time would be wasted if they left the organization. Charting out an attractive career path for them can do this. The amount of control that they exert in decision-making should be increased and more participative management should be put in place. Employees should have a greater say in designing their career paths. Organizing work in groups and teams can further enhance organizational belief system, which will increase continuance commitment.

Normative commitment reflects a feeling of obligation to continue employment on the part of the employee. Increasing the intensity of organizational belief system can help in developing normative commitment. Organizational belief system implies that the employees’ believe that their success in the organization depends on the degree to which they conform to the norms of the organization. Therefore, they attempt to assimilate the critical norms and values of the organization and are more committed to it. A sense of obligation towards the employer can be instituted by putting in place group norms that emphasize that the employee owes a great deal to the organization and leaving the organization is not a right thing to do. The organization could establish a culture whereby employees would experience a deep sense of guilt at the prospect of leaving the organization. Moreover, mechanisms to alienate people who are not committed and do not exert effort in the organization can be put in place. Strong group norms and a culture which compels employees to exert maximum effort and to feel that it is wrong to desert the organization and its people is a means of impacting organizational belief system such that it increases normative commitment.

A transformational leader goes beyond the transactional needs and responds to the moral development of the follower and as such appeals to and also effectively influences the more general values of the follower. However, in the present scenario, transformational leadership does not seem to play an important role in influencing work beliefs or organizational commitment of followers in the IT sector. This could be because in the IT sector, the channels of communication are impersonal and there is not much interaction between the leader and the follower. Communication channels such as emails abound which do not help a leader much in inspiring the followers. On the other hand, they hinder the identification, trust building, and emotional processes involved in charismatic leadership. The lack of personal interaction might have the same effects as being geographically distant. Howell and Hall-Merenda (1999) found that transformational leadership produced higher follower performance in close versus distant situations.

The role of a transformational leader if developed in the IT sector such that the leader enhances the employees’ work beliefs, would increase organizational commitment. Kirkpatrick and Locke (1996) conducted experiments that showed that a leader’s vision was most strongly related to attitudes and these attitudes played an important role, inducing outcomes such as organizational commitment. One can increase effectiveness of transformational leadership in the IT sector by increasing leader-follower interaction. This can be done by means of mentorship programs. Gatherings of project teams with their leaders could also be organized, which the leaders can use to generate enthusiasm and involvement with the organization or the project teams’ cause. In addition, study circles can be arranged. This carries much value in a sector like IT that depends on constant updating of skills and wherein it is necessary for the employees to keep abreast with the current happenings. Therefore, these study circles can be forums used by leaders to encourage employees to challenge old assumptions and drive them to learn more and hence intellectually stimulate them.

The absence of relationships between humanistic beliefs and commitment in the IT sector perhaps suggests that the importance of humanistic beliefs might be more evident at higher levels in the organization. The followers in the sample surveyed for the purpose of this study consisted primarily of employees at levels lower than that of the executive cadre and as such, humanistic beliefs may not be of much importance to them. For those not belonging to senior levels, fulfillment of lower needs and wants is possibly of greater significance as compared to being given the opportunity to discover and fulfill themselves as human beings.
Limitations and Suggestions for Future Research

There exist limitations stemming from the size as well as the nature of the sample. Since the sample of respondents is relatively small, this study needs to be replicated across a larger database of respondents to confirm the findings. A study that includes firms across different sectors like service or banking instead of being limited to only the IT and manufacturing sectors could shed more light on the variance in work beliefs and transformational leadership as a consequence of the nature of the industry. In addition, transformational leadership that can be observed at a given point of time should set in motion effects for some time in the future. In this case however, being a cross-sectional study, both transformational leadership and commitment were measured at the same time. A longitudinal study wherein commitment is measured subsequent to measuring transformational leadership could throw more light. Future research could also study the effect of specific organizational variables such as structure, environmental characteristics of that particular industry, etc., and quantify how much variance amongst the work beliefs and the effects of transformational leadership in the different sectors is caused as a result of differences in each of these organizational variables. Moreover, the belief systems used in this study might have undergone some modifications with other belief systems such as educational belief system, where work is seen as providing a continuous learning experience, coming into the picture. Hence, an attempt could be made to develop a theoretical framework incorporating any changes in belief systems concerning work.

Conclusion

Despite some limitations, this study makes some important contributions and has significant organizational implications. In summary, this study provides the link between commitment to an organization and work beliefs and the role of a transformational leader in changing work beliefs as well as enhancing organizational commitment. It brings out the fact that work beliefs are the immediate antecedents of organizational commitment. More importantly, this study brings out the differences in work beliefs, organizational commitment, and transformational leadership across IT and non-IT sectors. Results of the current investigation point to the importance of realizing the differences resulting from the nature of the organization so that these can be taken into account while formulating policies related to human resource management. It also demonstrates that the role of a transformational leader in the IT industries should be made more effective to modify work beliefs such that they enhance organizational commitment. Hence, it highlights the untapped potential of transformational leadership in the IT sector and its importance in enhancing organizational commitment and eventually reducing employee turnover.

References

- Conger, J. A. 1999. Charismatic and transformational
leadership in organizations: An insider’s perspective on these developing streams of research. The Leadership Quarterly, 10(2): 145-179.


- Pillai, R., Schriesheim, C. A., & Williams, E. A. 1999. Fairness perceptions and trust as mediators for


E-SERVICES IN BANK- SOLUTION FOR BETTER TOMORROW

R.K. Uppal*

Abstract: The present paper analyzes the perceptions of the bank customers regarding e-banking services in Punjab. The survey was conducted in Ludhiana district of Punjab in September, 2008. The perceptions of almost all the bank groups exhibit their perceptions in favour of e-delivery channels. Among all the e-delivery channels ATM is the most preferred e-delivery channel. Age-wise, up to 25 and 35-45 age groups more preferred e-delivery channels. Similarly professionals more preferred e-services. Chi-sq test reveals mostly significant difference in the opinion of the three bank group’s customers at 1% LOS. The paper concludes suggesting strategies to enhance the e-banking services.

Introduction

Modern technology has transformed the functioning of business. It has bridged the gaps in terms of the reach and the coverage of systems and enabled better decision-making based on latest and accurate information, reduced cost and overall improvement in efficiency. In the Indian context, the financial sector, especially the banking sector has been a major beneficiary from the inroads made by IT. Many new processes, products and services offered by banks and other financial intermediaries are now IT centered. E-delivery channels are also a gift of IT. Now-a-days many banks are providing the services of e-channels like ATMs, I-banking, M-banking, Tele-banking, Debit cards, Credit cards etc. Most of the initiatives regarding e-channels are aimed at providing better and more efficient customer service by offering multiple options to the customers. These e-channels have positive impact on the profitability of the bank groups. With the rapid improvements in technology and faster growth of e-channels society has become more sophisticated than in olden days. We have a better educated, better informed, better organized and better paid workforce than existed in olden days. With the help of e-channels, banking system has become more efficient with efficient e-payment system. This situation has resulted in more competition among banks and stimulated more technological developments. Customers are getting many benefits from e-services like balance enquiry, request for services, issuing instruction etc from anywhere in the world are possible, any time banking, convenience acts as a tremendous psychological benefit all the time, cash/card free banking through PC banking, brings down “cost of banking” to the customer over a period of time, cash withdraw from any branch, on-line purchase of goods and services including on-line payment for the same. With so many benefits from e-services, it is a need of an hour to study the satisfaction level of customers from these e-services. This paper studies the satisfaction of customers from different e-services.

ATM

ATM is a device that allows customers who have an ATM card to perform routine banking transactions without interacting with a human teller. ATMs are currently becoming popular in India that enables the customers to withdraw their money 24 hours, 9 days, 7 days a week. ATM sharing system through proper connectivity and switching technology provides the first real opportunity to serve the customers on a nation wide basis. International ATM sharing already a reality in North America and Europe seems likely to add a

*Dr. R.K. Uppal, Director ICSSR Financed Major Research Project, D.A.V. College, Malout (Punjab)
whole new dimension of convenience for both businessman and tourist traveling abroad. The ATM sharing in India across banks started with SWADHAN-Shared Payment Network System in Mumbai.

Benefits to Customers
- 24 hours access availability
- Less time for transactions
- Acceptability of card across multiple bank ATMs, even foreign tourists can access Maestro/VISA ATMs.
- Plethora of services available in addition to cash dispensing.

Benefits to Banks
- Cost of setting up ATMs much lower than the branch.
- Migration of the routine transactions to the ATMs frees the bank’s staff for more productive work
- ATMs serve as the crucial touch points for cross selling of bank’s products
- Enables the bank to display products on the screen and serves as a media for publicity for the bank.
- Less hassle in handling cash

Internet Banking
“Internet bank” to mean a bank offering its customers, the ability to transact business with the bank over the internet. Internet banking refers to the use of the internet as a remote delivery channel for banking services. Subsequently, dial-up connections, personal computers, Tele-banking and automated teller machines (ATMs) became the order of the day in most of the developed countries. It is a web-based service that allows the banks authorized customers to access their account information. In the system, customers are allowed to log on the banks website with the help of identification issued by the bank and personal identification number (PIN). Banks replies the user and enables customers to access the desired services.

Benefits to Customers
- Convenience
- Tailored products and services
- Ease of access
- Ease of changing supplier
- Low cost
- Financial planning capability

Benefits to Banks
- Cost saving
- Reaching new segment of the population
- Bring efficiency
- Enhancement of bank’s reputation
- Better customer service

Mobile Banking
Mobile banking is a system of providing services to the customer to carry out banking transactions on the ‘Mobile Phone’ through a cellular service provider. It is a service of banks to make available, the facility of banking wherever the customer is and whenever he needs. We can rather call this facility as “Anywhere and Any Moment Banking” but it is restricted to only information about his account and not cash services.

Benefits to Customers
- Customers need not stand in the bank counters/front offices for various enquiries about his account
- Customer can save his valuable time in banking transaction
- Give information at anytime and anywhere
- Customers can pay his utility bills in time and save paying penalties
- Plan funding his accounts for the cheques issued to various customers
- Cheque book request can be made sitting in his work place

Benefits to Banks
- Bank can utilized the time saved for expenses of business, marketing and sales activities by channel migration of customers to mobile banking
- Bank can take advantage of profits by way of commission for cellular companies by selling prepaid talk time through ATMs
- Banks providing mobile banking service can have
competitive advantage on those banks, which are
not providing this service
• Mobile banking enables banks to reduce costs of
courier, communication and paper works etc.

Smart Cards

It is a plastic cards with chips embedded on them
have been globally accepted as the most effective and
secure data storage and payment mechanisms. These
cards have the capability to store data and transact
using this data. Since data is stored in the card, it can
work in an offline mode and does not rely on a back-
end or networking for transaction.

Benefits to Customers
• Portable data, anywhere, anytime
• Time saving
• Large storage capacity
• Minimize the risk associated with fraud/theft

Benefits to Banks
• Secure data storage
• Reduce cash
• Data digitization without large scale investment
• Increased productivity of bank staff
• Remote access
• Increased customer base

Tele Banking

Tele-banking is only a relatively new electronic
banking product. However, it is a fast becoming one
of the most popular products. Customers can perform
a number of transactions from the convenience of their
own home or office, infact from anywhere they have
access to a phone. Customers can check balances and
statement information, transfer funds from one
account to another, and pay certain bills and other
statement or Cheque books.

Credit Card

Credit card can be called as and equivalent of a
loan sanctioned by the banks to its customer. Credit
card facilitates and makes it possible to “Use First and
Pay Later” the specified amount of credit as per the
agreed terms of sanction. Before issuing a credit card
to a customer, the bank would like to know and be
sure about the identification, age, level and source of
income and repaying capacity. A person intending to
get a credit card issued from a bank will have to fill in
a prescribed application form for the purpose.
Identification documents required to be enclosed
with the application.

Debit Card

Debit card is a deposit access product where the
card holder uses his own money in his bank account
on the principal of “Pay First and Use Later”.

Scheme of the Paper

This paper has been divided into five sections.
After the brief introduction, second section deals with
review of related study. Third section deals with
objectives and research methodology. Fourth section
deals with findings and last part conclude the paper.

Review of Related Study

Previous studies have shown that quality indeed
has a significant effect on market share and return on
investment (e.g., Anderson and Zeithaml, 1984; Phillips,
Chang and Buzzell, 1983). Positive consumers
perceptions of service quality also contribute to
enhance customer satisfaction (Durvasual and Mehta,
1998)

quality in one particular type of retailing, namely,
departmental stores. The dimensionality of service
quality was assessed using perception scores,
expectations scores, as well as gap scores in Singapore.
The results of the study showed that while the
perceptions of retailers about service quality actually
provided by the department stores was above the scale
neutral point; significant gaps existed between the
actual and expected service ratings.

Evans and Lindsey (1999) proposed the view that
customer satisfaction results from the provision of
goods and services that meet or exceed customer
needs. To retain customers and stay competitive in the
current competitive environment, organization in the
service sector especially banks need to make customer
perception of service quality on priority (Reichheld and
customer who holds positive perception regarding the
organization quality is likely to remain a customer of that organization. Some researchers like Rust and Zahorik (1993) and Nazir (2000) say that for the organizations, current customers provide a potential base for cross-selling and are less expensive for them to keep a current customer than to gain a new one. Rust and Zahorik (1993) contended that service quality makes a significant contribution to profitability. Service quality has also been recognized as a driver of corporate marketing and financial performance (Buttle, 1996). Assessment of customer perceptions has thus, become an important research topic as it has significant relationship to costs, return on investment, profitability, customer satisfaction, customer retention, service guarantee and marketing performance.

In India some practitioners and researchers have highlighted the need for better service quality in banks (Narnayana and Brahmanandam, 1990; Nageswar 1987; Elias, 1982; Srivastva, 1994; Malhotra and Arora, 1999; Seshu, 1999; Harsh, 2001; Nazir, 2000; Kumar & Mittal, 2002; Mushtaq, 2003; Debasish, 2003 and Krishnaveni & Prabha, 2004-05). These studies also express the worries of the researchers regarding the present trend of customer dissatisfaction among public sector banks. On account of the rising importance of the concept of service quality, several researchers have tried to define and conceptualize the dimensions of service quality (Lehtinen and Lehtinen, 1982 & 1991; Gronroos, 1984; Kotler, 1999; and Lewis and Booms, 1983). But the most widely reported set of definition of service quality is that of Berry and his colleagues (Parasuraman, Zeithaml and Berry, 1985, 1988).

Objectives

- To study and analyze the perceptions of the bank customers regarding e-delivery channels.
- Strategies to enhance the e-banking services.

Hypothesis

There is no significant difference in the opinion of the three bank group’s customers regarding e-banking services.

Research Methodology and Database

Research Methodology

The study is based on a survey conducted in Ludhiana (Punjab) in September, 2008. Public sector banks, Indian private sector banks and foreign banks operating in Ludhiana district of Punjab form the universe of the study. We have selected Ludhiana district of Punjab because all the bank groups’ branches are working in this district and it is known as industrial district of Punjab and it is also thickly populated. We have selected the three banks, one from each bank group. Further we selected three branches one from each bank group which are providing e-banking services. Total sample size is 768 which is equally divided among the three bank branches. The customers of only three banks have been taken which has experience of at least three years.

Data was analyzed with the help of percentage, ranking, weightage average score (WAS) method. The respondents were asked to respond on five-point likerts scale i.e. highly dissatisfied, dissatisfied, undecided, satisfied, highly satisfied regarding various statements. Weights of 2, 1, 0,-1,-2 were assigned to these levels of scale respectively for calculating the weightage average score. On the other hand, for the purpose of ranking, the following step-by-step method has been followed.

First Step: Firstly, in respect of some comparative issues, the number of times factor occupied the 1st, 2nd——— nth rank were computed in terms of frequency.

Second Step: Weights are assigned to each rank in the descending order. Weightage pattern was as: 1st rank-3, 2nd rank-2 and 3rd rank-1.

Third Step: The sum of the above given weights, for all the ranks were calculated which is denoted in the above step.

Fourth Step: Overall ranks were assigned on the basis of total score values for each factor calculated in the above step.

Database

Field Survey Results

Findings

Socio-Economic Profile of the Bank Customers

In table 1 total sample of customers 768 is equally divided into public, private and foreign banks. Among customers the maximum are male. The maximum
customers are post-graduates and belong to service class. 40.89 pc customers are under 25 years. The level of income affects the thinking of the customers. In the present survey, 41.66 pc customers have income above 2 laces.

**Table 1**

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Public</td>
<td>256</td>
<td>33.33</td>
</tr>
<tr>
<td>2. Private</td>
<td>256</td>
<td>33.33</td>
</tr>
<tr>
<td>3. Foreign</td>
<td>256</td>
<td>33.33</td>
</tr>
<tr>
<td>1. Male</td>
<td>516</td>
<td>67.19</td>
</tr>
<tr>
<td>2. Female</td>
<td>252</td>
<td>32.81</td>
</tr>
<tr>
<td>1. High School</td>
<td>48</td>
<td>6.25</td>
</tr>
<tr>
<td>2. Graduate</td>
<td>294</td>
<td>38.28</td>
</tr>
<tr>
<td>3. Post-Grad</td>
<td>372</td>
<td>48.44</td>
</tr>
<tr>
<td>4. Doctorate</td>
<td>54</td>
<td>7.03</td>
</tr>
<tr>
<td>1. Service</td>
<td>414</td>
<td>53.91</td>
</tr>
<tr>
<td>2. Business</td>
<td>138</td>
<td>17.97</td>
</tr>
<tr>
<td>3. Industry</td>
<td>52</td>
<td>6.77</td>
</tr>
<tr>
<td>4. Agriculture</td>
<td>18</td>
<td>2.34</td>
</tr>
<tr>
<td>5. Professional</td>
<td>82</td>
<td>10.68</td>
</tr>
<tr>
<td>6. Others</td>
<td>64</td>
<td>8.33</td>
</tr>
<tr>
<td>1. Upto 1 lac</td>
<td>178</td>
<td>23.18</td>
</tr>
<tr>
<td>2. 1-2 lac</td>
<td>270</td>
<td>35.16</td>
</tr>
<tr>
<td>3. Above 2 lac</td>
<td>320</td>
<td>41.66</td>
</tr>
<tr>
<td>1. Upto 25</td>
<td>314</td>
<td>40.89</td>
</tr>
<tr>
<td>2. 26-35</td>
<td>244</td>
<td>31.77</td>
</tr>
<tr>
<td>3. 36-45</td>
<td>138</td>
<td>17.97</td>
</tr>
<tr>
<td>4. Above 45</td>
<td>72</td>
<td>9.37</td>
</tr>
<tr>
<td>Total</td>
<td>768</td>
<td>100.00</td>
</tr>
</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>e-channels</th>
<th>Total Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATM</td>
<td>5024</td>
<td>1</td>
</tr>
<tr>
<td>Credit Card</td>
<td>3564</td>
<td>2</td>
</tr>
<tr>
<td>Debit Card</td>
<td>3284</td>
<td>3</td>
</tr>
<tr>
<td>M-banking</td>
<td>2790</td>
<td>5</td>
</tr>
<tr>
<td>I-banking</td>
<td>3140</td>
<td>4</td>
</tr>
<tr>
<td>Tele-banking</td>
<td>1778</td>
<td>7</td>
</tr>
<tr>
<td>Smart Card</td>
<td>1902</td>
<td>6</td>
</tr>
</tbody>
</table>

Source: Field Survey Results

Now-a-days customers prefers e-delivery channels because these channels are very cheap, time saving and easy available. Table 2 also exhibits that the most preferred e-delivery channel by customers is ATM because it is easily available and very convenient. Second preference is given to credit cards. Least preferred e-channels by customers are Tele-banking, smart cards, M-banking, I-banking and debit cards.

**ATM-Customers Perception**

ATM is the most popular e-delivery channel in the banking industry. In the present scenario of information technology satisfaction or delightedness is the prime aim of the banking industry. Table 3 shows the customers perception about the use of ATM. Survey shows that overall, 62.24 pc customers are highly satisfied and 36.20 pc are satisfied among all the three bank groups. The maximum customers of Indian private sector banks are highly satisfied. Chi-sq test highlights that there is a significant difference at 1% LOS in the responses of respondents from three bank groups. WAS of all the three bank groups is above 1 which shows that customers of these bank groups are satisfied from the service of ATM. Sex wise, females are more satisfied. Occupation wise, professionals and agriculturist are highly satisfied. Age wise, young people are more satisfied.

Overall, there is a significant difference in the opinion of the customers of private and foreign bank groups and statistically this difference is also significant at 5% LOS.
Credit Cards-

Customers Perception

The customers need not carry any cash and empowered to spend wherever and whenever he wants with his credit. Whenever a person uses the card, the merchant who in turn can get the money transferred to his account from the banks to buyer. Table 4 depicts the opinion of customers about the performance of credit card. Overall, 30.73 pc are highly satisfied and 48.96 pc are satisfied from the use of credit card among all the three bank groups. Majority of customers are from private sector banks. Chi-sq test shows the significant difference in the opinion of the customers among all the three bank groups at 5% LOS. WAS of public and private sector banks are above 1 which indicates that customers of these bank groups are satisfied from the service of credit card. Sex wise, females are highly satisfied i.e. 36.51 pc. Occupation wise, highly satisfied customers are the maximum from business class. On the basis of age, old age person are more satisfied.

Overall, there is a insignificant difference in the opinion of the customers of all the three bank groups.

### Table 4

#### ATM-Customers Perceptions

<table>
<thead>
<tr>
<th>Group</th>
<th>HDS%</th>
<th>DS%</th>
<th>UDC%</th>
<th>SFD%</th>
<th>HS%</th>
<th>WAS</th>
<th>Chi-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Public</td>
<td>0.78</td>
<td>2.34</td>
<td>0.78</td>
<td>43.75</td>
<td>52.34</td>
<td>1.45</td>
<td></td>
</tr>
<tr>
<td>2. Private</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Foreign</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>0.79</td>
<td>1.16</td>
<td>0.39</td>
<td>39.53</td>
<td>58.91</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>2. Female</td>
<td></td>
<td>0.79</td>
<td></td>
<td>29.37</td>
<td>69.05</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Service</td>
<td>0.48</td>
<td>0.97</td>
<td>0.48</td>
<td>42.03</td>
<td>56.04</td>
<td>1.52</td>
<td></td>
</tr>
<tr>
<td>2. Business</td>
<td></td>
<td>1.45</td>
<td></td>
<td>26.09</td>
<td>72.46</td>
<td>1.70</td>
<td></td>
</tr>
<tr>
<td>3. Industry</td>
<td></td>
<td></td>
<td></td>
<td>30.77</td>
<td>69.23</td>
<td>1.69</td>
<td></td>
</tr>
<tr>
<td>4. Agriculture</td>
<td></td>
<td></td>
<td></td>
<td>22.22</td>
<td>77.78</td>
<td>1.78</td>
<td></td>
</tr>
<tr>
<td>5. Professional</td>
<td></td>
<td></td>
<td></td>
<td>21.95</td>
<td>75.61</td>
<td>1.71</td>
<td></td>
</tr>
<tr>
<td>6. Others</td>
<td></td>
<td></td>
<td></td>
<td>46.88</td>
<td>53.12</td>
<td>1.53</td>
<td></td>
</tr>
<tr>
<td>Present Age (yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Upto 25</td>
<td>0.82</td>
<td>1.27</td>
<td></td>
<td>34.39</td>
<td>64.33</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>2. 26-35</td>
<td></td>
<td>2.90</td>
<td>1.45</td>
<td>36.23</td>
<td>59.42</td>
<td>1.52</td>
<td></td>
</tr>
<tr>
<td>3. 36-45</td>
<td></td>
<td></td>
<td></td>
<td>44.44</td>
<td>55.56</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>4. Above 45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0.26</td>
<td>1.04</td>
<td>0.26</td>
<td>36.20</td>
<td>62.24</td>
<td>1.59</td>
<td></td>
</tr>
</tbody>
</table>

Significance of difference of proportions:

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Public Banks</th>
<th>Private Banks</th>
<th>Foreign Banks</th>
<th>Stat.</th>
<th>Signi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs. 2</td>
<td>P1</td>
<td>P2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>0.99</td>
<td>0.99</td>
<td>0.96</td>
<td>2.34</td>
<td>*</td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>1.00</td>
<td>0.96</td>
<td>3.19</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey Results
Note: HDS-Highly Dissatisfied, DS-Dissatisfied, UDC-Undecided, SFD-Satisfied, HS-Highly Satisfied
Table 4  
Credit Card-Customers Perception

<table>
<thead>
<tr>
<th>Group</th>
<th>HDS%</th>
<th>DS%</th>
<th>UDC%</th>
<th>SFD%</th>
<th>HD%</th>
<th>WAS</th>
<th>Chi-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Public</td>
<td>1.56</td>
<td>7.03</td>
<td>11.72</td>
<td>46.09</td>
<td>33.59</td>
<td>1.03</td>
<td>Chi^2=19.54*</td>
</tr>
<tr>
<td>2. Private</td>
<td>4.69</td>
<td>14.84</td>
<td>47.66</td>
<td>32.81</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Foreign</td>
<td>1.56</td>
<td>10.94</td>
<td>8.59</td>
<td>53.12</td>
<td>25.78</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Male</td>
<td>1.16</td>
<td>10.38</td>
<td>12.79</td>
<td>48.06</td>
<td>27.91</td>
<td>0.91</td>
<td></td>
</tr>
<tr>
<td>4. Female</td>
<td>0.79</td>
<td>2.38</td>
<td>9.52</td>
<td>50.79</td>
<td>36.51</td>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Service</td>
<td>1.93</td>
<td>10.63</td>
<td>8.70</td>
<td>52.66</td>
<td>26.09</td>
<td>0.90</td>
<td>Chi^2=79.20**</td>
</tr>
<tr>
<td>8. Business</td>
<td>5.80</td>
<td>13.04</td>
<td>34.78</td>
<td>46.38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Industry</td>
<td>3.85</td>
<td>35.69</td>
<td>38.46</td>
<td>1.31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Agriculture</td>
<td>1.11</td>
<td>44.44</td>
<td>59.38</td>
<td>1.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Professional</td>
<td>2.44</td>
<td>21.95</td>
<td>41.46</td>
<td>34.15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Others</td>
<td>3.12</td>
<td>25.00</td>
<td>59.38</td>
<td>1.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present Age (yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Upto 25</td>
<td></td>
<td>3.28</td>
<td>12.74</td>
<td>56.05</td>
<td>27.39</td>
<td>1.07</td>
<td>Chi^2=44.54**</td>
</tr>
<tr>
<td>4. 26-35</td>
<td></td>
<td>8.20</td>
<td>9.02</td>
<td>45.08</td>
<td>34.43</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>5. 36-45</td>
<td></td>
<td>14.49</td>
<td>14.49</td>
<td>43.48</td>
<td>27.54</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>6. Above 45</td>
<td></td>
<td>8.33</td>
<td>11.11</td>
<td>41.67</td>
<td>38.89</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.04</td>
<td>7.55</td>
<td>11.72</td>
<td>48.96</td>
<td>30.73</td>
<td>1.01</td>
<td></td>
</tr>
</tbody>
</table>

Significance of difference of proportions:

<table>
<thead>
<tr>
<th>1. Public Banks</th>
<th>2. Private Banks</th>
<th>3. Foreign Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs. 2</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>0.80</td>
<td>0.79</td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>0.80</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Source: Same as table 3

Debit Card-Customers Perception

Debit card is also one of the e-delivery services provided by the banks. It is just like a credit card and has a same store value. Debit card is also becoming popular among the customers. Table 4 reveals the perceptions of customers about the performance of debit card. Overall, 33.33 pc customers are highly satisfied and 50.78 pc are satisfied from public, private and foreign bank groups. The maximum respondents are from public sector banks. Chi-sq test indicates that there is a significant difference in the opinion of the customers from all the three bank groups at 5% LOS. WAS of public and private bank groups are above 1 which shows that the customers from these bank groups are satisfied from the service of debit card. Gender wise, males are more satisfied. Occupation wise, the maximum highly satisfied customers i.e. 36.71 pc are from service class. Age wise, majority of highly satisfied customers are from 36-45 age group.

Overall, there is an insignificant difference in the opinion of the customers of public and foreign sector banks.
Internet Banking-Customers Perception

Internet is a network of network. Touching lifestyles in every sphere the NET has redefined methods of communication, work, study, education, health, trade and commerce. The NET is changing everything, from the way we distribute information. Table 6 exhibits the opinion of customers about the use of I-banking. The survey shows that 26.56 pc customers are highly satisfied and 48.18 pc are satisfied. Majority of customers are from public sector banks who are highly satisfied. Chi-sq test shows the significant difference in the opinion of the customers at 1% LOS from all the three bank groups. WAS of only public sector bank group is above 1 which indicates that respondents from this bank group are satisfied from the service of internet banking. Sex wise, females are more satisfied. Occupation wise, majority of highly satisfied customers i.e. 41.46 pc are professionals. Age wise, young people are highly satisfied.

Overall, there is a insignificant difference in the opinion of the customers from all the three bank groups.

### Table 5

<table>
<thead>
<tr>
<th>Group</th>
<th>HDS%</th>
<th>DS%</th>
<th>UDC%</th>
<th>SFD%</th>
<th>HS%</th>
<th>WAS</th>
<th>Chi-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Public</td>
<td>2.34</td>
<td>2.34</td>
<td>14.06</td>
<td>41.41</td>
<td>39.84</td>
<td>1.14</td>
<td>Chi^2=26.36**</td>
</tr>
<tr>
<td>2. Private</td>
<td>3.91</td>
<td>12.50</td>
<td>50.78</td>
<td>32.81</td>
<td>1.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Foreign</td>
<td>0.78</td>
<td>3.12</td>
<td>8.59</td>
<td>60.16</td>
<td>27.34</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>1.16</td>
<td>3.88</td>
<td>11.24</td>
<td>48.45</td>
<td>35.27</td>
<td>1.13</td>
<td>Chi^2=6.82</td>
</tr>
<tr>
<td>2. Female</td>
<td>0.79</td>
<td>1.59</td>
<td>12.70</td>
<td>55.56</td>
<td>29.37</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Service</td>
<td>0.97</td>
<td>2.90</td>
<td>10.63</td>
<td>48.79</td>
<td>36.71</td>
<td>1.17</td>
<td>Chi^2=32.49*</td>
</tr>
<tr>
<td>2. Business</td>
<td>1.45</td>
<td>4.35</td>
<td>11.59</td>
<td>47.83</td>
<td>34.78</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td>3. Industry</td>
<td>3.85</td>
<td>7.69</td>
<td>57.69</td>
<td>30.77</td>
<td>1.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Agriculture</td>
<td>33.33</td>
<td>55.56</td>
<td>11.11</td>
<td>0.78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Professional</td>
<td>2.44</td>
<td>5.44</td>
<td>7.32</td>
<td>53.66</td>
<td>34.15</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>6. Others</td>
<td>3.12</td>
<td>21.88</td>
<td>59.38</td>
<td>15.62</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present Age (yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Upto 25</td>
<td>0.64</td>
<td>2.55</td>
<td>12.74</td>
<td>54.14</td>
<td>29.94</td>
<td>1.10</td>
<td>Chi^2=22.70*</td>
</tr>
<tr>
<td>2. 26-35</td>
<td>2.46</td>
<td>3.28</td>
<td>9.84</td>
<td>50.00</td>
<td>34.43</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>3. 36-45</td>
<td>5.80</td>
<td>14.49</td>
<td>40.58</td>
<td>39.13</td>
<td>1.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Above 45</td>
<td>8.33</td>
<td>58.33</td>
<td>33.33</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.04</td>
<td>3.12</td>
<td>11.72</td>
<td>50.78</td>
<td>33.33</td>
<td>1.12</td>
<td></td>
</tr>
</tbody>
</table>

Significance of difference of proportions:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs. 2</td>
<td>0.81</td>
<td>0.84</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>0.81</td>
<td>0.88</td>
<td>1.95</td>
<td></td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>0.84</td>
<td>0.88</td>
<td>1.26</td>
<td></td>
</tr>
</tbody>
</table>

Source: Same as table 3
Mobile banking is becoming popular day by day. Mobile is very cheap and every person can buy it. Mobile banking offers a full range of benefits for financial institutions, ranging from reduced customer support costs to improved customer satisfaction and retention as well as revenue growth. Table 7 highlights the perceptions of customers about M-banking. The survey shows that overall, 24.74 pc customers are highly satisfied and belongs to public sector banks. Chi-sq test shows the significant difference in the opinion of the customers at 1% LOS among all three the bank groups. WAS of three bank groups is less than 1 which indicates that customers of these bank groups are not satisfied from the service of M-banking. Sex wise, females are more satisfied. Occupation wise, professionals are highly satisfied. Age wise, the maximum customers i.e. 26.09 pc are highly satisfied and belongs to 36-45 age group.

Overall, there is a significant difference in the opinion of the customers of private and foreign bank group. Statistically this difference is at 1% LOS.
Smart Card: Customers Perception

Smart card is a microchip, which will store the monetary value. When a transaction is made using the card, the monetary value gets debited and balance comes down automatically. Customers prefer smart card because of its large storage capacity and time saving feature. Table 8 also shows the responses of customers of three bank groups about the use of smart card. Survey reveals that overall 26.04 pc customers are highly satisfied and 35.16 pc are satisfied among all the three bank groups. Majority of highly satisfied customers i.e 36.72 pc are from public sector banks.

Chi-sq test highlights that there is a significant difference in the opinion of the customers among all the three bank groups at 1% LOS. WAS of all the three bank groups is less than 1 which indicates that customers not satisfied of these bank group from the service of smart card. Sex wise, females are more satisfied. Occupation wise, businessman i.e. 31.88 pc are more satisfied. Age wise, young people are more satisfied.

Overall, there is a significant difference in the responses of the customers of public sector and foreign bank groups. Statistically this difference is at 5% LOS.

### Table 7

**Mobile Banking: Customers Perception**

<table>
<thead>
<tr>
<th>Group</th>
<th>HDS%</th>
<th>DS%</th>
<th>UDC%</th>
<th>SFD%</th>
<th>HS%</th>
<th>WAS</th>
<th>Chi-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Public</td>
<td>3.12</td>
<td>3.91</td>
<td>28.12</td>
<td>26.56</td>
<td>38.28</td>
<td>0.93</td>
<td>Chi^2=74.31**</td>
</tr>
<tr>
<td>2. Private</td>
<td>6.25</td>
<td>34.38</td>
<td>39.84</td>
<td>19.53</td>
<td>19.53</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>3. Foreign</td>
<td>4.69</td>
<td>25.00</td>
<td>53.91</td>
<td>16.41</td>
<td>16.41</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>1.16</td>
<td>6.59</td>
<td>31.40</td>
<td>39.92</td>
<td>20.93</td>
<td>0.73</td>
<td>Chi^2=20.70**</td>
</tr>
<tr>
<td>2. Female</td>
<td>0.79</td>
<td>1.59</td>
<td>24.60</td>
<td>40.48</td>
<td>32.54</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Service</td>
<td>1.45</td>
<td>4.83</td>
<td>27.05</td>
<td>41.06</td>
<td>25.60</td>
<td>0.85</td>
<td>Chi^2=32.61*</td>
</tr>
<tr>
<td>2. Business</td>
<td>1.45</td>
<td>5.80</td>
<td>30.43</td>
<td>39.13</td>
<td>23.19</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>3. Industry</td>
<td>7.69</td>
<td>15.38</td>
<td>57.69</td>
<td>19.23</td>
<td>19.23</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>4. Agriculture</td>
<td>33.33</td>
<td>55.56</td>
<td>11.11</td>
<td>11.11</td>
<td>11.11</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>5. Professional</td>
<td>2.44</td>
<td>31.71</td>
<td>31.71</td>
<td>34.15</td>
<td>34.15</td>
<td>0.98</td>
<td></td>
</tr>
<tr>
<td>6. Others</td>
<td>6.25</td>
<td>46.88</td>
<td>28.12</td>
<td>18.75</td>
<td>18.75</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Present Age (yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Upto 25</td>
<td>0.64</td>
<td>5.10</td>
<td>28.66</td>
<td>38.22</td>
<td>27.39</td>
<td>0.87</td>
<td>Chi^2=24.34*</td>
</tr>
<tr>
<td>2. 26-35</td>
<td>2.46</td>
<td>5.74</td>
<td>23.77</td>
<td>45.08</td>
<td>22.95</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td>3. 36-45</td>
<td>1.45</td>
<td>36.23</td>
<td>36.23</td>
<td>26.09</td>
<td>26.09</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td>4. Above 45</td>
<td>8.33</td>
<td>36.11</td>
<td>38.89</td>
<td>16.67</td>
<td>16.67</td>
<td>0.64</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.04</td>
<td>4.95</td>
<td>29.17</td>
<td>40.10</td>
<td>24.74</td>
<td>0.83</td>
<td></td>
</tr>
</tbody>
</table>

Significance of difference of proportions:

<table>
<thead>
<tr>
<th>1. Public Banks</th>
<th>2. Private Banks</th>
<th>3. Foreign Banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs. 2</td>
<td>0.65</td>
<td>0.59</td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>0.65</td>
<td>0.70</td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>0.59</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Source: Same as table 3
Tele-Banking: Customers Perception

The customers can do entire non-cash related banking over the phone anywhere and at anytime. Automatic voice recorder or ID numbers are used for rendering Tele-banking services which have added convenience to the customers. Table 9 exhibits the customer’s perceptions about the use of Tele-banking. Survey depicts that overall 34.38 pc are satisfied and 28.12 pc are highly satisfied. The maximum customers i.e. 39.84 pc are highly satisfied and belongs to public sector banks. Chi-sq test shows the significant difference in the opinion of the customers of the three bank groups at 1% LOS. WAS is less than 1 of all the three bank groups which highlights that customers are not satisfied of these bank groups. Sex wise, females i.e. 34.13 pc are more satisfied. Occupation wise, professionals are more satisfied. Age wise, the maximum highly satisfied customers are from 36-45 age group.

Overall there is a insignificant difference in the opinion of the customers.
e-Channels are the gift of information technology. It is a necessary of time that every bank should provide e-channel services to customers. By providing e-channel services one bank can compete with other banks. Table 8 exhibits that overall 28.65 pc customers are highly satisfied and 41.93 pc are satisfied. The maximum highly satisfied customers i.e. 40.62 pc are from public sector banks. Chi-sq test highlights that there is a significant difference at 1 % LOS in the responses of respondents from three bank groups. WAS of public sector bank group is above 1 which shows that customers from this group are satisfied with all e-channel. Sex wise, females are more satisfied. Occupation wise, majority of highly satisfied respondents are businessmen. Age wise, the maximum customers i.e. 31.97 pc are from 26-35 age group.

Overall, there is a insignificant difference in the opinion of the customers of all the three bank groups.

Table 9
Tele-Banking: Customers Perception

<table>
<thead>
<tr>
<th>Group</th>
<th>HDS%</th>
<th>DS%</th>
<th>UDC%</th>
<th>SFD%</th>
<th>HS%</th>
<th>WAS</th>
<th>Chi-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Public</td>
<td>3.12</td>
<td>3.12</td>
<td>27.34</td>
<td>26.56</td>
<td>39.84</td>
<td>0.97</td>
<td>Chi^2=45.94**</td>
</tr>
<tr>
<td>2. Private</td>
<td>0.78</td>
<td>8.59</td>
<td>30.47</td>
<td>41.41</td>
<td>18.75</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>3. Foreign</td>
<td>0.78</td>
<td>3.91</td>
<td>34.38</td>
<td>35.16</td>
<td>25.78</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Male</td>
<td>2.33</td>
<td>6.59</td>
<td>33.33</td>
<td>32.56</td>
<td>25.19</td>
<td>0.72</td>
<td>Chi^2=21.40**</td>
</tr>
<tr>
<td>2. Female</td>
<td>2.38</td>
<td>25.40</td>
<td>38.10</td>
<td>34.13</td>
<td>1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Service</td>
<td>1.45</td>
<td>3.86</td>
<td>29.47</td>
<td>36.71</td>
<td>28.50</td>
<td>0.87</td>
<td>Chi^2=42.28**</td>
</tr>
<tr>
<td>2. Business</td>
<td>2.90</td>
<td>4.35</td>
<td>31.88</td>
<td>28.99</td>
<td>31.88</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>3. Industry</td>
<td>11.54</td>
<td>26.92</td>
<td>46.15</td>
<td>15.38</td>
<td>0.65</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Agriculture</td>
<td>4.44</td>
<td>44.44</td>
<td>33.33</td>
<td>22.22</td>
<td>0.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Professional</td>
<td>4.88</td>
<td>26.83</td>
<td>24.39</td>
<td>41.46</td>
<td>0.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Others</td>
<td>12.50</td>
<td>40.62</td>
<td>34.38</td>
<td>12.50</td>
<td>0.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present Age (yrs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Upto 25</td>
<td>0.64</td>
<td>7.64</td>
<td>27.39</td>
<td>37.58</td>
<td>26.75</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>2. 26-35</td>
<td>4.10</td>
<td>2.46</td>
<td>28.69</td>
<td>35.25</td>
<td>29.51</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td>3. 36-45</td>
<td>2.90</td>
<td>39.13</td>
<td>24.64</td>
<td>33.33</td>
<td>0.88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Above 45</td>
<td>8.33</td>
<td>36.11</td>
<td>36.11</td>
<td>19.44</td>
<td>0.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1.56</td>
<td>5.21</td>
<td>30.73</td>
<td>34.38</td>
<td>28.12</td>
<td>0.82</td>
<td></td>
</tr>
</tbody>
</table>

Significance of difference of proportions:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 vs. 2</td>
<td>0.66</td>
<td>0.60</td>
<td>1.47</td>
<td></td>
</tr>
<tr>
<td>1 vs. 3</td>
<td>0.66</td>
<td>0.61</td>
<td>1.29</td>
<td></td>
</tr>
<tr>
<td>2 vs. 3</td>
<td>0.60</td>
<td>0.61</td>
<td>0.18</td>
<td></td>
</tr>
</tbody>
</table>

Source: Same as table 3

All e-Channels- Customers Perception

E-Services in Bank- Solution for Better Tomorrow
A comparison of the overall WAS in table 3 to 8 of different e-channels reveals that WAS for all the e-channels except I-banking, M-banking, smart cards, Tele-banking is more than 1 which indicates that the respondents are satisfied with these e-channels.

**IMPLICATIONS**

The major implication of the paper is that customers of the all bank groups are willing to accept e-channels or e-banking services. Survival of the Indian banking industry only depends upon the e-delivery channels. If a bank will not adopt these channels their customers will shift to another bank and its survival will become very difficult in the highly competitive, privatization, globalization an IT era.

**STRATEGIES TO ENHANCE E-BANKING SERVICES**

New private sector banks and foreign banks are by birth fully computerized and many banks are providing all e-banking facilities. They have started
to penetrate in rural and semi-urban areas also which will be very harmful for the public sector banks. The customers of the public sector banks have started to shift in e-banks. Public sector banks should create awareness regarding e-banking facility in rural and semi-urban areas. They may be loser in the beginning but will be gainer in the future. Their survival also depends upon the adoption of e-bank services. Public sector banks should open their e-banking branches in the advanced and semi-urban areas. They can also open their branches at the focal point.

Conclusion

The paper concludes that customers have shown positive attitude towards e-banking services. Indian private sector banks and foreign banks customers’ are highly in favour of e-delivery channels. Females have shown more preference regarding e-channels compared to males. Similarly, professionals and youth is in favour of e-banking services. This paper also draws the conclusion that public sector banks should try to enhance the e-banking services.

FUTURE AREAS OF RESEARCH

A comprehend research study is required on the following aspects.

- State-wise adoption of e-channels
- Penetration e-banking in rural sector
- Strategies to develop low cost e-channel
- A comparison of e-banking services in India with the developed countries.

References

VALIDATING METRICS ON THE BASIS OF OBJECT ORIENTED

Gurvinder Kaur*
Vijay Singhal**

Abstract: Object-oriented design and development is very popular in today’s software development environment. It requires not only a different approach to design and implementation; it also requires a different approach to software metrics. This technology uses objects as its fundamental building blocks. IT professionals have to work using some kind of metrics to measure their productivity and the quality of their outcome. A wide range of metrics can aid in managing projects. A set of product metrics that highlight and quantify a system’s object-oriented (OO) properties are discussed in the paper. To get a handle on how metrics can be useful the field is divided into two broad categories: process metrics and product metrics. The purpose of this paper is to help project managers choose a comprehensive set of metrics, not by default, but by using a set of metrics based on attributes and features of object oriented technology.

1. Introduction

Metrics can play a valuable role in system development. OO metrics, in particular, can be used to help a) size and estimate work b) define review policies and development guidelines c) prioritize review and inspection efforts, and d) assess overall system quality. OO metrics can be grouped into four categories: 1) System size - System size metrics correlate to the total effort required for system construction. 2) Class or method size - Class or method size metrics can be considered to be equivalent to design or quality metrics because unusually large classes or methods indicate ill-conceived abstractions or overly complex implementations. 3) Coupling and inheritance - Coupling and inheritance metrics help measure the quality of an object model. 4) Class or method internals - This metric reveals how complex classes and methods are and how they are documented in code comments.

In Object-Oriented Metrics Brian Henderson-Sellers describes a number of such categories: reliability, availability, maintainability, understandability, modifiability, testability, and usability. Object oriented design is concerned with developing an object-oriented module of a software system to apply the identified requirements. Designer will use OOD because it is a faster development process, module based architecture, contains high reusable features, increases design quality and so on.

“Object-oriented design is a method of design encompassing the process of object oriented decomposing and a notation for depicting both logical and physical as well as static and dynamic models of the system under design” [BOO94]. Objects are the basic units of object oriented design. Identity, states and behaviors are the main characteristics of any object. A class is a collection of objects which have common behaviors. “A class represents a template for several objects and describes how these objects are structured internally. Objects of the same class have the same definition both for their operation and for their information structure” [JAC92].

2. Applying of Metrics

There are almost countless ways of applying metrics to the projects. 1) Sizing with a variety of metrics – The project planning requires determining a system’s current size and also estimating the size of future changes. The correlation of measures, such as LOC and function calls, means that they tend to move

*Gurvinder Kaur, Asso. Prof., Tecnia Institute of Advanced Studies, MCA Dept., Email id – allagh.gurvinder@gmail.com
**Vijay Singhal, Asso. Prof., Tecnia Institute of Advanced Studies, MCA Dept., Email id – vijay_singhal77@yahoo.com

Tecnia Journal of Management Studies Vol. 4 No. 1, April 2009 – September 2009
together. A system that has a high LOC value is highly likely to also have a high number of function calls, and vice versa. Another way to look at it is that their ratios are nearly constant from one system to another. 2) Measuring method and class complexity - Method complexity almost directly relates to how likely errors will be. Attempting to reduce complexity is one of the ways developers in the procedural- language world employ the cyclomatic complexity metric, which is also useful for analyzing OO systems. Even in OO systems complexity can be measured to screen methods for potential problems. 3) Determining critical quality - To find out how much quality there is in the system, number of metrics that provide abnormal measures at the system level can be found. Small systems seem to have a wide-ranging quality level. These are all production systems. There is less need for formal documentation since a small team has less communication overhead. With a small handful of developers, software can be more complex because good developers can more easily understand the whole system.

A large number of object-oriented metrics have been proposed over the last decade [BEN99] [BRI98] [CHI94]. The basic premise behind the development of object-oriented metrics is that they serve as early predictors of classes that contain faults or that are costly to maintain. [BIN98][BRI98].

2.1 Class Metrics

AHF (Attribute Hiding Factor) is the ratio of the sum of inherited attributes in all system classes under consideration to the total number of available classes attributes [MOR88], CCO (Class Cohesion) measures relations between classes [CHI91], CEC (Class Entropy Complexity) measures the complexity of classes based on their information content [DAV97], CLM (Comment Lines per Method) measures the complexity of classes based on their information content [DAV97] ,CM (Comment Lines per Method) measures the percentage of comments in methods [LOR94], DAM (Data Access Metric) is the ratio of the number of private attributes to the total number of attributes declared in the class [DAV97], FOC (Function Oriented Code) measures the percentage of non object-oriented code that is used in a program [LOR94], INP (Internal Privacy) refers to the use of accessory functions even within a class [CHI94], LCM (Lack of Cohesion between Methods) indicates the lack of cohesion between the methods [CHI94], MAA (Measure of Attribute Abstraction) is the ratio of the number of attributes inherited by a class to the total number of attributes in the class [DAV97], MFA (Measure of Functional Abstraction) is the ratio of the number of methods inherited by a class to the total number of methods accessible by members in the class [DAV97], MHF (Method Hiding Factor) is defined as the ratio of the sum of the invisibilities of all methods defined in all classes to the total number of methods defined in the system under consideration [HAR98], NAD (Number of Abstract Data types) is the number of user-defined objects used as attributes in a class that are necessary to instantiate an object instance of the class [DAV97], NCM (Number of Class Methods in a class) measures the measures available in a class but not in its instances [LOR94], NIV (Number of Instance Variables in a class) measures relations of a class with other objects of the program [LOR94], NOA (Number Of Ancestors) is the total number of ancestors of a class [KOL93], NPA (Number of Public Attributes) counts the number of attributes declared as public in a class [DAV97], NPM (Number of Parameters per Method) is the average number of parameters per method in a class [DAV97], NRA (Number of Reference Attributes) counts the number of pointers and references used as attributes in a class [DAV97], PCM (Percentage of Commented Methods) is the percentage of commented methods [LOR94], PDA (Public Data) counts the accesses of public and protected data of a class [MCA94], PMR (Percent of Potential Method uses actually Reused) is the percentage of the actual method uses [MOR88], PPD (Percentage of Public Data) is the percentage of the public data of a class [MCA94], RFC (Response For a Class) is the number of methods in the set of all methods that can be invoked in response to a message sent to an object of a class [SHA93], WCS (Weighted Class Size) is the number of ancestors plus the total class method size [KOL93], WMC (Weighted Methods per Class) is the sum of the weights of all the class methods [MCA94].

2.2 Method Metrics

AMC (Average Method Complexity) is the sum of the cyclomatic complexity of all methods divided by the total number of methods [MOR88], AMS (Average Method Size) measures the average size of program methods [LOR94], MAG (MAX V (G)) is the maximum cyclomatic complexity of the methods of one class [MCA94], MCX (Method Complexity) relates complexity with the number of messages [LOR94] [DRE89].

2.3 Coupling Metrics

CBO (Coupling Between Objects) counts the
number of classes a class is coupled with [FEN97], CCP (Class Coupling) measures connections between classes based on the messages they exchange [BOY93], CFA (Coupling Factor) is the ratio of the maximum possible number of couplings in the system to the actual number of couplings not imputable to inheritance [HAR].

2.4 Inheritance Metrics

AIF (Attribute Inheritance Factor) is the ratio of the sum of inherited attributes in all classes of the system under consideration to the total number of available attributes for all classes [BAS96], DIT (Depth of Inheritance Tree) measures the number of ancestors of a class [BAS96] [SHI97], FEF (Factoring Effectiveness) is the number of unique methods divided by the total number of methods [MOR88], FIN (FAN-IN) is the number of classes from which a class is derived and high values indicate excessive use of multiple inheritance [MCA94], HNL (Class Hierarchy Nesting Level) measures the depth in hierarchy that every class is located [LOR91], MIF (Method Inheritance Factor) is the ratio of the sum of the inherited methods in all classes to the total number of available methods for all classes [HAR], MRE (Method Reuse metrics) indicate the level of methods reuse [ABR94], NMI (Number of Methods Inherited) measures the number of methods a class inherits [LOR94], NMO (Number of Methods Overridden) is the number of methods need to be re-declared by the inheriting class [LOR94], NOC (Number Of Children) is the total number of children of a class [ROSEN97], PFA (Polymorphism Factor) is the ratio of the actual number of possible different polymorphic situations of a class to the maximum number of possible distinct polymorphic situations for this class [ABR94], PMO (Percent of Potential Method uses Overridden) is the percentage of the overridden methods [MOR88], RDB (Ratio between Depth and Breadth) is the ratio between the depth and the width of the hierarchy of the classes [BEL99], RER (Reuse Ratio) is the ratio of the total number of object reuses divided by the total number of library objects [MOR88], PRC (Problem Reports per Class) measures defect reports on this class [LOR94], PRO (Percent of Reused Objects Modified) declares the percentage of the reused objects that have been modified [BEL99], SRE (System Reuse) declares the percentage of the reuse of classes [ABR94].

2.6 Meta Metrics

Meta-metrics have been used for the evaluation of metrics [CON86] since 1986. Desirable characteristic of software metrics have been proposed at a higher level of abstraction by Weyuker [WEYU88]. Seven different meta-metrics that cover all aspects of the measurements procedure are used. 1) Measurement scale (MS). The values assigned to a metric could be on various scales. Such scales, according to Stevens [STE47], are: nominal, ordinal, interval, ratio and absolute. Metrics on nominal or ordinal scale could not be used as easily as metrics on ratio or absolute scale. 2) Measurements independence (MI). The ability of a metric to always offer the same result (measurement) for the same measured unit is important. Metrics that may have various interpretations from different users could not easily be used in surveys of historical data. For example, measurements of LOC need clarification on how lines of code have been measured but measurements of the number of separate classes need no further clarification and are similar to all measurement programs. 3) Automation (AU). The effort required to automate a metric varies. Some metrics are relatively easy to implement (e.g. LOC), some more difficult (e.g. HNL).
and some could not be implemented due to their nature (e.g. PMO). 4) Value of implementation (VI). This examines if the result of the metrics is dependent on the implementation. If the metric is independent of implementation, it means that there are measurements in early stages which hold regardless of the implementation language and programming style. On the other hand, if a metric is dependent on the implementation, it will offer a way to evaluate the success of the implementation and to take corrective action where needed. 5) Monotonicity (MO). This applies to a metric, if for two units embedded in a third unit the metric’s value for the third unit is always equal or greater than the sum of the metric’s values for the two smaller units. 6) Simplicity (SI). This meta-metric examines how simply a metric is defined related to the simplicity of the metric’s definition, how easily this definition could be understood and facilitate actions in the development plan. 7) Accuracy (AC). This examines if the metric actually measures what is supposed to be measured and how the metric is finally related to the abstract software characteristics or factors are to be measured.

Validation of object-oriented metrics proceeds by investigating the relationship between each metric and the outcome of interest. If this relationship is found to be statistically significant, then the conclusion is drawn that the metric is empirically validated. For example, recent studies used the bi-variate correlation between object-oriented metrics and the number of faults to investigate the validity of the metrics [BIN98]. Also, uni-variate logistic regression models are used as the basis for demonstrating the relationship between object-oriented product metrics and fault-proneness in [BRI98].

3. Metrics For Object Oriented Systems

A significant number of object oriented metrics have been developed in literature. For example, metrics proposed by Abreu [ABR94] [ABR95] [ABR96], C.K metrics [CHIDK93], Li and Henry [LIH93] metrics, MOOD metrics [ABR95], Lorenz and Kidd [LOR94] metrics etc. C.K metrics are the most popular (used) among them. Another comprehensive set of metrics is MOOD metrics.

3.1 Traditional Metrics

There are many metrics that are applied to traditional functional development. In an object-oriented system, traditional metrics are generally applied to the methods that comprise the operations of a class. Methods reflect how a problem is broken into segments [ROS97]. Traditional metrics have been applied for the measurement of software complexity of structured systems since 1976 [MCA99]. The traditional metrics are: AML (Average Module Length), BAM (Binding Among Modules), CCN (Cyclomatic Complexity Number), CDF (Control flow complexity and Data Flow complexity), COC (Conditions and Operations Count), COP (Complexity Pair), COR (Coupling Relation), CRM (Cohesion Ratio Metrics), DEC (Decision Count), DSI (Delivered Source Instructions), ERE (Extent of Reuse), ESM (Equivalent Size Measure), EST (Executable Statements), FCO (Function Count), FUP (Function Points), GLM (Global Modularity), IFL (Information Flow), KNM (Knot Measure), LOC (Lines Of Code), LVA (Live Variables), MNP (Minimum Number of Paths), MOR (Morphology metrics), NLE (Nesting Levels), SSC (composite metric of Software Science and Cyclomatic complexity), SSM (Software Science Metrics), SWM (Specification Weight Metrics), TRI (Tree Impurity) and TRU (Transfer Usage).

The three metrics that are applicable to object oriented development are Complexity, Size, and Readability. To measure the complexity, the cyclomatic complexity is used.

3.1.1 METRIC 1: Cyclomatic Complexity (CC)

Cyclomatic complexity (McCabe) can be used to evaluate the complexity of a method [ROS97]. It is a count of the number of test cases that are needed to test the method comprehensively. The formula for calculating the cyclomatic complexity is the number of edges minus the number of nodes plus 2. For a sequence where there is only one path, no choices or option, only one test case is needed. An IF loop however, has two choices, if the condition is true, one path is tested; if the condition is false, an alternative path is tested. [MCA94] [MCA76] [JAC92].

A method with a low cyclomatic complexity is generally better. This may imply decreased testing and increased understandability or that decisions are deferred through message passing, not that the method is not complex. Cyclomatic complexity cannot be used to measure the complexity of a class because of inheritance, but the cyclomatic complexity of individual methods can be combined with other measures to evaluate the complexity of the class. Although this metric is specifically applicable to the
evaluation of Complexity, it also is related to all of the other attributes [HUD94] [LEE93] [LOR94] [MCA94] [TEG92].

As described in Laing et al. [LIA01], McCabe et al. [MCA99] mention cyclomatic complexity is a measure of a module control flow complexity based on graph theory. Cyclomatic complexity cannot be used to measure the complexity of a class because of inheritance, but the cyclomatic complexity of individual methods can be combined with other measures to evaluate the complexity of the class [ROS97]. A high cyclomatic complexity indicates that the code may be of low quality and difficult to test and maintain [LIA01].

3.1.2 Metric 2: Size

Size of a class is used to evaluate the ease of understanding of code by developers and maintainers. Size can be measured in a variety of ways. These include counting all physical lines of code, the number of statements, the number of blank lines, and the number of comment lines. Lines of Code(LOC) counts all lines. However, since size affects ease of understanding by the developers and maintainers, classes and methods of large size always pose a higher risk. [HUD94] [LOR94] [MCA94]. a) Source Lines of Code (SLOC) - SLOC is used to estimate the total effort that will be needed to develop a program, as well as to calculate approximate productivity. The SLOC metric measures the number of physical lines of active code, that is, no blank or commented lines code [LOR94].

3.1.3 Metric 3: Comment Percentage

The CP metric is defined as the number of commented lines of code divided by the number of non-blank lines of code [LIA01]. The comment percentage is calculated by the total number of comments divided by the total lines of code less the number of blank lines [ROSEN97]. The line counts done to compute the Size metric are expanded to include a count of the number of comments, both online (with code) and stand-alone. The comment percentage is calculated by the total number of comments divided by the total lines of code less the number of blank lines. Since comments assist developers and maintainers, higher comment percentages increase understandability and maintainability [SHA93].

3.2 Object-Oriented Specific Metrics

The selected object oriented metrics are primarily applied to the concepts of classes, coupling, and inheritance. A method is an operation upon an object and is defined in the class declaration. A message is a request that an object makes of another object to perform an operation. The operation executed as a result of receiving a message is called a method.

Cohesion refers to the internal consistency within the parts of the design. Cohesion is centered on data that is encapsulated within an object and on how methods interact with data to provide well-bounded behavior. A class is cohesive when its parts are highly correlated. It should be difficult to split a cohesive class. Cohesion can be used to identify the poorly designed classes. “Cohesion measures the degree of connectivity among the elements of a single class or object” [BOO94].

Coupling is a measure of the strength of association established by a connection from one entity to another. Classes (objects) are coupled when a message is passed between objects; when methods declared in one class use methods or attributes of another class. Inheritance is the hierarchical relationship among classes that enables programmers to reuse previously defined objects including variables and operators. [CHI94] [HUD94] [LEE93] [ROS97]

Inheritance is a mechanism whereby one object
acquires characteristics from one, or more other objects. Inheritance occurs in all levels of a class hierarchy. “Inheritance is the sharing of attributes and operations among classes based on a hierarchical relationship”. [RUM91]

Encapsulation is a mechanism to realize data abstraction and information hiding. Encapsulation hides internal specification of an object and show only external interface. “The process of compartmentalizing the elements of an abstraction that constitute its structure and behaviour; encapsulation serves to separate the contractual interface of an abstraction and its implementation” [BOO94]. Encapsulation influences metrics by changing the focus of measurement from a single module to a package of data.

Booch [BOO94] states that, information hiding is the process of hiding all the secrets of an object that do not contribute to its essential characteristics. An object has a public interface and a private representation; these two elements are kept distinct. Information hiding acts a direct role in such metrics as object coupling and the degree of information hiding. “All information about a module should be private to the module unless it is specifically declared public”. [MEY98]

In object oriented design approach localization is based on objects. In a design, if there is some changes in the localization approach, the total plan will be violated, because one function may involve several objects, and one object may provide many functions. “Localization is the process of gathering and placing things in close physical proximity to each other.” [EDW]

3.2.1 Metric 4: Weighted Methods per Class (WMC)

The WMC is a count of the methods implemented within a class or the sum of the complexities of the methods (method complexity is measured by cyclomatic complexity). The second measurement is difficult to implement since not all methods are assessable within the class hierarchy due to inheritance. The number of methods and the complexity of the methods involved is a predictor of how much time and effort is required to develop and maintain the class. The larger the number of methods in a class, the greater the potential impact on children; children inherit all of the methods defined in the parent class. Classes with large numbers of methods are likely to be more application specific, limiting the possibility of reuse. [CHI94] [LOR94] [MCA94] [ROS97] [WEY88].

3.2.2 Metric 5: Response for a Class (RFC)

The RFC is the count of the set of all methods that can be invoked in response to a message to an object of the class or by some method in the class. This includes all methods accessible within the class hierarchy. This metric looks at the combination of the complexity of a class through the number of methods and the amount of communication with other classes. It is also a measure of the complexity, the coupling and the delocalization of the design.

The larger the number of methods that can be invoked from a class through messages, the greater the complexity of the class. If a large number of methods can be invoked in response to a message, the testing and debugging of the class becomes complicated since it requires a greater level of understanding on the part of the tester. A worst case value for possible responses will assist in the appropriate allocation of testing time. [CHI94] [LOR94] [MCA94] [ROS97] [WEY88].

3.2.3 Metric 6 – Lack of Cohesion (LCOM)

Lack of Cohesion (LCOM) measures the dissimilarity of methods in a class by instance variable or attributes. A highly cohesive module should stand alone; high cohesion indicates good class subdivision. Lack of cohesion or low cohesion increases complexity, thereby increasing the likelihood of errors during the development process. High cohesion implies simplicity and high reusability. High cohesion indicates good class subdivision. Lack of cohesion or low cohesion increases complexity, thereby increasing the likelihood of errors during the development process. Classes with low cohesion could probably be subdivided into two or more subclasses with increased cohesion [CHI94] [HUD94] [LOR94] [MCA94] [ROS97].

3.2.4 Metric 7: Coupling Between Object Classes (CBO)

Coupling Between Object Classes (CBO) is a count of the number of other classes to which a class is coupled. It is measured by counting the number of distinct non inheritance related class hierarchies on which a class depends. Excessive coupling is detrimental to modular design and prevents reuse. The more independent a class is, the easier it is reuse in another application. The larger the number of couples, the higher the sensitivity to changes in other parts of the design and therefore maintenance is more difficult.
Strong coupling complicates a system since a class is harder to understand, change or correct by itself if it is interrelated with other classes. Complexity can be reduced by designing systems with the weakest possible coupling between classes. This improves modularity and promotes encapsulation. [CHI94] [HUD94] [LEE93] [LOR94] [MCA94] [ROS97] [WEY88]. One of the difficult aspects of Object Oriented code is the delocalization of the plan, which is “wired” on the code in procedural programming [LIE89]. The CBO is a measure of such property.

3.2.5 Metric 8: Depth of Inheritance Tree (DIT)

This is the maximum length from the root to the leaf of the derived classes. The depth of a class within the inheritance hierarchy is the maximum number of steps from the class node to the root of the tree and is measured by the number of ancestor classes. If some class inherits only form the mother of all the classes (Object in Java), its DIT is considered to be 0. The deeper a class is within the hierarchy, the greater the number methods it is likely to inherit making it more complex to predict its behavior. Deeper trees constitute greater design complexity, since more methods and classes are involved, but the greater the potential for reuse of inherited methods. A support metric for DIT is the number of methods inherited (NMI) [CHI94] [HUD94] [LOR94] [MCA94] [ROS97] [WEY88].

3.2.6 Metric 9: Number of Children (NOC)

The number of children is the number of immediate subclasses subordinate to a class in the hierarchy. It is an indicator of the potential influence a class can have on the design and on the system. The NOC is directly related to the reuse by inheritance. It is a measure of how many subclasses are going to inherit the methods of the parent class. The greater the number of children, the greater the likelihood of improper abstraction of the parent and may be a case of misuse of subclassing. But the greater the number of children, the greater the reuse since inheritance is a form of reuse. If a class has a large number of children, it may require more testing of the methods of that class, thus increase the testing time. [CHI94] [LOR94] [MCA94] [ROS97] [WEY88] [BAS95].

3.3 Code and Design Metrics for Object-Oriented Systems

Object-oriented design and development has become popular in today’s software development environment. The benefits of object-oriented software development are now widely recognized [ALC98]. Object-oriented development requires not only different approaches to design and implementation; it also requires different approaches to software metrics. The traditional metrics such as lines of code and Cyclomatic complexity [MCA76] [WEY88] have become standard for traditional procedural programs [LIK00] [ALC98].

The metrics for object-oriented systems are different due to the different approach in program paradigm and in object-oriented language itself. An object-oriented program paradigm uses localization, encapsulation, information hiding, inheritance, object abstraction and polymorphism, and has different program structure than in procedural languages. [LIK00]

Software metrics are often categorized into product metrics and design metrics [LOK94]. Project metrics are used to predict project needs, such as staffing levels and total effort. They measure the dynamic changes that have taken place in the state of the project, such as how much has been done and how much is left to do. Project metrics are more global and less specific than the design metrics. Unlike the design metrics, project metrics do not measure the quality of the software being developed.

Design metrics are measurements of the static state of the project design at a particular point in time. These metrics are more localized and prescriptive in nature. They look at the quality of the way the system is being built. [LOK94]. Design metrics can be divided into static metrics and dynamic metrics [SYY99]. Dynamic metrics have a time dimension and the values tend to change over time. Thus dynamic metrics can only be calculated on the software as it is executing. Static metrics remain invariant and are usually calculated from the source code, design, or specification.

4. Chidamber and Kernerer Metrics

Although many metrics have been proposed, few have been based on sound measurement theory or, further, have been empirically validated. One of the first attempts to do this was by Chidamber and Kernerer (C&K). They have proposed six new OO metrics based largely on theoretical concepts [CHI94]. These metrics are: Weighted Methods per Class, Depth of Inheritance, Number Of Children, Coupling Between Object, Response For a Class and Lack Of Cohesion Between Methods.
Chidamber and Kemerer later revised their definition of CBO. For a class C, CBO is a measure of the number of other classes to which it is coupled [CHI94]. Thus, the Dynamic CBO for a class can be defined as being a count of the number of coupled classes at run-time. Chidamber and Kemerer [CHI94] defined a static cohesion metric for object-oriented applications known as Lack of Cohesion in Methods (LCOM). The Simple Dynamic LCOM is defined analogously to the static version, but only counting instance variables that are actually accessed at runtime. Thus, these values will always be less than their static counterpart. Also Dynamic Call-Weighted LCOM can be defined by weighting each instance variable by the number of times it is accessed at runtime. The metrics chosen for analysis can be divided into 7 categories viz. size, coupling, cohesion, inheritance, information hiding, polymorphism and reuse metrics.

4.1 Size metrics

This measure size of the system in terms of attributes and methods included in the class and capture the complexity of the class. a) Number of Attributes per Class (NOA) - It counts the total number of attributes defined in a class. Figure 1 shows the class diagram of Book Information System. In this system, Number of Attributes (NOA) for Publication class is 2. So NOA = 2 for Publication class. b) Number Of Methods per Class (NOM) - It counts number of methods defined in a class. c) Weighted Methods per Class (WMC) - The WMC is a count of sum of complexities of all methods in a class. To calculate the complexity of a class, the specific complexity metric that is chosen (e.g., cyclomatic complexity) should be normalized so that nominal complexity for a method takes on value 1.0. d) Response For a Class (RFC) - The response set of a class (RFC) is defined as set of methods that can be potentially executed in response to a message received by an object of that class. It is given by RFC = |RS|, where RS, the response set of the class, is given by RS = M_i ∪_{all j} {R_{ij}} where Mi = set of all methods in a class (total n) and Ri = {R_{ij}} = set of methods called by Mi.

4.2 Coupling metrics

Coupling relations increase complexity, reduce encapsulation, potential reuse, and limit understanding and maintainability. a) Coupling Between Objects (CBO) - CBO for a class is count of the number of other classes to which it is coupled. Two classes are coupled when methods declared in one class use methods or instance variables defined by the other class. [HAR]. b) Data Abstraction Coupling (DAC) - Data Abstraction is a technique of creating new data types suited for an application to be programmed. It provides the ability to create user-defined data types called Abstract Data Types (ADTs). Li and Henry defined Data Abstraction Coupling (DAC) as: DAC = number of ADTs defined in a class. c) Message passing Coupling (MPC) - Li and Henry defined Message Passing Coupling (MPC) metric as “number of send statements defined in a class”. So if two different methods in class A access the same method in class B, then MPC = 2. d) Coupling Factor (CF) - Coupling can be due to message passing (dynamic coupling) or due to semantic association links (static coupling) among class instances. It has been known that it is desirable that classes communicate with as few other classes and even when they communicate, they exchange as little information as possible. [RAY97] It is formally defined as:

\[
CF = \frac{\sum_{i=1}^{TC} \sum_{j=1}^{TC} \left[ is\_client(C_i, C_j) \right]}{TC^2 - TC}
\]

where TC is total number of classes

\[
is\_client(C_c, C_s) = \begin{cases} 1 & \text{if } C_c \supseteq C_s \wedge C_c \neq C_s \\ 0 & \text{otherwise} \end{cases}
\]

Couplings due to the use of the inheritance are not included in CF, because a class is heavily coupled to its ancestors via inheritance. If no classes are coupled, CF=0%. If all classes are coupled with all other classes, CF = 100%.

4.3 Cohesion Metrics

Cohesion is a measure of the degree to which the elements of a module are functionally related. A strongly cohesive module implements functionality that is related to one feature of the software and requires little or no interaction with other modules. Thus the interactions are maximized within a module. Four cohesion metrics are discussed here. a) Lack of Cohesion in Methods (LCOM) - Lack of Cohesion (LCOM) measures the dissimilarity of methods in a class by looking at the instance variable or attributes
used by methods [CHI94]. b) Tight Class Cohesion (TCC) - The measure TCC is defined as the percentage of pairs of public methods of the class with common attribute usage. c) Loose Class Cohesion (LCC) - In addition to direct attributes, this measure considers attributes indirectly used by a method. Method m directly or indirectly invokes a method m2, which uses attribute a. LCC is the same as TCC except that this metric also considers indirectly connected methods. The measure LCC is defined as the percentage of pairs of public methods of the class, which are directly or indirectly connected. d) Information flow based Cohesion (ICH) - ICH for a class is defined as the number of invocations of other methods of the same class, weighted by the number of parameters of the invoked method.

4.4 Inheritance Metrics

Four different inheritance methods are considered for analysis. a) Depth of Inheritance Tree (DIT) - The depth of a class within the inheritance hierarchy is the maximum number of steps from the class node to the root of the tree and is measured by the number of ancestor classes. In cases involving multiple inheritances, the DIT will be the maximum length from the node to the root of the tree. b) Number of Children (NOC) - The NOC is the number of immediate subclasses of a class in a hierarchy.

5. Mood Metrics

Abreu et al. [ABR95] defined MOOD (Metrics for Object Oriented Design) metrics. MOOD refers to a basic structural mechanism of the object-oriented paradigm as encapsulation (MHF, AHF), inheritance (MIF, AIF), polymorphism (POF), and message passing (COF). Each metric is expressed as a measure where the numerator represents the actual use of one of those features for a given design [ABR96]. In MOOD metrics model, two main features are used in every metric; they are methods and attributes. Methods are used to perform operations of several kinds such as obtaining or modifying the status of objects. Attributes are used to represent the status of each object in the system. Each feature (methods and attributes) is either visible or hidden from a given class [ABR95] [ABR96].

5.1 Inheritance (MIF, AIF)

Inheritance is the process by which objects of one class acquire the properties of the objects of another class. a) Method Inheritance Factor (MIF) - The MIF metric states the sum of inherited methods in all classes of the system under consideration. The degree to which the class architecture of an object-oriented system makes use of inheritance for both methods and attributes [ROGER]. MIF is defined as the ratio of the sum of the inherited methods in all classes of the system as follows. It is system level metrics and is defined as follows:

\[ \text{MIF} = \frac{\sum_{i=1}^{TC} M_d(C_i)}{\sum_{i=1}^{TC} M_d(C_i)} \]

Where \( M_d(C_i) = M_i(C_i) + M_d(C_i) \), TC = total number of classes, \( M_d(C_i) \) = the number of methods declared in a class and \( M_i(C_i) \) = the number of methods inherited in a class

b) Attribute Inheritance Factor (AIF)

AIF is defined as the ratio of the sum of inherited attributes in all classes of the system. AIF denominator is the total number of available attributes for all classes. It is defined in an analogous manner and provides an indication of the impact of inheritance in the object-oriented software [ROG]. It is defined as follows:

\[ \text{AIF} = \frac{\sum_{i=1}^{TC} A_d(C_i)}{\sum_{i=1}^{TC} A_d(C_i)} \]

Where \( A_d(C_i) = A_i(C_i) + A_d(C_i) \), TC = total number of classes, \( A_d(C_i) \) = number of attribute declared in a class and \( A_i(C_i) \) = number of attribute inherited in a class

5.2 Encapsulation (MHF, AHF)

Encapsulation is the process of hiding all the details of an object that do not contribute to its essential characteristics [BOO94]. a) Method Hiding Factor (MHF) - The MHF metric states the sum of the invisibilities of all methods in all classes. The invisibility of a method is the percentage of the total class from which the method is hidden. Abreu et al. [ABR94] States, the MHF denominator is the total number of methods defined in the system under consideration. It is a measure of encapsulation defined as:

\[ \text{MHF} = \frac{\sum_{i=1}^{TC} \sum_{m=1}^{M(C_i)} (1 - V(M_{m, i}))}{\sum_{i=1}^{TC} M_d(C_i)} \]
Where \( M_d(C_i) \) is the number of methods declared in a class, and

\[
V(M_{m_1}) = \sum_{j=1}^{TC} is\_visible(M_{m_1}, C_j) \over (TC-1)
\]

where TC is the total number of classes, and

\[
is\_visible(M_{m_1}, C_j) = \begin{cases} 1 & \text{if } j \neq i \land C_j \text{ may call } M_{m_1} \\ 0 & \text{otherwise} \end{cases}
\]

Thus, for all classes, C1, C2...Cn, a method counts as 0 if another class can use it and 1 if it cannot be used by another class. The total for the system is divided by the total number of methods defined in the system. b) Attribute Hiding Factor (AHF) - The AHF metric shows the sum of the invisibilities of all attributes in all classes. The invisibility of an attribute is the percentage of the total classes from which this attribute is hidden. MHF and AHF represent the average amount of hiding among all classes in the system. It is a measure of encapsulation defined formally as:

\[
AHF = \frac{\sum_{t=1}^{TC} \sum_{a=1}^{Ad(C_t)} (1 - V(A_{a_t}))}{\sum_{t=1}^{TC} Ad(C_t)}
\]

where \( Ad(C_t) \) is the number of methods declared in a class, and

\[
V(A_{a_t}) = \sum_{j=1}^{TC} is\_visible(A_{a_t}, C_j) \over (TC-1)
\]

where TC is the total number of classes, and

\[
is\_visible(A_{a_t}, C_j) = \begin{cases} 1 & \text{if } j \neq i \land C_j \text{ may call } A_{a_t} \\ 0 & \text{otherwise} \end{cases}
\]

Thus, for all classes, C1, C2...Cn, an attribute counts as 0 if it can be used by another class, and 1 if it cannot.

5.3 Polymorphism (POF)

Polymorphism allows the implementation of a given operation to be dependent on the object that “contains” the operation. a) Polymorphism Factor (PF) - The PF metric is proposed as a measure of polymorphism. It measures the degree of method overriding in the class inheritance tree.

\[
PF = \frac{\sum_{t=1}^{TC} M_o(C_t)}{\sum_{t=1}^{TC} [M_n(C_t) \times DC(C_t)]}
\]

\( M_n(C_t) = \) Number of New Methods, \( M_o(C_t) = \) Number of Overriding Methods and \( DC(C_t) = \) Descendants Count b) Number of Methods Overridden by a subclass (NMO) - When a method in a subclass has the same name and type signature as in its superclass, then the method in the superclass is said to be overridden by the method in the subclass. The value of metric is 2 for class Student declared for calculating PF metric.

5.4 Reuse Metrics

An object-oriented development environment supports design and code reuse, the most straightforward type of reuse being the use of a library class (of code), which perfectly suits the requirements. Yap and Henderson-Sellers discuss two measures designed to evaluate the level of reuse possible within classes [HEN96]. a) Reuse Ratio \( (U) \) - The reuse ratio, \( U \), is given by \( U = \) Number of Superclasses / Total Number of Classes b) Specialization Ratio \( (S) \) - Specialization ratio, \( S \), is given as \( S = \) Number of Subclasses / Number of Superclasses

6. Other Metrics Models

Lorenz and Kidd [LOR94] proposed metrics are focused on size, inheritance, internal, and external measurements. Size metrics for the object-oriented class focus on counts of attributes and operations for an individual class. Inheritance based metrics focus on the method in which operations are reused through the class hierarchy. Internal metrics are focus on cohesion and code oriented issue. External metrics observe coupling and reuse.

Belin et al. [BEL] categorized metrics in three groups. Group A consists of “number of methods” metric, “number of classes” metric, and “number of levels” metric in the class hierarchy tree. Group B focus on “code reuse” metric, “number of classes reused” metric, and “percent of reused” classes modified metric. Group C discusses coupling metric, cohesion metric, sufficiency metric, completeness metric and primitiveness metric. These metrics are deal with the quality of an abstraction in an OO system.
Brito e Abrue et al. categorized metrics are: design, size, complexity, reuse, productivity, quality, method, class and system levels. They provide a catalogue for object oriented design metrics. That taxonomy is based on a Cartesian product of the two vectors: (design, size, complexity, reuse, productivity, quality) and (method, class, system). His proposed metrics are CC2 (Class Complexity), CR1 (Class Reuse), CC3 (Class Complexity), CR2 (Class Reuse), CR3 (Class Reuse). In his measure, class and system quality metrics that the authors suggest are based on counts of observed defects, failures, and time between failures.

Metrics proposed by Chen et al. [CHE93] are: CCM (Class Coupling Metric), OXM (Operating Complexity Metric), OACM (Operating Argument Complexity Metric), ACM (Attribute Complexity Metric), OCM (Operating Coupling Metric), CM (Cohesion Metric), CHM (Class Hierarchy of Method) and RM (Reuse Metric). Metrics CCM through OACM are subjective in nature; metrics ACM through CHM involve counts of features; and metric RM is a boolean (0 or 1) indicator metric. [ARC95].

7. Conclusion

This paper introduces the basic metric suite for object-oriented design. The need for such metrics is particularly acute when an organization is adopting a new technology for which established practices have yet to be developed. Metric data provides quick feedback for software designers and managers. Analyzing and collecting the data can predict design quality. It leads to a significant reduction in costs of the overall implementation and improvements in quality of the final product.

8. References

Validating Metrics on The Basis of Object Oriented


**A Simulation – Based Approach To Software Release And Support**

**Vikram Singh**

**Abstract:** For any software development project, one of the biggest questions is “When to release the software product?” Software release policy may help the testing team to know how much more testing is required, and what to test further? In addition, software development houses may need to know “For how long should they support and maintain their software product after release in order to maintain their position in the market?” A simulator has been designed and developed for helping SQA team in choosing the best policy out of the wide spectrum of alternative software release and support policies. This simulator will prove an asset to software development community in releasing high quality software products within the scheduled time framework at competitive price.

**1. Introduction**

An important problem in the development of software system is to decide when to stop testing and release the software product to the customer. The longer the testing phase, higher the reliability and lower the operating cost. However, delays in software release increase the testing and other costs. Hence the optimum length of testing phase is a tradeoff between two competing factors. Also, before release the software product must meet pre-specified software reliability criteria before it can be released. Therefore, software reliability needs to be assessed during software testing.

Software release policy may be described as set of policies as to 1) for how long should the testing of the software product be carried? 2) For how long the software product be supported free of cost? 3) For how should the software development house provide a charged support to the software product? Elements of some of the widely accepted release policies [1]: Software products are released to the market:

- When the reliability has reached a given threshold?
- When the gain in reliability cannot justify the testing cost?
- When the delay in software release may hamper image of software? development house.

Also, software development houses may need to know “For how long should they support and maintain their software product after release?” A simulator was designed and developed for helping SQA team in deciding “Which of the many alternative software release and support policies will yield better results for the organization?”

**Some observations:**
- Longer the testing phase, higher the reliability.
- Higher the reliability, lower the operating cost.
- Release delays increase the testing & other costs – including loss of goodwill.

---

*Vikram Singh, Dean Faculty, Department of Computer Science, Ch. Devi Lal University, Sirsa, Haryana – INDIA (125055), vikramsinghbk@yahoo.com*
– So, when to stop testing and release the software?
– Also, before release a specified reliability criterion must be met.
– Therefore, reliability needs to be assessed during software testing.
– Optimum length of testing phase is a tradeoff between two competing factors – reliability and release time.

2. Why This Simulator?
– Previous approaches to release problem were based upon certain simplifying assumptions.
– Therefore, their applications are limited.
– This approach is as much general and as much realistic as one can think of.
– The generality and realistic nature of the approach comes from the very nature of system simulation.

Symbols and Notations:
– $FR_{rel}$ software failures reported per unit of time at release
– $FR_{free}$ software failures reported per unit of time during free support
– $FR_{paid}$ software failures reported per unit of time during paid support
– $c_1(t)$ defect removal cost function during testing
– $c_2(t)$ free support defect removal cost function
– $c_3(t)$ paid support defect removal cost function
– $C(T)$ total average release policy cost
– $T_{test}$ software testing time period
– $T_{free}$ free software support time period
– $T_{paid}$ charged software support period

The Cost Function:
The total release policy cost during testing and operations is:
\[
C(T) = \frac{T_{rel}}{\sum_{t} c_1(t) dt} + \frac{T_{free}}{\sum_{t} c_2(t) dt} + \frac{T_{paid}}{\sum_{t} c_3(t) dt}.
\]

The optimum software release time is testing time which minimizes the value of $C(T)$. Figure 1 depicts the phases of software life-cycle after a certain point in its testing phase. A software product is released if, either its failure rate drops to $FR_{rel}$ or its delivery deadline is reached. Just after the release, customer gets a free support for software product. Free software support continues till, either software failure rate drops to $FR_{paid}$ or free support period expires. Hereafter starts the charge-base software support. Further, the charged support stops (no support provided) when software failure rate drops $FR_{no}$ or charged support period expires. The optimum software release policy is the one which minimizes the value of cost function $C(T)$.

Figure 1 Testing and Operations phases of a software product

3. Simulation Algorithm

Step 1.
– Perform software testing.
– Compute failures reported/time
– Keep on testing as long as
– failures reported/time remains above $FR_{rel}$ or
– $T_{test}$ has not expired (i.e. release deadline has not reached);
– otherwise release the software.

Step 2.
– Provide free support.
– Compute failures reported/time
– Keep on providing free support as long as
– Failures reported/time remains above $FR_{free}$ or
– $T_{free}$ (free support period) has not expired;
– otherwise start charging the support service.

Step 3.
– Provide charged support.
– Compute failures reported/time
– Keep on providing charged support as long as:
– Failures reported/time remains above $FR_{paid}$ or
– $T_{\text{paid}}$ (paid support period) has not expired;
– otherwise stop support service.

Effect of $FR_{\text{rel}}$, $FR_{\text{free}}$, $FR_{\text{paid}}$, $T_{\text{test}}$, $T_{\text{free}}$ and $T_{\text{paid}}$ on $C(T)$ – total cost of software release and support policy, has been worked, scaled down (by hundred) and analyzed.

4. Discussion on Results and Conclusion

The simulator described in this paper has been implemented using Visual Basic for Applications (VBA). A software product considered for simulation study was assumed to have initial 500 software defects. It was further assumed that the software defects followed a Decreasing Failure Rate (DFR) distribution function. Further, it was assumed that defect-removal-cost-constants during testing, during free support, and during paid support ($c_1$, $c_2$, and $c_3$) are 1, 2.5 and -1, respectively. It has been described earlier that out of three cost functions [$c_1(t)$, $c_2(t)$, and $c_3(t)$], $c_1(t)$ and $c_2(t)$ are assumed to increase monotonically with time, whereas $c_3(t)$ decreases with time. Tables (1 to 6) and corresponding graphs (Fig 2 to 7) summarize the results of simulation experiment. Results in tables 1 to 6 shows the effect of changing one of the six parameters ($FR_{\text{rel}}$, $FR_{\text{free}}$, $FR_{\text{paid}}$, $T_{\text{test}}$, $T_{\text{free}}$ and $T_{\text{paid}}$) on the $C(T)$, while keeping other five parameters constant. Following constant values have been used in this simulation experiment for studying the sensitivity of these parameters on the cost factor.

$FR_{\text{rel}} = 0.50$, $FR_{\text{free}} = 0.075$, $FR_{\text{paid}} = 0.025$,
$T_{\text{test}} = 26$, $T_{\text{free}} = 26$ and $T_{\text{paid}} = 26$.

Where, $FR_{\text{rel}}$, $FR_{\text{free}}$, and $FR_{\text{paid}}$ are the numbers of failures observed per unit time and all the time periods are measured in weeks.

In above two tables (1 and 2) and corresponding graphs (Fig 2 and 3) simulation experiments’ results showing the effect of $FR_{\text{rel}}$ and $FR_{\text{free}}$ on $C(T)$ are placed. The results depicted that for given parameters the optimum value of $FR_{\text{rel}}$ for example software was around 0.75. Also, the optimum value for $FR_{\text{Free}}$ came out to be 0.050.

Tables, 3 and 4 and corresponding graphs (Fig 4 and 5) depict the effect of $FR_{\text{Paid}}$ and $T_{\text{Test}}$, respectively on $C(T)$, provided other factors do not change. Results show that 0.042 was the optimum value for $FR_{\text{Paid}}$ and for the example software optimum testing time was 12 weeks.

---

<table>
<thead>
<tr>
<th>Table 1 Effect of $FR_{\text{Rel}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FR_{\text{Rel}}$ in failures per week</td>
</tr>
<tr>
<td>0.05</td>
</tr>
<tr>
<td>0.15</td>
</tr>
<tr>
<td>0.25</td>
</tr>
<tr>
<td>0.35</td>
</tr>
<tr>
<td>0.45</td>
</tr>
<tr>
<td>0.55</td>
</tr>
<tr>
<td>0.65</td>
</tr>
<tr>
<td>0.75</td>
</tr>
<tr>
<td>0.85</td>
</tr>
<tr>
<td>0.95</td>
</tr>
<tr>
<td>1.05</td>
</tr>
<tr>
<td>1.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2 Effect of $FR_{\text{Free}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FR_{\text{Free}}$ in failures per week</td>
</tr>
<tr>
<td>0.010</td>
</tr>
<tr>
<td>0.020</td>
</tr>
<tr>
<td>0.030</td>
</tr>
<tr>
<td>0.040</td>
</tr>
<tr>
<td>0.050</td>
</tr>
<tr>
<td>0.060</td>
</tr>
<tr>
<td>0.070</td>
</tr>
<tr>
<td>0.080</td>
</tr>
<tr>
<td>0.090</td>
</tr>
<tr>
<td>0.100</td>
</tr>
<tr>
<td>0.110</td>
</tr>
<tr>
<td>0.120</td>
</tr>
</tbody>
</table>

Tables 5 and 6 (Fig. 6 and 7) show the effect of $T_{\text{Paid}}$ and $T_{\text{Free}}$, respectively, on $C(T)$, given other parameters are constant. The results of simulation experiment for example software depicted that optimum values for $T_{\text{Free}}$ and $T_{\text{Paid}}$ were 32 and 100 weeks, respectively.

This simulator assists:
– the software developers to launch the product in the highly competitive software market by
### Table 3 Effect of $F_{\text{Paid}}$

<table>
<thead>
<tr>
<th>$F_{\text{Paid}}$ (in failures per week)</th>
<th>$C(T)$ in ‘000 rupees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0009</td>
<td>99.3</td>
</tr>
<tr>
<td>0.006</td>
<td>85.4</td>
</tr>
<tr>
<td>0.012</td>
<td>72.1</td>
</tr>
<tr>
<td>0.018</td>
<td>63.3</td>
</tr>
<tr>
<td>0.024</td>
<td>50.9</td>
</tr>
<tr>
<td>0.030</td>
<td>40.5</td>
</tr>
<tr>
<td>0.036</td>
<td>31.2</td>
</tr>
<tr>
<td><strong>0.042</strong></td>
<td><strong>25.1</strong></td>
</tr>
<tr>
<td>0.048</td>
<td>27.9</td>
</tr>
<tr>
<td>0.054</td>
<td>31.0</td>
</tr>
<tr>
<td>0.060</td>
<td>34.9</td>
</tr>
<tr>
<td>0.066</td>
<td>40.0</td>
</tr>
</tbody>
</table>

### Table 4 Effect of $T_{\text{Test}}$

<table>
<thead>
<tr>
<th>$T_{\text{Test}}$ (weeks)</th>
<th>$C(T)$ ‘000</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>136.6</td>
</tr>
<tr>
<td>18</td>
<td>98.2</td>
</tr>
<tr>
<td>16</td>
<td>67.1</td>
</tr>
<tr>
<td>14</td>
<td>47.8</td>
</tr>
<tr>
<td><strong>12</strong></td>
<td><strong>29.5</strong></td>
</tr>
<tr>
<td>10</td>
<td>52.3</td>
</tr>
<tr>
<td>08</td>
<td>86.6</td>
</tr>
<tr>
<td>06</td>
<td>128.0</td>
</tr>
<tr>
<td>04</td>
<td>178.5</td>
</tr>
</tbody>
</table>

### Table 5 Effect of $T_{\text{Paid}}$

<table>
<thead>
<tr>
<th>$F_{\text{Paid}}$ (weeks)</th>
<th>$C(T)$ ‘000</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>48.1</td>
</tr>
<tr>
<td>180</td>
<td>45.6</td>
</tr>
<tr>
<td>160</td>
<td>41.9</td>
</tr>
<tr>
<td>140</td>
<td>38.1</td>
</tr>
<tr>
<td>120</td>
<td>35.2</td>
</tr>
<tr>
<td><strong>100</strong></td>
<td><strong>32.8</strong></td>
</tr>
<tr>
<td>80</td>
<td>34.1</td>
</tr>
<tr>
<td>60</td>
<td>36.0</td>
</tr>
<tr>
<td>40</td>
<td>37.5</td>
</tr>
<tr>
<td>20</td>
<td>38.3</td>
</tr>
</tbody>
</table>

### Table 6 Effect of $T_{\text{Free}}$

<table>
<thead>
<tr>
<th>$T_{\text{Free}}$ (weeks)</th>
<th>$C(T)$ ‘000</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>42.1</td>
</tr>
<tr>
<td>48</td>
<td>37.6</td>
</tr>
<tr>
<td>44</td>
<td>33.0</td>
</tr>
<tr>
<td>40</td>
<td>30.1</td>
</tr>
<tr>
<td>36</td>
<td>26.9</td>
</tr>
<tr>
<td><strong>32</strong></td>
<td><strong>25.3</strong></td>
</tr>
<tr>
<td>28</td>
<td>26.9</td>
</tr>
<tr>
<td>24</td>
<td>27.6</td>
</tr>
<tr>
<td>20</td>
<td>28.4</td>
</tr>
<tr>
<td>16</td>
<td>29.3</td>
</tr>
<tr>
<td>12</td>
<td>30.3</td>
</tr>
</tbody>
</table>

### Fig. 2 Effect of FRrel on Cost

![Graph showing the relationship between FRrel and Cost with a downward trend.]

### Fig. 3 Effect of FRfree on Cost

![Graph showing the relationship between FRfree and Cost with a downward trend.]

---

*Tecnia Journal of Management Studies Vol. 4 No. 1, April 2009 – September 2009*
optimizing the dual goal of cost and time tradeoff – safety goals.

- the project manager/leader to decide when to stop testing the software.
- the top-level management to provide a quantitative basis in maintaining reliability and risk factors in order to compete with similar software products

References


1. Introduction

Any system be it bio, mechanical, academic or social runs on information. Information is a vital input of any organization be it academic, governmental, commercial or defence. But proper use of information lies in the manpower of the organization. Only expert and staff can give any context or meaning to the information grained or communicated. What lies in a man’s head in knowledge. Knowledge is not superior to information, but it also gives contact to it. When we refer to knowledge most of us mainly tend to think of codified and documented knowledge like patents, databases, manuals, white papers etc. With this ‘explicit knowledge’ is important what is even more important and value adding from the perspective of competitive advantage is the ‘tacit knowledge’ which is embedded in the minds of the people. The tacit knowledge is intuitive, contextual, linked to experience, past memories and difficult to codify document and communicate. It is estimated that this tacit knowledge constitutes between seventy to eighty percentages of all knowledge in an organization and is difficult to identify, quantify, and convert into real value, unless a structured approach is adopted to manage knowledge. The world is witness unprecedented change in application of knowledge in every dimension of development, growth, revitalization, and organization. The concept KM is not about technology management, but rather about

Abstract: Information revolution and knowledge society are two important buzzwords of 21st century. Internet and web-based technologies in the last couple of years have influenced all the boundaries. The Knowledge Management (KM) a concept that evolved in the mid 20th century now is a core concept of knowledge domain. The knowledge management is not about technology management but rather, then about deciding what kind of information is critical and valuable for the success of an institution or organization. The emerging trends and issues of web based knowledge management and its implementation in the libraries and information centres require intensive attention and actions especially in the changing perspectives. It has been widely and undoubtedly accepted and proved from the various national & international studies that the future will be the knowledge based. Therefore, knowledge management, content management and content engineering will be the process and practices of the coming time.

As it is a well-established fact that knowledge is the dynamic, new, expandable source of the economic wealth and a critical asset to an organization. Hence, it is demanded from the library and information centers that ‘the right information needs to be in the hands of the right people at the right place’. The paper discuss in detail the various aspects related to web based knowledge management such as Evolution of the KM, Concept of Knowledge Management, web based knowledge management models. The paper further explores the possibility, opportunity to implementation the web based knowledge management system in its parental organization.
deciding what information and knowledge is critical to the success of the organization. The emergence of ICT and its offshoots technologies such as, Internet, Intranet, WWW, Web-portals, Groupware etc. have made a drastic impact on the work culture of libraries and information centers worldwide, and make libraries more responsive, focal-centered towards imparting the critical knowledge to their concerned organization. It has been widely accepted through various research studies that Future will be knowledge based, the future wealth shall be knowledge and the KM tools certainly will play a catalytic role in changing environment in libraries. Therefore, LIS professionals must redesign reshaped their tools and techniques and give serious attention towards the new emerged technologies and tools for effective implementation in their works. The Knowledge Management, which is a core study area of management science today, is the discovery of library science and the term Knowledge Management (KM) for the first time used in library context in 1985.

2. Knowledge Management And Its Evolution

The systematic process of finding, selecting, organizing, distilling and presenting information, improves and employee’s comprehensions in a specific area of interest. KM helps an organization to gain insight and understanding from its own experience. The specific knowledge management activities help focus the organization on acquiring, processing, storing and utilizing knowledge for problem solving, dynamic learning, strategic and decision making. It also prevents intellectual assists from decay, adds to firm intelligence and provides increased flexibility. Knowledge creation has two dimensions, one is explicit knowledge, and other is implicit knowledge. The explicit knowledge comes from the published books, written materials, proceedings, presentations, etc., whereas the implicit knowledge is derived through the systematic observation and capturing of data the tacit knowledge available among the individuals in the organization, through their approach to problem solving, bottle-neck removal, goals setting, interactions, etc. Therefore, we need a systematic mechanism to capture this knowledge to make the organization a truly learning organization, which use of exiting knowledge judiciously and efficiently.

The use of knowledge in all the sectors has become a greater factor of production than men, machine and material. The term ‘knowledge management’ or KM is a recent one which emerged in late 1990s. The term KM appeared for the first time in the context of library and information work which was coined by Marchand in 1985 then the Dean of the School of Information Studies at Syracuse University, UK. In the initial stage of evolution the knowledge management has only two basic components i.e. Information and knowledge capital, and structural capital. Later on account of advent of Internet and Web technologies a Trinity concept has evolved for knowledge management which is known i.e., information and knowledge capital, structural capital, and customer capital.

In Indian context the term ‘Knowledge Management’ appeared for the first time and applied in a world leading Service Company i.e., Tata Consultancy Services (TCS) in 1995 while the Management Board of the TCS has initiated a process of refinancing the framework in 1996. for this purpose a dedicated knowledge management team called “Corporate Groupware” was formed in 1998. After a preliminary study this group launched a Knowledge Management pilot project in 1999, since then the project is now being successfully implemented in TCS which consists a matrix of several groups: the Steering Committee, Corporate Groupware, Implementers, Branch Champions, Application Awareness, and the Infrastructure support Group.

3. Conceptual Paradigm Of Knowledge Management

Unfortunately, there is no universal definition of KM just as there’s no agreement as to what constitutes knowledge in the first place. For this reason, it’s best to think of KM in the broadest context. KM is the process through which organizations generate value from their intellectual and knowledge-based assets. It is the practice of harnessing and exploiting intellectual capital to gain competitive advantage and making customer more commitment and efficient. Most often,
generating value from such assets involves sharing them among employees, departments and even with other organizations. Knowledge management is a cross-disciplinary domain. Library professionals are already ushered into knowledge management activities and practices and the paradigm shift that is taking place whereby libraries are getting transformed into knowledge management centers. KM will inject new blood into the library culture.

Today, the concept knowledge management is well established and applied almost in all facets of management sciences and well defined by various management guru/experts as well as information experts. There are numerous definitions of KM to be found in various publications printed as well as on Web. The following definitions are the most commonly used and cited.

The first by Davenport (Real success knowledge management projects. Sloan Management Review. 39 (1)1998; 43-57) that: ‘knowledge management is the process of capturing, distributing, and effectively using knowledge’ is one of the earliest and one of the simplest and stark. The second definition more comprehensive is given by Gartner Group (DUHON (B). It’s all out heads. Inform. 12 (8)1998; 9-13) that ‘knowledge management is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise’s information assets. These assets may include databases, documents, policies, procedures, and previously uncaptured expertise, and experience of individual workers’ is illuminating because it makes very implicit that aspect of knowledge management of including not just conventional information and knowledge units, but also ‘tacit knowledge’ that which is known but not captured in any formal or explicit fashion’ The third definition as given by Ruggles (The state of the nation: Knowledge management in practice. California Management Review. 40 (Spring) 1998; 80-89) reads ‘knowledge management is newly emerging, interdisciplinary business model dealing with all aspects of knowledge within the context of firm, including knowledge creation, codification, sharing, learning, and innovation. Devenport and Prusak (Working knowledge: How organization manages. 1998. Boston: Harvard Business School) given another pragmatic description of knowledge management which says ‘A fluid mix of contextual information, framed experiences.

It is revealed from the above definitions that knowledge management is not about technology management, but rather about deciding what information and knowledge is critical to the success of the organization, and to ensure that knowledge management activists get prioritized within the organization. In very simple words, knowledge management is a considered ‘techno-cultural solution.’

4. Why Knowledge Management?

Tacit and explicit knowledge has become a much greater factor of production than land, labour, and capital and the increasing culture/phenomenon for giving the emphasis for promoting and rewarding the pooling together of knowledge resources such as documentations, experiences, expertise’s, and analysis have compelled for knowledge management. The following given reasons justify the need of knowledge management.

- Knowledge is the basis of services and prime mover of the society.
- Knowledge helps to cope up with changes and re-designs, re-expanding, and re-casting the production and services.
- Knowledge sharing is the natural next step to information sharing for the maximum utilization of resources.
- Knowledge management combing dissimilar resources to provide innovative products in multiple markets
- Knowledge is the new, expandable source of economic wealth and there is an emerging recognition that the most valuable resources of any country is its inherent intellectual assets/effectively exploited through innovation.
- Knowledge helps in streamline operations and reduce costs by eliminating redundant processes.

5. Types of Knowledge

Knowledge is the intellectual capital which is created by the intellectuals and this intellect is intellectually organized by the LIS professionals. When people out of creation and value to information, knowledge is generated. There are three basic types of knowledge which are required to be captured.
5.1 Explicit Knowledge

This is the simple form of knowledge, which is formal and easy to communicate and documented. This is the knowledge of rationality i.e. policies, rules, specifications, patents, formulae, etc. this is also known as declarative knowledge or sequential knowledge. The libraries and librarians are primarily deals with this category of knowledge.

5.2 Tacit Knowledge

This is highly personal and contextual knowledge, which is in the human mind and hard to formalize, and often difficult to communicate. This is the knowledge of experiences, expertises, skills, processes, etc. some expert also called it simultaneous knowledge. This is very complex form of knowledge, which lies most of the time as implications. It has two dimensions i.e., technical and cognitive dimensions.

5.3 Cultural knowledge

It is the knowledge which includes assumptions, and beliefs that are used to understand, describe and explain the reality as well as conventions, values and significance to new information. These shared beliefs, norms and values from the frame work in which organizational numbers construct reality, recognize the new information and evaluative alternative interpretations and actions6.

6 RAJYALAKSHMI (D). Information professionals: Knowledge and skills for information management. ILA Bulletin. 42(4) 2007; 8-15


6. Knowledge Management Versus Traditional Information Management

These comparative outlines will help in understanding the concept of knowledge management more precisely. The view is often expressed in traditional library and information science discipline that knowledge management is just old wine in new bottles, just the new name for information resource management, which in turn was just a new name for Documentation, which in turn was just a new name for Librarianship. The major difference between knowledge management and traditional information management are given as7

<table>
<thead>
<tr>
<th>Knowledge management</th>
<th>Traditional information management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emphasis upon unstructured and informal information and knowledge</td>
<td>Emphasis upon structured and formal information and knowledge</td>
</tr>
<tr>
<td>KM plays an active role in corporate culture transformation and act as metamorphosis</td>
<td>Information Management remains natural in terms of transformation within organization</td>
</tr>
<tr>
<td>Knowledge context, organization sectoral, and supplier customer</td>
<td>Growing contextual knowledge but often not well recognized within organization</td>
</tr>
<tr>
<td>An awareness of knowledge as text but coming from a background in non-textual information</td>
<td>Information primarily as text secondarily as numeric or graphic</td>
</tr>
<tr>
<td>KM linking knowledge sharing with compensation policy</td>
<td>Information Management has never been involved with competition policy</td>
</tr>
<tr>
<td>KM Poorly organized</td>
<td>Information Management well organized with help of various information tools e.g., classification, cataloguing, thesaurus, etc.</td>
</tr>
<tr>
<td>Emphasis on internal information but now, increasingly external information that is competitive in nature</td>
<td>Information Management generally emphasis on external information more precisely published literature</td>
</tr>
<tr>
<td>Information and knowledge sharing, in the context of a dense web structure</td>
<td>Information and knowledge delivery, as a hub and spoke structure</td>
</tr>
</tbody>
</table>

7 Tecnia Journal of Management Studies Vol. 4 No. 1, April 2009 – September 2009
7. Knowledge Management Tools

The present century is the age of digital nervous system, which aims at leveraging the two-core revolutions-PC and the Internet. Therefore, the knowledge management became imperative as the world moves from industrial economy to knowledge economy. The role of effective knowledge management tools in integrating the resources of an organization has become necessary. The knowledge management tools run the gamut from standard tools packages to sophisticated collaborations tools designed specially to support community building. Generally, tools fall into one or more of the following categories: Knowledge repositories (Libraries), expertise access tools, E-learning application’s, discussion and chat technologies, search and mining tools, e-portals, enterprises knowledge portals, groupwares, etc. are available to manages the knowledge resources. The following are most popular knowledge management tools

7.1 Intranet/Extranets

Most popular and effective knowledge management tool based on Internet and www technology with the help of this tool libraries, organizations, can easily communicate, distribute information and products, facilitate project collaborations, projects etc, and a also checked unauthorized access.

7.2 Groupware

A kind of application software with built-in calendars, scheduling, e-mail, navigational tools that supports the collaborative activities of work groups team experts. The Lotus Notes Domino and Microsoft’s MS Exchange Servers are the popular Groupware software and widely used as knowledge management tools

7.3 Data Warehousing

Data warehousing is one of the key knowledge management tool. As it is often cumbersome to access data from the heterogeneous databases’ It serves the following functions such as: Reporting and query that store current and historical data, extracted from the various operational systems and consolidated for management and report analysis.

7.4 Data Analysis

These tools are used for generating and creation the new knowledge.

7.5 Metadata

These tools are specially designed and developed to organising the ‘data about the data’ more precisely these tools are primarily used to manages and organizes the informational contents of the resources (of any kinds) which are available in e-form either Internet or outside the ocean of the Internet.

7.6 Machine learning/ artificial intelligence

These sophisticated tools and technologies designed and developed on the parallel thinking and reasoning on the human mind proved to be very effective in generating new knowledge.

7.7 Ontologies

Designed and developed on the technology of artificial intelligence which helps in structure of the representation of information and knowledge.

7.8 Library/Document Management System

Library application software are those software, which are specially designed and developed to computerized / automate/ manage the library materials (such as books, journals, etc.). Typical library software has the following modules such as acquisition, cataloguing, circulation, indexing articles, OPAC, library administration. The common brands/ software which are commonly used by the libraries to automate their library activities are CDS/ISIS, WINISIS (by UNESCO), Libsys (by Libsys Corporation, New Delhi), SOUL (by INFLIBNET, UGC, Ahmadabad), SLIM++ (by Informatics India Ltd, Bangalore), e- Ganathalaya (by NIC, New Delhi), etc. On account of world wide collaborated research and associations one of the new breed of the library automation/digital software have emerged, which usually refers as ‘open source sotwere’ such as KOHA, Greenstone (GSDL), D-Space, E-Prints, NewGenlib, etc are available on public domain for freely download and use. This new movement has brought new revolution in the domain of library automation, digital libraries for managing their resources digitally and globally.

8. Technology For Web Based Knowledge Management

With the recent growth and development in the domain of ICT particularly on Internet technology and its wider acceptance and popularity there are many
products available today to facilitate knowledge sharing, distribution, downloading, publishing and collaboration using the web technologies. The main advantage of web-based knowledge management is that it can be deployed/implemented to any organization over Internet on Intranet. The Internet is also used to create a VPN (virtual private network) using Intranet as medium of data transmission. Worldwide organizations have been using different platforms to deploy a KM system. The following web technologies are the basic requirements for web based knowledge management system.

8.1 Web Server

The hardware of the web server is to be decided based on the traffic, network configuration etc. Web server operating system is the part of the system which delivers the required files to the client browser after necessary processing. Web server is to be selected based on the scripting (programming) language, database supports, etc. There are many web servers available in the market today. The Microsoft’s windows® server is a major player in the corporate market. Windows 2003 server is also have its presence almost in all the major organizations. While the Linux server is of great demand as a part of open source community. Window server usually runs IIS (Internet Information Server) as the web server while Linux server runs APACHE as the web server.

8.2 Programming Languages and Database

Depending on the server support the programming language can be selected. Some of the languages popularly used for scripting are Java Server Pages (JSP), ASP or ASP, PHP, Cold fusion, Perl, etc. Database support is a common requirement in such cases as details of files, members, system tracking etc are to be stored. Popular database for web applications are MySQL, MSSQL, Oracle, etc. In the client side any web browser can be used to access the server. Popular browsers are MS Internet Explorer, Netscape Navigator, Mozilla FireFox etc.

8.3 Network

An existing network can be used to develop/implemented web based KM system and their subordinate offices. Internet also used for this with open or controlled access to their users. Organizations having their offices on the various geographical locations can use virtual private network (VPN

8.4 KM Portal

Web portals can be developed/implemented through Internet in any organization having login based access to their clienteles. Users with different levels of permission can access and contribute their input. This type of system helps in sharing best practices, experiments, innovations, failure stories, etc to the internal employees. Further, KM portal can also be developed with database support system to keep the records of authors, members, access levels, visitor tracking and many other requirements.

8.5 Web Based Discussion Board or Forum

A virtual community can be created by using web based discussion boards. Different sections or areas can be created for different sections for discussions. Here the discussions are available for all in the organization to view / post / reply to the topics. This is an ideal solution for branch offices, communities located in different geographical areas but having common area of interest. They can share there common problems, areas of concerns, experience and help each other in building a strong bond of networking. Little help from organization in creating trust among members by organizing face to face interactive sessions will encourage the members to actively participate in the forums. There are many ready made scripts available in the market and one such system can be developed in house keeping in mind the requirements of the organization. Under open source community some scripts are popular for web application like PHPBB.

8.6 Blogs

Web blogs are very popular nowadays and organizations have utilized this tool to create awareness and evolve opinions on different issues. Blogs can be hosted in the organization Intranet or popular blog sites like blogspot.com can be used to give a platform to the employees to post their views. Many companies have their blogging policy also.

8.7 Expert System

Many organizations don’t know what they know. By encouraging employees posting their problems or difficulties to an expert system organization can save time and money in finding best solutions to the problems. Expert databases with profile updating can be kept for the public view and queries can be posted.
to specific experts based on the areas of domain and expertise of the experts. This helps not only in creating innovation but also the learning culture of an organization.

9. Why Web Based Knowledge Management System?

Web based knowledge management system can be deployed/implemented to any organization through Internet or on the Intranet with or without a secured login. The organization/institutions can develop/implement a knowledge management system using the Internet with login access to all its department/employees located at different places. Web based KM system are more effective and useful to the organizations in a situation when the different subordinate offices/departments are located at different geographical locations of a region. Such system provides an online platform to the organizations and their staff in sharing their best practices, problems solutions, personnel interactions etc. The following points necessitate the web based KM system in the present scenario:

- It is easy to design, develop and maintain as the development operations taken place only the server side by the developer;
- Changes/up gradation jobs can be done to the system at any point of time from any where by the developer;
- The client can access the system by any web browser with their appropriate login system;
- The reach of the portal is not limited it can be expand to any extend as and when required by the organization through the creating additional network connectivity.
- Due to the common command features a of KM portal, the user can be trained with a minimal effort/skills;
- Whenever, any new employee join the organization he/she can use the system instantly without having any formal training related to web based KM system.
- Due to these reasons web based KM system is imperative and vital for sharing tested/experimented knowledge, experiences and expertises.

10. Knowledge Management Models

The human action and the information flow shall be the two most dominant inputs for sustainable development of any organization or even a country. It is imperative that the right information needs to be in the hands of the right people/place at the right time for content specific delivery and use and re-use. The success of an organization does not depend on the better infrastructure but on the proper integration of human intellect (experiences and expertise) and IT based technologies. The following web based knowledge management models are identifies, based on the various research and practices followed in the corporate organization worldwide. These models are believed to represent the current level of knowledge management based on the existing web technologies. There could be four representative models of web based knowledge management system as discussed below:

10.1 Library Model

Under this model a large collection of documents is established, with proper indexed and classified. Each item of this model should contain the basic attributes of a document (i.e., author, title, subject, sources, publisher, date, pages number and full content of document if possible). This model should have the provision of searching, saving, downloading capabilities (i.e., each bit of the contents must be accessible though this model and this could be possible if, the content of document rigorously digitized through appropriate library automation/digital technologies.

---

10.2 Association/Attachment Model

Under this model the value added information which can be use and shared by common groups of persons, faculties, departments and centres are organized under the various subtopics. This model basically is the solution for downloading, upgrading the software facilities being used by the various centres/departments of an organization/University. This KM Repository model is available (but not exclusively and exhaustively) on the portal of DU <http://helpdesk.du.ac.in>

10.3 Directory Model

Resource pooling and sharing from person to person and institutions to institutions has become easy and accessible through the web enabling technologies. Under this model the experts, research scholars, thinkers, policy makes, lawyers, top administrators, from the different areas (interdisciplinary as well as multidisciplinary) are to be identified, and a directory of expert is created and put on the web for utilizing their experiences, expertises.

VICKY - A directory prototype repository model on DU Intranet is available, where the DU intellectual community can virtually communicate/share their views on various issues on academic and research. However, the model is in its initial stage and it requires more and more active participation among the teaching & research communities. For making it a effective tool among the academic & research communities for exchanging their academic thoughts and innovations it should be interlink/integrated with The ROUND TABLE GROUP <www.roundtable.com> which was founded in 1994. The Round Table Group is the world wide network of more than 5000 academicians and researchers who are the expert in their respective field and thus the connected experts are available to consult with client around the world.

10.4 Press Centre Model

Under this model all information that can be possibly collected, including in housed news communications, relevant articles/publications of teachers, rules and regulation, announcements and notifications, examination date sheet and results, deliberations and discussions of AC and EC, project guidelines, advertisements and selections, etc., may be put on this model for reducing the amount occurs on corresponding/distributing among the faculties/departments/colleges, etc and thus saving the money, manpower and time of the university. In addition to the information/utility forms needed to university employee such as GPF, leave, loan and advances, hospitals list, accommodations, advertisements, etc., should also be included. In the light of NIC Intranet portal where all sorts of information/forms related to employee are available on this model and its employee use/download such facilities at their working side.

11. Knowledge Management And Librarianship

Value added information and their timely distribution/use are the key components for sound development strategies and actions. According to the Ranganathan that the ‘right information needs to be in the hands of the right people at the right time’ act as
catalytic role in any activities and actions of an organization. The success does not rely on an individual's knowledge but the knowledge of the organization as a whole. The Libraries and LIS professionals since its inception more or less are the part and parcel of their attached organization and an epic center of delivering the strategic knowledge to the users for their organization. In changing perspective, the work culture of libraries and LIS professionals and their tools and techniques have also undergone several sea changes now the terms information explorer, knowledge manager, resource manager, information specialists, technology gatekeeper, web navigator, are more or less commonly applicable to LIS professionals. The new generations of LIS professionals are more advanced and well versed with the IT application and contributing not only to the LIS activities of their organization but also to the important activities of institution in knowledge creation and distribution.

In 1990 Prusak and Matarazzo has conducted a study to determine the value of LIS professionals in a corporate sector in growth and development of company, they found the role of library manager as: The online searches performed by librarians was the most valuable service offered they also found that most companies surveyed had no methods or processes in place to evaluate the effectiveness, efficiency or productivity of what librarians and while every one appeared to 'like' libraries and librarians, few firms thought of them as 'mission critical'. They concluded that with no methods to evaluate library contributions to productivity and profits, the stature of librarians within the firm was likely to sink further in terms of compensation, status, value and impact.

In another study conducted by Fleck and Bawpen in the professional field of Law and Medicine has revealed that the ‘The working librarians in their associated institutions were highly regarded by their clients but they fulfilled very much a service oriented and reactive function, serving clients by responding to their needs, rather anything more dynamic and proactive. Their clients perceived the librarians as efficient, intelligent, helpful, and processing specialized knowledge. They were also seen as un-ambitious people whose satisfaction was in helping others to their ends’.

Today, the top executives of corporate organizations well recognized the value of managing knowledge for their effective and timely use for this they shows their interest to appoint Chief Knowledge Officer (KKO) who will helps the enterprise as whole. The responsibility of CKO is a kind of extension of library affairs. Therefore, this is the right time that LIS professionals re-think, about LIS ethics, responsibilities, participations, services, status, and the more important the needs of their institution so that LIS professionals may play their active role in the sustainable growth and development of their institution.

12. Future Paradigm Of Knowledge Management

In coming days, the web-portal based products and services, such as e-journal portals, e-gateways, e-learning portals etc., will certainly improve the creation and delivering of the content to users more efficiently and efficiently. According to Gerry Murray, Director, IDC, knowledge management technologies such as enterprise knowledge portals (EKPs), which connect people, information centres, and processing capabilities in same environment will be the technology of future. Further, he also identifies three levels of web portal technologies for knowledge management such as enterprises information portals (EIP) which provide personalized information to users on a subscription and query basis, enterprises expertise portal (EEP) which provides connection people based on their abilities, and enterprises collaboration portals (ECP) which provide, virtual places for people to work together. Undisputedly, the knowledge management technologies, tools particularly the web based certainly will play a significant role in 21st century and certainly will be the killer technologies of the knowledge bade capital profession.

Conclusion

Knowledge management (KM) has been identified as the major and important management initiative that will help organization, institution, library and information centers, to utilize the every fruit of information technology in fulfills the objectives of parent organization. The availability of new IT offshoots technologies, particularly Internet and World

10 FLECK (Isabel) and BAWDEN (David). The information professional: Attitudes and images, examples from information services in Law and Medicine. Journal of Librarianship and Information Science. 27 (4);1998
Wide Web, has been instrumental in catalyzing the knowledge management. It is equally important that if, the ICT tools and techniques are well resourced and effectively implemented certainly provides a comprehensive knowledge platform that is speedily, pin-pointedly, exhaustively accessed, interactive, and delivered the requisite contents to users. Internet a wonderful invention of modern society has revolutionized the entire work culture and managerial aspects of libraries and information centers, and LIS professionals by playing a key role in building the true image of knowledge management in shape of electronic storage of information, retrieval, content delivery, content management, accessing of information through online databases, transfer of files etc. Most of the technological tools now available in LIS segment tend to help in how to disseminate information but offers less assistance for how to use knowledge. Tools that assist in knowledge creation are even less and not well developed particularly in libraries and information centers. However, some of the more user friendly technologies such as face-to-face discussions, the telephone, electronic mail and paper based tools such as books, periodicals, film charts, etc. are traditional tool and are not much effective in knowledge management in changing perspectives and emergence of new-sophisticated technologies. The knowledge creation and sharing is widely recognized as strategically important assets of any organization. For effective and efficient knowledge management LIS professionals must redesigned and re-shaped the traditional management tools and techniques and apply more advanced knowledge management tools for capturing, processing, preserving, and disseminating the contents to the user in a real time. Knowledge management and its facets such as content management, content engineering, web content management, etc., requires a holistic and multi disciplinary approach to management processes and an understanding of the dimensions of knowledge work. Therefore, LIS professionals as they are the ultimate knowledge worker must contribute in a multi dimensions so that their efforts and services can be recognized their parental organization.

Further Readings

Introduction to the Oracle SGA Regions

When an Oracle database is started, the Oracle executable issues the malloc() command to create.

The Oracle DBA controls the size of SGA, and proper SGA management can have a huge impact on performance. However, we must remember that the SGA is a static memory region, and the needs of the oracle database are commonly changing. Until Oracle9i, the SGA was not dynamic and could not be altered. After Oracle9i became commonplace in 2002, the dynamic adjustment of the SGA was common, and there is also speculation that a future release of Oracle will reconfigure itself based on the needs of the database.

(Figure 1 shows the Oracle system architecture) a region of Ram memory. RAM heap.

RAM Allocation at Oracle Instance Startup

To fully understand RAM usage, it is interesting to observe Oracle RAM and CPU allocation at startup.
Figure 2 is a time-based snapshot of an Oracle database’s CPU and RAM resource consumption at database startup time. We see the RAM allocated when the SGA is started and the RAM usage remains relatively constant after this point. As for CPU usage, we see that the CPU stress peaks during database mounting and declines as the background processes become idle.

It is important to know that the allocation of RAM memory for an Oracle server can be done solely with mathematics, and no expensive performance monitors are required to properly estimate the initial RAM demands of your Oracle database. Once your Oracle database is configured, you can change the RAM according to demand.

Prior to release 8.1.7, the most difficult part of Oracle RAM optimization in any environment was accurately predicting the high water mark of dedicated, connected user sessions once the instance was started. This was because of a bug in the v$resource_limit view. After release 8.1.7, you can use v$resource_limit to see the high water mark of connected sessions since startup time.

If we have an unexpected spike of dedicated, connected sessions, it is possible that we would exceed the amount of RAM on the server, causing active programs’ RAM regions to go out to the swap disk. In sum, the goal is to fully allocate RAM without ever experiencing RAM paging and to re-allocate RAM within the Oracle SGA to optimize performance.

To see the size of your SGA, you can issue the show sga command from SQL*Plus, as shown below. The output of the show sga command appears here:

```
SQL> connect system/manager as sysdba;
SQL> show sga
Total System Global Area 405323864 bytes
Fixed Size 49240 bytes
Variable Size 354066432 bytes
Database Buffers 49152000 bytes
Redo Buffers 2056192 bytes
```

**Oracle SGA Parameters**

Self-tuning Oracle's memory regions involves altering the values of a number of Oracle parameters. While there are over 250 Oracle9i parameters that govern the configuration of every aspect of the database, there are only a handful of Oracle9i parameters that are important for Oracle SGA tuning:

- **db_cache_size** - This parameter determines the number of database block buffers in the Oracle SGA and is the single most important parameter in Oracle memory.
- **db_keep_cache_size** - db_keep_cache_size is used to store small tables that perform full table scans. This data buffer pool was a sub-pool of db_block_buffers in Oracle8i.
- **db_recycle_cache_size** - This is reserved for table blocks from very large tables that perform full table scans. This was buffer_pool_keep in Oracle8i.
- **large_pool_size** - This is a special area of the shared pool that is reserved for SGA usage when using the multi-threaded server. The large pool is used for parallel query and RMAN processing, as well as setting the size of the Java pool.
- **log_buffer** - This parameter determines the amount of memory to allocate for Oracle’s redo log buffers. If there is a high amount of update activity, the log_buffer should be allocated more space.
- **shared_pool_size** - This parameter defines the pool that is shared by all users in the system, including SQL areas and data dictionary caching. A large shared_pool_size is not always better than a smaller shared pool. If your application contains non reusable SQL, you may get better performance with a smaller shared pool.
- **sort_area_size** - This parameter determines the memory region that is allocated for in-memory sorting. When the stats$sysstat value sorts (disk) becomes excessive, you may want to allocate...
additional memory.

- **hash_area_size** - This parameter determines the memory region reserved for hash joins. Starting with Oracle9i, Oracle Corporation does not recommend using `hash_area_size` unless the instance is configured with the shared server option. Oracle recommends that you enable automatic sizing of SQL work areas by setting `pga_aggregate_target`. `hash_area_size` is retained only for backward compatibility purposes.

- **pga_aggregate_target** - This parameter defines the RAM area reserved for system-wide sorting and hash joins.

- **sga_max_size** – This parameter defines the maximum size of the Oracle SGA, and cannot be modified while the instance is running.

With over 250 Oracle parameters and thousands of metrics, it is no small task for the Oracle administrator to zero-in on the most important measure of the health of his or her Oracle database. Many database administrators use the following list to get a general idea of the overall health of their systems.

**List of different alerts for DBA**

- **Data Buffer Hit Ratio Alert** - This report alerts the DBA when the data buffer hit ratio falls below the preset threshold.

- **Redo Log Space Requests Alert** – If redo log space requests are greater than, you may want to increase the `log_buffer` parameter.

- **Shared Pool Connection Alert** – Enqueue deadlocks can indicate contention within the shared pool, as well as locking-related problems.

- **System Waits Alert** - This query interrogates the Oracle event structures to locate events that may be experiencing excessive waits. If you experience waits on latch free, enqueue, LGWR waits, or Buffer busy waits, you need to locate the cause of the contention.

- **Library Cache Misses Alert** – This query looks for excessive library cache miss ratios. When the library cache miss ratio is greater than .02, you may want to increase the value of the `shared_pool_size` parameter.

- **Database Writer Contention Alert** – This query checks Oracle for values in summed dirty queue length, write requests, and DBWR checkpoints. When the write request length is greater than 3 or your DWBR checkpoint waits, you need to look at tuning the database writer process.

- **Data Dictionary Miss Ratio Alert** – This script alerts the DBA when requests for data dictionary metadata are high. Increasing the `shared_pool_size` parameter can sometimes relieve this problem.

**Reserving RAM for Oracle session Connections**

Oracle allocates an OS area of RAM for every connected user if the system uses external PGA regions (i.e. if the `pga_aggregate_target` parameter is not used and you are not using the multi-threaded server). To determine the optimal RAM allocation for any Oracle server, the DBA may use a formula. We will assume in this example that the server is a dedicated MS-Windows Oracle server, and that Oracle is the only program running on the server.

For dedicated Oracle servers, the maximum total RAM is computed as follows:

**OS Reserved RAM** – This is RAM required to run the OS kernel and system functions.

- 20% of total RAM for MS-Windows
- 10% of total RAM for UNIX

**Oracle Database Connections RAM** – Each Oracle connection requires OS RAM regions for sorting and hash joins. (This does not apply when using the Oracle multi-threaded server or `pga_aggregate_target`.) The maximum amount of RAM required for a session is as follows:

- 2 megabytes RAM session overhead
- + `sort_area_size`
- + `hash_area_size`

**Oracle SGA RAM** – This is determined by the Oracle parameter settings. The total is easily found by either the `show sga` command or the value of the `sga_memory_max` parameter.

We should subtract 20 percent from the total available RAM to allow for MS-Windows overhead. Windows uses RAM resources even when idle, and the 20 percent deduction is necessary to get the real free RAM on an idle server. Once the amount of RAM on the server is known, we will be in a position to size the Oracle database for RAM usage.

First, we need to know the high water mark (HWM) of Oracle connections. As noted previously,
each session connected to the Windows server requires a memory region for the program global area (PGA), unless Oracle’s multi-threaded server architecture or pga_aggregate_target is utilized.

The high water mark of connected Oracle sessions can be determined in several ways. One popular method uses Oracle login and logoff system-level triggers to record sessions in a statistics table. Another method uses Oracle STATSPACK to display the values from the stats$sysstat table, or the v$resource_limit view (only after release 8.1.7, because of a bug).

Determining the optimal PGA Size

In our example, we have 1,250 Megabytes of RAM memory on our MS-Windows server, and less 20 percent, we wind up with the total available allocation for Oracle of One GB.

The size for each PGA RAM region is computed as follows:

- **OS Overhead** - We reserve 2 MB for Windows and 1 MB for UNIX
- **Sort_area_size parameter value** - This RAM is used for data row sorting inside the PGA
- **Hash_area_size parameter value** - This RAM defaults to 1.5 time sort_area_size, and is used for performing hash joins of Oracle tables.

We can use the Oracle show parameters command to quickly see the values for sort_area_size and hash_area_size:

```sql
SQL> show parameters area_size
```

<table>
<thead>
<tr>
<th>NAME</th>
<th>TYPE</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>bitmap_merge_area_size</td>
<td>integer</td>
<td>1048576</td>
</tr>
<tr>
<td>create_bitmap_area_size</td>
<td>integer</td>
<td>8388608</td>
</tr>
<tr>
<td>hash_area_size</td>
<td>integer</td>
<td>1048576</td>
</tr>
<tr>
<td>sort_area_size</td>
<td>integer</td>
<td>524288</td>
</tr>
<tr>
<td>workarea_size_policy</td>
<td>string</td>
<td>MANUAL</td>
</tr>
</tbody>
</table>

A Script for estimating Total PGA RAM

This script will prompt you for the high-water mark of connected users, and then compute the sum of all PGA RAM to be reserved for dedicated Oracle connections. In this example, we have a 2-MB overhead for MS-Windows PGA sessions.

```
accept hwm number prompt 'Enter high-water mark of connected users:'

select &hwm*(2048576+a.value+b.value) pga_size from v$parameter a, v$parameter b
where a.name = 'sort_area_size'
   and b.name = 'hash_area_size'
;
```

When we run the script, we see that we are prompted for the HWM, and Oracle takes care of the math needed to compute the total RAM to reserve for Oracle connections.

```sql
SQL> @pga_size
Enter the high-water mark of connected users: 100
OLD   2: &hwm*(2048576+a.value+b.value) pga_size
NEW   2: 100*(2048576+a.value+b.value) pga_size

PGA_SIZE
362,144,000
```

Oracle Views for PGA Management

Oracle9i has introduced several new views and new columns in existing views to aid in assessing the internal allocation of RAM memory in Oracle. The following new v$ views can be used to monitor RAM memory usage of dedicated Oracle connections:

- **v$process** - Three new columns are added in Oracle for monitoring PGA memory usage. The new columns are called pga_used_mem, pga_alloc_mem, and pga_max_mem.
- **v$sysstat** - There are many new statistics rows, including work area statistics for optimal, one-pass, and multi-pass.
- **v$pgastat** - This new view shows internals of PGA memory usage for all background processes and dedicated connections.
- **v$sql_plan** - This exciting new view contains execution plan information for all currently executing SQL. This is a tremendous tool for the performance-tuning professional who must locate suboptimal SQL
v$workarea - This new view provides detailed cumulative statistics on RAM memory usage for Oracle9i connections.

v$workarea_active - This new view shows internal RAM memory usage information for all currently executing SQL statements.

The Future of Oracle Self-tuning

As people get more sophisticated in their self-tuning endeavors, many more Oracle metrics may become self-tuning. For example, there are dozens of self-tuning parameters that are considered immutable that may be found to be changeable. As an example, let's consider the optimizer_index_cost_adj parameter.

Oracle Corporation has invested millions of dollars in making the cost-based SQL optimizer (CBO) one of the most sophisticated tools ever created. The job of the CBO is to always choose the most optimal execution plan for any SQL statements.

However, there are some things that the CBO cannot detect. The type of SQL statements, the speed of the disks, and the load on the CPUs all affect the “best” execution plan for an SQL statement. For example, the best execution plan at 4:00 AM, when 16 CPUs are idle, may be quite different from the same query at 3:00 PM, when the system is 90% utilized.

Despite the name “Oracle,” the CBO is not psychic, and it can never know in advance the exact load on the system. Hence, the Oracle professional must adjust the CBO behavior, and most Oracle professionals adjust the CBO with two parameters: optimizer_index_cost_adj and optimizer_index_caching.

The parameter optimizer_index_cost_adj controls the CBOs propensity to favor index scans over full-table scans. As we shall see, in a dynamic system, the “ideal” value for optimizer_index_cost_adj may change radically in just a few minutes, as the type of SQL and load on the database changes.

Is it possible to query the Oracle environment and intelligently determine the optimal setting for optimizer_index_cost_adj? Let’s examine the issue. The optimizer_index_cost_adj parameters default to a value of 100 and can range in value from 1 to 10,000. A value of 100 means that equal weight is given to index versus multi-block reads. In other words, optimizer_index_cost_adj can be thought of as a “how much do I like full-table scans?” parameter.

With a value of 100, the CBO likes full-table scans and index scans equally, and a number lower than 100 tells the CBO that index scans are faster than full-table scans. However, even with a super-low setting (optimizer_index_cost_adj=1), the CBO will still choose full-table scans against no-brainers, like tiny tables that reside on two blocks.

In sum, the optimizer_index_cost_adj parameter is a weight that can be applied to the relative cost of physical disk reads for two types of block access:

- A single-block read (i.e. index fetch by ROWID)
- A multi-block read (a full-table scan, OPQ, sorting)

Physical disk speed is an important factor in weighing these costs. As disk access speed increases, the costs of a full-table scan vs. single block reads can become negligible. For example, the new TMS RamSan-210 solid-state disk provides up to 100,000 I/Os per second, six times faster than traditional disk devices. In a solid-state disk environment, disk I/O is much faster, and multi-block reads are far cheaper than traditional disks.

The speed of performing a full-table (SOFTS) scan depends on many factors:

- The number of CPUs on the system
- The setting for Oracle Parallel query (parallel hints, alter table)
- Table partitioning
- The speed of the disk I/O sub-system (e.g. hardware cached I/O, solid-state disk RAM-Disk)

With all of these factors, it may be impossible to determine the exact best setting for the weight in optimizer_index_cost_adj. In the real world, the decision to invoke a full-table scan is heavily influenced by runtime factors such as:

- The availability of free blocks in the data buffers
- The amount of TEMP tablespace (if the FTS has an order by clause)
- The current demands on the CPUs

Hence, it follows that the optimizer_index_cost_adj should be changing frequently, as the load changes on the server.

However, is it safe to assume that all of the SOFTS factors are reflected in the relative I/O speed of FTS versus index access? If we make this assumption, we
have to measure the relative speed in $v$system_event and have a foundation for creating a self-tuning parameter. To do this, we must accept several assumptions.

No systems are alike, and a good DBA must adjust optimizer_index_cost_adj according to the configuration and data access patterns. The SOFTS is measurable, and it is reflected in the wait times in $v$system_event.

The overall amount of time spent performing full-table scans is equal to the percentage of ‘db file sequential read’ waits as a percentage of total I/O waits from $v$system_event.

Here is a script that interrogates the $v$system_event view and displays a suggested starting value for optimizer_index_cost_adj.

```
select ...
  (b.average_wait / a.average_wait)*100 c5
from
  v$system_event a,
  v$system_event b
where ...... ;
```

The suggested starting value for optimizer_index_cost_adj may be too high because 98% of data waits are on index (sequential) block access. How can we “weight” this starting value for optimizer_index_cost_adj to reflect the reality that this system has only 2% waits on full-table scan reads (a typical OLTP system with few full-table scans)? As a practical matter, we never want an automated value for optimizer_index_cost_adj to be less than 1, nor more than 100.

Also, these values change constantly. As the I/O waits accumulate and access patterns change, this same script may give a very different result at a different time of the day.

This example has served to show the dynamic nature of an active database and demonstrate the value of being able to dynamically change important parameters as the processing load on the system changes.

**Conclusion**

Tuning the database can become quite complex, but Oracle9i offers the administrator an unparallel ability to control the PGA and SGA. Until Oracle9i evolves into a completely self-tuning architecture, the DBA will be responsible for adjusting the dynamic configuration of the system RAM.

This paper is intended to give the DBA a high-level overview of the salient features involved in scheduling dynamic reconfigurations within Oracle. In the future, we may expect complete self-tuning database to emerge, but in the meantime, the administrator must track the historical behavior of the database and apply it to predictive models. It is only in this way that scarce instance resources can be proactively applied to develop an optimally-tuned Oracle.

**References**

- Cochrane, R.J., Pirahesh, H., and Mattos, N. M. “Integrating triggers and declarative constraints in SQL database systems”. In Proceedings of the Twenty-Second International Conference on Very Large Data Bases, pages 567-578, Mumbai, India.
ref-erential integrity maintenance”. In Proceedings of the Eighth International Conference on Data Engineering, pages 548-556, Phoenix, Arizona, February.


MEASURING RETURN ON INVESTMENT (ROI) IN ERP IMPLEMENTATION – A MANAGEMENT PERSPECTIVE

C. M. Maran*

Abstract: Most of the returns of implementing an ERP solution are intangible in nature and cannot be quantified, nevertheless, these gains have to be factored in finding the ROI of the implementation or the ERP will not be deemed as a good investment. The study aims to handle some of the issues that are to be dealt with to get a more realistic approximate of ROI of an ERP implementation. By the medium of this study, it will discuss in detail both tangible & intangible factors with regards to costs & benefits to arrive at an accurate estimation of ROI for an ERP implementation.

Introduction

In the age of globalization when firms are concentrating on stringent cost cutting measures, justifying an investment of the tune of around $10 million on an initiative which promises to improve the supply chain operations of a firm by granting visibility to all operations and a unified view of data generated across the organization can prove to be really difficult. When the CIO goes to the board to ask for the initial investment, the issue of ROI will later or sooner crop up. This issue is further obfuscated by the fact that successful implementation of ERP is not guaranteed and most of the costs are incurred at the initial stages of the project & most of the gains are realized much later. Not only this, most of the returns of implementing an ERP solution are intangible in nature and cannot be quantified, nevertheless, these gains have to be factored in finding the ROI of the implementation or the ERP will not be deemed as a good investment. Moreover the probability of underestimating the costs is pretty high too since it’s a convenient fallacy to just include the hardware and salary costs & overlook the costs of disruption, training & employee resistance.

The study aims to handle some of the issues that are to be dealt with to get a more realistic approximate of ROI of an ERP implementation. By the medium of this study, it will discuss in detail both tangible & intangible factors with regards to costs & benefits to arrive at an accurate estimation of ROI for an ERP implementation.

Review of Literature:

ERP systems defined

Enterprise Resource Planning Systems or Enterprise Systems are software systems for business management encompassing modules supporting functional areas such as planning, manufacturing, sales, marketing, distribution, accounting, financial, human resource management, project management, inventory management, service and maintenance, transportation and e-business. The architecture of the software facilitates transparent integration of modules providing flow of information between all functions within the enterprise in a consistently visible manner. Corporate computing with ERPs allows companies to implement a single integrated system by replacing or

* C. M. Maran, Asst. Prof. Senior, IT & Systems Division, VIT Business School, VIT University, Vellore – 632014, Tamilnadu, E-mail : cmaran78@yahoo.com, cmmaran@vit.ac.in
re-engineering their mostly incompatible legacy information systems. American Production and Inventory Control Society (APICS, 2001) has defined ERP systems as “a method for the effective planning and controlling of all the resources needed to take, make, ship and account for customer orders in a manufacturing, distribution or service company.” We quote several definitions from the published literature to further explain the concept: “ERP (Enterprise Resource Planning Systems) comprises of a commercial software package that promises the seamless integration of all the information flowing through the company - financial, accounting, human resources, supply chain and customer information (Davenport, 1998). “ ERP systems are configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization” (Kumar & Hillsgersberg, 2000). “One database, one application and a unified interface across the entire enterprise” (Tadjer, 1998). “ERP systems are computer-based systems designed to process an organization’s transactions and facilitate integrated and real-time planning, production, and customer response” (O’Leary, 2001).

ERP systems and organizations

It is generally a misleading perception that implementing an ERP system will improve organizations’ functionalities overnight. The high expectation of achieving all-round cost savings and service improvements are very much dependent on how good the chosen ERP system fits to the organizational functionalities and how well the tailoring and configuration process of the system matched with the business culture, strategy and structure of the organization. Overall an ERP system is expected to improve both backbone and front-end functions simultaneously. Organizations choose and deploy ERP systems for many tangible and intangible benefits and strategic reasons. In many cases the calculation of return on investment (ROI) is weighted against the many intangible and strategic benefits.

ERP Business Benefits

ERP is an enabler of business benefits, and should not be viewed as a standalone initiative with the requirement to pay back its implementation cost. The most immediate ERP benefits include (1) improved visibility of procurement spend and savings from improved sourcing policies, (2) decrease of work-in-progress and days-of-sale-outstanding, and (3) improved productivity through better sales order handling, better procurement operations and more efficient planning.

However, the most important business benefits will often be delivered after the ERP backbone is established, by other initiatives that use the ERP backbone:

- Integrated supply chain: from network planning through scheduling and Manufacturing Execution Systems (MES)
- Easier integration of business processes with business partners
- Shared services and outsourcing of support functions
- Increased information transparency to enable better decisions
- Agility in acquisitions and “carve-outs” or divestments
- Increased regulatory compliance
- Robust and future-proofed backbone systems

ROI and ERP

Return on Investment (ROI) is a process of making any financial decision. In this method the decision maker compares the magnitude and time of the gain he is expecting with the investment he has to make to get the gain. For different companies there are different levels of gains and if the ROI exceeds that level only then the investment is made. Investors always look for different ways to maximize gains or accelerate gains by reducing costs (cost cutting etc.) and increasing revenues. This approach is widely used in asset purchase decisions or go/not go decisions.

Enterprise Resource Planning (ERP) is the study
which deals with efficient handling of the resources (material, people, customers etc.) and how these resources can be moved from one position to another position whenever necessary without causing any loss or if unavoidable causing minimum loss. The return on investment from ERP comes from the improvements of the systems and processes caused by the implementation of the ERP system; it does not come from the ERP software alone. For getting higher return on investment it is necessary that business sectors which can undergo change be identified. Then the right ERP package should be selected with proper modules. If along with the changes with the business process and operating technologies, there is minimum change of the ERP system installed, then it is a cost effective investment and increases ROI.

**Reason behind ERP implementation**

Most of the ERP packages available have overwhelming qualities that looks highly efficient for an external observer. Combined with the presentation and convincing skills of the ERP sales force, organization’s administration may find it exciting to proceed with an ERP implementation without weighing its possibilities of producing business value. Hence, for bringing objectivity into the organization’s decision making, it is necessary that the organization determines if there is a compelling business case for implementing the ERP system.

**Convincing the stakeholders**

The introduction of ERP software will necessarily bring in changes in the operation of a company. This changes influence the entire organization including almost all of its employees and in some cases, other players also in the value chain. It is possible that the stakeholders will look at this with an eye of suspicion, especially because of the resistance to change. So, it is necessary that before the implementation of ERP, we convince all the stakeholders involved about the ERP package and how it will help in the betterment of the company as a whole and improve the quality of their work. This is better explained by an ROI calculation.

**Obtaining necessary funding**

More often than not, the need to implement the ERC software is perceived by the CIO and the IT think tank. But a typical ERP implementation is a very expensive and resource consuming process and therefore will not sound very impressive to the higher management. The first step in a successful ERP implementation will be to get the support of higher management, which can be better achieved with an objective ROI analysis. This will also help the ERP project team to obtain sufficient funding and free up necessary resources for the implementation process.

**Approval of Project Sponsor**

Project Sponsors shall have commitment towards the ERP implementation process and sufficient authority to make necessary changes to it. However, the Project Sponsors will feel empowered when they are clear about the expectation levels of the organization and its achievability. When provided with a good quality ROI calculation, the Project Sponsors will be made aware of the expectations of the organization from the ERP implementation. Before implementing any new software system there are few questions which have to be answered. The company or the personnel must do an ROI analysis before deciding whether to invest in that ERP implementation scheme or not. Before implementing any such new system it should be judged properly what types of costs are going to be incurred and whether by implementing the system one can get back enough gain so that the costs are not only recovered but a profit is also achieved. The main costs likely to be incurred while implementing a new ERP system are as follows:

- Cost for the software selection
- ERP software licenses
- Database licenses
- Hardware – servers, end user personal computers, cables, racking, bar code printer and Radio Frequency (RF) equipments
- Licenses for add on packages (mainly provided by third party)
- Communication costs
- System installation costs
- Project management
- Technical and end user training
- Costs for maintenance and support

Now after implementing the system the following returns are expected:

- Improvement in the functionality of the existing system
• Optimized cycle times
• Increase in efficiency to fulfill customer requirements – EDI, compliance labeling, lead times and delivery windows, e-commerce functionality
• Improved information processing – retrieval of quick and accurate data
• Reduction in operating costs
• Less headcount
• Enhanced organizational growth
• Less time to reach market and hence to the consumer

That is why a thorough ROI analysis is important to find out whether one is getting all the expected returns from such a high level of investment. ERP implementation should generally address the issues related to:

Qualitative or Quantitative?

ERP software by itself offers many inherent benefits. But the question is whether those benefits are qualitative or quantitative. It needs to be clearly understood that ERP is not a driver but an enabler to business. All expected benefits couldn’t be achieved unless business owners are committed to it. Hence one can achieve ROI provided:

• KPIs are identified and targets are decided and agreed upon by all process owners.
• Necessary business initiatives are in place to achieve these targets which have been set.
• ERP, is also aligned to perform and measure these initiatives to give the necessary feedback to the business instead of the day to day business transaction

In short, the right partnership between business and ERP will certainly help business to meet its targets and achieve the ROI planned.

Quantifiable Tangible Benefits

• Increased Order Fill Rates: choosing a fully integrated ERP package can easily increase order fill rates by 1%. If existing order fill rates are currently at 90%, a move to only 91% is a 1% increase in efficiencies or a 1% decrease in annual freight costs.

Annual Freight Cost x 1% = Annual Benefit

• Inventory Level Reductions – TGI has experienced more than 50% inventory level reductions after just one year of implementation. Taking a much more conservative estimate of a 10% reduction, we will get benefit as follows:

Current Inventory Carrying Value x 10% = Annual Benefit

• Increased Shipments per Day - As much as 50% increases in shipments per day have been experienced in many prior implementations. Taking a very conservative estimate of saving 10% overall warehouse labor costs, the annual benefit would be:

Annual Warehouse Labor Costs x 10% = Annual Benefit

• Accounts Payable Cost Reductions: An account payable department moving to a system based matching process receives heavy cost reduction by reducing clerical staff as well as minimizing overall operating time assuming a stable economic condition.

Annual Account Payable Overtime Costs x 50% = Annual Benefit

• Increases IT Output – An integrated system which includes data warehousing, decision support systems and business intelligence drastically reduces the need for specialized report creation. There are many other IT savings which come from less user support and less annual cost of maintenance fees for out of date software.

Atleast the estimated saving would be 10% of annual IT personnel costs.

Annual IT Personnel Costs x 10% = Annual Benefit

• Increased Manufacturing Output: An integrated IT support environment can quickly enhance production schedule efficiencies by lengthened production runs and by reducing frequencies in machine changeovers.

At least 10% to 30% manufacturing cost reductions is possible in this case.

Intangible Benefits

• It is very hard to measure success in quantifiable terms, ERP can lead to important changes in employee attitudes and the overall culture of the
company. In addition to generating direct cost savings, ERP also helps companies to make better management decisions as all information are available. ERP functions as a powerful management tool that allows the owner/CEO to get a daily report (in graphical format) of sales orders, work in progress, inventory, receivables and all the critical areas of the business. With timely and accurate information at their fingertips, the business owner/CEO can make better decisions.

- ERP enables one person to do the work of several, particularly in an area like purchasing. In smaller companies, individuals who perform several functions can do them in far less time and have more time to devote to other areas of the business.

- ERP enhance teamwork. ERP makes every process in the system more visible. As people begin to see how all the different processes are interconnected and how their jobs affect each other, they become more open to sharing information and working together to resolve problems and improve processes.

- ERP will improve morale of the employees. ERP raises the professionalism in the company. It also lessens the pressure and frustration employees feel when forced to work with outdated and inefficient processes. ERP users feel more competent and professional and they gain a real sense of accomplishment from learning new skills.

- ERP will make a real difference in the bottom line, both in terms of hard dollars and in developing the people who run your business. The initial investment to purchase and implement ERP may seem steep, but it’s a benefit compared to the return on investment the software will generate for years to come after implementation.

**ROI Formulas**

There are a number of formulas available for Calculating ROI. Use of right formula depends on the organizational structure, project information and actual purchase of software.

**Standard ROI Formula**

Standard ROI formula for investment calculations:

\[
\text{ROI} = \frac{\text{Net Benefits}}{\text{Project Investment}}
\]

It is the basic and most preferred formula for evaluating a future IT purchase.

**Alternate formula to calculate ROI**

**Payback Period Formula**

---

*Figure 2*
Payback Period = Investment Amount / Annual Net Cash Flow

**Net Present Value (NPV) Formula**

\[
NPV = \frac{\text{Year One Savings}}{(1 + \text{Discount Rate})} + \frac{\text{Year Two Savings}}{(1 + \text{Discount Rate})^2} + \frac{\text{Year Three Savings}}{(1 + \text{Discount Rate})^3}
\]

Discount rate = Organization’s Investment Yield Rate

(Time value of money for three years is used in above formula)

**Industry Research Findings**

As per industrial research study following are the few findings regarding use of ROI:

- One third of companies calculate ROI on all IT investments.
- Among those projects where ROI is calculated most of them just calculate ROI at the beginning of project to justify whole project spending.
- Most of the company believes intangible benefits are important to ROI and theses benefits need some value assigned to it for use in ROI calculation.
- Most of the organization struggle to calculate ROI but many few of them only takes outside help.
- There is a general belief among a large segment of professionals that ROI calculations fail to capture the full value of the project.
- There is another common belief that it is difficult to quantify ROI on IT investments.
- Companies which have invested in ERP system, less than 50% of them calculated an ROI on the project and their ROI calculated was greater than anticipated.

**Key Factual Findings about Software ROI**

In a report which presents the findings of an exhaustive Peerstone survey of over 200 companies using ERP applications from SAP, Oracle, & JD Edwards. The following are some of the key factual findings of their study:

- 63% of Big ERP customers say they achieved some form of significant business benefit from their software investment.
- Only 39% of these companies say they achieved hard dollar ROI from ERP.
- There are no significant differences between the major ERP vendors in terms of customer ROI results except for those due to the vertical industry composition of their customer bases. 47% of manufacturing customers say they achieved hard dollar ROI from their ERP investment vs. only 26% of government agencies and educational institutions.
- In fact, 38% of all respondents never actually did a formal ROI evaluation of their projects. Failure to measure ROI is more common at public sector institutions (e.g. government agencies and universities) than in manufacturing companies.
- The most common reason for not buying new applications in 2003 was lack of top line growth (35% of respondents). Only 18% of respondents say they don’t actually need any new apps, and only 7% say they recently experienced a major application project catastrophe.
- For typical ERP projects, labor is by far the largest cost component, running about 2/3 of total implementation costs.
- For most customers, the key business goals of their ERP investments were non-financial in nature. The goal most often ranked as key was improved management vision of operations (71%). The goals least often ranked as key were headcount reduction (22%) and radical business process reengineering (20%)
- The most common reason why ERP projects fail to achieve their business goals is inadequate executive leadership (26%), followed by vendor overpromising (21%), runaway professional service costs (20%), and buggy vendor code (19%).

**Controversies and conflicts in calculating ROI in ERP**

ROI in ERP implementation is often a source of conflict because of many reasons. ROI is a straightforward concept which is widely known and used to estimate the gains in terms of profits or cost savings that accrue from a capital IT investment. Most of these costs and benefits are not quantifiable in financial terms. For these reasons, ROI in just financial terms (IRR, NPV, Payback Period, and Discounted Payback Period) does not do justice with ERP Implementation and does not make much sense as
single evaluation criterion.

Moreover, we must also remember that for calculating the financial ROI one has to make cash-flow projections into the future, which may be easy in industries where the degree of uncertainty is low, but is extremely difficult if not impossible in the IT industry where the degree of uncertainty is high. Everyone understands that in IT it is very difficult to make future estimates and consequently it is hazardous (often fatal) to follow conventional analytical methods. Quite often we need to justify projects using means other than pure financial terms.

ROI conflict can be propelled by either under/over estimating the benefits/costs. Benefits can be divided into Tangibles, intangibles and strategic benefits. The costs on the other hand can be hidden or visible, there are a few items in the costs list which can remain hidden and be overlooked. Overlooking the costs may lead to time overruns as well as budget overruns.

Conclusion

ERP must be driven by the right strategic and tactical process improvement objectives, with documented assumptions and valid ROI expectations and metrics. The new processes and ERP must be implemented correctly and quickly to meet ROI expectations and become positively measurable. Unarguably, ROI comes from process improvements ERP supports, not from new ERP software. ERP software alone, no matter how good it is, makes little impact on improving business performance. If you continue to follow the same pre-ERP business processes after implementation, you can expect the same or possibly worse performance. ERP software can, however, enable and support many new processes, but not without the organization deciding what those processes are and accepting their use.

References

- http://www.microsoft.com/dynamics/community/mbs_measuring_your_erp.mspx
- http://www.innovationsolutions.com/pdf/Getting%20ROI%20from%20Your%20ERP.pdf
- http://www.cgn.net/pdf/Measuring%20ERP.pdf
- Aberdeen estimates ERP implementation costs to be approximately $5,000 to $6,000 US per user external costs (except infrastructure) for large implementation (more than 1500 users, using Oracle or SAP). “The Total Cost of ERP Ownership”, October, 2006.
BOOK REVIEW

1. DATA COMMUNICATIONS AND NETWORKING

Author : Behrouz A. Forouzan, Sophia Chung Fegan
Publisher : Tata Mc Graw-Hill Publishing Company
Edition : Fourth, 2009
Pages : 1134
Price : Rs. 425.00
Reviewed by : Mr. Vijay Singhal

Data communications and networking presents a unique challenge, in view of one of the fastest growing technologies in our culture today. Using a bottom-up approach, the book presents highly technical subject matter without relaying on complex formulas by using a strong pedagogical approach. Overall, the book proves to be very useful for both students and professionals.

The book includes better coverage, improved figures and better explanations on cutting-edge material which brings the student right to the forefront of the latest advances in the field, while presenting the fundamentals in a clear, straightforward manner. The “bottom-up” approach allows instructors to cover the material in one course, rather than having separate courses on data communications and networking. It may not be perfect for a strongly math-centric or engineering-based curriculum, but it’s perfect for Computer Science students. This book is well organized, well written, well researched, comprehensive, and is consistently high quality across the board (table of contents, end of chapter material, glossary, index, illustrations, figures, tables, boxes, etc.).

The layout of the book is surprisingly conducive to learning. It has a comprehensive coverage of OSI and networking protocols with illustrative details of packet and frame contents with emphasis on the first four layers and gives full coverage of all of the basics of data communications including signals, modulation, transmission media, and ECC. The book covers most important networking technologies including TCP/IP, ATM, ISDN, frame relay and SONET. The illustrations are appreciable. Each chapter includes a list of books and sites that can be used for further reading, Each chapter includes a list of key terms & ends with a summary of the material covered in that chapter. The summary provides a brief overview of all the important points in the chapter. The first part gives a general overview of data communications and networking. The second part is a discussion of Physical layer of the Internet model. It discusses telecommunication aspects of physical layer. Also, it covers transmission media, switching techniques, telephone & cable TV, discussion of Data Link layer which covers error detection & correction. There is an overview of LANs and WANs.

The later parts part covers Network Layer in the Internet model covering IP addresses, network layer protocols, delivery, forwarding & routing of packets, discussion of transport layer protocols, Congestion control & Quality of Service. The last part incorporates discussion of application protocols, Network Security covering cryptography security aspects & its applications.

2. SOFTWARE ENGINEERING

Author : Prof. K. K. Aggarwal, Prof Yogesh Singh
Publisher : New Age International Publishers
Pages : 507
Price : Rs. 275.00
Reviewed by : Dr. Nirmal Singh

The book entitled “SOFTWARE ENGINEERING” authored by Prof, K.K. Aggarwal, Prof. Yogesh Singh is a good book which takes an all-round approach to software engineering processes as a discipline in software development. This book is intended to serve the requirements of courses on software engineering both at undergraduate and post graduate level. The terminologies used in software engineering field have been discussed.
in details to make the readers more clear. The ultimate objective of software engineering is to produce a good quality software which can be achievable through the well defined processes mentioned in the book.

The authors have covered all aspects of Software Engineering specifying, designing, developing and maintaining software applications by applying technologies and practices from computer science, project management, and other fields. At the end of each chapter the ‘references’, ‘Multiple Choice Questions’ and ‘Exercise’ to provide the readers with further material of study and important questions corresponding to the topics are given. A reader gets benefit by studying the references and can evaluate himself by answering the questions given at the end.

The book introduces the evolving role of software in the recent years. Software has become critical to advancement in almost all areas of human endeavor. The art of programming is not limited to writing programs which just provides a solution to the given problem. There are several other issues associated with software development like quality, cost, maintenance etc. this chapter further talks about the worth of software engineering as a discipline in software development. Moreover, terminologies used in software engineering field have been discussed to make the readers more clear. ultimate objective of software engineering is to produce a good quality software. This is achievable through some well defined processes which in turn follow some specific phases.

The book also deals with software development processes known as Software Development Life Cycle Models. Since, it is very difficult to categorize which model should be used for which software so there are certain parameters to decide the suitable model for the development of software. It also provides a comparative study of all the parameters w.r.t. various models. It also covers the initial phase of Software Development Life Cycle (SDLC) i.e. Analysis. Before developing any software one must need to gather the requirements and understand the project. It further talks about various techniques to gather the requirements and understand the project. It further talks about various techniques to gather the information like FAST, QFD, Interviews and the tools like DFD, ER diagrams, Use cases that assist the analysis process. The main objective of performing analysis is to generate a forma document called Software Requirement Specifications (SRS) which comprises of the details ‘what is to be done’.

After the finalization of SRS, it is necessary to estimate size, cost and development time of project. This is what is called software project planning. Further it talks about various size estimation methods and cost estimation models which play an important role in software planning, SDLC i.e. software design or broadly known as ‘how to do’ stage. It is a highly significant phase in which the designer plans how a software system should be generated to make it functional. SRS serves as the basis for it and the resultant is Software Design Document (SDD). It also explains the various objectives of design i.e. modularity, coupling and cohesion. The book also covers various parameters of the software that are measurable. These factors are classified under Software Metrics which are valuable management and engineering tools. Emerging trends in software development field and presents various concepts related to software reliability and also their importance. A comparative study of hardware and software reliability is also given.

Software testing being an important discipline has also captured a large amount of business in software industry and consumes significant amount of effort known as software testing. The author has divided the testing activities into types of testing and levels of testing. Further, various testing tools and the concept of debugging have been discussed. It is a necessary activity from the software development point of view. If the previous phases are not carried out properly testing can consume one-half of the total development cost.

After the installation of the software at customer’s site the task remains is software maintenance. The book covered various categories and models of maintenance.

The book has very emphatically emphasized the role of software engineering discipline in the development of quality oriented software. The concepts are discussed with the help of real life examples and numerical problems. This edition focuses on discussing the various stages of SDLC. The appropriate figures associated with the text have made the book more useful for the students and academicians for learning software engineering concepts.
To

All the Contributors

Sub: Call for papers for publication in “Tecnia Journal of Management Studies”

Dear Sir

Tecnia Journal of Management Studies Wish you a very happy and Prosperous New Year.

The Advisory Board and Editorial Board thank all contributors and readers for making “Tecnia Journal of Management Studies” an outstanding success. The Journal has been granted International Standard Serial Number (ISSN) on the basis of its high quality contents. The sixth issue has been received well by one and all. The issue contained articles like Analysis Of Financial Statements Utilizing The Multidiscriminant Model To Assess The Working Capital Management In Spinning Industry, An Empirical Analysis Of Retail Salespersons’ Perspective Of Ethical Situations In Retailing, Spirituality At Good Work, Retail Management - Global emerging trends : Indian Perspective, Scope and Challenges of E-Learning in Rural Areas of Haryana, Employee Branding – An Exploratory Study to Analyze the Set of Preferences of an Employee for an Employer, Journalism-A Journey From Mission To Profession.

The eighth issue, Volume 4, No.2 is slated to come soon. We take this opportunity to invite original research articles from faculty members and research scholars. The articles may be based on summary of Ph. D thesis recently completed, post doctoral research any other related research work, current business development etc. One may send case studies and book reviews also. The detailed guidelines for contributors are enclosed herewith.

To encourage participation from all the faculty members the Management has decided to confer a certificate of appreciation and a token honorarium of Rs. 1000 to the authors for the best Research papers accepted and published in the Journal.

The message may kindly be circulated among all faculty members, research Scholars & Concerned authors. An early response will be appreciated.

With best Regards.

Editor
Guidelines for Contributors

General Instructions:

The manuscripts should be error free to the maximum extent possible. Along with the manuscript, author(s) should provide declaration that the article is the original work of the author(s) and that it has not been published or submitted for publication anywhere else.

Authors are requested to submit the manuscript (hardcopy) along with a softcopy (CD-ROM) using MS Word processing package. The soft copy of the manuscript may also be sent through e-mail* with attachment.

The selection of papers for publication will be based on their originality, relevance and clarity, the extent to which they advance knowledge, understanding and application and their likely contribution towards inspiring further research and development.

The articles will be sent to the evaluation board for approval and only the selected articles will be published. Authors may be asked to revise and resubmit the manuscript based on the referees’ comments. Unaccepted papers will not be sent back. Copyright of all accepted papers will vest with the journal.

Guidelines: Based on American Psychological Association (APA) Style Manual:

1. Manuscripts must be typed on one side of the page in 12-point font on A-4 size paper in double-space, with the margins of 1.5 inches on all sides to facilitate editing and styling. All text, including abstract, quotations, notes and references should be typed in double-space.

2. The page number must be on all pages of the paper, including the title page. Use Arabic numerals and position the page number one inch from the right hand edge of the paper, in the space between the top edge of the paper and the first line of text.

3. The title of the paper must be typed in upper and lower case letters, and is centered between the left and right margins and positioned in the upper half of the page. If the title is two or more lines in length, double-space between the lines.

4. The manuscript must include a reference list at the end, which list the articles, books, etc. cite in the paper. The reference list must be double-spaced, and in alphabetical order.

5. The manuscript should be sent along with a cover page containing article title, author’s name, designation, official address, contact address, phones, fax numbers, and e-mail address. Details of the author’s name and other information should not appear elsewhere in the manuscript.

6. The cover letter should indicate the title, the names, addresses, phone, fax numbers and e-mail addresses of two or three relevant reviewers for your paper. These may or may not be considered by the Editorial Advisory Board.

7. Articles should not ordinarily exceed 5000 words exclusive of charts, tables and other graphics. Present each figure and table on a separate sheet of paper, gathering them together at the end of the article. Use short and crisp titles and headings in tables and figures. Include a mention of each figure or table in the text itself in the margin where the figure or table should go.

8. Abstract (between 150-200 words) outlining the purpose, scope and conclusions of the paper. No abstracts are required for review essays or case studies.

9. Quotes should be cited accurately from the original source, should not be edited and should give the page numbers of the original publication.

10. Notes should be numbered serially and presented at the end of the article.

11. No stop after abbreviations (ISO, USA, BBS, MBA etc.) Use stop after initials (B.P. Singh).

12. Only those book reviews will be accepted that pertain to Business Management or allied disciplines. The book review must contain the title of the book, author’s name, publisher's name, year of publication, price, ISBN etc. The review should not normally exceed 2000 words.

13(A) Rules for citing the books on the reference list:

a) Use the author’s surname and initial(s) only. Do not use first names, degrees, and the like.

b) Cite all authors listed for the book in the order they are listed.

c) Follow the author’s name with the year of publication. Year of publication will be in parentheses.

d) The title of the book is next and it is italicized. Only the first word in the title or any proper name should be in upper case.

e) The place of publication follows.

f) The publisher of the book is listed last followed by a period ( . ).

g) Space must be after periods that separate the parts of the citation and after the periods of the initials in personal names.

h) Often, no single example from the manual will fit your citation exactly; in that case follow the closest example possible or combine appropriate elements from two examples.

*Manuscripts and all editorial correspondence should be addressed to: The Editor, Tecnia Journal of Management Studies, Tecnia Institute of Advanced Studies, 3, PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-110085, e-mail: journal.tecniaindia@gmail.com

Tecnia Journal of Management Studies Vol. 4 No. 1, April 2009 – September 2009
i) In edited books, pagination should be mentioned in parenthesis immediately after the title of the book.

References: Books (Citation)

Edited Book

Book by a Corporate Author

13(B) Rules for citing the periodical articles on the reference list.
The Reference section appears at the end of the paper and lists all the research materials, which have been used.

a) Use the author’s surname and initial(s) only. Do not use first names, degrees, and the like.
b) Cite all authors in the Reference list in the order they are listed with the source.
c) Following the author information, give the date of publication in parentheses.
d) For weekly and daily periodical/magazines such as newspapers and popular magazines, cite the year, month and day.
For monthly article/magazine, cite the year and the month.
For the professional journals, cite only the year.
e) The title of the article follows. Only the first letter of the first word of the title or subtitle or any proper name appearing in the title should be in upper case.
f) The title of the journal (in italic) comes next, followed by the volume number, and if appropriate, the issue number.
If the journal uses continuous pagination, i.e., it runs page numbers throughout a year or volume; no reference to an issue number is needed. In that case, the title of the journal is italicized, as well as the volume number.
g) If the journal is re-paged issue by issue, i.e., each issue has a page number 1, then the issue number must follow the volume number. The issue number is in parentheses but is not italicized.
h) The next part of the citation is the pagination. The page designation p is not used except when citing newspaper articles.
i) If the journal is from an electronic database, retrieval information must be included which states the date of retrieval and the proper time of the database.

References: Articles (Citation)
Weekly Magazine/Article:

Monthly Magazine/Article:

Professional Journal (continuous pagination)

(Re-paged issue)

13(C) Other References (Citation)
Newspaper article

Computer Software

Electronic Database

Paper Presentation

Ph.D. Thesis
Tecnia Group of Institutions

Tecnia Institute of Advanced Studies (PG Campus)
(Aff. to GGSP University, App. by AICTE, Min. of HRD, Govt. of India)
3, PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-85
Website: www.tecniaindia.org
Ph.: 27555121-22-23-24 Fax : 27555120

MBA (F/T), MBA (P/T), MCA (F/T)

Tecnia Institute of Advanced Studies (UG Campus)
(Aff. to GGSP University, App. by Directorate of Higher Education Dept.)
2A/2B, PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-85
Website: www.tecniaindia.org Email : info@tecniaindia.org
Ph.: 27550341-42-43-44 Fax : 27555120

BBA (F/T), BJMC (F/T)

Tecnia Institute of Applied Studies
(App. by AICTE, UGC & DEC Delhi)
BD-1, Near Power House, Pitam Pura, Delhi-34
Website: www.tecnia.co.in Email : info@tecnia.co.in
Ph.: 27319091-92 Fax : 27319090

PGDM, PGDEL, GDEL, PGDELT
IGNOU Courses

MBA, MCA, M.Com, B.Com, BBA

Tecnia Institute of Art & Design
(Aff. to IKSVV, Khairagarh, (C.G.)
F-19/14, Sector-8, Rohini, Delhi-85
Website: www.tidmfa.org Email : info@tidmfa.org
Ph.: 27948900 Fax: 47010676

MFA, BFA, B Music, B Dance
Affiliated to SCERT

ETE, ECCE
IGNOU Courses

Tecnia Institute of Teachers Education
(App. by National Council for Teacher Education)
F-19/14, Sector-8, Rohini, Delhi-85
Website: www.tite.in Email : tite.rohini08@gmail.com
Ph.: 27948909/27948904, Fax: 47010676

B Ed., MA (Edu), MLIS, BLIS, PGLAN
CETE, DCE, CTE, CFE, DECE, CIG

Tecnia International School
(Proposed Sr. Sec. School, CBSE Board)
F-19, Sector-8, Rohini, Delhi-85 Ph.: 27948900/27942400
Email : tecnia.inschool@gmail.com

Class 1 to 12*

Tecnia Institute of Rehabilitation Sciences
(Under Approval of Rehabilitation Council of India)
5, PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-85
B Ed. (HI)*, B Ed. (MR)* BASLP*, PGDRP*

* Under active consideration
Subscription Order Form

I wish to subscribe Tecnia Journal of Management Studies, for 1/2/3 year(s).

A draft bearing No._______________________ dated________________ for Rs.________________________
________________________________________ drawn in favour of “Tecnia Institute of Advanced Studies, Delhi” is enclosed.

Subscriber’s Details

Name_______________________________________________________________________________________
Designation__________________________________________________________________________________
Organisation__________________________________________________________________________________
Mailing Address_______________________________________________________________________________
__________________________________________ PIN___________________________________________
Phone_________________________________________ Fax_________________________________________
E-mail________________________________________________________________________________________
Date________________________________  Place __________________________________ Signature and Seal

Post the duly filled form along with your draft to:

Tecnia Journal of Management Studies, Tecnia Institute of Advanced Studies, 3 PSP, Institutional Area, Madhuban Chowk, Rohini, Delhi-110085.

Ph: 011-27555121-122-123-124 Fax: 011-27555120, Email: journal.tecniaindia@gmail.com
TECNIA INSTITUTE OF ADVANCED STUDIES

TIAS maintains a FACULTY DATA BANK for its future requirement as per the following details:

1. **Professor**
   - **Management Discipline**: Ph.D. degree or a fellowship of IIMs, ICAI or ICWAI with First class Master’s degree in Business management / Administration / other relevant management related Discipline/ PGDBM/ PGDM Programmes (minimum 2 years duration) recognized by AICTE/ MHRD/UGC and declared equivalent to MBA by AICTE/ AIU with 10 years experience in Teaching / Industry / Research out of which 5 years must be at the level of Assistant Professor. 
   - Candidate from Industry / Profession with First Class Master’s degree in Business Management/ Administration / other relevant management related discipline. 
   - Professional work which is significant and can be recognized as equivalent to Ph.D. degree with 10 years managerial experience of which at least 5 years should be at a senior level comparable to that of an Assistant Professor would also be eligible.
   - **Computer Application**: Ph.D. degree with First class Degree at Bachelor’s or Master’s level in Computer Science / Computer Technology / Computer Engineering / Information Technology or Ph.D. degree in any relevant area of Computer Science / Information Technology with First class Master’s Degree and 10 years experience in Teaching / Industry / Research out of which 5 years must be at the level of Assistant Professor and / or equivalent.
   - Candidate from Industry / Profession with first class M.E./ M. Tech. In Computer Science / Information Technology and Professional work experience of 13 years in relevant industry of which at least 5 years should be at Sr. Level comparable to that of an Assistant Professor.

2. **Reader**
   - **Management Discipline**: Ph.D. degree or a fellowship of IIMs, ICAI or ICWAI or other Institutions recognized by AICTE with first class degree in Business management / Administration / other relevant management discipline/ PGDBM/ PGDM Programmes (minimum 2 years duration) recognized by AICTE/ MHRD/UGC and declared equivalent to MBA by AICTE/ AIU with 5 years experience in Teaching / Industry / Research / Profession OR First class master’s degree in Business Management / Administration / other relevant Management related Discipline/ PGDBM/ PGDM Programmes (minimum 2 years duration) recognized by AICTE/ MHRD/UGC and declared equivalent to MBA by AICTE/ AIU with 5 years experience in Teaching / Industry / Research / Profession. Such candidate will be required to obtain Ph.D. degree or a fellowship of IIMs, ICAI or ICWAI or any AICTE approved institution with period of 7 years from the date of appointment as reader failing which the increment will be stopped until same degree is earned. 
   - Candidate from Industry / Profession with First Class Master’s degree in Business Management / Administration / other relevant management related discipline. 
   - Professional work which is significant and can be recognized as equivalent to Ph.D. degree with 2 years managerial experience in Industry / profession would also be eligible.
   - **Computer Application**: Ph.D. degree with first class degree at Bachelor’s or Master’s level in Computer Engineering / Computer Technology or Ph.D. degree in any relevant area of Computer Science / Information Technology with First Class Master’s degree and 2 years experience in Teaching / Industry / Research. OR First class Master’s degree in Computer Science / Information Technology or First Class MCA degree and with 5 years experience in Teaching / Industry / Research at the level of lecturer or equivalent . such candidates will be required to obtained Ph.D. degree with a period of 7 years from the date of appointment as Reader. 
   - Candidate from Industry / Profession with First Class B.E. / B. Tech. in Computer Science / Information Technology / M.Sc. (Comp Sc) / M.Sc. (IT)/ MCA degree and Professional work experience of 7 years in relevant industry. Such candidates will be required to obtained Ph.D. degree with 7 years from the date of appointment as Reader.

3. **Lecturer**
   - **Management Discipline**: First Class Master’s Degree in Business Management / Administration or other relevant management related discipline (viz. Economics, Commerce, Maths etc) / PGDBM / PGDM Programmes (minimum 2 years duration recognized by AICTE/ MHRD/UGC and declared equivalent to MBA by AICTE/ AIU with NET Qualification. 
   - **Computer Application**: First Class B.E./ B. Tech in Computer Science/ Engineering with GATE qualification of minimum 80% percentile score or First Class MCA Degree with NET qualification.

<table>
<thead>
<tr>
<th>EMOLUMENTS</th>
<th>PAY SCALE</th>
<th>PRESENT MIN. TOTAL EMOLUMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor</td>
<td>Rs. 16,400-450-20,900-50-22,400</td>
<td>Rs. 55,824.00</td>
</tr>
<tr>
<td>Reader</td>
<td>Rs. 12,000-420-18,300</td>
<td>Rs. 37,200.00</td>
</tr>
<tr>
<td>Lecturer</td>
<td>Rs. 8, 000-275-13,500</td>
<td>Rs. 25, 560.00</td>
</tr>
</tbody>
</table>

- Higher starting salary admissible in deserving cases
- Recently retired persons, at the level of Professor only below 70 years of age may also apply.
- Candidates qualifying through Distance Education Programme need not apply.
- Application form for the same can be downloaded for the Institute’s website: www.tiasindia.org

Dully filled in application form can either be submitted on line or in person at the Institute’s address mentioned above.
Tecnia Institute of Advanced Studies (TIAS) was established in the year 1998 by Health and Education Society (Registered) to advance the cause of quality education in Management, Information Technology and Mass Communication. Since then, it has made commendable progress and stands today as an Institute of excellence in management and technical education, training, research and consultancy services. The Institute is affiliated to G.G.S. Indraprastha University for conducting MBA, MCA, BBA and BJMC programmes. The Institute is ISO 9001:2000 certified in recognition of its well established system, procedures and quality education and is rated as Best Business School by Latest AIMA –Business Standard Publication Rated amongst Top 100 IT Schools in India by Dalal Street Investor Journal.

Mr. R. K. Gupta, the promoter of the institute, is a well known philanthropist and visionary with several sterling endeavors in the field of primary and higher education. He is also an active social worker.

The Institute, located at Madhuban chowk in the north-west zone of Delhi, provides an environment for academic excellence. The campus is uniquely positioned to equip students for today’s new business environment. The Institute has four state-of-art fully air-conditioned computer centers with more than 250 Pentium IV machines, with facilities for scanning and printing. The computer labs are provided with the latest application and system softwares. The computer labs have 24 hours power back-up and internet facilities through two different service providers. The institute has state of art Audio and Video Labs with Professional Cameras, Audio & Video Mixers, and Lights & Studio Floor. Institute has well equipped Photo Lab with Digital SLR Cameras & Digital printing Unit.

TIAS library has a spacious reading room and is well equipped with latest books and journals. The reference section contains encyclopedia, yearbooks, updated government and corporate reports, in addition to host of reading material from industry and international agencies. Apart from more than 13,773 volumes of books on 73 different subjects having more than 4500 titles, the Institute subscribes to 95 National & 17 International Journals. The Library has a collection of 800 CDs & Video Tapes in non-book format. The library has also acquired membership of DELNET through which it can access to over 1027 Libraries of the world. It is also a member of the British Council Library. It maintains the record of back volumes of Journals and Periodicals to facilitate research activities. Reprographic facility is also available in the library.

The Institute has two fully air-conditioned Auditoriums each with seating capacity of 500. In addition, it has a Seminar Hall with seating capacity of 100 and a Conference Room with capacity of 35 seats augmented with Audio Visual and Edu Sat facility for online interaction with other technical Institutions.

The Institute has qualified and experienced faculty members with specialization in the area of marketing, finance, economics, human resource, information technology and mass communication. The Institute also invites vast pool of experts from reputed business enterprises, government organizations; research Institutes and Universities from time to time for providing academic impetus.
Where Dreams are Chiselled into Reality

TECNIA INSTITUTE OF ADVANCED STUDIES
(Approved by AICTE, Ministry of HRD, Govt. of India and affiliated to GGS Indraprastha University, Delhi.)
Madhuban Chowk, Rohini, Delhi-110 085
Ph.: 011-27555121-124, Fax: 011-27555120
E-Mail: journal.tecniaindia@gmail.com, Website: www.tiasindia.org

ISO 9001-2000
Certified Institute
TECNIA INSTITUTE OF ADVANCED STUDIES

TECNIA INSTITUTE OF ADVANCED STUDIES, Flagship of Tecnia Group of Institutions, India's Premier Management Institute rated as 'A' Category by All India Management Association and Business Standard & Business India Surveys and included in Top 100 B-Schools and IT Schools by Dalsal Street Investment Journal’s latest surveys. Approved by AICTE, Ministry of HRD, Govt. of India & Affiliated to Guru Gobind Singh Indraprastha University, Delhi INSTITUTIONAL AREA, MADHUBAN CHOWK, ROHINI, DELHI- 110085
E-Mail: director.tecniaindia@gmail.com, Website: www.tecniaindia.org Fax No: 27555120, Tel: 27555121-24

Programmes Offered: MBA, MCA, MBA (Part Time)

TECNIA Institute Of Advanced Studies - CDL
APPROVED BY AICTE, UGC, MINISTRY OF HRD & DEC
5 PSP, INSTITUTIONAL AREA, MADHUBAN CHOWK, ROHINI, DELHI-110 085,
E-Mail: cdltias@gmail.com, Website: www.tecnia.in

ADMISSION TO

POST GRADUATE DIPLOMA IN MANAGEMENT - PGDM
Equivalent To MBA Approved by AICTE - UGC - DEC


HIGHLIGHTS
- Programmes Offered through Regular Face-to-Face Mode
- Industry Specific and Contemporary Curriculum Design
- Innovative Pedagogy
- Experienced & dedicated Core & Visiting faculty
- State- of Art Classroom with A V Aids
- Digital Library with 13,000 Vol, DELNET & British Council Membership
- Online data-bases CMIE PROWESS, IBID, EBSCO, Emeared, Jstor
- Hi-Tech Computer Lab with Wi-Fi
- Intensive Internship Programme
- Employability Enhancement Programme
- Study Tours & PDCS Classes
- Industry Interface
- Placement Support
- Multicuisine cafeteria

SALIENT FEATURES OF PROGRAMMES
- PGDM Programme is Approved by AICTE, UGC, Ministry of HRD & DEC
- PGDM is Equivalent to MBA Programme approved by AICTE - UGC - DEC
- Institute Offers Programmes through Distance Mode
- Relaxed entry requirements with earning & learning
- Provision of learning at one's own pace, place and time
- Cost-effective and cost-efficient educational operations
- Multi-media approach in the preparation of course packages
- Self-Instructional course material
- Network of student support services
- Face-to-face Counseling and Tele-counseling
- Continuous evaluation through assignments
- Provision of terminal examination two times a year
- Interactive Satellite Aided Communication Network (Teleconferencing).
- Provision of equal opportunity of admission with no domicile requirement from any state

Eligibility:
Graduation, and clearance of CAT/ MAT/ NMAT/ TECNIAMAT or any other entrance test conducted by State Governments / any other recognized body.

Give yourself the edge of Excellence through Tecnia