Chapter-3

Literature Review
CHAPTER–3
LITERATURE REVIEW

3.1 INTRODUCTION

Present conveys its meaning in terms of past. In fact, there is nothing new in the context of old. Every new thing is learned with reference to the old. It is universally acknowledged fact that effective research cannot be accomplished without critically studying what already exists in relation to it in the form of general literature and specific studies. The survey of related literature therefore is considered as an important prerequisite to actual planning and execution of any research project.

So for the fuller and better understanding of the problem, the research scholar has made his sincere efforts to review the related literature regarding the research problem. All possible related books, journals, periodicals, research papers, thesis and material over electronic media were browsed through for this purpose. This chapter reviews previous literature and research findings related to the research topic, including the earlier research work done in this field. Research areas covered are banking & technologies, technical products adopted by Indian Banking Industry, technology adoption and diffusion, decision-making, multiple criteria decision-making (MCDM) and system dynamics (SD). The knowledge obtained from earlier study was used to setup frame work for this study. However, we have covered the latest technologies which were not covered under earlier studies. Further, literature review not only contributes to title research process but also reveals differences between previous research and this study, thereby confirming the significance of this study.

3.2 BANKING & TECHNOLOGIES

Information technology is one of the most important facilitators for the transformation of the Indian banking industry in terms of its transactions processing as well as for various other internal systems and processes. The various technological platforms used by banks for the conduct of their day to day operations, their manner of reporting and the way in which interbank transactions and clearing is affected has evolved substantially over the years.
The technological evolution of the Indian banking industry has been largely directed by the various committees set up by the RBI and the government of India to review the implementation of technological change. No major breakthrough in technology implementation was achieved by the industry till the early 80s, though some working groups and committees made stray references to the need for mechanization of some banking processes. This was largely due to the stiff resistance by the very strong bank employees unions. The early 1980s were instrumental in the introduction of mechanisation and computerisation in Indian banks. This was the period when banks as well as the RBI went very slow on mechanisation, carefully avoiding the use of ‘computers’ to avoid resistance from employee unions. However, this was the critical period acting as the icebreaker, which led to the slow and steady move towards large scale technology adoption.

The need for improved implementation of Information Technology (IT) has been emphasised in both empirical and prescriptive research studies. This problem is magnified in the banking industry, which has been slow to embrace and utilise new technologies with negative consequences on business and credibility. Implementing IT in an Indian banking system dominated by government-owned banks has not been easy. In his book ‘Imagining India – Ideas for the New Century’, Nandan Nilekani makes interesting references to this issue. He writes about his travels around the country in the early 1990s, speaking about the role of, what was then called in typical Indian English as ‘electronification’ in Indian banking. After one such presentation, Nandan writes, the chairman of a bank advised him to stop preaching, warning him that (quote), ‘The unions will gherao you in your house!’ (unquote) Nandan goes on to describe another presentation before an incredibly hostile audience, who dismissed out of hand all his ideas and suggestions. But at the end of the presentation, the union leader told him privately that both his sons were working for Microsoft on software solutions. I am told that during the initial days of IT implementation at the Reserve Bank, systems had to be smuggled into the office when ‘the world was sleeping’. Happily for us, IT implementation no longer faces opposition from any quarter. Indeed, everyone welcomes it. Even the trade unions have become extensive users of technology. “Technology in Indian banking has surely emerged from being "reactive" to "proactive" and the need of the hour is to enhance the foundation on which applications of future can safely stand if a bank is to lead through the next wave of growth in banking” (CII-PwC Report of Technology readiness of Indian Banks 2006).
These are the conclusive statement of PwC exclusive study of Indian banks preparedness about technologies. As per this study there is consensus amongst the senior executives in the banking industry that there exists significant opportunities for the Banking Industry to leverage Technology as an enabler for gaining competitive advantage. At the same time, there are significant challenges that need to be addressed. For technology to drive the competitive advantage in a sustainable fashion, banks need to have clearly defined strategic goals and translate them into appropriate IT goals. The purpose of this study is to understand if Banks in India have the right foundations in place to leverage technology to its maximum potential. Currently, banking and financial institutes are able to gain their reputation not only from their robust financial status but also from adoption of new technologies. For example, Bank of Baroda has been known as hi-tech bank of India and the same has been their punch line. Bank of Baroda has been pioneer in implementing some technical products. As previously mentioned, banking technologies contribute great benefits not only to banks themselves but also to their customers (e.g. convenience, security, improvements, better access to information and an alternative to cash).

For technology to drive the competitive advantage in a sustainable fashion, banks need to have clearly defined strategic goals and translate them into appropriate IT goals. To support the IT goals, banks would need to invest in building architectures, infrastructure, processes, IT organizations and governance frameworks. This means, i) Ensuring business benefits expected from IT are clearly identified, ii) Having governance structures in place including Policies and procedures around data quality, metadata management, disaster recovery, business continuity planning and Ensuring governance has enterprise-wide coverage, iii) Ensuring core transactional applications are in place, iv) Having a plan and solution in place for Infrastructure management, and finally, v) Having a clearly defined IT organization with appropriate skill sets.

3.2.1 Current Indian banking Scenario - The Indian Banking industry has witnessed an 18.4% growth in its assets in the fiscal year 2008-2009. (CII-PwC Report of Technology readiness of Indian Banks 2009) A sustainable overall economic growth has laid the foundation of a robust banking sector. The Industry has been largely classified on the basis of its origin & ownership into Indian Public Sector Banks, the Indian Private Sector Banks and the Foreign Banks. Their respective size and coverage as on March 2009 is as illustrated below.
3.2.1.1 Assets Composition - The total asset size is approximately Rs. 27,878,916 mn of which 72.3 % is controlled by the Indian Public Sector Banks. The Indian Private Sector Bank segment continues to grow and at present holds 20.5% of the assets (18.2% of the entire asset base in 2008) while the foreign banks hold 7.2%.

Figure: 3.1 Assets Market Share

Source: CII-PwC Report of Technology readiness of Indian Banks 2009

3.2.1.2 ATMs - The total ATM network of the banks in the country is 21,523. Nationalized banks accounted for the largest share of installed ATMs, followed by the new private sector banks, SBI group, old private sector banks and foreign banks. While SBI group, new private sector banks and foreign banks had more off-site ATMs, nationalized and old private sector banks had more on-site ATMs.

Figure: 3.2 ATMs Market Share

Source: CII-PwC Report of Technology readiness of Indian Banks 2009
3.2.1.3 Branches - The total number of branches of Schedule Commercial Banks at end March increased to 54791, comprising 19,254 rural branches, 12,933 semi-urban branches and 22,604 urban and metropolitan branches.

Figure: 3.3 Branches Market Share

Source: CII-PwC Report of Technology readiness of Indian Banks 2009

3.2.1.4 Information Technology - The financial sector has been a large user of information technology (IT). Banks, in particular, have been increasingly using IT in their day to day operations. Over the years, banks have

- extended the reach of core banking solutions (CBS) to more branches so as to facilitate anywhere banking;
- introduced technology based products and services such as mobile banking;
- expanded the internet banking facilities

The Reserve Bank continued to function as a business facilitator for developing new products and services by banks. Some of the systems developed by the Reserve Bank for use by banks are NDS, RTGS, CFMS and SFMS over the INFINET. The RTGS system has stabilized and the use of the facility for transfer of funds, especially for large value and for systemically important purposes, has been on the rise. The number of members using the system has gone up to 110 with nearly 25,000 bank branches offering RTGS based fund transfers to their customers.

3.2.1.5 Computerisation - The process of computerisation marked the beginning of all technological initiatives in the banking industry. Computerisation of bank
branches had started with installation of simple computers to automate the functioning of branches, especially at high traffic branches. Thereafter, Total Branch Automation was in use, which did not involve bank level branch networking, and did not mean much to the customer.

<table>
<thead>
<tr>
<th>Name of the Bank</th>
<th>Branches under Anywhere/Core banking solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Sector Banks</td>
<td>90%</td>
</tr>
<tr>
<td>Nationalized Banks</td>
<td>85.9%</td>
</tr>
<tr>
<td>State Bank Group</td>
<td>100</td>
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</tbody>
</table>

Source: Report on Trend and Progress of Banking in India 2009-10

Networking of branches are now undertaken to ensure better customer service. Core Banking Solutions (CBS) is the networking of the branches of a bank, so as to enable the customers to operate their accounts from any bank branch, regardless of which branch he opened the account with. The networking of branches under CBS enables centralized data management and aids in the implementation of internet and mobile banking. Besides, CBS helps in bringing the complete operations of banks under a single technological platform. CBS implementation in the Indian banking industry is still underway. The vast geographical spread of the branches in the country is the primary reason for the inability of banks to attain complete CBS implementation.

Over the past few years, the banking sector has witnessed a large increase in the use of IT based delivery channels and internet banking activity. Some of the new facilities provided include:

- funds transfer options to cover third party customer accounts within the same bank;
- funds transfer across banks;
- utility bill payments and other regular periodical payment facilities;
- integration with 3rd parties for transactions such as for booking of tickets for rail and air.
Mobile banking is another activity, which is gaining ground. Many customer-friendly facilities from short messaging service (SMS) alerts to action based on mobile instructions are being incorporated. These technological advances could have far reaching implications for the financial sector. As per the recent RBI report, the public sector banks incurred an expenditure of Rs. 14,000 crores on computerization and development of communication networks between September 1999 and March 2008.

Banking technologies have been introduced since 1980 in the form of electronic banking and home banking services (Federal Bureau of Consumer Affairs, 1995). In fact, banks are being forced to adopt new technologies and make technological changes for many reasons. First, older technologies cannot be extended. Second, new technologies provide more lucrative opportunities. Third, old technologies cannot keep up with business' growth rates or fulfill organizational needs (Inmon & Hackathom, 1994). Following four dimensions have been observed to evaluate technology in banks across four broad dimensions. They are:

i) Infrastructure & Data: This dimension examines some critical issues with regard to size of enterprise data, volume of historical and future growth, factors driving this growth and models used by banks for vendor management.

ii) Organizational structure & IT spend: This dimension examines IT organization structure, team size, degree of centralization in IT decision making, IT budgets and distribution amongst various budget heads.

iii) Governance & Architecture: This dimension examines various questions such as what are the types of governance frameworks within a bank, whether they have been defined clearly, which team is responsible for maintaining data accuracy and what is the degree of centralization maintained by the banks.

iv) Applications: This dimension examines different applications present in the bank and their coverage focusing specifically on degree of coverage under core banking applications. Going forward it also examines presence of business intelligence platforms within banks and regulatory compliance initiatives.
3.2.1.6 Satellite Banking - Satellite banking is also an upcoming technological innovation in the Indian banking industry, which is expected to help in solving the problem of weak terrestrial communication links in many parts of the country. The use of satellites for establishing connectivity between branches will help banks to reach rural and hilly areas in a better way, and offer better facilities, particularly in relation to electronic funds transfers. However, this involves very high costs to the banks. Hence, under the proposal made by RBI, it would be bearing a part of the leased rentals for satellite connectivity, if the banks use it for connecting the north eastern states and the under banked districts.

3.2.2. Concern related to strategy and the business benefits expected out of IT -

The banks in India are on a growth path as is apparent from the organization strategy which is focusing towards building top line growth while managing costs. The banks have responded that around 60% of the organization’s focus is on building top line and around 40% is for managing costs. The scenario is consistent across all classifications of the banks. Around 95% of firms have mentioned that retaining customers is critical and 88% of firms feel the same about acquiring new customers while only 53% of firms said that cutting costs will be a top priority this year. (Report on Trend and Progress of Banking in India 2009-10).

This is in line with International trends. In conformance with the expressed plans for growth, banks have mentioned the following top 5 benefits expected from leveraging IT for business. This is again in conformance with global trends where Regulatory pressure around Governance, Risk and Compliance and increasing Global Competition in terms of Markets and Customers, are seen as the two key drivers for the adoption and use of technology.

- New Customer Acquisition
- Leveraging Cross-Sell Opportunities
- Increasing Process Efficiency
- Increasing Customer Service Levels, and
- Adherence to Compliance
Table 3.2 List of benefits out of IT

<table>
<thead>
<tr>
<th>Top 5 Business Benefits Out of IT</th>
<th>Rank 1</th>
<th>Rank 2</th>
<th>Rank 3</th>
<th>Rank 4</th>
<th>Rank 5</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>New Customer Acquisition</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
<td>7</td>
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<tr>
<td>Leveraging Cross-Sell Opportunities</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Multi-Channel Customer Management</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>6</td>
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<tr>
<td>Better Cost Management</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Increasing Process Efficiency</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Increased customer service levels</td>
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<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>8</td>
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<tr>
<td>Adherence to Compliance</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Better Risk Management</td>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

Source: Report on Trend and Progress of Banking in India 2009-10

IT Infrastructure today is the backbone of the banking industry. It is becoming extremely critical with the growing business pressures of managing explosive data volume and transaction growth along-with high uptime needs. The core banking infrastructure for a bank typically consists of business application software, systems software, delivery channels, hardware, networks, security, office equipment, communication systems, storage, power back-up, helpdesks and contact centres, and various other evolving elements.

In the Indian context, banks appear to have skipped out on the mainframe-driven trend of computing, owing to a dearth of skilled resources, costs, and being a comparatively late adopter of technology. The technology adoption by the Indian banking industry has assumed a big-bang approach. This has resulted in the replacement of disparate systems to the state-of-the-art core banking solutions and appropriate infrastructure to go along with it. The banking industry is prompt to integrate various kinds of banking technologies with their business performance. Prendergast and Marr (1994) revealed the greatest potential bank technologies (i.e.
ATMs, EFTPOS, telephone banking and credit cards) and predicted that human tellers in transaction-based services would be replaced by self-service technologies.

Previous studies of banking technologies have highlighted the characteristics of adopters, critical factors for technological adoption and diffusion, and technological impacts. Their findings indicated that favorable attitudes toward ATMs come from cardholders who are young, and have a high income. Education, occupational status, computer knowledge and experience with other banking technological products also contribute to favorable attitudes to ATMs (e.g., credit cards and telephone banking).

The barriers for technological acceptance were customer's free will ability to understand, external stakeholders, and incompatibility of the innovation with existing workflows. However, the impediments sometimes are contingent upon the characteristics of technology. For example Internet adopters have to consider structural issues of the technology such as information, technology infrastructure, languages, cultures and legal frameworks (Samiee 1998).

No doubt deployment of IT offers ample rewards. But these rewards can be claimed only by organizations which successfully address the alignment challenge. Alignment of IT and business, alignment of IT and HR and alignment of IT and organizational structure, these are all critical to derive true value. Working in silos deprives several benefits. All this should culminate in IT governance as an important component of corporate governance.

The success of banking technology relies heavily on factors such as training, reliability of machines and the extent of the machine’s network. In turn, these factors depend on educational level of potential customers, level of economic activities and business practices of the market (Arunee Intrappariot). The Indian Banking Industry is witnessing significant double digit growth. The sector is also slowly emerging into a market that is becoming increasingly regulated in keeping with global trends and practices. Some of the early growth areas within the banking sector; like private banking, wealth management and investment banking are showing potential to become significant businesses in the coming years. The huge rural sector at the bottom of the pyramid will lead the next wave of retail banking. With India
witnessing an increased demand from the west for raw and finished goods in addition to its own rapidly growing consumption levels, significant investments are pouring into the manufacturing, infrastructure and services sectors, leading to high growth in corporate banking. With this high growth activity leading to increased competition in the banking sector, technology has emerged as the key differentiator in the marketplace.

In terms of coverage too, there are some interesting variations if we consider the private sector and public sector banks separately. In the case of public sector banks it seems that is still some way to go with respect to rolling out multi branch transaction systems. There seems to be heavy corporate side consolidation and processing as well. In the case of private sector banks however, there seems to be very little corporate side processing. The consolidation seems to be taking place with the help of the multi branch packages.

Another serious challenge, particularly for public sector banks, is capacity building and talent retention. The success of IT implementation is ultimately manifested at the counters of the bank or at the ATMs and not in the data centres. If IT implementation in the early stages faced challenges from the trade unions today banks face different kinds of challenges.

Bank investors also realize that not all technologies bring about a good return on investment without risks. For example, the focal point project launched by SBI in 90’s failed during gestation period only. Centralized loan applications lunched at Chandigarh also met with same fate. Remote login still gives rise to problems (Global Banking Intelligence Corp., 1996). Therefore, strategic planning is vital for management of banking technology adoption and diffusion. The effective planning may help organizations to adopt only mature technology which will prevent them from wasteful investment, ensure the success of technology implementation, and maximize utility of-technologies (Moore, 1995; 1998).

Further banks may adopt same technology but, there seems to be some variation with respect to functional coverage of implemented solution. Large asset size banks seem to have all functional areas covered by the CBS. In terms of branch coverage however there is again a clear distinction between the private sector as well
as public sector banks. In the case of the latter there is full coverage while in the case of the latter an 80-20 rule seems to have been followed wherein the branches that generate the largest business volume are covered by a CBS. Care should be taken to consider the rural focus of public sector banks while looking at branch wise coverage of public sector banks. However it must also be stressed at this stage that the rural market might very well be the next battleground and banks should aim at greater coverage.

Common complaints about disintegrated applications were:

1. Issue of hand off of data
2. Data not being up to date or on time
3. Duplication of data and business logic

To manage the choice of technology, few decision-making models or strategic planning have been used for technology adoption. Takac and Singh (1992) proposed an information framework combining business and investment planning (BIP) and information systems planning (ISP) for technological adoption and management to improve decision-making and planning processes. Buzzacchi, Colombo and Mariotti (1995) developed a conceptual model to analyze innovations in the banking sector. The model emphasized the role played by demand-pull variables and stimulating innovative behavior. The identified phases consist of determining IT benefits, evaluating available IT, recognizing the internal environment, reviewing IT management procedures, and assessing the external environment.

Avasthi and Sharma, (2000-2001), advances in technology are set to change the face of the banking business. Technology has transformed both the delivery channels used by banks in retail banking. It has also greatly impacted the whole markets of banks. Both the authors explored the challenges that the banking industry and its regulators face. B. Janki, (2002), analyzed in his article that how technology is effecting employee’s productivity. There is no doubt; in India particularly PSBs will need to use technology to improve operating efficiency and customer services.

Bajaj, (2009), highlighted e-commerce related issues due to the adoption of recent IT. All over the world, banks traditional business of taking advances & lending out the proceeds is in terminal decline. The spread of IT & the dramatic
advances in financial theory have made it cheaper for big companies to raise money in the capital markets than from banks. IT is also helping in cutting costs by providing cheaper ways of delivering products to customers ATMs, telephone banking and now the Internet Banking. He also explained e-commerce, payment system, smart card and electronic cheque etc. He concluded that electronic payment systems are emerging and getting accepted in the market place. They need to gain both consumer & business acceptance. But the major point emerges from the above discussion is that banking stands to radically change. It remains to be seen whether banks use e-commerce and other IT systems to reinvest themselves, gain access to new markets or become extinct as dinosaurs whether advances in technology create new opportunities for banks or they became extinct.

As per Bajaj (2009), Information & Technology are the key drivers of the Information Age, also referred to as the postindustrial society. The information age has ushered in a knowledge-based industrial revolution. The business in this era is networked & uses IT to survive in a highly competitive environment. The relationship between IT & business is discussed in this article and it is explained that how IT is effecting business.

In view of Benton (1990), no doubt, with the introduction of IT, it has positively affected the productivity, profitability and efficiency of banks. But many bank frauds are also taking place. They are the hidden threat to the financial institutions. He analyzed the mechanism that how bank frauds are taking place & how to tackle with them.

Bhasin (2001), analyzed the impact of IT on banking sector. The IT has revolutionaries various aspects of our life. It has transformed the repetitive and overlapping systems and procedures, into simple single key pressing technology resulting in speed, accuracy and efficiency of conducting business. The computerization of banks has provided a major push for enabling them to enter into the newer activities.

The banking industry has itself prepared itself and is strongly emerging to play a major supplementary role in nurturing e-commerce applications, which is still in the infancy stage in India. While few of the generation private sector banks have taken an
early initiative in these innovative areas, other banks are gradually catching up. The author feels that utmost importance that proper security infrastructure should be in place for routing seemed transactions through the public network.

Birla Institute of Scientific Research, conducted a study to evaluate the performance of nationalized banks in comparison with that of banks in private sector. The emphasis of the study was on the objectives of nationalization and their achievements, relative performance of private sector banks and nationalized banks since 1969 and the effect of the nationalization on rest of the banking sector. The study reveals that the growth and development in banking after nationalization was not just because of transfer of ownership. It was rather because various incentives and punitive measures were implemented with more vigilance and care after 2969 by the govt. and the Reserve Bank of India to makes bank fulfill their social responsibilities. Similarly in same spheres the non-nationalized banks achieved even better results.

The performance of private banks in the post-nationalized period was noteworthy, especially because of the odds they faced in securing the growth of the business. The achievement of significantly high growth in deposits, advances and branches etc. clearly showed the high quality of entrepreneurship and management of these banks.

Due to the introduction of IT, the role of banks, mutual funds & insurance companies are changing. The banks will never be the same again. The dimensions of banking business are changing in the new economy.

Federick & Phil, (2000), analyzed the E-Loyalty. With the introduction of IT, it has created many doubts and questions. In the rush to build Internet business, many executives concentrate all their attention on attracting customers rather than retaining them. According to them, the unique economics of e-business make customer loyalty more important than ever. Johri & Jauhari, (1994), also analyzed the importance of computers in banking industry. He also analyzed various issued related to computerization in banks in India. Whether banks use e-commerce and other IT systems to reinvest themselves, gain access to new markets or become extinct as dinosaurs whether advances in technology create new opportunities for banks, or they
become extinct. Kohli, (2001), emphasized on the importance of technology & issues emerging from this technology. According to him technology is emerging as a key-driver of business in the financial services industry. The advancement in computing and telecommunications has revolutionized the financial industry and banking on the net is fast catching on. As e-commerce gets transformed into m-commerce with the increasing use of technologies like WAP, banking business is in for a major overhaul.

Nirajan, (2000), studied the charging business dimensions of banks due to the introduction of IT. The Internet is taking banks in directions other than loans & deposits. Banking in India will never be the same again. E-Banks have started E-Commerce & many banks are entering in insurance sector.

Pathrose, (2001), banking the world over is undergoing a rapid and radical transformation due to the all-pervasive influence of IT and breath taking developments in the technology of telecommunications and electronic data processing.

The winds of change are blowing in India too. The IT which implies the integration of information systems with communication technology has radically altered the traditional ways of doing banking business and allowed banks to wipe out the difference in time as well as distance.

Rangarajan (2000), in his inaugural address at the 4th Bank Educationists’ Conference on 6th March, 2000 at Hyderabad explained the importance of IT in the financial sector. At a time when banking around the world over is undergoing a radical transformation due to the all-pervasive influence of IT. Banking education and training must not only respond to the fast changing needs of the financial system but also become proactive and play the role of ‘Change agent’ and bring about a ‘Skill revolution’ in the banking industry. Banks will began to function increasingly under competitive pressures. In meeting the new challenges, the use of computer, Internet and communication technology will assume a critical role. Bank customers are becoming very demanding and it is the extensive use of technology that will enable bank to satisfy adequately the requirements of customers. The use of technology would also improve availability of information for management discussions and for monitoring operations.
Rao (2002), has analyzed the impact of new technology on banking sector. The advent of technology both in terms of computers and communication has been changing totally the ways and doing banking business. Technology has opened new vistas and in terms brought new possibilities every day for doing the same work differently and in most cost-effective manner. Tele-banking and Internet banking are making forays such that branch banking may give to home banking. In order to protect their profitability, the banks need to address urgently.

Saxena (2000), also analyzed the importance of IT in banking sector. According to him, the future promises to be even more exciting, interesting and challenging. The Internet has enables us to talk to each customer as an individual, with different needs and requirements. This IT will affect the productivity and profitability of the banks.

Vageesh (2000), highly appreciated the Non Public sector Banks (NPSBs), which have adopted IT. The NPSBs with their state-of-the-art technology and grandiose plans to make in-roads into e banking are now darlings of the stock markets. Banks like HDFC and ICICI are foraying into net banking which offers great convenience to the customers on one hand and result in lower transaction cost for the banks on the other hand.

Verma (2000), analyzed the impact of IT on PSBs & NPSBs in her article ‘Banking on Change’. The IT is a threat for the PSBs. It has to be a complete phase off for the PSBs. With the business per employee, even for the front-run PSBs a mere fraction of that of NPSBs, PSBs have to do a lot on improving their productivity and efficiency. NPSBs are fully computerized and providing services on Internet.

A review of the literature on the subject indicated that the introduction of IT is very vital for the present banking system. The concept of IT in its present form, is new, no comprehensive study has yet been made regarding the impact of IT on banking industry. No doubt some articles in the leading newspapers, magazines & journals have highlighted the importance of IT in banking industry.

Hence there is a need to examine the impact of IT on the growth & performance of banking industry on the one hand & on the other hand, it is equally important to assess the customers satisfaction levels in the banks where this IT is
used. Therefore this study is concerned with mainly two aspects (i.e., performance of these banks and customers satisfaction in these banks).

3.3 TECHNOLOGY ADOPTION AND DIFFUSION

Since early in this century, various "new" educational technologies have been touted as the revolutionary pedagogical wave of the future. Classroom films, programmed learning devices, language laboratories, educational television, computer-assisted instruction and, more recently, interactive videodisc technology have been adopted and integrated into the curriculum with varying degrees of success. Each technology was widely perceived as meeting a need, and each gained a measure of initial commitment of resources from a high level administrative or legislative entity. Their adoption and diffusion process generally followed what has been termed the "traditional model," a "top-down" process in which administrative "mandate" introduced the technology and administrative perceptions, decisions and strategies drove adoption and diffusion. Successful adoption was highly dependent on the degree, stability and wisdom of administrative sponsorship.

None of these technologies, however, has been generally available for individual or private use due to cost, scope or application. This deterred a "grass roots" technology adoption cycle as it was nearly impossible to generate movement from the bottom up by influencing faculty peers and administrators with demonstrations of successful applications.

Today's educational generation, however, sees personal computers, the Internet and the World Wide Web as technology's new wave. Proponents of distributed learning environments and distance learning on the World Wide Web forecast dramatic innovation at all levels and in all areas of education. And although this enthusiasm is reminiscent of that of past innovators, there are significant differences in the nature of this technology revolution in education and that of earlier ones with corresponding implications for adoption and diffusion.

Unlike earlier technologies which were thrust upon the education community, Internet technology is individually available to faculty and students who can use their own systems to serve their own purposes. The impetus for the innovation frequently grows from individual users of the technology, and as their communication and
influence moves laterally through their contacts, a body of support can grow and exert "pressure" on the institutional administration to commit to adoption of the technology. There is, therefore, a high potential for a "bottom-up" or "grass roots" adoption process to succeed.

Indeed, Everett Rogers (1986), considered by many the "guru" of adoption/diffusion research since publishing Diffusion of Innovations (now in its fourth edition) in 1960, reveals three important ways in which the adoption of interactive communications differs from that of previous innovations. 1) A critical mass of adopters is needed to convince the "mainstream" teachers of the technology's efficacy. 2) Regular and frequent use is necessary to ensure success of the diffusion effort. 3) Internet technology is a tool that can be applied in different ways and for different purposes and is part of a dynamic process that may involve change, modification and reinvention by individual adopters.

Internet technology actually embodies a number of technologies--e-mail, databases, chat rooms, information and education resources, among others. Additionally, the Internet exhibits many elements that constitute a culture or community--language, symbols, rituals, interaction, and other elements of communication. It thus essentially becomes an environment into which users enter (December, 1993; North, 1995). "Visionary" innovation and "pragmatic" application can begin with grass-roots enthusiasts who enter this environment. Viewed as a culture or community, however, the Internet can be perceived as a threatening competitor to the established norms of an existing culture or community, such as an academic department or some other institutional entity.

3.3.1 Technology Adoption/Diffusion different views - Since early in this century, various "new" educational technologies have been touted as the revolutionary pedagogical wave of the future. Classroom films programmed learning devices, language laboratories, educational television, computer-assisted instruction and, more recently, interactive videodisc technology have been adopted and integrated into the curriculum with varying degrees of success. Each technology was widely perceived as meeting a need, and each gained a measure of initial commitment of resources from a high level administrative or legislative entity. Their adoption and diffusion process
generally followed what has been termed the "traditional model," a "top-down" process in which administrative "mandate" introduced the technology and administrative perceptions, decisions and strategies drove adoption and diffusion. Successful adoption was highly dependent on the degree, stability and wisdom of administrative sponsorship.

None of these technologies, however, has been generally available for individual or private use due to cost, scope or application. This deterred a "grass roots" technology adoption cycle as it was nearly impossible to generate movement from the bottom up by influencing faculty peers and administrators with demonstrations of successful applications.

Today's educational generation, however, sees personal computers, the Internet and the World Wide Web as technology's new wave. Proponents of distributed learning environments and distance learning on the World Wide Web forecast dramatic innovation at all levels and in all areas of education. And although this enthusiasm is reminiscent of that of past innovators, there are significant differences in the nature of this technology revolution in education and that of earlier ones with corresponding implications for adoption and diffusion.

Unlike earlier technologies which were thrust upon the education community, Internet technology is individually available to faculty and students who can use their own systems to serve their own purposes. The impetus for the innovation frequently grows from individual users of the technology, and as their communication and influence moves laterally through their contacts, a body of support can grow and exert "pressure" on the institutional administration to commit to adoption of the technology. There is, therefore, a high potential for a "bottom-up" or "grass roots" adoption process to succeed.

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i) A critical mass of adopters is needed to convince the "mainstream" teachers of the technology's efficacy.
ii) Regular and frequent use is necessary to ensure success of the diffusion effort.

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Adoption/Diffusion Theories: The "top-down" and "bottom-up" models of adoption/diffusion provide a directional perspective to the process. Another theory dichotomy relates to the scale of innovation efforts by distinguishing between macro-level theories and micro-level theories. Macro-level theories focus on the institution and systemic change initiatives. Innovation typically involves broad aspects of curriculum and instruction and might encompass a wide range of technologies and practices. Micro-level theories, on the other hand, focus on the individual adopters and a specific innovation or product rather than on large-scale change.

Rogers (1995) recently presented four additional adoption/diffusion theories.

i) **Innovation Decision Process theory.** Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion); they then must decide to adopt it (decision); the innovation must then be implemented (implementation); and finally, the decision must be reaffirmed or rejected (confirmation). The focus is on the user or adopter.
ii) Individual Innovativeness theory. Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

iii) Rate of Adoption theory. Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline.

iv) Perceived Attributes theory. There are five attributes upon which an innovation is judged: that it can be tried out (trialability), that results can be observed (observability), that it has an advantage over other innovations or the present circumstance (relative advantage), that it is not overly complex to learn or use (complexity), that it fits in or is compatible with the circumstances into which it will be adopted (compatibility).

Each of the above can be considered in the context of either a top-down or a bottom-up adoption/diffusion process and in either macro-level or micro-level reforms. But there is another adoption/diffusion theory that is relevant to the discussion of Internet innovation. The distinction is between a determinist (developer-based) focus and an instrumentalist (adopter-based) one.

Determinists regard technology as the primary cause of social change. The process is seen as a series of revolutionary advances that are thought to be out of direct human control. Consequently, focus is on an innovation's technical characteristics. Successful adoption/diffusion is the assumed result of an innovation's technological superiority. The innovation's developer is viewed as the primary change agent.

For instrumentalists the process is evolutionary, and the causes of change are in social conditions and in human aspirations for change and improvement. Thus their focus is on the user (adopter) of a technology and its value as a tool to bring about desired change. Human control over the innovation is a key issue, and it is considered essential to understand the social context in which it will be used and the function that it will serve.
Thus the focus of the process has shifted to the potential adopter and the organization into which the technology will be integrated. An adopter based, instrumentalist approach incorporating both macro-and micro-level perspectives now appears to be the most widely used to promote the adoption and diffusion of Internet technology.

**Ernest Burkman’s (1987)** user-oriented development approach exemplifies those currently favoured for the adoption and diffusion of instructional technology generally and Internet technology in particular. It consists of 5 adopter-focused steps: 1) potential adopter identification, 2) measurement of their relevant perceptions, 3) user (adopter)-friendly product design and development, 4) informing the potential user (adopter) of the product, and 5) support after adoption. An alternative model developed at the University of Minnesota’s Telecommunication Center recommended a complete analysis of educational need and user characteristics along with the identification of a new educational technology’s relevant and appropriate features and factors (Stockdill and Morehouse, 1992).

**Tessmer (2011)** stresses the need to analyze the environment in which the potential adopter is expected to use the technology. This process includes identifying the relevant physical and use characteristics of both the instructional situation and the support system. The approach is intended to ensure actual, correct and continual product use.

No single approach or process may be sufficient to ensure successful innovation adoption. But clearly, Internet and Web-based technology is individual-user based in application, and the adoption/diffusion process should start at that level. It should focus on the potential adopters and address their characteristics in the context of the environment in which they will be using the technology.

### 3.3.2 Adoption and Diffusion Need Theory

- Addressing the needs implied by the early adopter-early majority differences when designing diffusion strategies can greatly enhance the likelihood that a technology will be successfully integrated into the curriculum by groups beyond the innovators and early adopters (Geoghegan, 1994).
Need for recognition and process involvement: The chances of successfully "selling" an innovation to the pragmatic early majority will significantly increase if their differences are addressed in terms of their perceptions and needs. They should be recognized as a distinct group within the community and made a part of the planning and policy making process. Attempts to "convert" them to the point of view of the innovators and early adopters are likely to be futile, not to mention almost certainly disastrous to impose the technology on them otherwise. Diffusion of the innovation to the late majority and laggards is more likely to occur through this early majority involvement since the vertical lines of communication between the three groups are more direct than with the innovators and early adopters.

Need for vertical support structure to overcome technophobia: When technology adoption begins from the grass roots, innovators and early adopters, with their strong technology orientation, may be able to get by on their own initiative. Narrowly focused technical support staff may not pose a threat or discouragement to them and their needs for initial training and support may be relatively easy to accommodate. Members of the early majority, however, tend to have no interest in the technology per se and some may exhibit a form of technophobia. Their introduction to the technology should be related to their perceived program and process needs. Since they tend to focus vertically within a discipline, training and support provided by staff who enjoy discipline/content credibility will likely be best received. Correspondingly, such training and support will be more transferable to the late majority and laggards.

Need for well-defined purpose or reason: The very existence of a technology may be reason enough for innovators and early adopters to pursue it. Their bent for experimentation and their innate interest in technology may dispose them to adopt it and be content with "finding a problem to fit the solution". Members of the early majority (and the others by extension), however, tend to derive their purposes from problems related to their disciplines. If the innovation can be demonstrated as an effective, efficient and easily applied solution to those focused needs, it is more likely to be adopted and integrated into the program.

Need for ease of use and low risk of failure: The early majority’s aversion to risk quite naturally translates into a need for ease of use and early success if they are to
adopt and diffuse the technology. The overlap with support and training requirements is obvious.

Need for institutional/administrative advocacy and commitment: In the top-down adoption effort, institutional sponsorship and support is a given. The innovation may be mandated and grant moneys or other funds are committed. Without advocacy and resource commitment by the institution's "policy setters" and "holders of the purse strings", other issues become moot as the process is likely doomed to stalemate, if not to an early demise. But innovation that occurs from the bottom-up also requires institutional attention and an administration as an entity (except for some possible rare exceptions) tends to emulate the early majority rather than the innovators and early adopters. And even when an institution initiates an innovation from the top, their perspective tends to be a pragmatic one based on a problem or need that a given technology promises to alleviate. It may relate to staffing, financing, scheduling, teaching, distance or communication. In any case, the mindset is similar to that of the early majority and, as always, there is a need for advocacy to occur if the conditions and activities that can promote adoption by the early and late majorities and laggards are to prevail.

Meeting these needs is an essential part of any successful diffusion strategy. From their work at the University of Colorado, Wilson, Ryder, McCahan and Sherry (1996) derived several principles that apply particularly to situations in which students and faculty are introduced to networked learning environments.

3.3.3. Other theories of Adoption and Diffusion - There have been many other theories explaining the basic concept of adoption and diffusion, some of them are summarized below:

First-time success: No one enjoys frustration or failure. An innovation is most likely to be accepted and integrated by the early and late majorities if success is experienced initially and subsequently built upon. E-mail is typically introduced early on because of its ease of use, and its success is almost guaranteed. It also extends the peer network, both within and outside the institution, thereby magnifying its impact on adoption and diffusion (VH Carr Jr 1999).
On-going peer support: Complementing the experience of initial success, there should be ample "hand-holding" along the way of integration as other Internet applications are introduced. Live peer support not only serves as assistance and encouragement; it contributes to the person-to-person communication that promotes diffusion throughout an educational community. In addition to a training cadre of recognized peers, a network of on-line mentors can expand the potential of the support structure to promote the exchange of innovative techniques (VH Carr Jr 1999).

Real task activities: The early and late majorities are pragmatists who see technology in terms of real problem and task solutions. Activities designed to introduce and teach the technology should address those needs. As pointed out earlier, institutional administrations tend to emulate this pragmatic perspective. Internet access to information and resources, and its use for intra and inter-institutional communication can address many administrative needs in addition to those of the faculty, as well as establish a well-defined and recognizable need for adopting the technology (VH Carr Jr 1999).

Ownership and identity on the Internet: Encouraging and enabling faculty and students to "create an active presence" on the Internet is important. Participating in live chats, creating a personal home page, and publishing electronic papers all contribute to the electronic world-community and help ease "cultural assimilation." As with using e-mail to ensure early success with the technology, this "presence" extends the peer network impact on its adoption and diffusion. Beyond that, it also creates a professional identity and a credibility standing similar to that derived from traditional publication.

Variety of incentives: Attempts to impose a technology through explicit mandates and requirements, as in the top-down scenario, are not likely to be effective. This is particularly true with Internet and Web technology because the technology is so generally available to anyone who has a mind to adopt it. Policies and procedures promoting the technology should grow naturally from its application, and incentives for using it likewise should be tied to its practical use. Adoption and diffusion is more
likely to occur where incentives and policies encourage a natural acceptance and use of the new technology (KS Gallagher 2011).

Technology innovation in the educational community has often been hindered by the lack of a reward structure. Written publication has long been held as evidence of scholarly work that is worthy of recognition through promotions or tenure. In contrast, time consuming effort directed to pragmatic problem solving, instructional materials design and development or innovative classroom teaching has rarely received similar recognition. Integrating a technology like the Internet into one's teaching is time consuming and "effort intensive," usurping time and energy that otherwise could be devoted to more traditional and more rewarded endeavours. If innovative behaviour is to be sustained, there must be a recognized and acknowledged system of rewards parallel to, and equal to that associated with "traditional" academic pursuits.

3.3.4 Aspects of Adoption and Diffusion of Technology - An adoption of IT is initiated mostly through hardware purchase followed by need of relevant software. However, the decision to adopt one specific technology may relate to other technology adoptions, learning and skill management, and other strategic choices in an organization. In addition, technologies are implemented within a social context accommodating various factors such as economic, political, cultural, and behavioral, which are unique for each society (Varshney P.N. and Mittal D.K. 2000). Thus, considering only physical properties of the adopted technology, without taking relating factors into account cannot fulfill the requirements of the organization and may inhibit the success of technology adoption and increase the risks of failure for subsequent diffusion (Arunee Intraparirot-2004).

The adoption and diffusion of an innovation within an institution does not guarantee its successful integration into the curriculum or its continued use. A classic example might be the once ubiquitous classroom film, frequently used in public schools as "Friday afternoon filler" rather than as a planned learning experience. Similarly, the lack of appropriate and adequate teacher training inhibited the full use of language laboratories in public schools decades ago.
In addition to a strong stable advocacy needed to ensure the conditions necessary for technology adoption and diffusion, training in its technical aspects and application to real needs is crucial to its integration beyond the innovators and early adopters. Time for experimentation and development of applications is essential. Successful peer users are needed to lead its integration into the curriculum. If the technology is perceived as difficult to learn and/or too time consuming to prepare and use, or is in some other way perceived as threatening, it probably will not be used. No amount of administrative force would likely be effective reversing a negative trend (Ahuja, G., Katiala, R. 2001). A perception of value in terms of needs/problem solving and academic or other rewards through establishment of policies, incentives, recognition and an on-line presence in the Internet culture and environment need to be nurtured by the institution's administration.

The most recent empirical evidence confirms the positive effect of information and technologies (IT) on firm performance not only in terms of productivity, profitability, market value, and market share, but also in intermediate performance measures, such as process efficiency, service quality, cost savings, organizational and process flexibility, and customer satisfaction.

IT management is a difficult job. The virtually endless list of challenges that CIOs face includes new technologies, global economic uncertainty and demands from end-users. For these IT heads, combining traditional management skills with technology is a necessity.

In the ZDNet Asia IT Priorities 2008/09 survey, IT managers in the Asia-Pacific region rated business management issues as their highest priorities. Technology is important, but it is how that technology is implemented in a business environment that remains their paramount concern. The survey, conducted online in August 2008 on 722 IT decision makers and influencers across the region, found that user organizations had broadly similar concerns no matter what country they were in, their industry, or how big they were.

Respondents were asked how much money their companies were spending on IT, their future IT priorities, and their open source and Web 2.0 adoption strategies. They were also asked about their commitment to environmentally friendly IT
practices, and the extent to which global economic circumstances were affecting their IT budgets.

Figure: 3.4 Companies Spending

<table>
<thead>
<tr>
<th>Top IT Priorities</th>
<th>% of respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management: Business</td>
<td>16.6</td>
</tr>
<tr>
<td>Management: IT</td>
<td>11.4</td>
</tr>
<tr>
<td>Software: Business apps.</td>
<td>10.9</td>
</tr>
<tr>
<td>Management: Workplace and staffing</td>
<td>5.8</td>
</tr>
<tr>
<td>Networking: General</td>
<td>5.0</td>
</tr>
<tr>
<td>Security: General</td>
<td>4.7</td>
</tr>
<tr>
<td>Software: Application dev</td>
<td>4.5</td>
</tr>
<tr>
<td>Hardware: General</td>
<td>3.6</td>
</tr>
<tr>
<td>Vendor-specific</td>
<td>3.6</td>
</tr>
<tr>
<td>Software: Web dev/services</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Source: ZDNet Asia IT Priorities Survey 2008/09

Many respondents mentioned priorities that had to do with business, rather than IT. These included increasing profitability, reducing costs, improving quality and efficiency, among others. For the third year in a row, management issues, IT management, business management, and workplace and staffing issues generally ranked higher than technology concerns. IT management issues, which included improving response times, resilience, stability, consolidation and performance, also rated very highly, as did business applications.

Nowadays, the debate is focused on variables relating to IT usage and ways of increasing the positive impact of IT on firm performance. Knowledge about the relationship between IT and firm characteristics, firm strategies, and the competitive environment can help firms to obtain greater benefits from IT adoption. There is no doubt about the fact that, to obtain such benefits, it is absolutely essential to identify the variables that affect the decision of firms to adopt IT. This concern has led in the last years to several studies analyzing the drivers of IT adoption and diffusion. (Arunee Intraparirot 2004)
In this way, new conclusions can be drawn regarding the introduction of the new technologies into the firm. By developing a better understanding of the factors that influence IT diffusion, policy makers should be able to design more accurate policies to efficiently promote IT adoption and managers could take measures within their organizations to maximize the effectiveness of their efforts to stimulate IT usage and increase organizational performance and productivity.

Since the efficacy of technology and its advantages depend on management of technology rather than the physical technology, technology adoption and diffusion should focus on managerial/organizational processes, and social contexts, and adapt to local cultures, markets and the circumstances (Bhargava-1997). Many institutions are investing heavily in implementations of technology not all successfully. Many factors come into play in determining the success or failure of a technology implementation: the technology chosen, the organization’s readiness, processes affected by the implementation, and user involvement with the implementation, to name just a few.

Technologies implementation efforts offer extraordinary challenges to information technology professionals and the organizations impacted by the implementations. A successful implementation can reap vast rewards in organizational strengths and efficiencies. A failure can drain an organization of people, funds and vitality. Consequently, many people have puzzled over the reasons for the successes and failures experienced with these implementations. Various studies suggest ways to ensure the success of technology adoption. For example, Geisler (1992) identified seven criteria for IT adoption including the capabilities of technology, consistencies between technologies and organizational requirements, user acceptance, extendibility, compatibility, and life cycle of technology. Factors such as business size and executive characteristics are critical for the success of technology adoption.

Technology has become an integral part of nearly every business and social endeavor. However, in spite of this, each profession has different definitions for what technology is. A universally shared definition has not emerged— which indicates that the transformation of these professions by technology is still occurring faster than it can be codified.
Technology is the making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organization in order to solve a problem or perform a specific function. It can also refer to the collection of such tools, machinery, and procedures. Technologies significantly affect human as well as other animal species’ ability to control and adapt to their natural environments. The word technology comes from Greek τεχνολογία (technologia); from τέχνη (téchnē), meaning "art, skill, craft", and -λογία (-logia), meaning "study of -. The term can either be applied generally or to specific areas: examples include construction technology, medical technology, and information technology. An IT professional sees technology as the computer hardware and software that is used to automate internal business operations. A manufacturing plant manager might suggest that technology refers to all of the assets that enable and enhance production operations. An economist sees technology as an enabling force in society that can make significant improvements to productivity on a global scale. The diversity of these perspectives is an indication of the pervasiveness of technology, and the challenges associated with understanding how it impacts business and social activities.

Dictionaries and scholars have offered a variety of definitions. The Merriam-Webster dictionary offers a definition of the term: "the practical application of knowledge especially in a particular area" and "a capability given by the practical application of knowledge.

Technology can be most broadly defined as the entities, both material and immaterial, created by the application of mental and physical effort in order to achieve some value. In this usage, technology refers to tools and machines that may be used to solve real-world problems. It is a far-reaching term that may include simple tools, such as a crowbar or wooden spoon, or more complex machines, such as a space station or particle accelerator. Tools and machines need not be material; virtual technology, such as computer software and

Technology can be viewed as an activity that forms or changes culture. Additionally, technology is the application of math, science, and the arts for the benefit of life as it is known. A modern example is the rise of communication technology, which has lessened barriers to human interaction and, as a result, has
helped spawn new subcultures; the rise of cyber culture has, at its basis, the development of the Internet and the computer. Not all technology enhances culture in a creative way; technology can also help facilitate political oppression and war via tools such as guns. As a cultural activity, technology predates both science and engineering, each of which formalizes some aspects of technological endeavor.

Prahalad and Hamel (1990) emphasize the importance of integrating technology assets in order to develop the core competencies of the organization, "core competencies are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies." But they do not detail what these streams of technologies are.

In their 1994 book, Competing for the Future, these same authors state that, "a core competence is a tapestry, woven from the threads of distinct skills and technologies. Many companies have had difficulty blending the multiple streams of science or technology that comprise their heritage into new, higher-order competencies" (Hamel and Prahalad, 1994, p. 214). Again they identify the importance of technologies, but assume that the manager will be able to identify all of the streams of technology that are important to his business.

Information Technology (IT) is concerned with technology to treat information. The acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications are its main fields. The term in its modern sense first appeared in a 1958 article published in the Harvard Business Review, in which authors Leavitt and Whisler commented that "the new technology does not yet have a single established name. We shall call it information technology (IT)." Some of the modern and emerging fields of Information technology are next generation web technologies, bioinformatics, cloud computing, global information systems, large scale knowledgebase, etc. Advancements are mainly driven in the field of computer science.

Information Technology, once adopted, needs to be diffused to prospective customers as quickly as possible in order to gain benefits before it is obsolete. Rogers (1983) cited conclusively that the diffusion of an innovation follows a s-shape curve
over time. Subsequently, the s-curve is considered a normal pattern (i.e. a reference mode) for any technology diffusion and evident in many studies despite the different types of technologies. Critical success factors for technology implementation are top management support, interactions during implementation, compatibility between technologies being used and its organization and tasks, motivated and capable users, and sufficient available organizational resources (e.g. capable developers, time, funding, technical skills) (Arunee and Quaddus).

Banks are making significant investments in information technology to align business strategies, enable innovative functional operations and provide extended enterprise networks. Banks have adopted information technology to foster changes in managing customer relationships, acquiring new customer base, and all other key activities (Agarwal & Sambamurthy 2002; Barua & Mukhopadhyay 2000) and to enhance their competitive capabilities (Sambamurthy et al. 2003). A number of information technologies researchers have posited information technology as an important ingredient of innovation development (e.g., Corso & Paolucci 2001; Dewett & Jones 2001; Xu et al. 2005). Banks implement information technology to enhance and/or enlarge the scope of their customer base and services. As many innovation activities involve adding new services, expanding existing ones and/or improving the service delivery process, the success of an organization hinges on how well it implements its IT products/innovation (Berry et al. 2006).

Good innovation practices help enhance a firm's competitive advantage (e.g., Afuah 1998; Bharadwaj et al. 1993). However, there is little theoretical work on the development of nomological relationships among information technology, service innovation and competitive advantage. Systematic empirical investigations of these relationships are also scarce and no dominant pattern has emerged (Preissl 1999). To address these gaps and advance understanding of information technology adoption and specific service innovation practices, we explored information technology adoption as a coordination mechanism (Dedrick et al. 2003; Galbraith 1973), which has led to changes in innovation-related activities.

Khasawneh defines the meaning of technology adoption as “the first use or acceptance of a new technology or new product”. Rogers states, “Diffusion is the
process by which an innovation is communicated through certain channels over time among the members of a social system”. Generally, diffusion is associated with how to spread new knowledge to target adopters, while adoption is related to the decision to accept and use the idea. Many people perceive both terms as the same. However, scholars recognize these terms differently. Some researchers identify that the adoption process starts from selection procedures when a firm is aware of the need to purchase a technology while other scholars focus more on real usage when the technology is about to be utilized or implemented. Several adoption process models have been developed in order to identify the process of how technology is adopted. Beal and Bohlen divide adoption process into five stages:

- awareness,
- interest,
- evaluation,
- trial,
- adoption.

Similarly, Rogers mentions in his publication that people adopt a technology by first being aware of the existence of a technology and forming attitudes towards a technology, following by decision making process whether to adopt or reject a technology. After the adoption decision is made, adopters will use a technology and eventually reach the final stage by confirming the adoption decision if a technology could function as expected. Therefore, the adoption process could be generally defined as process starting from gathering knowledge until the actual implementation of that technology. To address the issue of technology adoption in an organization, the process is re-classified into two main stages: the initiation and the implementation stage.

Gopalakrishnan and Damanpour stated that the decision to adopt a new technology takes place in between these two stages. For any firms, adoption can be generally divided into two levels:

- organizational level (primary adoption)
- individual level (secondary adoption)
Kamal supports this terminology by developing “a novel taxonomy of IT innovation adoption process” that consists of two key levels of adoption, each of which are subdivided into stages relating to the level. If an organization decides to invest in a new technology, it then takes a further step into secondary level of technology adoption in which employees will use the purchased technology. From this rationale, it can be inferred that the actual adoption is contingent on a prior decision made by an organization. Without an official decision, employees would not have an opportunity to utilize that technology. On the other hand, without the acceptance from individuals, the firm would not be able to obtain any benefits from investing in that technology.

Generally, technology adoption could be impacted through seven dimensions: functional performance, acquisition cost, operating cost, ease-of-use, reliability, compatibility, and serviceability. The definitions of the mentioned dimensions are discussed below:

- Functional performance is the characteristic of how the technology will perform.
- Acquisition cost is the cost of technology that adopters have to pay in order to possess the product.
- Ease-of-use is referred to as how easy to users in order to use the technology.
- Operating cost is the cost that occurs when a user utilize the technology.
- Reliability relates to how free the technology is from malfunctionality, including the useful lifetime of it.
- Serviceability refers to how long it takes and how expensive it is to repair the technology if it goes wrong.
- Compatibility is the way that the new technology fits with other existing devices or business requirements.

According to King and Gribbins’ study, the key variables include technology characteristics (e.g. costs, usefulness, ease-of-use, and compatibility), business
strategies, managerial logic, locus of control, firm size, human resources, financial resources, and environmental factors (e.g. pressure, legal issues, and industry push).

We conclude that for the success of technology adoption and diffusion we need to choose an appropriate technology followed by effective management strategy. Furthermore, an organization must loam to integrate business and technology in order to bring technology to be an integral part of the business strategies rather than to have it as a supportive role (Saeed, 1990; Sharif, 1994a; Takac & Singh, 1992).

3.3.5 Hindrances in Technology Adoption and Diffusion - While working in Information Technology Services department and having an experience of about 15 years in implementing various IT Projects/Products, it has transpired that many technological products doesn’t get the desired result and as such are closed for operation. The problems faced by Banks in their efforts to implement technical products are extensive and varied. One of the ultimate and overriding problems is that there is no model for these localities to follow or consult that is tailored to their specialized issues and needs. One of the first questions that come to mind in relation to this problem is “Why is a model for IT Adoption is so important?” Obviously, no model can completely address all of the issues each individual organization faces. Organizations are each subtly different even from those in the same arena. What a model provides is a framework designed to address the issues and needs of a particular process which are related across organizations of comparable circumstance. A number of IT implementation models exist in the private sector, and some of them are quite advanced and certainly have substantial information which could be translated to the public sector. The problem with appropriating one of these models from outside the public sector is that it may or may not fit the area in question. Any number of issues and needs may be different and therefore must be approached in a different way. While it is certainly problematic and often counterproductive to create a generalized model for all types of organizations across one particular sector, it is doubly unwise to generalize a model for use in a different sector entirely. (Information Technology Implementation Issues: An Analysis Suzanne Beaumaster 2003).

The research by Suzanne Beaumaster suggests that there are three primary fundamentals aspects to assist in IT implementation. The first is that strategic
planning for IT is fundamental to the ultimate effectiveness of IT implementation. Planning with regard to IT acquisition and deployment has proven to be a difficult accomplishment regardless of organization type or sector. Secondly, it is shown that interdepartmental coordination has proven to be a major factor in effective IT implementation. Finally, the expertise levels of executives with regard to IT have proven to be a contributing factor to effectiveness of the IT development and deployment process. We conclude that many factors affect the rate of adoption including innovation’s characteristics and various economical, sociological, organisational and psychological variables.

As such we find that after spending massive resources on technology adoption and implementation, the rejection of technology occurs commonly because organizations cannot overcome these problems. Socio-economic and political impediments for the success of an adoption and diffusion process are lack of institutions of higher/technical education, poor facilities, difficulty in retaining qualified technical personnel, ignorance of local conditions, differences in culture and work habits, insufficient management support, and user attitudes (Arunee Intraparirot).

We concluded that failure in new technology implementation comes from lack of an understanding of the politics of organizational decision-making, technical difficulties, professional norms, lack of training, insufficient support, and absence of user involvement. Some of the problems which affect the adoption and diffusion of technology are discussed below. These have been summarized on the basis of experience and literature and also from previous studies.

3.3.5.1 Reliability - The biggest problem from Bank’s prospective is reliability, for both Bankers and Customers. There was no business and IT plan to leverage technology for increasing business and profits. IT should help banks not just to deliver robust and reliable services to their customers at a lower cost, but also generate and manage information effectively. Information comprises data collected based on principles of integrity, reliability, and accuracy. The reliability of Information Technology products as well as reliability of Database both are critical for Bank and customers.
3.3.5.2 **Technology cost** - Going by the financial system being followed many Banks are concerned about the cost of Technology being implemented. As we know that yield of technology implemented is over years and take long times. As such Cost is one of the most important prohibiting factor that comes in the path of IT implementation particularly in the developing countries like India where most of the people living below the poverty line. Its return is not visible in the near future. As such cost is perceived as a hindrance factor to adopt the database marketing systems in financial services. Generally, a more costly technology is less likely to be adopted. However, once it is adopted, organizations have to put much effort to diffuse it because of the large investment made by the organization.

3.3.5.3 **Support by IT Team** - Being in Information Technology Services Department it has been realized, that how critical is the positive attitude of IT support team. The end users being non-technical, (Bankers) with no/limited knowledge about products and some time without proper training are supposed to manage the technology usage. If IT support team can provide an assurance to extend the support as and when required, half of goal is achieved. Listening to end user patiently provided big relief to the end user who incidentally is stuck-up with the issue.

3.3.5.4 **Rapid Obsolescence** - As per Moore's Law, the cost of computing, data storage, and communication (can be taken as Information Technology) has fallen consistently for more than 25 years and as such developing countries have been able to acquire technologies. At the same time advances in information technology offer unprecedented opportunities as well as challenges like getting obsolete especially in an organisation of large size (State Bank of India) having vast geographical spread. Organizations hesitate to invest in new technology because of the rapid rate of technological evolution. By the time it is implemented at the last mile, we get to know revised versions are already available in the market. This is another reason for not investing much in technology.

3.3.5.5 **Technology Selection** - Some time the choice of technology to be adopted is governed by individual perception or influenced by vendors projections. The technical specification along with result projects should be genuine. The information related to technology selected should be correct and shared till end user. At many time the
decision is taken on theoretical basis and without concerning the ground realities or by biased information given by vendors. Technology required at one branch of Bank may not be suitable at the other branch. As such quite often, organizations reject new adopted technologies despite spending massive resources on implementation of technology. Focal Point Processing Centre launched by State Bank of India at various cities, including Sector 17 Chandigarh can be one such example.

3.3.5.6 Poor adoptability for new technology - Another issue observed as hindrance in technology adoption is time taken to learn the technology. Since every technology has an economic life any delay in adoptability reduces the benefits associated with the technology. Trained staff is required to successfully adopt and diffuse the technology. However, training the staff is a big question for banks particularly considering the fast changing pace of technology. The transfer policy and average age also sometimes become hindrances in increasing technical expertise of staff in a branch. As such using technology productively is contingent upon not only the capacity of technology itself but also other factors including users, organizations, tasks and organizational environments. The Bank officials are stuck-up with two concepts difficulties in using the technologies and difficulties in learning to use technologies. Training is must as we know that training solves the problem of leaning.

3.3.5.7 Customer Acceptance - We have studied both type of technical products implemented by Bank’s i.e. customer oriented and Back office support. Still thrust is on Customer’s convenience. Customer acceptance depends on familiarity and the degree of awareness and use of any given tool. The more people using them, the more valuable they become. Text messaging has been culturally accepted as a standard communication practice by most people and IM will likely follow a similar path as people gain greater exposure to its use and value. A good example of this is Skype, an international company that includes text messaging with IM within a VoIP calling system, and is taking IM to the next level with the addition of voice communication capabilities. Customer acceptance is a key issue for organizations to determine whether to adopt new technologies or not. Despite many opportunities and advantages, people usually hesitate to be early adopters because being in the forefront they may be confronted with a large number of risks, mainly because change is always taken as negative by most of people. Further, acceptance of technology is
depends upon individual profile of customer i.e. education, need, job profile etc. The tendency to technology may be due customer’s inability to understand, incompatibility with existing systems, lack of confidence in computer competence and inferiority complex if the environment is not homogeneous.

3.3.5.8. Employee Acceptance - Acceptance of technology by end user in any organization is crucial for the success of any technology opted by organization. Implementation is hard to be successful unless ultimate users is made aware of technology, policies of organization, benefits of that technologies, proper training is provided, and how to manage crisis followed by backend support. Apart from this IR issues also can be one of the reasons for delay or non acceptance of technology. Therefore, it is vital for an organization to create user awareness of new technology and manage its organizational diffusion effectively to ensure that adopted technology can bring a good return on investment (Agarwal 2003). Since any hardware, software cannot succeed until supported by equally good human-ware, the availability of employees with positive attitude is must for the success of any technology adoption. The issues of user acceptance have been explored from several different research streams, including organizational change and innovation diffusion theory.

3.3.5.9. Lack of high-level executive support - It has been seen that many times Senior Executives support plays a vital role in ensuring diffusion of adopted technology down the line. Some time change in top management during the implementation phase also adversely affects the diffusion process. The decision taken by earlier management may not always be appended by new management. As such without the full support from top executives, technology cannot be successfully implemented.

3.3.5.10 Competency with existing Technological - One of the most crucial factors for the success of any technology adopted is the competency with existing technical setup. It has been seen that gradual changeover are accepted in easier way and always yield good results viz-a-viz out of phase changes. An important factor affecting an adoption rate of any innovation is its compatibility with values, beliefs, past experiences of an organization, and its existing facilities. Technological mismatch occurs commonly due to the disparities between a donor of technology and adopters
in terms of differences in culture, management philosophies, and work habits (Pradhan, 1994).

3.3.5.11. Competitive Advantages - The organization has to have some means to cater its customer economically and efficiently or in some better ways, to be called having competitively advantages. Many researchers advocate that competitive/relative advantage or expected benefit is the key factor that attracts organizations to adopt technology. Accordingly, if greater benefits are perceived more technical products/projects are likely to be implemented by the Bank’s. Relative advantage refers to benefits including increased sales, extended market shares, increased competitive advantages, improved efficiency, more accurate and timely information, better image, reduced costs, and effective decision-making.

The introduction of technological products is fraught with many difficulties and uncertainties. Products based on information technology are the most challenging because they interact with end users in a variety of different ways and can lead to many different outcomes: some intended, some unintended. Problems with user acceptance of seemingly well-designed and sound information systems have been observed since the early days of information technology. Yetton et al. (2000) examined the influence of both system characteristics and implementation process on system success. He found that the characteristics of the innovation are critical for low task interdependence innovations, while the implementation process is more important for high task interdependence systems.

Innovation diffusion theory recognizes that while the technical attributes of the innovation per se may be not significant, perceptions of technology do matter and are important factors influencing technology adoption. A competitive advantage means that an organization has found a better way to serve its customers or acquire new customers through an adoption of new technologies, A competitive advantage brings about a greater market share, a higher profit or a better return on investment (Takac & Singh, 1992). The results, of an extensive longitudinal study of the effects of early adoption of ATM by banks on market share and income, conducted by IDRBT, advocated that organizations can gain long-term competitive advantages by early adoption of new IT applications. Increased performance efficiency (e.g. quicker
turnaround time, reducing credit risk exposure, decreasing bad-debts) is one of the reasons for adopting information technology cited by many researchers.

The adoption of information technology may provide a better image and thus can be used as punch line being used by Bank of Baroda in India. It has been seen that customers get attracted towards such services and increase in business is observed.

3.3.6. **Technological Features** - Though foreign banks pioneered technology adoption in the Indian financial sector followed by domestic private sector bank. This set an example for Public sector banks which traditionally have lagged behind private and foreign banks in this regard. Apart from Competitive/Relative advantage discussed above many technological features e.g. costs, complexity, reliability, risk, compatibility with existing systems, trialability, observability, and standardisation) are the main features, considered while deciding the technology to be adopted.

We have already discussed these features in details apart from cost technology has to be easy to understand and apply to ease out its adoption. Further reliability and security are two more aspects which matters to the degree of adoption. If user is not sure about reliability and security especially in banking system, user will become hesitant about technology adoption.

The other two factors that influence technology adoption are trialability (the degree to which an innovation may be experimented with on a limited basis) and observability (the degree to which the results of an innovation are visible to others). In general, the rate of adoption is positively related to perceived relative advantage, compatibility, trialability, and observability, and is negatively related to perceived complexity of the innovation.

3.3.7. **Internal issues** - The internal environment consists of the inherent competencies of the firm and the structure of its internal systems and processes. It is imperative for the organization to conduct an internal analysis to obtain a clear picture regarding its strengths and weaknesses. This helps the organization to design suitable strategies towards leveraging its strength to gain sustainable competitive advantage in the market. The need to focus on internal issues when implementing technologies leads logically to a focus on the human factors including management of cultural change. This need had been identified by Forrester (J. Forrester, 1998) in his early
work on industrial dynamics and the identification of what is now called the “bullwhip effect” (H.L. Lee, V. Padmanabhan, 1997). Later system dynamics researchers extended this concept, isolating the primary influence as being irrational human behaviour. In particular, given the growing dependence on effective technology deployment. The importance this theory places on managing social systems in order to deploy technical systems effectively is highly relevant. The need to share information as well as benefits between participating parties (Ballou, Gilbert, & Mukherjee, 2000). The essence of the importance of this interaction between humans and technology designed to facilitate access to, and more effective use of, supply chain relevant information is perhaps succinctly captured by Churchman when he states: “knowledge resides in the user and not in the collection of information. It is how the user reacts to a collection of information that matters.” (Malhotra, 2000).

Generally, internal driving forces are those kinds of things, situations, or events that occur inside the business, and are generally under the control of the company. Examples might be as follows: available facilities, executive support, staff acceptance, communication amount, economic externalities, and experience in technology, employee morale. The positive organizational factors contribute to the success of technology diffusion.

Available facilities always help in successful technology implementation. Same way perceived management commitment exerts a significant impact on technological adoption and diffusion because an adoption and subsequent implementation of technology consumes massive resources of an organization Staff acceptance exercises positive impacts on technology adoption and diffusion. Thus, promotion for staff acceptance thereby mitigating failures deriving from lack of understanding (both technological and organizational aspects), providing sufficient training and support, and increasing user involvement is essential (Manish Arora and M. Syamala Devi).

At the same time when any technology is adopted it is bound to have problems, as such, a backlog of unsolved problems associated with its functioning begins to build up. Management has to manage the backlog of problems because it has a potential not only to discourage further adoption but also encourage abandonment by existing adopters. An "externality" is a situation in which one
individual's behavior has spillover effects on others. Positive "network externalities" exist when an individual increases benefits from using a product because of an increase in product uses by others or an increase in complementary uses of that product. For example, the usefulness of a personal computer depends on the number of people who use computers and the wide range of available software. Externalities may hinder adoption of new technologies because potential customers may resist using a certain product provided by several producers because of the lack of compatible technological standards (Arunee Intraparirot).

3.3.8. Customer behaviors - Various studies have been done in India to understand the behaviors of Consumers in Banking Industry (Rahul Jog, Ram upadhaya, Raj Kishan, Paveen deoora –IIPM). Consumer behaviour can be defined as the decision-making process and physical activity involved in acquiring, evaluating, using and disposing of goods and services. This definition clearly brings out that it is not just the buying of goods/services that receives attention in consumer behaviour but, the process starts much before the goods have been acquired or bought. In this era of mature and intense competitive pressures, it is imperative those banks maintain a loyal customer base. In order to achieve this and improve their market and profit positions, many retail banks are directing their strategies towards increasing customer satisfaction and loyalty through improved service quality. In the present competitive Indian banking context, characterized by rapid change and increasingly sophisticated customers, it has become very important that banks in India determine the service quality factors which are pertinent to the customers’ selection process. A process of buying or availing services starts in the minds of the consumer, which leads to the finding of suitable alternatives that can be acquired with their relative advantages and disadvantages. This leads to internal and external research. Then follows a process of decision-making for purchase and using the services and then the post purchase behaviour which is also very important, because it gives a clue to the marketers whether his product/services has been a success or not. To understand the likes and dislikes of the consumer, extensive consumer research studies are being conducted. Technologies may seem promising, still sometimes an organization hesitates to implement them because of worries about customer acceptance.

3.3.9. External Issues - Competition and adaptation have been issues for any business entity to survive in the business world. To understand the competitive
environment of technology adoption decisions by a business entity, it is necessary to look into the external factors that may influence the technology adoption decision. The fundamental approach to study the adoption and diffusion of new technologies is the diffusion of innovations theory (Rogers, 2003). The literature on adoption and diffusion of innovations has mostly focused on the factors affecting adoption and diffusion. One of the factors that affect technology adoption and diffusion includes the environment context (Scupola, 2003; Tonartzky and Fleischer, 1990). The environment context includes the external actors and factors that affect a company’s decision to adopt a technology, either directly or indirectly. These may include customers, competitors, market, government or economy. The external environment comprises the industry (suppliers and customers), the competitors, and dealing with regulatory bodies such as the government (Tonartzky and Fleischer, 1990). Scupola (2003) stressed that the competitors, the suppliers and the customers can exert direct or indirect pressures on SMEs to adopt new technology.

A summary of the external factors mentioned in the literature that affect technology adoption in companies is shown in Table 3-3

| Table: 3.3
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<thead>
<tr>
<th>External factors affect technology adoption</th>
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<td>Supplier perspective</td>
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<tr>
<td>Santarelly and D’altri (2003)</td>
<td>Global markets</td>
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<td></td>
<td>Dynamic market</td>
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<td>Scupola (2003)</td>
<td>Competitors</td>
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<td></td>
<td>Suppliers</td>
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<td>Customers</td>
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<tr>
<td>Sadowski, Maitland, Van Dongen (2002)</td>
<td>Competitive pressure</td>
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<td>External support</td>
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<td>Incentives</td>
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<td>Chengalur-Smith, Duchessi (1999)</td>
<td>Market condition</td>
</tr>
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<td></td>
<td>Competitors</td>
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</table>

Source: Technology diffusion and adoption (Okada 2006; Bennet & Bennet, 2004)

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Among the external factors relating to technology adoption, the researcher has found the following are common:

- customer demand,
- competitors,
- supplier perspective,
- dynamic market,
- government support,
- Government regulation.

Besides these main factors, the incentives to adopt and diffuse technologies are as follows: improving budgets; keeping up with new technologies; improving quality of new products and communication methods; solving work problems; increasing flexibility; and helping retain/recruit skilled people (Arunee Intraparirot 2002).

### 3.4 ADOPTION AND DIFFUSION MODELS

The high level of investigative activity to update into information systems and information technology acceptance and diffusion has witnessed the use of a wide range of exploratory techniques, examining many different systems and technologies in countless different contexts and geographical locations. The aim of this paper is to provide a comprehensive and systematic review of the literature pertaining to such adoption and diffusion issues in order to observe trends, ascertain the current ‘state of play’, and to highlight promising lines of inquiry including those lacking investigative activity or simply being in need of renewed interest. Previous research activity was analyzed along a number dimensions including units of analysis, research paradigms, methodologies, and methods, theories and theoretical constructs, and technologies/contexts examined. (Journal of Information Technology- 2009).

The technology diffusion models are particularly useful for new or emergent technologies where no history is available and the nature of the offering to the market has a new or novelty dimension. The speed with which a new technology can be introduced and accepted by customers can also be obtained from the technology
diffusion models (TDM). The risk in adopting a new technology cannot be ignored in the long run. Thus we need to access from the models as to which technology is most suitable in the present scenario of the country. All the diffusion models are well established mathematical models which are used in decision making process. We need to understand both the capital and organizational capabilities required to successfully exploit the technological opportunity. There are multiple diffusion models and the understanding of the dynamics and applicability of various models is also crucial to the investment analysis. The economical growth of organisation depends on the diffusion of technology which is cost effective and feasible.

The major development of the Diffusion of Innovation theory and practice is attributed to Rogers (Rogers, 1962) who framed innovation adoption as a life cycle involving; innovators; early adopters; early majority; late majority and laggards. Roger’s research has indicated that the spread of a new technology depends mainly on two factors; innovation and imitation. Innovators are driven by their desire to try new technologies or methods and the likelihood of an innovator using a new technology does not depend on the number of other users. On the other hand, imitators are primarily influenced by the behaviour of their peers. The likelihood of an imitator embracing a new technology or new way of doing work is dependent on the number of people who are already using it. Normally imitators are the main contributors to the diffusion or spread of innovation (i.e. early and late majority).

The innovation and imitation factors shape the speed at which the technology is accepted into everyday use. The theory of adoption and diffusion of new products by a social system has been discussed at length by Rogers (Rogers, 1962). This discussion is largely literary. It is, therefore, not always easy to separate the premises of the theory from the conclusions. In the discussion the timing of adoption is also evaluated. Unfortunately few models address the question of how constraints to adoption can or should be dealt with. Little attention has been paid to the fact that learning from other producers constitutes externalities, and no attentions at all has been paid to the question of how to optimise adoption in view of learning externalities.
As per. Rogers E.M. 'Diffusion of Innovations ' The Free Press, New York, originally published in 1962, 3rd Edition 1983, A broad social psychological / sociological theory called Diffusion of Innovations (DoI) Theory purports to describe the patterns of adoption, explain the mechanism, and assist in predicting whether and how a new invention will be successful. The theory has potential application to information technology ideas, artefacts and techniques. DoI Theory is concerned with the manner in which a new technological idea, artefact or technique, or a new use of an old one, migrates from creation to use. According to DoI theory, technological innovation is communicated through particular channels, over time, among the members of a social system.

The stages through which a technological innovation passes are:

- **Knowledge** (exposure to its existence, and understanding of its functions);
- **Persuasion** (the forming of a favorable attitude to it);
- **Decision** (commitment to its adoption);
- **Implementation** (putting it to use); and
- **Confirmation** (reinforcement based on positive outcomes from it).

Innovation decisions may be optional (where the person or organisation has a real opportunity to adopt or reject the idea), collective (where a decision is reached by consensus among the members of a system), or authority-based (where a decision is imposed by another person or organisation which possesses requisite power, status or technical expertise). Important characteristics of a technology include:

- **Relative advantage** (the degree to which it is perceived to be better than what it supersedes);
- **Compatibility** (consistency with existing values, past experiences and needs);
- **Complexity** (difficulty of understanding and use);
- **Trialability** (the degree to which it can be experimented with on a limited basis);
- **Observability** (the visibility of its results).
Different adopter categories are identified as:

- Innovators (venturesome),
- Early adopters (respectable),
- Early majority (deliberate),
- Late majority (sceptical),
- Laggards (traditional)

Earlier adopting individuals tend not to be different in age, but to have more years of education, higher social status and upward social mobility, be in larger organizations, have greater empathy, less dogmatism, a greater ability to deal with abstractions, greater rationality, greater intelligence, a greater ability to cope with uncertainty and risk, higher aspirations, more contact with other people, greater exposure to both mass media and interpersonal communications channels and engage in more active information seeking. (A Primer in Diffusion of Innovations Theory Roger Clarke-1997).

Rogers’ Diffusion of Innovation Theory has served as the basis of research focusing on the special case of information technology implementations. Moore and Benbasat draw on Rogers’ Theory as well as Technology Acceptance Model to develop eight constructs measuring users’ perceptions of adopting an information technology innovation: voluntariness, image, relative advantage, and compatibility, ease of use, result demonstrability, trialability, and visibility. This model transforms the general innovation theory to the specific area of technology innovation. Rogers’ stages of diffusion have also taken on a variety of reinventions with some indicating that certain constructs predict “adoption”, while others predict “diffusion”. To distinguish between the two terms, adoption pertains to initial use of an innovation, whereas diffusion pertains to continued.

Since information technology began to have an important impact on the way firms are both managed and organized, researchers have investigated the organizational factors behind the degree of adoption of computing, robotic or telecommunications technologies. Organizational factors behind information technology adoption may be as important as other elements such as technical factors (Premkumar et al., 1997).
Many literatures have identified several organizational factors associated with information technology adoption (Desai et al., 1998). Among them, we might mention: the management's direct and explicit support for the adoption of information technology (Damanpour 1997) the existence of technology leaders ("champions" or "prominent actors") who support the technological change (Sharma and Rai. 2003); the level of technological education of the workers in the technical departments (Premkumar et al. 1994); the level of technological education of the rest of the workers; the strategy chosen with regards implementation (proactive, reactive, technology leader follower, etc.).

Ganesh and Kumar (1996); and Ganesh, Kumar, and Subramaniam (1997) found that technology such as retail point-of-sale scanners can be rapidly diffused from lead countries into lag countries because of the learning process, which is determined by country characteristics, product/innovation characteristics, and time lag. Parthasarathy and Bhattacherjee (1998) reported the study on the post-adoption behaviour of technology adoption that the decision to remain continued adopters depends on their sources of influence (external and interpersonal), perceived satisfaction from innovation in terms of benefits and compatibility, and network externality during their time of initial adoption.

Apart from the various models explained by Arunee in her previous study we explored the Technology Acceptance Model (TAM) is an information systems theory that models how users come to accept and use a technology. The model suggests that when users are presented with a new technology, a number of factors influence their decision about how and when they will use it, notably:

- **Perceived usefulness** (PU) - This was defined by Fred Davis as "the degree to which a person believes that using a particular system would enhance his or her job performance".

- **Perceived ease-of-use** (PEOU) - Davis defined this as "the degree to which a person believes that using a particular system would be free from effort" (Davis 1989).

The most frequently cited model addressing technology adoption process is the technology acceptance model (TAM), which identifies the relationships between
perceived attributes of a technology, attitudes toward a technology, and actual usage. The theory employs the perceptions towards a technology, perceived usefulness and perceived ease-of-use, as main determinants explaining the adoption process. Perceived usefulness is referred to as the degree to which an adopter believes the new technology would improve job performance, and perceived ease-of-use refers to an adopter’s perception of the minimum effort required for the use of new technology.

Figure: 3.5 Technology Acceptance Model

Source: Technology Acceptance Model (PICMET 2009 Proceedings, August 2-6)

The TAM has been continuously studied and expanded—the two major upgrades being the TAM 2 (Venkatesh & Davis 2000 & Venkatesh 2000) and the Unified Theory of Acceptance and Use of Technology (or UTAUT, Venkatesh et al. 2003). A TAM 3 has also been proposed (Venkatesh & Bala 2008).

TAM is one of the most influential extensions of Ajzen and Fishbein’s theory of reasoned action (TRA) in the literature. TAM replaces many of TRA’s attitude measures with the two technology acceptance measures— ease of use, and usefulness. TRA and TAM, both of which have strong behavioral elements, assume that when someone forms an intention to act, that they will be free to act without limitation. In the real world there will be many constraints, such as limited freedom to act (Venkatesh & Bala 2008).

Bagozzi, Davis and Warshaw said “Because new technologies such as personal computers are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form attitudes
and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using `. Attitudes towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions. (Venkatesh & Bala 2008)"

Several researchers have replicated Davis’s original study (Davis 1989) to provide empirical evidence on the relationships that exist between usefulness, ease of use and system use (Subramanian 1994; Szajna 1994). Much attention has focused on testing the robustness and validity of the questionnaire instrument used by Davis. They also extended it to different settings and, using two different samples, they demonstrated the internal consistency and replication reliability of the two scales.

Venkatesh and Davis extended the original TAM model to explain perceived usefulness and usage intentions in terms of social influence and cognitive instrumental processes. The extended model, referred to as TAM2, was tested in both voluntary and mandatory settings. The results strongly supported TAM2 (Venkatesh & Davis 2000).

Further, IT diffusion models based on a dynamic approach deal with the time related spread of IT usage. Generally, if new technology adopted by early adopters is successful, a bandwagon effect will tempt potential adopters to imitate. It has been observed that technology diffusion and an imitation process over time can be modeled by a logistic or s-shaped curve (Arunee-2002).

Another model “Bass diffusion model” which was developed by Frank Bass and describes the process of how new products get adopted as an interaction between users and potential users. It has been described as one of the most famous empirical generalizations in marketing, along with the Dirichlet model of repeat usage and brand choice. The model is widely used in forecasting, especially product forecasting and technology forecasting.

Frank Bass published his paper "A new product growth model for consumer durables” in 1969. Prior to this, Everett Rogers published Diffusion of Innovations, a highly influential work that described the different stages of adoption. Bass contributed some mathematical ideas to the concept.
This model has been widely influential in marketing and management science. In 2004 it was selected as one of the ten most frequently cited papers in the 50-year history of Management Science. It was ranked number five, and the only marketing paper in the list. It was subsequently reprinted in the December 2004 issue of Management Science.

Economic analysis of technology adoption has traditionally focused on imperfect information, uncertainty, institutional constraints and inadequate human capital as potential explanations for delayed adoption decisions. Other explanations have included inadequate schooling and infrastructure (Kohli and Singh (1997). Recently, however, an influential body of literature on technology adoption has focused on the effect of social learning on adoption decisions. He applied a dynamic model to study the diffusion of spreadsheet software and found that its diffusion followed a dual s-curve.

Today, the new competitive environment is characterized by its demand for continual innovation in the productive systems of businesses, which allows their performance to be improved and their profits to increase constantly (Reicheld, 1993; Howard, 1995). In this innovation process, we highlight the key role of information technologies (IT) as a value-producing variable because of the importance of information as a basic input for any economic activity. IT have become an essential tool for the correct development of corporate activity, significantly affecting the various productive systems and leading to the computerisation of their basic functions (Korunka et al., 1997; Doherty and King, 1998). As a result, the diffusion of new IT has increased in the business world, giving rise to significant transformations of traditional business structures.

After doing review of eighteen empirical studies in this field “Robert G. Fichman” (MIT Sloan School of Management), published “Information Technology Diffusion: A Review of Empirical Research”. Whereby he finds that Innovation diffusion theory provides well-developed concepts and a large body of empirical results applicable to the study of technology evaluation, adoption and implementation. Diffusion theory provides tools, both quantitative and qualitative, for assessing the likely rate of diffusion of a technology, and additionally, identifies numerous factors
that facilitate or hinder technology adoption and implementation. These factors include characteristics of the technology, characteristics of adopters, and the means by which adopters learn about and are persuaded to adopt the technology (Rogers 1983). It is not surprising then, that innovation diffusion is becoming an increasingly popular reference theory for empirical studies of information technologies (IT). As a borrowed theory, innovation diffusion provides the advantage of a rich cumulative tradition. Yet, when borrowing theory, researchers must take care to ensure that the context to which the theory is being applied matches well with the context in which the theory was developed, or alternatively, to tailor the theory to account for contextual differences. Much of diffusion theory was developed in the context of adopters making voluntary decisions to accept or reject an innovation based on the benefits they expect to accrue from their own independent use of the technology.

In addition, the adoption decision of individuals or organizations may depend on the dynamics of community-wide levels of adoption (i.e., whether "critical mass" has been established) because of network externalities (Katz and Shapiro 1986; Markus 1987). These sorts of complicating factors are quite common in the context of IT adoption; hence, the opportunities to apply classical diffusion "as is" may be rare indeed.

### 3.5 GROUP SUPPORT SYSTEMS

To define with A Group Decision Support System (GDSS) is an interactive, computer-based system that helps a team of decision-makers solve problems and make choices. GDSS are targeted to supporting groups in analyzing problem situations and in performing group decision-making tasks (DeSanctis and Gallupe, 1987; Huber, 1984). The name is very descriptive. A GDSS is a hybrid system that uses an elaborate communications infrastructure and heuristic and quantitative models to support decision-making.

Further, GDSS are a class of electronic meeting systems, a collaboration technology designed to support meetings and group work. GDSS are distinct from computer supported cooperative work (CSCW) technologies as GDSS are more focused on task support, whereas CSCW tools provide general communication support. Group Decision Support Systems are categorized within a time-place
paradigm. Different features may be required for synchronous vs asynchronous communication, as well as local vs distant.

Computerized decision support systems became practical with the development of minicomputers, timeshare operating systems and distributed computing. The history of the implementation of such systems begins in the mid-1960s. As technology evolved new computerized decision support applications were developed and studied. Researchers used multiple frameworks to help build and understand these systems. Today one can organize the history of DSS into the five broad DSS categories explained in Power (2001; 2002; 2004b), including: communications-driven, data-driven, document driven, knowledge-driven and model-driven decision support systems.

Beginning in about 1980 many activities associated with building and studying DSS occurred in universities and organizations that resulted in expanding the scope of DSS applications. These actions also expanded the field of decision support systems beyond the initial business and management application domain. These diverse systems were all called Decision Support Systems. From those early days, it was recognized that DSS could be designed to support decision-makers at any level in an organization. Also, DSS could support operations decision making, financial management and strategic decision-making.

Much of the model-driven DSS research emphasized use of the systems by individuals, i.e., personal DSS, while data-driven DSS were usually institutional, ad hoc or organizational DSS. Group DSS research emphasized impacts on decision process structuring and especially brainstorming.

In a 1988 paper, Sharda, Barr, and McDonnell reviewed the first 15 years of model-driven DSS research. They concluded that research related to using models and financial planning systems for decision support was encouraging but certainly not uniformly positive. As computerized models became more numerous, research focused on model management and on enhancing more diverse types of models for use in DSS such as multicriteria, optimization and simulation models.

In about 1990, data warehousing and On-Line Analytical Processing (OLAP) began broadening the realm of EIS and defined a broader category of data-driven DSS.
Eventually Group Systems matured into a commercial product. Jay Nunamaker, Jr. and his colleagues wrote in 1992 that the underlying concept for Group Systems had its beginning in 1965 with the development of Problem Statement Language/Problem Statement Analyzer at Case Institute of Technology. In 1984, the forerunner to Group Systems called PLEXSYS was completed and a computer-assisted group meeting facility was constructed at the University of Arizona. The first Arizona facility, called the PlexCenter, housed a large U-shaped conference table with 16 computer workstations.

The benefits, or process gains, from using a GDSS (over more traditional group techniques) are:

- More precise communication,
- Synergy: members are empowered to build on ideas of others,
- More objective evaluation of ideas,
- Stimulation of individuals to increase participation,
- Learning: group members' imitate and learn from successful behaviors of others.

The costs, or process losses, from using a GDSS (instead of more traditional group techniques) are:

- More free riding,
- More information overload,
- More flaming,
- Slower feedback,
- Fewer information cues,
- Incomplete use of information.

However, the researchers found that GDSS over traditional group techniques limits or reduces the following process losses:

- Less attention blocking
- Less conformance pressure
• Less airtime fragmentation
• Less attenuation blocking
• Less socializing
• Less individual domination

3.6 MULTIPLE CRITERIA DECISION-MAKING (MCDM)

Human performance in decision terms has been the subject of active research from several perspectives. From a psychological perspective, it is necessary to examine individual decisions in the context of a set of needs, preferences an individual has and values they seek. From a cognitive perspective, the decision making process must be regarded as a continuous process integrated in the interaction with the environment. From a normative perspective, the analysis of individual decisions is concerned with the logic of decision making and rationality and the invariant choice it leads to.

Yet, at another level, it might be regarded as a problem solving activity which is terminated when a satisfactory solution is reached. Therefore, decision making is a reasoning or emotional process which can be rational or irrational, can be based on explicit assumptions or tacit assumptions.

One must keep in mind that most decisions are made unconsciously. Jim Nightingale, Author of Think Smart-Act Smart, states that "we simply decide without thinking much about the decision process." In a controlled environment, such as a classroom, instructors encourage students to weigh pros and cons before making a decision. However in the real world, most of our decisions are made unconsciously in our mind because frankly, it would take too much time to sit down and list the pros and cons of each decision we must make on a daily basis.

Logical decision making is an important part of all science-based professions, where specialists apply their knowledge in a given area to making informed decisions. For example, medical decision making often involves making a diagnosis and selecting an appropriate treatment. Some research using naturalistic methods shows, however, that in situations with higher time pressure, higher stakes, or increased ambiguities, experts use intuitive decision making rather than structured approaches.
following a recognition primed decision approach to fit a set of indicators into the expert's experience and immediately arrive at a satisfactory course of action without weighing alternatives. Recent robust decision efforts have formally integrated uncertainty into the decision making process. However, Decision Analysis, recognized and included uncertainties with a structured and rationally justifiable method of decision making since its conception in 1964.

A major part of decision making involves the analysis of a finite set of alternatives described in terms of some evaluative criteria. These criteria may be benefit or cost in nature. Then the problem might be to rank these alternatives in terms of how attractive they are to the decision maker(s) when all the criteria are considered simultaneously. Another goal might be to just find the best alternative or to determine the relative total priority of each alternative (for instance, if alternatives represent projects competing for funds) when all the criteria are considered simultaneously. Solving such problems is the focus of multi-criteria decision analysis (MCDA) also known as multi-criteria decision making (MCDM). This area of decision making, although it is very old and has attracted the interest of many researchers and practitioners, is still highly debated as there are many MCDA / MCDM methods which may yield very different results when they are applied on exactly the same data. This leads to the formulation of a decision making paradox.

Multiple Criteria Decision Making was introduced as a promising and important field of study in the early 1970’s. Since then the number of contributions to theories and models, which could be used as a basis for more systematic and rational decision making with multiple criteria, has continued to grow at a steady rate. A number of surveys, e.g. Bana e Costa, show the vitality of the field and the multitude of methods which have been developed. When Bellman and Zadeh, and a few years later Zimmermann, introduced fuzzy sets into the field, they cleared the way for a new family of methods to deal with problems which had been inaccessible to and unsolvable with standard MCDM techniques. There are many variations on the theme MCDM depending upon the theoretical basis used for the modelling.

Bellman and Zadeh, 1970 and argue that with MCDM the first contributions to a truly scientific approach to decision making were made, but find fault with the
objectives to carry this all the way as we have to deal with human decision makers who can never reach the degree of consistency needed. They introduce multiple criteria decision aid MCDA as a remedy; this approach can be given the aim “to enhance the degree of conformity and coherence” in the decision processes carried out among (predominantly groups of) decision makers - this is done with a cross-adaptation of the value systems and the objectives of those involved in the process. Even if there are some distinctions between MCDM and MCDA the overall objective is the same: to help decision makers solve complex decision problems in a systematic, consistent and more productive way.

The difficulty of the problem originates from the presence of more than one criterion. There is no longer a unique optimal solution to an MCDM problem that can be obtained without incorporating preference information. The concept of an optimal solution is often replaced by the set of non-dominated solutions. A non-dominated solution has the property that it is not possible to move away from it to any other solution without sacrificing in at least one criterion. Therefore, it makes sense for the decision maker to choose a solution from the non-dominated set. Otherwise, he could do better in terms of some or all of the criteria, and not do worse in any of them. Generally, however, the set of non-dominated solutions is too large to be presented to the decision maker for his final choice. Hence we need tools that help the decision maker focus on his preferred solutions (or alternatives). Normally one has to “tradeoff” certain criteria for others.

MCDM is considered as a method that is suitable to deal with problems in the real world. In the first place, a decision problem is complicated because it is associated with multiple alternatives and criteria. Furthermore, in a decision-making process, decision-makers are confronted with constraints such as time, available resources and potential competence. Therefore, it is difficult to find an optimal solution where every affected party achieves satisfaction. Finally, most criteria conflict with each other. For example, to achieve the best technical feasibility requires prohibitive costs to develop that technique and leads to an impact on economic feasibility. Thus, decision-makers have to trade-off among different alternatives.
Because of MCDM, decision-makers are able to handle complex and difficult decisions. Firstly, they can compare end results between using their intuition and using a MCDM analysis supported by user-friendly software leading to enhancing their level of understanding and learning, and subsequently improving their decision-making. Secondly, the steps in MCDM can be undertaken in an organization without difficulties or interpersonal conflict, and encourage people to shift from their intuition to rational decision-making. Thirdly, an MCDM analysis can be conducted for group decision-making, accommodating many participants at different time and places.

In effect, MCDM is suitable to be employed in the technology adoption phase because it helps decision-makers evaluate and prioritize competitive technological alternatives that can enhance the achievement of the business goals of an organization. Once the best technology is selected, the organization can elaborate on the technology using other decision tools in order to utilize it productively.

Multiple Criteria Decision Making is all about making choices in the presence of multiple conflicting criteria. MCDM has become one of the most important and fastest growing subfields of Operations Research/Management Science. As modern MCDM started to emerge about 50 years ago, it is now a good time to take stock of developments. MCDM research in the 1970's placed emphasis on mathematical programming of multiple objectives, and the development of procedures and algorithms to solve multiple objective linear programming problems and discrete problems. During the 1980s, emphasis shifted towards the implementation of MCDM models on computers with the aid of decision support systems (DSS).

Ward Edwards (1927–2005) is generally regarded as the father of behavioural decision research. He published two seminal articles, one in 1954 and the other in 1961, creating behavioural decision research as a new field. In his 1954 article “The Theory of Decision Making,” Ward Edwards introduced the expected utility model to psychologists and posed the (good) question: do people actually behave as if they have a utility function? However, it was Edwards’ later publication “Behavioural Decision Theory” in 1961 that really established the field of behavioural decision making. The paper discussed issues such as how people make decisions and how one could improve decisions. In recent years, it has increasingly been recognized that we
ought to have a better understanding of how humans make decisions, in order to provide decision makers better support.

Another giant of decision making is Herbert A. Simon (1916–2001).

Against the mainstream of economics, he claimed that decision making does not obey the postulates of the “rational man.” Simon won the Nobel Prize in Economics in 1978. In a series of articles and books starting in the 1940s, Simon wrote about decision making. Among other things, he developed a behavioural theory based on limited or bounded rationality (see “A Behavioural Model of Rational Choice,” 1955.) Simon claimed that humans are not utility maximizers, but “satisficers.” They set aspiration levels. If they are able to meet such aspiration levels, they are happy. It has been suggested that the theory has normative as well as descriptive value. Aspiration levels play a major role in modern MCDM techniques.

In connection with social choice theory, we would also like to mention the far-reaching contributions of Amartya Sen (1970). According to the Royal Swedish Academy of Sciences, Sen has, among other things, specified the general conditions that eliminate intransitivities of the majority rule.

Lotfi Zadeh also made an original contribution to what became to be known as robustness analysis by inventing fuzzy set theory. Many MCDM scholars followed in Zadeh’s footsteps by suggesting Fuzzy MCDM techniques. The original paper was titled “Fuzzy Sets” and was published in 1965. Zadeh’s fuzzy set theory or fuzzy logic has found widespread applications. It has been applied to diverse fields, from control theory to artificial intelligence, yet still remains controversial among many scientists.

Johanna Bragge, Pekka Korhonen, Jyrki Wallenius and Hannele Wallenius have done an extensive bibliometric study of MCDM and MAUT using the ISI Web of Science database. The paper entitled "Bibliometric Analysis of Multiple Criteria Decision Making/Multiattribute Utility Theory" was presented at the International Conference on MCDM in Auckland in January 2008. Among the interesting findings is the yearly publication trend in our field which shows a dramatic increase in the number of publications during the last decade.
Multi-criteria decision making has been one of the fastest growing areas during the last decades depending on the changing’s in the business sector. Decision maker(s) need a decision aid to decide alternatives and mainly excel less preferable alternatives fast. With the help of computers the decision making methods have found great acceptance in all areas of the decision making processes. Since multi-criteria decision making (MCDM) has found acceptance in areas of operation research and management science, the discipline has created several methodologies.

Multi criterion Decision Making (MCDM) methods have demonstrated their immense versatility in solving many problems in physical plane marked by extensive nature of conflicts. The decision makers are often confronted not only with the task of classifying, analysing and arranging suitably the vast information concerning the system but also the choice and ranking of the optimal possibilities. These choice possibilities could be, among many, a number of alternative plans. Multi criterion decision support systems (MCDSS) are computer based systems that employ multiple criteria decision methods as part of the decision support system. Jelassi et al.(1984 ) explained the requirements of MCDSS as 1)an extensive data base 2) a portfolio of multiple criteria methods 3) user friendly interface. A number of multi criterion
decision support techniques have emerged in recent years which use varying computational approaches to arrive at the most desirable solution and thereby 'recommend' a course of action.

MCDM allows decision analysts to conduct decision-making under several conflicting criteria simultaneously, whereby the improvement or achievement of one criterion can occur at the expense of another. These criteria may be either quantifiable (e.g. explicit costs and tangible benefits) or non-quantifiable (e.g. quality of service, risk, image and aesthetics). Additionally, decision-makers are able to account for a subjective evaluation that actually represents characteristics of the real world decision-making problems. According to the subjective evaluation, the decision-makers can express their preferences by weighting evaluation criteria, making comparisons between pairs or simply arranging an ordinal ranking of a set of alternatives (Mohanty, R. P-1993).

There have been hundreds of examples where MCDM has been used to solve variety of problems having complex situation. Subramanian and Gershon (1991) applied MCDM for the selection of computer-aided software engineering (CASE) tools. Mohanty and Venkataraman (1993) used an analytic hierarchy process (AHP) to justify problems of automated manufacturing systems (AMS) based on strategic, technological, and social impacts. AHP was also used by K. Srinivasa Raju and D. Ngesh Kumar, Assistant Professor, Department of Civil Engineering, S.E.S. College of Engineering, Kopargaon, India Ahire and Rana (1955) to identify and select key pilot. MCDM approach to evaluate optimum maintenance strategy in textile industry was successfully used by K. Shyjith, M. langkumaran and S. kumana. MCDM was used for making automobile purchase using an integrated analytical quality fuzzy technique by Rakesh D. Raut, Harsh V. Bhasin, Sachin S. Kamble. Developing decision support system software for cotton fiber grading and selection was used by Y Majumdar, Abhijit Mangla, Robin Gupta and Ashay.

MCDM is suitable for use with decision support systems (DSS), which is known as MCDSS. Since DSS combines the strengths of computers with those of human beings to solve semi-structured or un-structured problems (Licker, 1997),
decision-makers are able to use appropriate structures of computers, analytical aids, and supportive tools, together with their own judgment to make decisions.

In an integrated DSS for the analysis and financing of firms by an industrial development bank, the system evaluates the financial performance of firms (financial ratios of profitability, managerial performance, and solvency) during a 5-year period and allows inferences about their development tendencies. Furthermore, multivariate statistical techniques (discriminate analysis, principal components analysis) are available to aid in the identification of the most significant financial ratios and in the grouping of the firms in coherent categories. Finally, a multi-criteria method is used, which ranks the firms from the most dynamic to the bankrupt and in this way dynamic to the bank to select the less risky for financing. The capabilities of the system are illustrated with actual data provided by the bank.

Another model of interactive decision support system for bank asset liability management (IDSSBALM) using MCDM and DSS, help decision-makers conduct sensitivity analysis for urgent planning problems and objectives Dieter (Langen, 2003). The MCDSS prototype developed by Quaddus (1997) is used for information system project portfolio planning in an IS department.

Presenting his model Nihan Chinar (2004) used MCDSS for selecting the location of branch. He explains that location selection is one of the most important decision making process which requires to consider several criteria based on the mission and the strategy. This study’s object is to provide a decision support model in order to help the bank selecting the most appropriate location for a bank’s branch considering a case study in Turkey. The object of the bank is to select the most appropriate city for opening a branch among six alternatives in the South-Eastern of Turkey. The model in this study was consisted of five main criteria which are Demographic, Socio-Economic, Sectoral Employment, Banking and Trade Potential and twenty one sub-criteria which represent the bank’s mission and strategy. Because of the multi-criteria structure of the problem and the fuzziness in the comparisons of the criteria, fuzzy AHP is used and for the ranking of the alternatives.

Currently, MCDM has become one of the most active, international, and interdisciplinary fields of management research. It is becoming a part of the mainstream of
operation research, management science and decision support systems (Manish Arora and M. Syamala Devi) The research in this area is gaining popularity in research areas due to the interdisciplinary nature of MCDM, the predominance of multiple criteria in decision problems, good communications networks and it provides ways to solve practical problems in the real world.

3.6.1. Group MCDA Process - Most decision problems involve several responsible decision makers. They can for instance represent different department of a firm, or different partners involved in a project. However, the comprehension, analysis, and support of the decision making process can be extremely difficult for three reasons: 1) the basic problem is badly structured, 2) the dynamic environment in which the decision making process develops, 3) the presence of multiple decision makers, each of them with their own points of view about the way the problem has to be managed and what decisions have to be adopted (Srinivas, N-1994).

The strongest obstacle to resolving a group decision problem is that each individual has his/her own perception about problem. Consequently, he/she has his/her own belief about what should be the result or the correct decision to make. Therefore, in such an environment, it is logical and common to find conflicts between the opinions and desires of the group members. These conflicts arise due to the several factors present such as different values and objectives, different criteria and preference relations, lack of communication support between group members, etc. (Roy, 1996) encapsulates the diverse factors in conflict under the term “distinct value systems.” Although these individual objectives are often strongly conflicting, a consensual decision must be reached. This is not an easy problem. This problem can be managed by ranking a finite set of multicriteria alternatives by a collaborative group of decision makers with a Web-based Multiple Criteria Group Decision Support System (MCGDSS).

Group MCDA processes usually require a facilitator to formulate initially the problem; moreover, successful group decision making requires appropriate coordination processes for incorporating diverse individual views into an aggregated final decision. Suitable decision support tools may facilitate the processes and help the group improve the decision quality (Malone and Crowston, 1990).
asynchronous and distributed environments a key problem with the MCDA processes is the increased need for coordination of individual activities (Tindale, 1989). A coordination mode refers to a series of procedures and aggregation methods, which incorporate the group and individual members activities and facilitate them to reach agreement of a high quality group decision (Cao and Burstein, 2000). In such an environment, each participant can sometime work individually and/or collaborate with the rest of the group at other time. We can distinguish two main general approaches, which use a multi criteria decision aid technique for aggregating group preferences:

i) In the first way, the group is asked to agree on the alternatives, criteria, scores, weights, thresholds and remaining parameters before the model provides a ranking. The group discussion focuses on what actions and criteria should be considered, what weights and other necessary parameters are appropriate. Once the discussion is closed and all the individual information has been gathered, a technique is used for obtaining values of these model parameters, which should represent the collective opinion. With this information, the multi criteria decision model gives us the group ranking.

ii) Although members can exchange opinions and relevant information, a group consensus is needed only for defining the set of potential actions. Each member defines his own criteria, the appropriate evaluations and model parameters (weights, thresholds, etc.), and then the multi criteria decision aid method is used to get a personal ranking. Next, each actor is considered as a separate criterion, and the preferential information contained in its particular ranking is aggregated in a final collective ordering with the same (may be other) multi criteria decision approach.

Lee (1990) are focused on distributed and asynchronous meeting support, via an interconnected computer network. In these systems, the elements of a debate can be documented, reviewed or used again in any phase of the process, although, in contrast, they do not have structured techniques to solve problems of group decision making. MCGDSS have emerged just in the 80’s, almost twenty years after the introduction of the field of MCDA.
A large number of multi criteria techniques have been developed to deal with different kinds of problems. Whereas each technique has pros and cons and can be more or less useful depending on the situation, few approaches were proposed to guide the selection of a technique adapted to a given situation. Various papers present frameworks that guides the analysis of each selection approach according to its own characteristics, and to the characteristics of the MCDM techniques that the approach helps to select. Two outcomes have been observed:

a. Comparative analysis of the presented approaches,

b. Collection of requirements for a "good" selection approach.

Goodwin and Wright (1993) commented that the MCDM in a group environment was the best method for providing a guide to action, not a 'black box' prescription for action. Phillips (1988) proposed the requisite decision modeling which treated problem solving as a dynamic process. Based on this model, all affected actors became clearer about the problem, developed an understanding of it, and agreed on a set of perceptions of the problem situation.

In his paper “Applying the MCDM technique to selecting the right Geographic Information Systems (GIS) software to invest in for a project” (March 2012) Khalid Eldrandaly elaborates on how MCDM is the most effective methodology for Geographic Information System software selection. The author’s overall goal was to provide a framework that assists computer system developers to select the most appropriate GIS software application for their organization.

Our proposed integrated fuzzy multiple criteria decision making (MCDM) method addresses this issue within the context of the vendor selection problem. First, we use triangular fuzzy numbers to express the subjective preferences of evaluators. Second, we use interpretive structural modeling (ISM) to map out the relationships among the sub-criteria. Third, we use the fuzzy analytical hierarchy process (AHP) method to compute the relative weights for each criterion, and we use non-additive fuzzy integral to obtain the fuzzy synthetic performance of each common criterion. Fourth, the best vendor is determined according to the overall aggregating score of each vendor using the fuzzy weights with fuzzy synthetic utilities. Fifth, we use an empirical example to show that our proposed method is preferred to the traditional
method, especially when the sub-criteria are interdependent. Finally, our results provide valuable suggestions to vendors on how to improve each sub-criterion so that they can bridge the gap between actual and aspired performance values in the future.

Further, Problem solving is set of activities designed to analyse problem systematically and provide valuable solution. Decision-making is mechanism for making choices during every step of problem solving. Standard problem solving models ensure that decisions made are logical and rational. During decision-making, quantitative and non-quantitative decision making factors are considered and evaluated. Quantitative factors provide a numerical value for making decision. Such factors are insufficient in decision-making process, hence non-quantitative factors like SWOT (Strength, Weakness, Opportunity, Threat) and PEST (Political, Economical, Social, Technology) analysis are also considered.

Such non-quantitative factors are not easy to evaluate in terms of numeric value. Decision-making models to solve problems are classified into three categories: Decision Theory Approach, Economic Analysis and Operational Research Approach. Decision Theory models rely on subjective or qualitative input variables, Economic Analysis is based on probability in terms of investment required and expected revenue. It makes use of methods like NPV (Net Present Value) and Discounted Cash Flow and assumes that profit is the only objective. NPV and other discounted cash flow methods are inappropriate in research and development project selection as they favour short-term projects not long term.

Projects where market is uncertain. Problem arises when non-economic benefits are considered. The Operational Research uses mathematical programming techniques to optimize selection of alternatives, provided constraints and other resources are available Decision-making problems require systematic approach to evaluate alternatives using both quantitative and non-quantitative factors. Standard methods to solve problems lack considerations of non-quantitative factors, in which numeric value is difficult to assign. Different techniques like Fuzzy set theory, Analytic Hierarchy Process (AHP) and Multi Criteria Decision Making (MCDM) are presently being used in decision-making process. These techniques take multiple factors with vague values and /or concrete values. In their research paper “A Fuzzy-
AHP Approach to Solve Multi criteria Budget Allocation Problem “ by Manish Arora & M. Syamala Devi (DOEACC Society, Chandigarh Centre, Chandigarh, India; Panjab University Chandigarh, India) provides solution to a decision-making problem of budget allocation problem, to allocate funds to deserving and competing organizations by using integrated Fuzzy, AHP and MCDM techniques. In budget allocation problem, fund seekers submit their proposals to avail funds to fund allocator to execute their projects. Fund allocators allocate funds to fund seekers after evaluating their proposals. During evaluation, 12 decision making factors are considered and these are given weights. Weights are calculated using Fuzzy set theory and AHP. Fuzzy set takes subjective values like preferred, strongly preferred etc. and AHP technique evaluates relative importance of factors by forming pair wise comparison matrix. Experts in this domain were consulted to give their preferences through questionnaire. The technique of evaluating proposals helped in ranking after assigning weights to decision-making factors.

3.7 SYSTEM DYNAMICS (SD)

System dynamics is a methodology and mathematical modeling technique for framing, understanding, and discussing complex issues and problems. Originally developed in the 1950s to help corporate managers improve their understanding of industrial processes, system dynamics is currently being used throughout the public and private sector for policy analysis and design.

Convenient GUI system dynamics software developed into user friendly versions by the 1990s and has been applied to diverse systems. SD models solve the problem of simultaneity (mutual causation) by updating all variables in small time increments with positive and negative feedbacks and time delays structuring the interactions and control. The best known SD model is probably the 1972 The Limits to Growth. This model forecast that exponential growth would lead to economic collapse during the 21st century under a wide variety of growth scenarios.

System dynamics is an aspect of systems theory as a method for understanding the dynamic behavior of complex systems. The basis of the method is the recognition that the structure of any system — the many circular, interlocking, sometimes time-delayed relationships among its components — is often just as important in
determining its behavior as the individual components themselves. Examples are chaos theory and social dynamics. It is also claimed that because there are often properties-of-the-whole which cannot be found among the properties-of-the-elements, in some cases the behavior of the whole cannot be explained in terms of the behavior of the parts. Three components are required for SD modelling: decisions, information sources and policies. A decision-making process consists of three parts: the creation of a desired state, the actual state, and decisions to control action that will be taken in accordance with any discrepancy between the two. The information used for SD model building based on three databases: mental, written and numerical. Policy management is the process of converting information into action.

System dynamics was created during the mid-1950s by Professor Jay Forrester of the Massachusetts Institute of Technology. In 1956, Forrester accepted a professorship in the newly-formed MIT Sloan School of Management. His initial goal was to determine how his background in science and engineering could be brought to bear, in some useful way, on the core issues that determine the success or failure of corporations. Forrester's insights into the common foundations that underlie engineering, which led to the creation of system dynamics, were triggered, to a large degree, by his involvement with managers at General Electric (GE) during the mid-1950s. At that time, the managers at GE were perplexed because employment at their appliance plants in Kentucky exhibited a significant three-year cycle. The business cycle was judged to be an insufficient explanation for the employment instability. From hand simulations (or calculations) of the stock-flow-feedback structure of the GE plants, which included the existing corporate decision-making structure for hiring and layoffs, Forrester was able to show how the instability in GE employment was due to the internal structure of the firm and not to an external force such as the business cycle. These hand simulations were the beginning of the field of system dynamics.

During the late 1950s and early 1960s, Forrester and a team of graduate students moved the emerging field of system dynamics from the hand-simulation stage to the formal computer modeling stage. Richard Bennett created the first system dynamics computer modeling language called SIMPLE (Simulation of Industrial Management Problems with Lots of Equations) in the spring of 1958. In 1959, Phyllis
Fox and Alexander Pugh wrote the first version of DYNAMO (DYNAmic MOdels), an improved version of SIMPLE, and the system dynamics language became the industry standard for over thirty years. Forrester published the first, and still classic, book in the field titled Industrial Dynamics in 1961.

From the late 1950s to the late 1960s, system dynamics was applied almost exclusively to corporate/managerial problems. In 1968, however, an unexpected occurrence caused the field to broaden beyond corporate modeling. John Collins, the former mayor of Boston, was appointed a visiting professor of Urban Affairs at MIT. The result of the Collins-Forrester collaboration was a book titled Urban Dynamics. The Urban Dynamics model presented in the book was the first major non-corporate application of system dynamics.

The second major non-corporate application of system dynamics came shortly after the first. In 1970, Jay Forrester was invited by the Club of Rome to a meeting in Bern, Switzerland. The Club of Rome is an organization devoted to solving what its members describe as the "predicament of mankind" -- that is, the global crisis that may appear sometime in the future, due to the demands being placed on the Earth's carrying capacity (its sources of renewable and nonrenewable resources and its sinks for the disposal of pollutants) by the world's exponentially growing population. At the Bern meeting, Forrester was asked if system dynamics could be used to address the predicament of mankind. His answer, of course, was that it could. On the plane back from the Bern meeting, Forrester created the first draft of a system dynamics model of the world's socioeconomic system.

Three components are required for SD modeling: decisions, information sources and policies. A decision-making process consists of three parts: the creation of a desired state, the actual state, and decisions to control action that will be taken in accordance with any discrepancy between the two. The information used for SD model building based on three databases: mental, written and numerical. Policy management is the process of converting information into action (i.e. decision-making, Forrester, 1992).

However, many practitioners have currently highlighted structures within the system (i.e. qualitative analysis) rather than the numbers. Lane (1992) proposed...
"Modeling as Learning" as a consultancy methodology for decision support using analytical tools in close involvement with clients; Senge (1992) constructed qualitative modeling based on word and arrow archetypes. Wolstenhoime (1993) proposed a revised framework for system dynamics (i.e. system thinking) which combines knowledge acquisition and both qualitative and quantitative modelling, supported by micro worlds and archetypes to gain more insights of system behaviours.

Recently, SD has become more accessible to policymakers and the academic community due to developments in this field. First, there had been improvements in the symbols and software to create system structures. Second, new ideas adopted from behavioural decision theory help policymakers to transform their knowledge into computer models. Third, improvements in simulation analysis provide better insights about dynamic behaviour. Fourth, games and computer simulations make models transparent to comprehend. In their paper “System Dynamics Integrative Modelling in the Diffusion Dynamics of Indian Telecom Sector” Dr. Sanjay Bhushan (Visiting Research Faculty, IIM Bangalore) and Janat Shah (Professor in Operations Supply Chain Management Centre Indian Institute of Management Bangalore) had endeavoured to present a system dynamics framework to explain diffusion dynamics and associated dimensions for handling them in the Indian telecom sector. It is proposed to design a robust innovation model through the selection of appropriate set of decision variables based on real time observed values.

The work done here proves how the application of system dynamics modeling and simulation can contribute in a meaningful way to improve the holistic understanding of the dynamic structural complexities and forces driving and arising from the supply line of telecom diffusion. Several model simulations show the potential of using system dynamics as a promising modelling approach to capture, integrate and predict the structural behaviour of innovation diffusion process. In the end, a novel interface of neural net has been explored to perform sensitivity analysis and a scenario projection of multiple usage situations has also been conducted.

SD has been employed to enhance strategic and holistic insights and promote understanding about the effectiveness of different policies in various areas. Schmidt
(1989) demonstrated computer-based decision support of strategic planning and management for the German federal railway. Gupta and Gupta (1990) investigated a Japanese production system (just in time-JIT) and an inventory system. Chowdhury and Sahu (1992) studied the long-term dynamic behaviour of the Indian oil and gas exploration/exploitation industry.

Gupta, Y. P., & Gupta, M. C. (2002). and Abdel-Hamid (1989a; 1989b; 1990) developed the system dynamics model of software development to rectify problems occurring in software development projects (e.g. poor portability of software development). The model aimed at identifying managerial factors that impact costs, and quantifying the degree of that impact. The studies provided interesting insights into the policies both explicit and implicit for managing projects and human resource management. SD was employed to support a traditional decision-making process by quantifying the influence of client behaviour on a project (e.g. schedule restrictions, high demand on progress reports, approval delays, and work-scope changing). They concluded that traditional and system dynamics models provide complementary support to project management. The traditional model supports the detailed operational problems whereas the SD model provides strategic insights and understanding about the effectiveness of different managerial policies (Arunee innaproprio).

A system dynamics model representing the operational and performance dynamics of Indian PSUs in the era of transformation from the pre-globalization through globalization and post-globalization periods was developed by by Rajshekher, Venketsh and Verupaxi (International Journal of Research 2012-vol 6. No.2 pp135-148) Policy experimentation reveals that chief executive officers with strategic orientation towards research and development improve revenue generations. Furthermore, it revealed that Indian PSUs would have earned more revenues had there not been globalization.
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Ernest Burkman's (1987) user-oriented development approach exemplifies those currently favored for the adoption and diffusion of instructional technology generally and Internet technology in particular. It consists of 5 adopter.


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