INFORMATION TECHNOLOGY ACCEPTANCE AND ORGANIZATIONAL AGILITY: APPLICATION IN INDIAN FIRMS

A THESIS

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DOCTOR OF PHILOSOPHY

by

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CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled **INFORMATION TECHNOLOGY ACCEPTANCE AND ORGANIZATIONAL AGILITY: APPLICATION IN INDIAN FIRMS** in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies of the Indian Institute of Technology Roorkee, Roorkee is an authentic record of my own work carried out during a period from August 2004 to August 2010 under the supervision of Dr. J. P. Singh, Professor and Dr. Zillur Rahman, Assistant Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

(JAMSHED SIDDIQUI)

This is to certify that the above statement made by the candidate is correct to the best of our knowledge.

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Abstract

With markets becoming global and volatile, for contemporary businesses to survive, avoiding change and continuing with the traditional practices is like anathema. Organizational agility is replete with principles of customer focus that include customer enrichment, mastering change, leveraging resource and cooperating to compete. Practices such as linkages in workforce, virtual enterprise, customized manufacturing and concurrent engineering are agile attempts that can be catalyzed if integrated with information technology and lead to achieving agility. Governed by an organization wide IS strategy for the management of information systems it needs the commitment of top-management and positive attitudes from the workforce. IT enablement of business processes leads to dynamic capabilities that provide an advantage over the competitors. Success of IT based agile attempts might lead to organizational goals and realization of financial benefits but the Indian industry is in the process of resolving issues of socio-technical nature in technology acceptance for agility. In this research an attempt has been made to analyze the trends in the market and evaluate the potentials for agility.

Survey of literature on agility and technology acceptance suggested the need of this topic to be investigated in Indian private sector. Literature was surveyed for current issues in agility and information technology acceptance. Gaps were identified from empirical studies and enlisted for being addressed in the review. A survey was designed to assess the current trends in the industry. A questionnaire was formulated to take opinions from managers and executives of companies in the Indian private sector. Mail survey was conducted in a specified period of time. The questionnaire was designed to enquire about the agile level of

companies, their integration with information technology and the potential practices to achieve agility. Demographic details were also taken. Analyses of the responses provided the demographic statistics on the basis of which inferences were drawn about how managers feel about accepting technology and adapting principles of agility. Certain hypotheses were set about the sectors of the industry and IT enablement of business processes. These were tested using multivariate analyses and discussed in the light of the findings. Finally an ANP based model has been tested and developed for agile drivers to help outrank an agile organization on the basis of the over all weightage assigned to the determinants of agility. The conclusions have been discussed with their implications for managers and academicians. Future research directions have been suggested.

The research makes the following significant contribution:

- The concept of agility has been envisioned for the Indian industry
- An extensive review of literature has been conducted to identify the issues in agility and technology acceptance.
- A questionnaire has been designed to address the issues of agility and IT/IS
- Survey of industry has been done and descriptive statistics have been given
- Certain hypotheses have been set and tested
- An ANP based model for outranking agile organizations has been presented

The present research gives practical insights for managers and practitioners to implement agility with the help of information technology. Analyses of agile enablers and determinants would be useful for further research.

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This work is an outcome of the kind and generous contribution of some special entities without the cooperation of whom this thesis would not have seen the light of the day. First and foremost I thank my research supervisors Dr. J. P. Singh, Professor and Dr. Zillur Rahman, Assistant Professor, Department of Management Studies, Indian Institute of Technology, Roorkee. Their vision enlightened me about the vitality of this research in contemporary times and initiated me to doing scientific investigation in business and technology. For every step that took me forward to the completion of my thesis I am deeply indebted to the guidance and support of my supervisors.

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The opinions and responses given by managers and executives from reputed companies in the Indian Private sector, constitute the main crux on the basis of which it was possible for me to construct and defend my thesis. Their energies flow in every tiny bit of calculation made to arrive at conclusions in this investigation. For this indispensable service from each one of the respondents a collective, sweeping word of gratitude seems unbefitting. I wish I could thank them here by name, yet it is paucity of space and the condition of anonymity put up from some of them that prevent me from doing so. Hence, I put on record my heartfelt appreciation to every individual for his/her valuable time and interest in responding to my queries in time.

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To Allah Almighty in whose Master Plan for the universe the mortal undersigned has been endowed with education and now a doctoral thesis, I bow in solemn submission.

(JAMSHED SIDDIQUI)

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviations	Full Name
AD	Accessible Databases
ADT	Advanced Design Technologies
AHP	Analytic Hierarchy Process
AM	Agile Manufacturing
AMT	Advanced Manufacturing Technologies
ANP	Analytic Network Process
AT	Agile Technologies
ATM	Automatic Teller Machine
BPR	Business Process Reengineering
CAD	Computer Aided Design
CAM	Computer Aided manufacturing
CC	Cooperation with Customers
CCP	Close Collaboration throughout the Process
CE	Concurrent Engineering
CIM	Computer Integrated Manufacturing
CS	Cooperation with Suppliers
DM	Decision Makers
EDI	Electronic Data Interchange
EI	Early Involvement
FM	Flexible Manufacturing
FMCG	Fast Moving Consumer Goods
HR	Human Resource
ICIS	Integrated Customer/Supplier Information Systems
IDC	Inter-Departmental Cooperation
IDT	Innovation Diffusion Theory
IMIS	Integrated Manufacturing Information Systems
IS	Information System
ISDN	Integrated Services Digital Network
IT	Information Technology
JIT	Just In Time
KM	Knowledge Management
LAN	Local Area Network
LSP	Logistics Service Provider
MDP	Formal Mechanisms to Disseminate best Practices
MLR	Multiple Linear Regression
OSSE	Organizational Systems to Support Experimentation
OWI	Overall Weightage Index
PS	Planning Systems
SCM	Supply Chain Management
SCT	Social Cognitive Theory
SD	Standard Deviation

Abbreviations	Full Name
SPPD	Simultaneous Product and Process Development
SPSS	Statistical Package for Social Scientists
TAM	Technology Acceptance Model
TBP	Theory of Planned Behavior
TK	Tacit Knowledge
TQC	Total Quality Control
TQM	Total Quality Management
UTAUT	Unified Theory of Acceptance and Use of Technology
VCI	Value Chain Integration
VE	Virtual Enterprise
VMI	Vendor Managed Inventory
WAN	Wide Area Network
WT	Working Teams that access, apply and update knowledge

Chapter 1

Introduction

Present chapter provides a brief introduction to organizational agility, information technology/information systems (IT/IS) and its role in improving organizational performance. It also details the challenges faced by an agile organization, motivation for this research, objectives and hypotheses of the present research, an indication of the research methodology, and research overview. In the end the organization of this thesis and a brief conclusion have been given.

1. Introduction to the present research

Globalization is here and it is here to stay. As the free market economies decentralize businesses are confronted with unprecedented changes in the external environment. When first experienced these unpredictable changes seem unfathomable and turbulence in markets impacts business performance. In the current wake of this newly dawned market reality it is required of a firm to manage a change in the external environment by not only responding to it but also by bringing such internal changes that would make them more adaptable to the new ecology. Having more experience tackling these changes unfurls the reality that with timely action within the given framework, firms can manage these alterations and even turn them into opportunities.

India having embraced the liberal market policies and the world changing into a global village where destinations that are oceans apart can be covered by the flick of a button,

IT and IS have acquired a scope to grow in such leaps and bounds that was experienced by no other revolution in the past bringing a watershed on human history (Buckler 1994, Deming 1996). This has been possible because of the unique nature of IT that makes it possible to handle large volumes of complex data and management decision making in order to make sure that the strategy is well followed according to the firm's corporate mission and objectives (Breu *et al* 2001). India being a developing country, IT has emerged as an essential element in providing the right information at the right time to help organizations accomplish the missions. Operating globally is increasingly becoming a threshold skill and no more an option required to meet the skyrocketing growth in the stock market and survive incessant competition.

1.1 Organizational agility

Quick, deft and active responses towards new developments in the market make a firm agile and provide a competitive advantage for long term survival in the future. Agility in operations, manufacturing and inputs draws from the earlier concepts of leanness (Narsimhan 2006) and flexibility (Baykasgolu and Ozbakir 2008) but encompasses more than that as product life cycles shorten and customization is the new production mantra. Dynamic capabilities are the need of the hour for a firm to remain agile and secure an edge over competitors. Use of IT/IS with its tremendous opportunities of innovation and dynamism endow a firm with agility. Potential for linkages facilitating free flow of information and exchange of ideas give a firmer ground to agility as cooperation with customers, suppliers and employees is encouraged through creative associations.

The rate of change in markets, technologies and value chains is accelerating. The new age business reality dawns a significant reduction in the average lifetime of companies and products (Ahire *et al* 1996). On the contrary there is an increase in commoditization of

products, switching of customers, and competition that intensifies pressures on cost and price. An organization's foresight and responsiveness in dealing with such external factors whether it thrives perishes or simply survives. Set in this backdrop *agility* has a crucial status.

Historically the agility of firms was first identified by Goldman *et al.* in 1991 as focusing on IT/IS to provide strategic directions and capabilities to help organizations to be change efficient and gain competitive advantage. It is about having strategic management to help a company to stay long and flexible in facing uncertain and unpredictable changes (Nagel and Dove 1993). The four strategic dimensions of beating competition by being agile are given in the pioneer studies as follows

- Enriching the customer
    - Selling solutions
    - Rethinking design
    - Appreciating information
- Cooperating to enhance competitiveness
    - Virtual organizations
    - Substituting bytes for bricks
    - Competing globally equipped with technology
- Organizing to master change and uncertainty
    - Giving up control
    - Optimizing opportunism
    - Strategic intent
    - Management by design
- Leveraging the impact of people and information
    - Enabling people
    - Motivating people

- Nurturing competencies
- Exploiting information

As evident in the above, the vital role played by of information technology is to ensure that the company will improve its efficiency in getting jobs done with minimum waste to be effective in selling its products or services and to be able to build up a loyal and expanding customer base. Agility has found to be related with words like flexibility, speed, learning, responsiveness and becoming boundary less in a survey of thought leaders (Eichinger and Ulrich 2002). The capacity to anticipate changing market dynamics, adapting to those dynamics and accelerating enterprise change faster than the rate of change in the market to create economic value are the requirements of an agile organization. According to (Melarkode *et al.* 2004) the key to clearly linking technology with business is agility. They also identify five levers of agility which need to be used together.

- Quality
- Efficiency
- Visibility
- Velocity
- Flexibility

Characteristically an agile organizational facility has six attributes:

1. Produces to order – whereas traditional mass production produces to stock
2. Meets the customer's specific needs instead of producing a good average product.
3. Achieves a speed and flexibility in its functioning that is matched to that of the technologies that it manages.
4. Mobilizes and manages all forms of knowledge intelligently to support an agile strategy
5. Adopts new ways of working when these facilitate agility (moving from functional to team working and from arm's length to interdependent relationships with other companies).
6. Creates virtual project and *ad hoc* organizations for capabilities as and when needed

Metes *et al* (1998), outline in Table 1.1 that the strategic model of mass production is no longer a viable paradigm for world-class firms in today's competitive environment and the dimensions of agility brace up the firm to meet these challenges.

Table 1.1: Strategic functioning of agile organization

Agile principles	**Customer enrichment**	**Mastering change**	**Mobilizing resource**	**Cooperating to Compete**
Agile Mission	Provide solutions that customers value	Be ready to respond to any change in the business environment	Make every asset add value to the bottom line	Make partnering a strategy of choice
Top level agile strategies	1. Customized niche-solutions and not mass market products 2. Customer collaboration	1. Change proficiency 2. Reconfigurable operations and infrastructure 3. Information transparency 4. Flexible operations 5. Rapid response	1. Entrepreneurial environment 2. Empowered people 3. Virtual teamwork 4. Knowledge management	1. Proficiency in partnering 2. Virtual organizations

Meredith and Francis (2000) studied small and medium sized enterprises and proposed the agile wheel reference model to audit each company on its degree of agility. It mentions 16 interdependent components as in Table 1.2.

Table 1.2: Agile wheel reference model

Agile strategy 1. Wide deep scanning 2. Strategic commitment 3. Full deployment 4. Agile scoreboard	**Agile Processes** 5. Flexible assets and systems 6. Fast new product acquisition 7. Rapid problem solving Rich information systems
Agile Linkages 8. Agility Benchmarking 9. Deep customer insight 10. Aligned suppliers 11. Performing partnership	**Agile People** 12. Adaptable structure 13. Multi-skilled flexible people 14. Rapid, able decision making 15. Continuous learning

1.2 The information era

Post 1991 the dominant theme for businesses across India is globalization. The world is becoming smaller. Telecommunications, travel, information, ideologies, partnerships and

businesses are becoming global. Businesses, regardless of size, must get global. Globalization might be characterized with an industry life – cycle metaphor. We experienced rapid consolidation along with deregulation. Competing globally has become more than creating a product in a home market and shipping it "as is" to new markets (Lynch and Werner 1992). It has become a very complex interrelated network of establishing global centers of excellence that draw on technologies invented in one locale and shared worldwide (Fleidner and Vokurka 1997). It requires rapid movement of products, people, *Information* and ideas around the world to meet local needs. It requires managing the paradox of global economies of scale and local responsiveness. It requires a global mindset and a local commitment. It's thinking global and acting local.

In an attempt to see why change would be necessary Eichinger and Ulrich (2002) found no single or dominant reason but rank technology as the second most important reason for which businesses were going to have to adopt in a list of ten top drivers of change over the next five to seven years. Table 1.3 indicates that along with economic, political, structural and educational issues technology comprises 75 percent of the straightforward pressures for future business.

Table 1.3: Drivers of change in future business (Eichinger and Ulrich 2002)

Rank	**Driver**	**Place on 10-point scale**	**% of drivers Mentioned**
1	Economic/ financial	2.6	17%
2	Technological	3.4	16%
3	Political	3.5	14%
4	Structural	3.7	15%
5	Education	4.7	14%
6	Labor market	4.8	7%
7	Social	5.7	5%
8	Strife and conflicts	7.4	5%
9	Environment	7.7	2%
10	Crime	8.3	3%
Listed in order of rank			

Following globalization but clearly impacting and getting impacted by IT are technology trends. This is a burgeoning computer literate age where ideas and images are shared worldwide. Technology has decreased geographic distances as well as language and cultural differences. Access is now full and immediate. Staying ahead of the technology game requires constant investment on the new competitive highways. IT/IS qualify for such investments be it hardware, internet, or software personnel.

The impacts of modern information technology (IT) on distributed, networked enterprise systems can be classified into three categories: (1) speeding up activities; (2) providing intelligent and autonomous decision-making processes; and (3) enabling distributed operations with collaboration along communication networks. All three categories lead to agility. The impacts of IT not only can improve productivity and quality of production and service activities, but also enable enterprises to intelligently alter themselves and the way they interact. They can now collaborate with each other to best adapt to various customers' demand changes in tastes, design, time, and quantity, while keeping the cost at a reasonable level. Such enterprises are hence termed *agile enterprises* (Huang 2000).

India being a sunrise economy, Information technology has emerged as the harbinger of growth in the development goals. Facilitating free flow of information anytime, anywhere and allowing the exchange of ideas it has the capacity to revolutionize industry both in the manufacturing and the service sector. Organizations can make a foray into world class manufacturing building upon on IT/IS proficiencies such as CIM (Computer Integrated Manufacturing), TQC (Total Quality control) and JIT (Just in time production) which are considered as the three pillars of world class production (Saxena and Sahay 2000).

1.3 Information technology for organizational agility

Oriented towards the four cardinal principles of agility as proposed by the Iacocca Institute, Lehigh University in 1991 being customer enrichment, mastering change,

leveraging resource and cooperating to compete IT /IS have been playing a major role in making firms agile. Agile drivers such as agile manufacturing (Gunasekaran 1998, Gunasekaran and Yusuf 2002, Hormozi 2001) Virtual Enterprise (Goldman *et al* , Dove) knowledge management KM (Sher and Lee 2004, Malhotra 2005), workforce agility (Breu *et al* 2001, Oyen *et al* 2001) have been facilitated by information technology and imparted dynamic capabilities.

In the wake of the critical looming trends of the businesses of the future which is quite dissimilar from the traditional practices of trading and barter, a move is being made from mass production to customization where the customer is focused upon as an individual and not a statistic. Table 1.4 depicts the critical value of information technology, mastering its uses and building core competencies for remaining agile.

Table 1.4: Role of information technology to master the trends of future business (Eichinger and Ulrich 2002)

S.No	Criterion	Factor	Rank
1	Critical looming trends	Mastering Technology for • Personal use • Organizational use	2 of 7
		Understanding and adopting to new markets	5 of 7
		Moving quicker, being able to change faster	6 of 7
		Recognizing new factors for being competitive	7 of 7
2	Possibilities of impact on global business	Organizational capabilities: seamlessly move talent, ideas and information	4 of 6
3	Things general managers must do to get ready for future	Building core competencies	2 of 7
		Become better masters of rapid change	4 of 7
		Focus even more on customers	5 of 7
4	Essential skills for HR executives	Ability to use information technology	4 of 7
5	HR practices technologies for future success	Information technology	5 of 13
6	Building functional mastery for HR managers	Know and learn relevant information technology	3 of 5

In an earlier study investigation was made on the premise that a synergy between agility and Information Systems can be quite fruitful in improving the quality of products and

services offered to the end customer and making the company agile (Rahman *et al.* 2005). Figure 1.1 demonstrates the performance of the organization is shown benefiting from working on strategies to incorporate IT with its people and making the business future agile. The strategies push the agile drivers and hence the agile capabilities achieved contribute to the organizational performance.

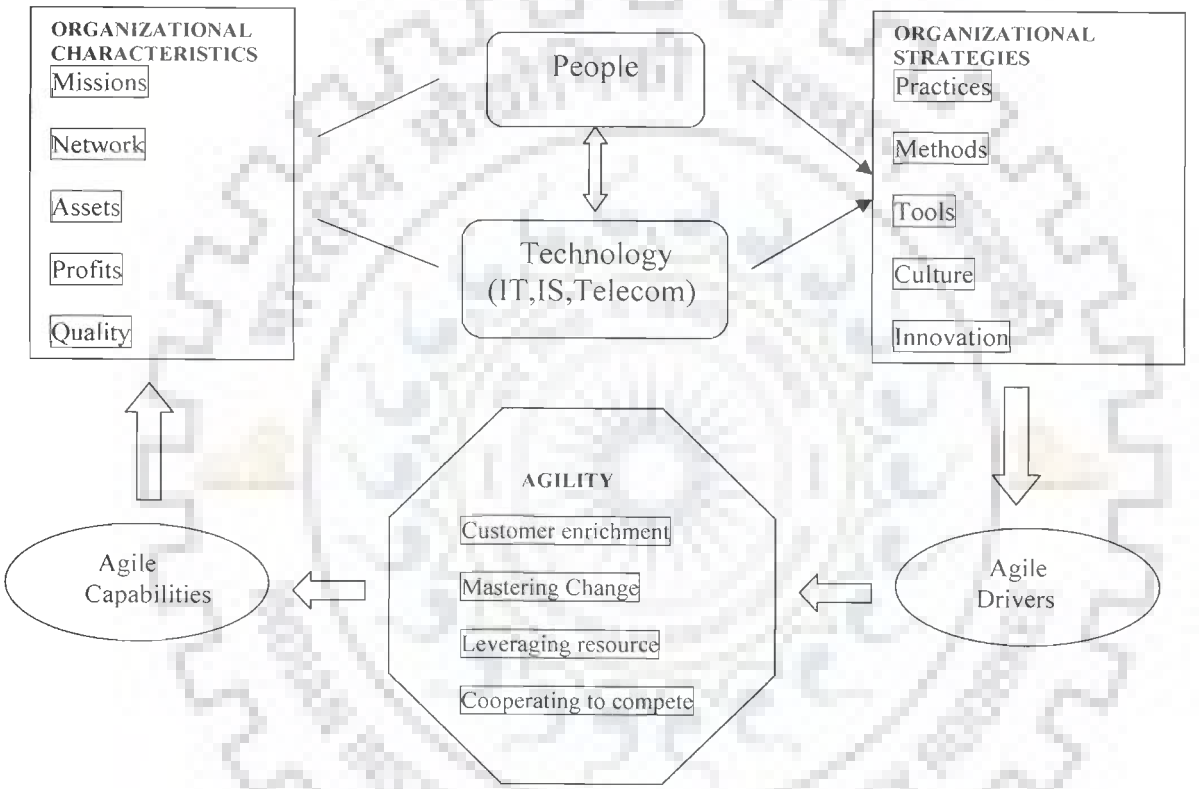

Figure 1.1: Synergies between information technology and existing capabilities for organizational agility (Rahman *et al.* 2005)

The present study investigates upon the measures for integrating business processes with IT/ IS with a perspective of increasing agility so as to make the firm change efficient.

1.4 Challenges of IT integration for business agility

Ironically though as the cost of computers decreases the spending on IT/ IS infrastructure increases. Cases have been reported that not always do investments on IT/IS

translate into profits specially financial gains. The classical *standard production theory* of economics (Sircar *et al.* 2000), propounds that the firm's output is the direct function of the inputs it uses. However, building upon the extensive work produced on the infamous 'Productivity Paradox' (Bryjnolfsson and Hitt 1993) where the findings are inconsistent and contradictory, IS managers are now questioning the more investments on newer versions of software and digital technology when they possess older ones. Some even results suggest that IT is associated with a sharp drop in capital productivity and with stagnation in labor productivity. There is need to resolve such issues regarding the IT behavior mediating IT acceptance (Agarwal and Prasad 1999) agility enablers and their contribution to organizational performance while assessing the survivors (Dove 1995) on their agile practices for reference base and their level of use of IT/IS. Further there is a need to explicitly analyze the association of agility drivers with potentials of IT/IS.

Agility along with innovation has been identified as the two critical capabilities for organizations competing to grow in the globalizing world and amongst others it hinges strongly upon information technology (Reese 1995). Some of the most important things general managers need to do to be ready for the unknown enfolded in future are the basic principles of agility. Professionals need to leverage technology (Freedman 1992). It dramatically affects how work is done. To manage shared data sources organizations need to investigate opportunities of staying ahead of the technology curve and to learn to leverage information for business results (Sharifi and Zhang 2001).

Along with the shedding of geographical barriers it is also realized that companies need to bring dramatic changes in the way they did business earlier. In the current scenario where business ethics are fast adopting globalization norms, firms should be able to manage change quickly and easily in order to survive proficiently, particularly in a turbulent and capricious business atmosphere. To be precise they need to take a paradigm shift to wards being faster,

smarter and more energetic (Iacocca 1991). If explained in one word, *agility* seems to be the need of the hour for Indian firms and since timely information is a vital resource the paradigm shift towards being agile, depends to a great extent on the acceptance of IT/IS in Indian firms. Use of IT/IS for functioning in the interest of customers, employees or stakeholders in the manufacturing and service providing sector contributes to the organizational agility (Hayes and Wheelright 1979, Kiely 1993).

1.5 Motivation

- More than three dozen International Journals regularly report the ongoing research in the area of IT/IS and agility. These journals provide a framework and guidelines to researchers with explicit discussion and the research approaches. Various inductive, and deductive kinds of reported research are good source of motivation.
- ABI/Inform (ProQuest), which links articles with full text in other databases like Business Source Complete (EBSCO), Emerald, Blackwell, Science Direct, etc. revealed many Agility and IT acceptance research of international level.
- Agility Forum, Iacocca Institute at the Lehigh University has given the concept of agility in 1991 and is continuously engaged in research from the industry. Most of the agility attributes are closely related to facilities of IT/IS. To review investment on IT infrastructure and evaluate their worth in an agility perspective provided main motivation for this work
- In a virtual enterprise the implications of information technology are put on a premium to benefit from agility, compared with networking and partnerships that are based on core competencies. There is need to identify technologies required to manage the market segment, product or service. Yet failing to integrate core competencies with information technology would neither improve productivity nor quality (Gunasekaran and Yusuf 2002).

- The implications of information technology for addressing the gaps of production and marketing have not been addressed in Indian firms. Direct inputs from customers, reduced response time and cost of identifying market requirements are to be focused upon.

The study being conducted in Indian companies, has a vibrant rationale because as the Indian customer becomes more and more brand savvy – largely owing to the globalization and advertising boom, quality consciousness is doomed to increase and if quality issues in the Indian industry viz. a viz. products of the foreign market are not addressed in time, market invasion from overseas might give such competition that would result in elimination of Indian firms. To be able to respond to the challenges of globalization firms need to be agile and learning the use of IT/IS is an acclaimed major component of agile empowerment.

Although similar studies have been conducted in other developing countries too the business ambience in India has its own specific cultural, economic, socio-political and legal structure. Strong reforms are unfurling each new day in the Indian market but a section of the Indian society still seems unprepared for them. In these conditions the entire market seems to be under stress to adopt itself to the fast diversifying needs of the customer and changes in Government policies. Much of the past research explored the various aspects of perceived usefulness, ease of use and user acceptance of IT, without examining the impact of these variables on organizational performance (Hubob 2004).

1.6 Hypothesis and Objectives

Agile firms need to have strategic *agility* planning that will indirectly form a structure to fulfill customer needs by offering the right products and services at the right time with the right quality that can be achieved by working with the increased use of IT/IS technological inputs. These systems will reward the company with a huge advantage over other companies

in their field. The success of an IT/IS system can be measured in terms of its success in generating information to achieve its strategic objectives and therefore it is essential for the organization to create an appropriate information management strategy and systems infrastructure to support it. Decisions are made in support of the organizational objectives and nowadays information is required to be handled more freely and openly. Such timely information received by the top management can positively impact the decision making of top management in the firm which may help the firm maintain quality and survive competition. IT/IS can be implemented solely to get ahead of competition by extracting online information and supporting decision-making.

Therefore, the bottom-line of this study as it has proceeded up till now is to determine the use of IS in management decision making which could later result into *agility* translating realization of organizational benefits. This is how they may master change and remain competitive in their respective markets, while not compromising on the quality inputs of the firm that affect the firm's relationship with its customers and the productive abilities of the employees – any where, any time. This study will address these facts through its exploratory nature in investigating the relationship between IT acceptance by managers and executives in their organization and organizational agility.

The study addresses some fundamental question of organizational performance and acceptance of Information technology and information systems –

Q1a: What are the factors impacting IT acceptance?

Q1b: Does it affect agility or not?

Q2: Does investing on achieving agility contribute to an organization's financial performance in the long run?

Q3: How do firms in India survive competition from multi-nationals if they use Information Technology to remain agile?

Q4: What is the viability of firms adopting IT and improving agility?

Insight to the answers of these questions is sought by testing the following hypotheses:

Hypothesis 1

Customer demands are met with (i) Adopting new technology, (ii) Bringing changes in the organization, and (iii) Launching new products.

Hypothesis 2

Customer satisfaction increases with agile capabilities of organization by (i) Sustainable quality and customization (ii) Introduction of reconfigurable products (iii) Offering total solution, and (iii) Flexibility and adaptability.

Hypothesis 3

Manufacturing sector and Auto sector exhibit more agility as compared to other sectors in the organizations of the root sample.

Hypothesis 4

Manufacturing sector and Auto sector continuously change strategy to remain competitive.

Hypothesis 5

Process sector believes in following liberal agile strategy.

Hypothesis 6

Manufacturing Sector pays more attention in technology utilization for competition.

Therefore, the primary objective of this study will be to investigate IT/IS contributions in organizational agility which later could result in helping the firm realize benefits and achieve objectives in term of financial performance. It will also provide insight pertaining to the level of agility in Indian firms belonging to various sectors in comparison with each other. Further it will be quantified as to what extent of top management support for

bringing agility is warranted, the extent of benefits realized by agility and IT acceptance, relationship between IS-agility realized benefits and relationship between the realized benefits and agile drivers in a model for outranking organizations. This study aims to assess the level of IT/ IS use for organization agility in Indian firms and investigates best practices for IT enablement of business processes to improve performance. Further, a model has been developed for outranking agile organizations with the help of agility enablers and drivers considering the various operations of the firms.

1.7 Research methods

Drawing from the existing literature on information technology acceptance and organizational agility, the parameters of the study were selected with reference to their Indian context. Constructs pertaining to level of agility in a firm, use of IT/ IS for being agile and best practices for agile capabilities were defined and subjected to a pre-test of a sample size of ten. The responses were subjected to validity analysis and variables were segregated for future survey. Drivers of agility, determinants of agile functions in affirm and enablers of agility were also derived from the Indian context for testing a proposed model on outranking agile organizations.

A questionnaire based survey is the primary method of this study. Detailed questionnaire on the organizational variables relevant to IT integration of business processes were sent to all kinds of firms in the Indian corporate sector. The respondents were mainly managers or executives and the company demographics were also sought in the respondent's and organization's profile. Opinions were sought on a five-point likert type scale where the degrees of agreement were spread from strongly disagree to strongly agree.

Data analysis was done using simple statistical tests where required as well as multivariate analysis for significant associations and differences. The hypotheses were tested

and model was drawn based on the results of analysis. A detailed account of the research methodology including variables, data collection and analysis is provided in chapter 3.

1.8 Research Overview

Realizing the unprecedented changes of globalization investigation is made upon the integration of IT and business processes with committed leadership in moving towards agility, taking a holistic view of agility for firms in which a competitive stance is gained through the synergy of information technology, machinery, function, strategy, people and management. Utilization of the key requirements and advantages of the agility process to analyze the interplay of IT and organizational associates in achieving agility would be done.

In a survey of Indian firms upon the nature and extent of IT utilization, research in computer utilization and acceptance and how the technology contributes to a firm's competitiveness in a developing country environment where it can keep a sustained quality check on the various aspects of its functioning as well as remain agile to responding to changes from the competitive business milieu, conclusions are reached upon for practitioners and managers. Proposing a research model for outranking organizations on their agile skills determinants, factors and drivers of agility are detailed according to their information technology operations.

1.9 Organization of the thesis

The organization of the present research work has been proposed in the following seven chapters which elaborate upon the topic, the requirement to justify it, detailed methods observed and the scientific defense of the research and its findings:

Chapter 1: It deals with the introduction of organizational agility and its philosophy for boosting organizational performance, IT/ IS acceptance and use for achieving the enablers of

agility, future trends the area of agile practices and IT, motivation for the research, & its objectives, brief outline of methodology and thesis organization.

Chapter 2: It deals with the reviews of the literature which covers definitions used for agility, tools of IT that may enhance organizational agility, literature classification scheme under which gaps have been identified in the areas of IT acceptance and organizational agility. The first presents a summary of published literature on proposed models, frameworks and best practices for agile organizations, surveys and empirical studies testing the various hypotheses regarding agile operations and findings and main postulates of studies on technology acceptance.

Chapter 3: This presents in detail the methodology adopted for data collection, data analysis, survey reliability and questionnaire validity, hypothesis testing and modeling.

Chapter 4: This delineates post response segregation, the sample characteristics, demographics of the sample population and descriptive statistics of responses received.

Chapter 5: Data analysis and hypothesis testing, results have been presented in this chapter after synthesizing significant associations, variance and correlations of the variables.

Chapter 6: An ANP based model for outranking agile organizations on the basis of overall weightage index to the determinants, drivers and enablers has been presented as a framework after model testing.

Chapter 7: It presents the summary of the research undertaken, management implications, significant contribution and limitation. At the end, scope for further research is also enumerated.

1.10 Conclusion

Not even two decades old agility is a relatively new concept that puts customer at the centre of focus. In wake of the unpredictable changes of the free market regime initiating

economies the world over, sudden rough and tumbles are becoming all the more capricious and managers can no longer remain content with mastering traditional modes of business. Engaging wherever necessary making ad hoc virtual enterprise is the critical trend of the markets of tomorrow.

It is concluded that Indian corporate sector is required to rise to the principles of agility and make its advancements in information technology a tool to remain agile. Drawing dynamic capabilities from the IT infrastructure provides a firm the competitive advantage in an ever changing environment. However, only investments on IT/ IS are not the solution owing to the infamous productivity paradox. This study highlights potential areas in Indian service and manufacturing industry for integrating information technology with agility drivers and strategically putting them in place for realizing organizational goals.

Chapter 2

Literature Survey

2.1 Introduction

As the proficiencies of IT/IS for making companies capable of not only handling change in the external environment but also changing themselves to adapt to competition more over in a Darwinian ethic of struggle for existence and survival of the fittest were made evident the concept of agility began to be fashioned and was presented in the early nineties (Nagel and Dove 1993, Goldman *et al* 1994; 1995 and Dove 1995b). This attracted focus of practitioners, managers and the academia examining the various parameters of IT enablement for new age manufacturing and business processes. The literature surveyed in this chapter takes into account previously published literature on IT acceptance and organizational agility where the two broad focus areas under the purview of this study have been investigated upon collectively or separately.

Several studies from India and abroad - mostly empirical in nature have investigated aspects of IT/IS and agility. Empirical studies on assessing the relationship between information technology acceptance and organizational agility were conducted by Zain *et al* (2003, 2004). Conducting a survey of Malaysian firms they found that IT/IS hold a critical value to the agile management and performance of Malaysian firms. Yet it was seen by them that firms could not use IT/IS effectively for providing adequate information to their customers about their competitors. The need of making information more accessible to

customers is also elucidated by Zhang and Sharifi (2000). They further propose practices for achieving agility in manufacturing firms (Sharifi and Zhang 2001) through the validation of self-developed methodology.

Skinner (1974) suggests that there are trade-offs in such variables as cost, time, quality, technological constraints and customer satisfaction. Factories attempt to perform too many conflicting production tasks within one inconsistent set of manufacturing objectives (Tidd *et al* 1997). A single factory cannot perform well on every yardstick. Hence there are performance trade-offs which must be identified and compromised to meet several goals simultaneously. Agile manufacturing is being pushed by such market demands where timeliness and flexibility are the key factors to hold back customers. Hence companies the world over are abandoning old ideas of mass production be it of world class standards and shifting towards manufacturing in small amounts products delivered exactly on time. For instance in Australia alone the traces of agile manufacturing can be found to early 1980s where large companies have made significant progress towards just in time production (Sohal 1999). This new age phenomenon of the twenty-first century has brought to the forefront the need of cooperation within and amongst organizations even if they are competitors, for the sake of product innovation and research through small short term alliances. Such unique alliances are possible in virtual co-operations essentially enabled by IT/IS.

Gunasekaran (1998) has identified enablers of agility where innovation, creation and adoption of the new with free flow of information are given requisite positions (Fig 2.1).

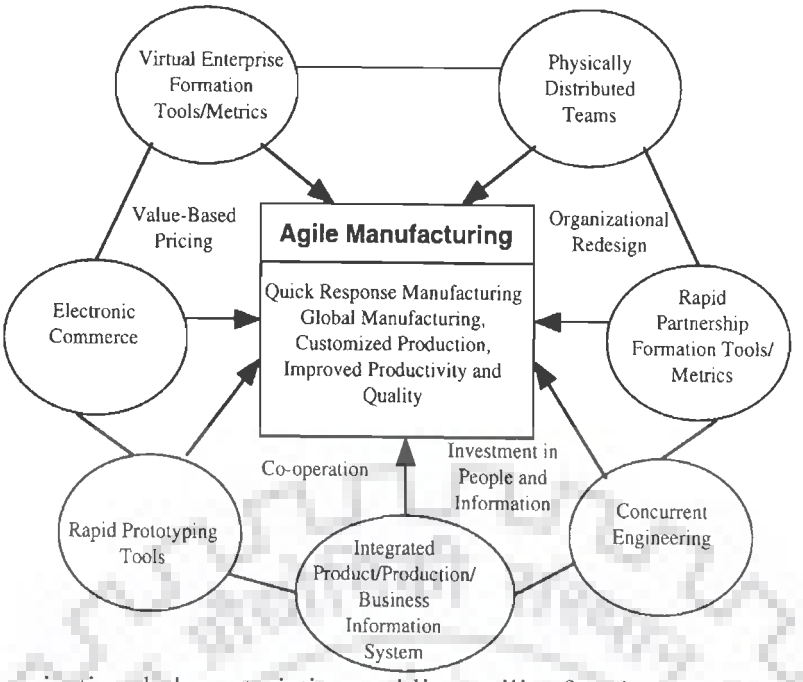

Figure 2.1: Organisational characteristics enabling agility for change management *(Gunasekaran 1998)*

2.1.1 Theme for classification of literature

Since its inception the various topics related to agility and its synergy with information technology for improved organizational performance have received considerable scholarly attention with useful managerial implications. The literature reviewed for this study can be broadly classified in the following categories depending upon the methodology used:

- Case studies on agility and technology acceptance
- Models for achieving agility
- Articles on frameworks
- Other literature reviews
- Surveys of IT/IS for organizational performance
- Models developed for technology acceptance

Apart from discussing literature in these categories, gaps related to papers on a particular aspect as realized and identified by other authors as well as unavailability of the same in the body of literature reviewed have been discussed under the head for gap

identification. These gaps have also been withdrawn from the future line of research depicted by many papers after having justified their preset hypotheses.

The scheme of this classification is delineated in the organizational chart given below (Fig 2.2) for a better understanding. Given the nature of a chart more than one categories share a common predecessor and hence many papers that have been reviewed fall under multiple categories. In such cases the papers have been placed under only one category being closest to the final focus of the objectives of the same.

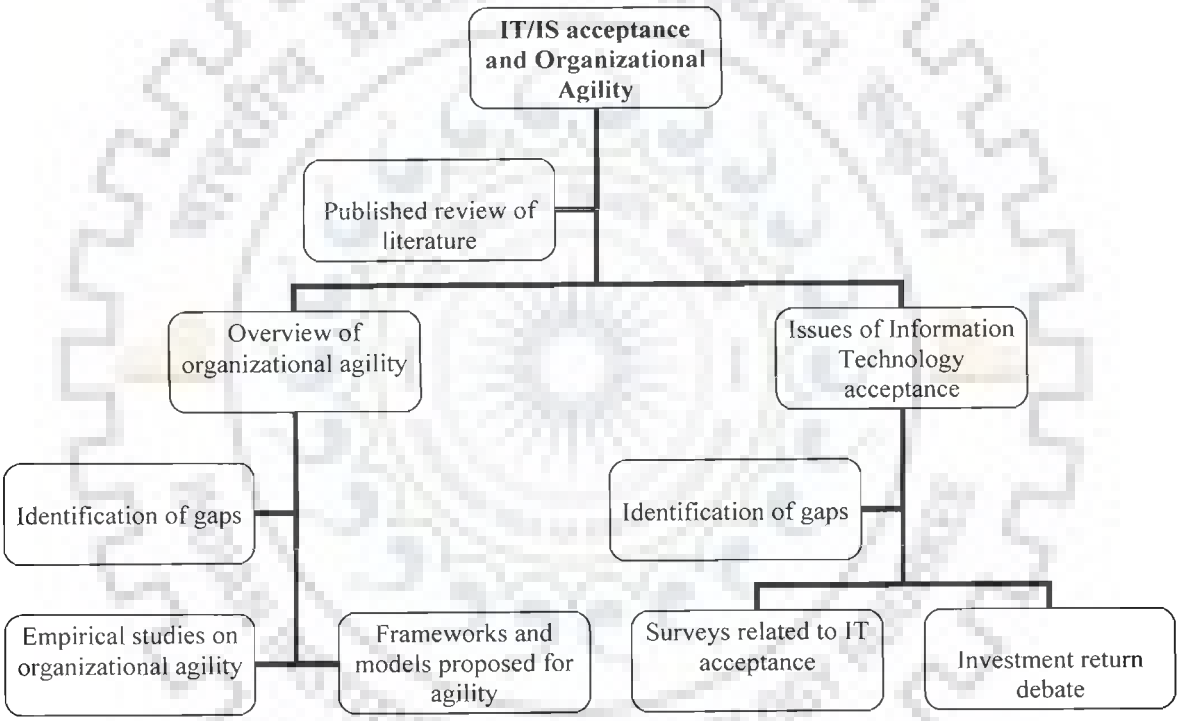

Fig 2.2: Scheme of classification used for reviewing literature on agility and IT/IS acceptance

2.1.2 Method

A comprehensive literature review was conducted with the aim of constructing a classification framework for technology acceptance for organizational agility studies and developing a research agenda for the future. The review focused on refereed journal papers published mainly between 1990 and 2008. However, for a comprehensive review of definitions and models such as the TAM proposed by Davis (1989) some papers published before 1990 are also included.

2.1.3 Analysis and findings

Nature and research purpose wise contribution

As summary of published work was prepared papers were segregated under the three heads constituting the lowest level of the organization chart in figure 2.2 namely empirical studies on organizational agility (Type I) which discovered existing practices, conceptual models for agile organizations (Type II) which proposed the constructs and organization of agile pathway, and papers on acceptance of technology (Type III) which contour the investment return debate. A total number of 127 papers were reviewed under this section and the findings are depicted in Figure 2.3.

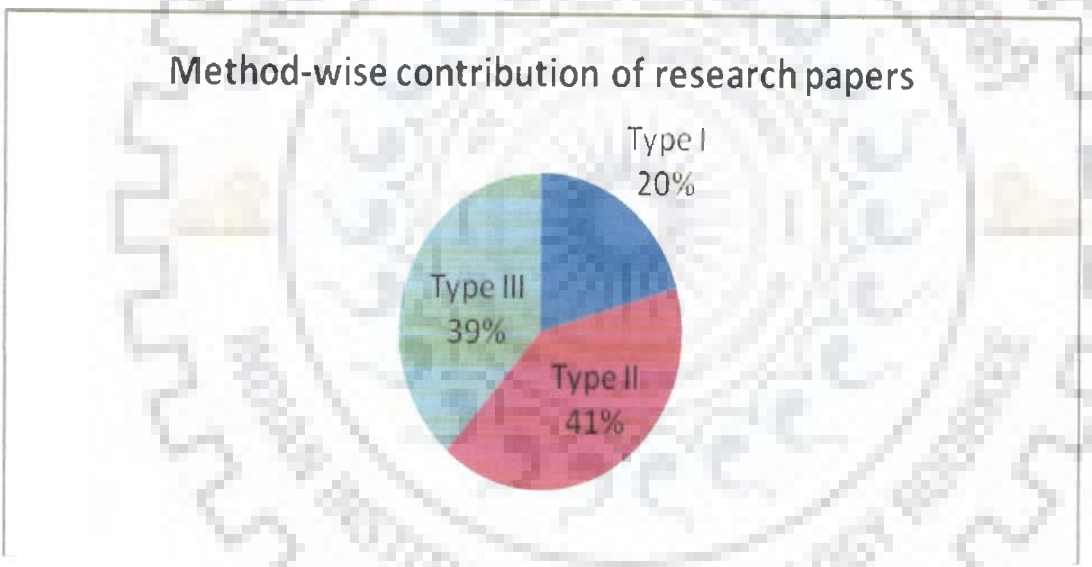

Figure 2.3: Method wise contribution of research papers

The analysis of literature is based on multiple dimensions as both content and method – oriented criteria are used. The papers were firstly classified according to their nature (empirical vs. conceptual) and the according to their research purpose (descriptive vs. normative). Drawing from Decision Theory in statistics some literature was found to be concerned with identifying the values, uncertainties and other issues relevant in a given decision, its rationality and the resulting optimal decision. Regarding acceptance of IT/IS for

organizational agility the Indian firm's decision may be normative or prescriptive *i.e.*,concerned with identifying the best decision to take assuming an ideal situation with full information that can be computed with perfect accuracy and full rationality. Such studies aimed at finding tools, methodologies and frameworks for effective decision support. However since user behavior in technology acceptance is not always consistent with normative rules it leads to violations of optimality giving rise to a separate genre of literature called or positive or descriptive research which attempts to describe what is happening. However, in hypotheses testing the two fields are linked (Goodwin and Wright 2004). Figure 2.4 classifies IT/IS acceptance for organizational agility literature in terms of research purpose and nature of the study

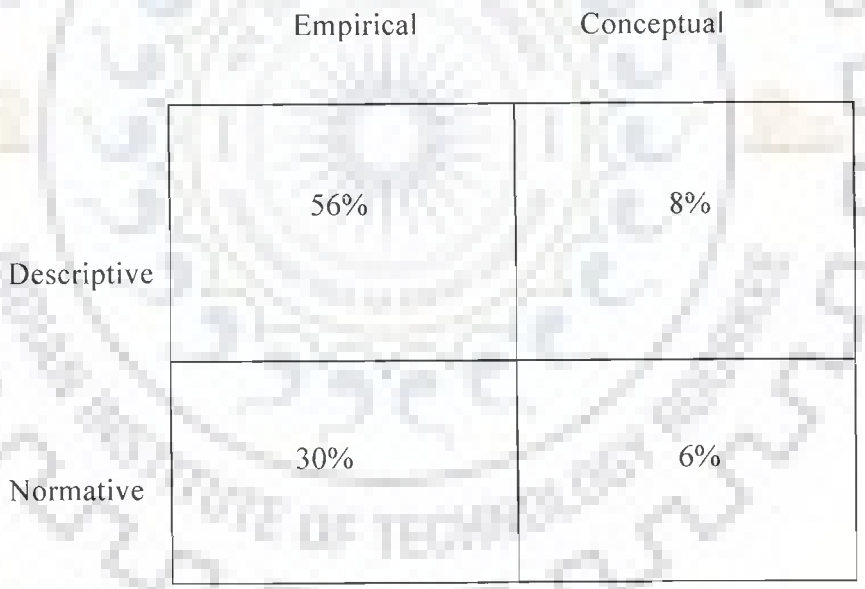

Figure 2.4: Classification of literature in terms of research purpose and nature

Period-wise contribution

A total number of 206 papers were retrieved from online research sources and analysed for a period wise contribution to the body of knowledge on agility and technology acceptance. Each of the 206 papers were categorized into the following three time periods:

1. Period I: Pre 1990

2. Period II: year 1991 to 1999

3. Period III: year 2000 to 2009

The period wise contribution of research papers across the three time periods delineated above is shown in Figure 2.5. The smallest amount of research has been contributed in the period before 1990 (4%). This saw a steep rise of contributions in the period II where the figure reached 44%. The rise was steadied and maintained with the largest amount of publications surfacing in the period III.

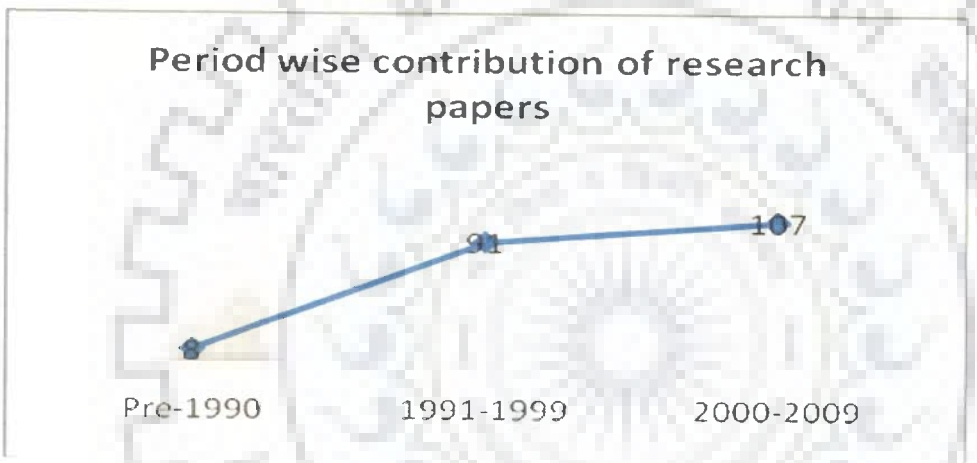

Figure 2.5: Period wise contribution of research papers

Objective-wise contribution

The body of literature reviewed features papers on use of IT/IS and organizational agility corresponding to various objectives which require to be addressed owing to the specific market conditions surfacing in the new age economy of globalization. As companies compete for profits on the front of responsiveness there are certain conditions that enable the organization to remain agile and maintain responsiveness (Dove 1995a, Goldman 1994, Goldman and Nagel 1993). Enablers of organizational responsiveness are environmental scanning (Hambrick 1982), strategic planning (Pearce *et al* 1987), flexible manufacturing (Steiner and Solem 1988), infrastructures, supply chain governance mechanisms and multi skilled workers Hoyt *et al* (2007). The reasons for putting agility at the core of strategy for

the twenty – first century were based on observation of the following phenomena (Goldman *et al* 1995).

- Increasing market fragmentation
- Growth in the need to produce to order
- Recognizing markets are heterogeneous
- Shrinking product life cycles
- Converging products and services
- Globalization of production
- Simultaneous cooperation and competition between firms
- Distribution infrastructures which support greater customization

Similar phenomenon were investigated by Pine at Harvard Business School in a separate study which combined them into a single concept of turbulence (Pine 1993) by conducting empirical research in a selected range of industry selectors. It was concluded that an approximate strategy to deal with turbulence was to reconfigure operations to allow individual customer specifications to be accommodated even in high volume manufacture. The term Mass Customization was coined to describe this. There are numerous internal and external strategic initiatives that promote agility. Some of them given below are proposed by Fleidner and Vokurka (1997) these can also be pursued in various combinations. Strategic initiatives should be able to promote multiple competitive priorities simultaneously.

- Reductions in manufacturing cycle times and order response time
- Partnerships
- Outsourcing
- Schedule sharing
- Supply channel performance improvements
- Postponement

- Teamwork and cross functional management teams
- Employee education training and empowerment
- Business process reengineering

To categorize the papers reviewed for this study the factors have been enumerated from and adopted from the above mentioned authors and a framework has been elicited in Figure 2.6 for the need of agility and its enablers in information technology and information systems for a firm operating to maintain competitive advantage in the 21st century market.

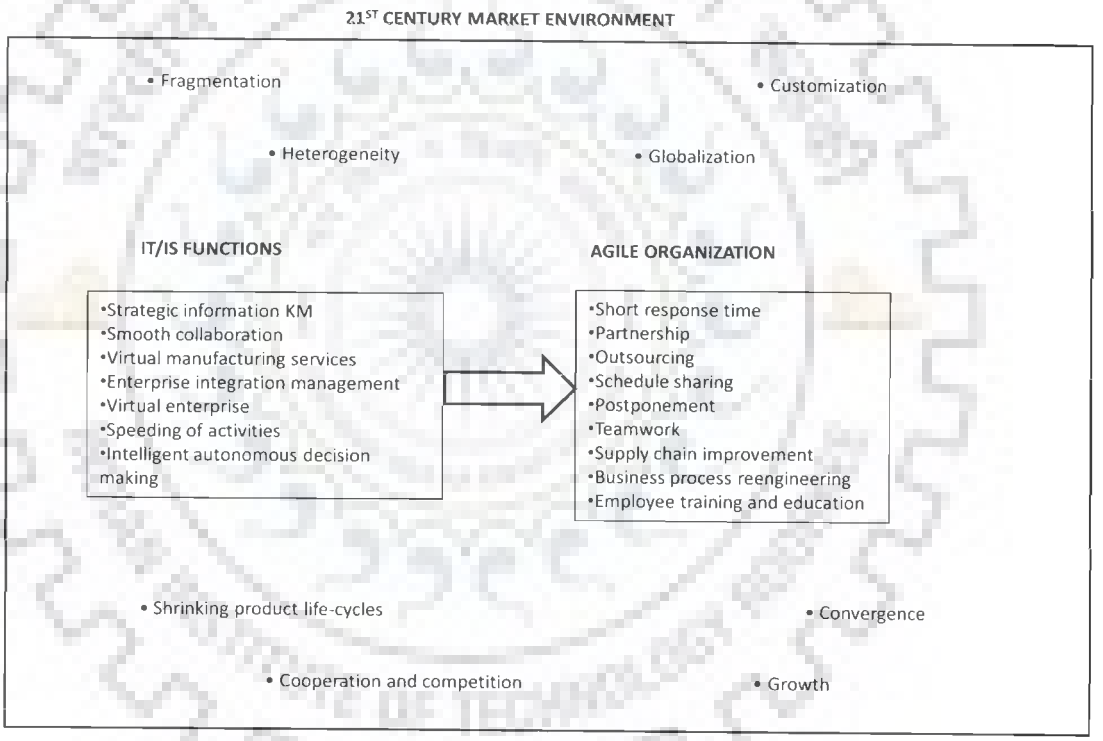

Figure 2.6: IT/IS functions enabling agile organizations in a changing market environment of 21st century

In Table 2.9 the various papers included in this literature survey have thus been classified according to the factors of agile response facilitated by IT/IS in an organization operating in the new market environment.

2.2 Overview of organizational agility

Studies conclude that organizational responsiveness is a central issue in determining business success (Webb and Pettigrew 1999, Kuratko *et al* 2001; Liao *et al* 2003) given the amount of uncertainty that may be present in a firms operating environment as it enables companies to detect market changes, reconfigure their processes to meet new market requirements, share information across organizational borders, take maximum advantage of information processing systems, and adopt new product and process technologies ahead of their competition (Gunasekaran 1998). Thus it is critical to understand the organizational conditions that contribute to or support the ability of firms to quickly and effectively respond to environmental change (Daft *et al* 1988, Yu 2001). Agility is implemented through two interdependent yet closely aligned aspects – strategic and operational where strategy is more than assessment as positions have to be taken and commitments made urgently as situations can change with bewildering frequency (Stalk and Hout 1990, Sproul and Keisler 1991).

As organizations are pushed toward agility they are challenged by society, community and family norms which tend to be traditional but organizations must be geared for continual change (Reese 1995). Also historically the production operation part of the organization also known as the "operating core" is the part of the organization most likely to be standardized. This emphasis on standardization and interdependent tasks would be efficient and perhaps be conducive to leanness but the antithesis of agility making it difficult for managers (Doyle 2000, Sharifi and Zhang 2001).

2.2.1 Definitions of agility

Since the first work on agility by the Lehigh University's Iacocca Institute report of 1991 on '*21st Century Manufacturing Enterprise Strategy: an Industry led view*' the concept of agility has been dealt with by numerous authors and hence there are several definitions of the term. A comprehensive discussion of the same may be found in Yusuf *et al* (1999) who

conclude that 'Agility is the successful exploration of competitive bases (speed, flexibility, innovation, proactivity, quality and profitability) through the integration of reconfigurable resources, and best practices in a knowledge rich environment to provide customer driven products and services in a fast changing market environment'. Having been proposed in the report the first definition of agility implies an organization's extraordinary capabilities in meeting change in the markets. In the forthcoming books (Goldman 1994 Goldman *et al* 1994, 1995) also the concept was discussed in the light of the four pillars of agility namely Customer satisfaction, mastering change, leveraging resource and cooperating to compete, where methods proposed range from Virtual Enterprise to leanness.

As the concept of agility evolved it began to develop some overlaps with flexibility and leanness. In this issue there is a difference of opinion among various scholars. Some have used the term interchangeably (Sharifi and Zhang 1999) where as others have differentiated (Baker 1996). The real distinction is the level of application where agility places greater focus on the strategic level and flexibility emerges in association with operational levels. However to provide "agility", flexible operations are needed hence the two should be seen as complementary rather than mutually exclusive. Flexibility has been studied in recent empirical studies also for job scheduling and machine flexibility contributing to performance levels similar to effects of agile technologies on business performance Baykasoglu and Ozbakir (2008).

An account of the various definitions of agility proposed from time to time by various authors is given in Table 2.1. However the concept of agility in the unique perspective of some authors can be understood only when their definition of an agile organization is taken into account. This further stretches to the understanding of agile attributes in virtual enterprises.

2.2.2 Agility and the use of IT/IS

Hugos (2004) demonstrates the importance of IT in making a company agile by demonstrating a supply chain built to deliver quality product tailored to the need of the customer at the required time. This was achieved in his networking company simply by creating a system of a combination of computer based files such as spreadsheets, web pages, some Java programs and the profuse utilization of e-mails. Nonetheless, expanding the system for changing business needs remains a viable option for this chain as the orders from the customer cease to be received.

The available literature on agility widely recognizes the importance of IT/IS utilization to improve business operations. Being regarded as enablers and facilitators of agile manufacturing, they impact organizational performance by speeding up activities, providing intelligent and autonomous decision making and smoothening distribution operations with collaboration. Suggested by many scholars (Huang *et al* 2000, Coronado *et al* (2002) the change proficiency achieved by firms with use of IT/IS are new manufacturing/services, strategic information and knowledge management, enterprise integration and management, virtual enterprise and virtual manufacturing/services. Sharifi & Zhang (2001) have illustrated as in Fig 2.7 the factors that influence successful IT adoption in Malaysian firms and the resultant agility through its attributes.

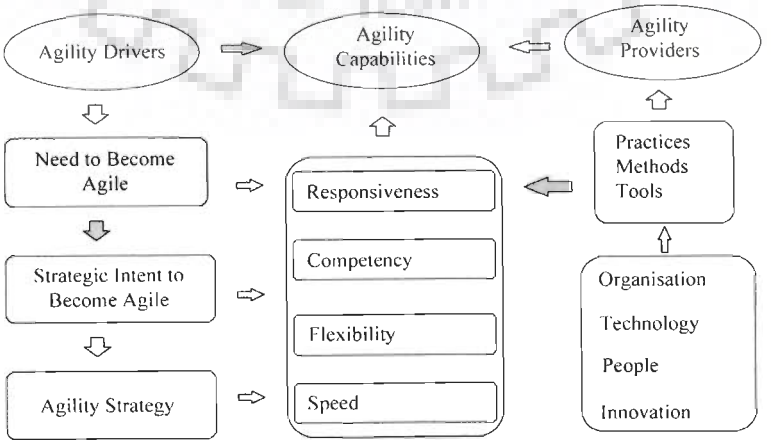

Figure 2.7: Influence of variables of IT adoption on agility (*Sharifi & Zhang 2001*)

The Agility Forum (Goldman *et al* 1994) identifies IS as part of the organisational relationships subcategory. The Forum defines IS units as "the interactive relationships among individual units of information automation equipment and software programs that collectively comprise an organization's information technology infrastructure". However, the transition is not always smooth. When it comes to establishing IS based systems there are issues with personnel in the organization. Individual units can easily be replaced with new or different technology that is found to be more advantageous. To resolve such issues research suggests that IS units of different origin, age and capability should productively coexist and interact with the idea of improving all business activities.

Business agility is applied predominately in the context of e-governance, which depends largely upon IT. The main advantage of IT in making firms agile is the customizability of products and services by the client. This unmet need of the customer is catered to a great extent by IT. The production and operations management aspect of management focuses on agility through such factors as supplier-customer chains, reduction of lead-time, rapid inventory accessibility and mathematical models with an overall emphasis on IT (Harper and Utley 2001). Education and training for production depend on the internet connectedness or self owned Integrated Services Digital Network (Earls 1994). Zain *et al* (2005) show in their study on Malaysian firms that ease of use and perceived ease of use of IT/IS are influencing factors for the ultimate adoption of information technology for organizational agility (Fig 2.8).

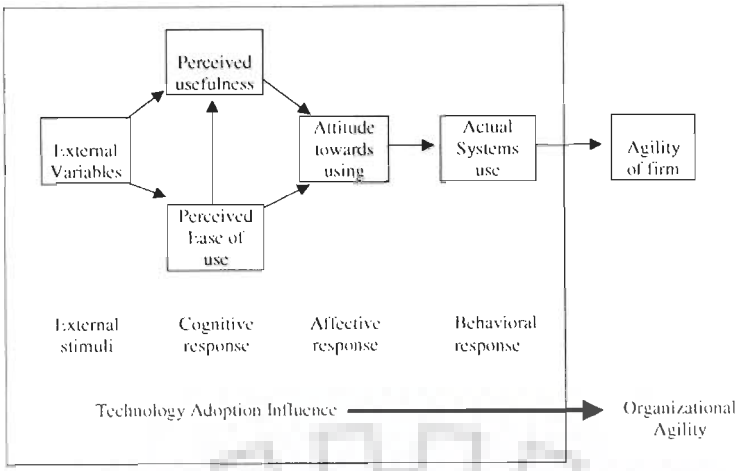

Figure 2.8: A schematic representation of organizational agility achieved by use of IT (***Zain et al 2005***)

Dove (1995a) conclude in his case study that the development of IS solutions for specific business problems and opportunities was the direct influence of the business environment supporting innovation than a defined IS strategy. Realizing that throughout the revolution of internet and wireless technologies the need to change has only been refueled Andrade and Fiadeiro (2002) have depicted that coordination technology forming synergies between software and information system engineering has shown to contribute to the agility of information systems. seen

Most authors conclude that IT/IS acceptance in a firm works toward achieving the characteristics required of an agile firm in the given time frame. The various attributes of agility as synthesized by various authors can be seen in table 2.2. It is well evident from these attributes that a strong trace of IT/IS exists in establishing and maintaining the organizational characteristics required for agility. Many IT/IS facilities in the form of computer technologies, such as communication networks, computer aided design and electronic data exchange are being reviewed for their contribution to organizational performance and enhanced agility. Synthesized from existing literature these have been illustrated in Table 2.3.

2.2.3 Empirical studies

Surveys of industry to explore concepts regarding agility have been on the rise in the academic literature. Dove (1995b) analyses the outcome of an investigation carried out by a team of participants from the Agility Forum's focus group. Six different areas with an important linkage to business agilities were selected and a case from each was reviewed. The areas were: people issues, legal issues, virtual enterprise, process and equipment, information and control and product realization. Back then the discussion suggested more empirical studies investigating what an agile enterprise does to secure competitive advantage and also what are potentials of becoming agile for a firm in the coming decade.

Accordingly there are surveys and database analyses of firms in both the recommended areas. Table 2.4 summarizes the various cases studies and empirical surveys from the industry to evaluate the levels, practices and outcomes of agility in their findings. Stating the sample size and the sector of the industry in its home country the survey of these studies describes in short the main postulates and key findings.

Some case studies report the complete revival of firms that had been floundering for profits by adopting the principles of agility (Mc Dougal 2004, Narsimhan 2005) where the two critical capabilities bringing dynamism in the firm were identified as innovation and agility (Eichinger and Ulrich 1994). Performance indicators specially financial have been found to improve by IT adoption and web-based technologies (Pablos 1998, Weill *et al* 2002, Coronado 2003). Development of agile workforce has also been the focus of many studies on agile manufacturing and business processes (Alan 1994, Koga 1998, Breu *et al* 2001, Jacob 2001) which suggest that socio-technical systems where IT can be augmented with existing capabilities for competitive advantage certainly by the top management commitment (Bridger 2001, Soriano-Meier and Forrester 2002).

From the Indian industries too IT enabled supply chains and computer integrated manufacturing have been examined and strategic partner ships in virtual environments on the pillars of agility have been confirmed (Saxena and Sahay (2000), Jharkharia (2004), Khan and Pillania 2008).

2.2.4 Models, frameworks and best practices for agile organizations

A considerable amount of scholarly publications are related to development of models for achieving agility or frameworks for assessment of agile capabilities, its business benefits and the role of IT/IS in the same. These include case studies, meta-analysis of available data and explanation based concept papers structured into models. In this section a review of such literature that draws from available findings to suggest a path way for estimation and attainment of agile drivers is given while discussing the parameters, focus and main postulates. A summary of reviewed literature on practices for agility can be seen in table 2.5

The customer enrichment principle of agility where information system frameworks are implemented for agile interactions between customers and companies also figures in the new and emerging mass customization strategy (Frutos and Borenstein 2003). Delivering the right product to the right customer at the right price implies that the success or failure of a supply chain is decided by the end user that is the customer. Such an increasingly competitive environment does not pit companies forging low prices but supply chain management supporting lean manufacture and agile supply (Christopher 1992, Womack *et al* 1990, Christopher and Towill 2000) and hence leanness alone is not the universal recipe for beating all competition (Richards 1996). Aitken *et al* (2002) suggest a model for synergizing the not so mutually exclusive paradigms of leanness and agility to building competitive advantage. In an analysis of various manufacturing firms in the USA and Europe Hormozi (2001) suggests paradigm shifts in use of technology and policy formation towards AM for

overall economic progress of nations, which is customized production of upgradeable not replaceable products in short lead times with no compromise. This distinguishes AM from its precursors which happen to be craft production, mass production and lean/just-in-time (JIT) production.

Schonsleben (2000) proposed automation with broad information technology to support agility towards effective logistics networks. Validating the traditional partnership strategies such as customer-supplier relationship, supply management, supply chain management and virtual organization; as well as the latter forms of cooperation developed in response to short lead times. Good communication paths like telephone, fax, ISDN, and EDI along with personal meetings at regular intervals and across all hierarchical levels (Alberti and Frigo-Mosca 1990) are proposed to be necessary for reduction in time.

Building upon insights from the industry Maskell (2001) emphasizes on the human side of organizations for AM by increasing customer prosperity, having informed people, cooperation within and between firms and hence fitting a company for change. To address these key factors the organization requires highly trained and educated staff significantly empowered within the constraints of a clear vision and delineated company goals. Humans involved in making firms agile first need a thorough understanding of the frameworks on which the company works in order to be better informed. Theories such as configuration (McCarthy and Tsinopoulos 2003) are of help to avoid pitfalls over simplifications and generalizations. Crocitto and Yousef (2003) advocate integration of the people involved in organizational performance through information technology. Further the human aspect of organizational agility is made to rest upon the ability of the HR managers of today to foresee and identify the drivers of change in the future global business (Eichinger and Ulrich 1994) such as politics, socioeconomics and technological advances.

2.2.5 Gaps identified in literature on agile management

Scholarly work on agile practices for gaining competitive advantage have provided leads for future research work identifying gaps in the existing literature. McGaughey (1999) has pointed out the underutilization of internet and its tools for becoming agile and highlights the need of studies devoted to identify measures for firms on using internet and becoming agile. Paucity of measurement scales for rates of organizational responsiveness (Hoyt *et al* 2007), flexibility (Schlonsleben 2000) and leanness (Kidd 1994) has also been mentioned in literature.

McCarthy and Tsinopoulos (2002) have depicted the limited efforts at examining the value of configuration analysis as method for realizing studies on agile manufacturing. Very little work was noticed on exploring the relationships between IT acceptance and agility drivers. Similar work carried out in Malaysia by Zain *et al* (2004), Zhang and Sharifi (2000), Sharifi and Zhang (2001) suggest that measure are needed to aid practitioners in identifying their capabilities and those required for developing agile drivers and consequent improved business performance. In the field of flexible manufacturing also there is a dearth of studies on factors that must be considered for FM solutions (Abdel-Malek 2000)

2.3 Technology Acceptance for agility

Perhaps the most encompassing view of agility through IT and organizational competitiveness coexisting with behavioural management and socio-technical systems can be found in the field of total quality management. The mathematical aspects of the human technology aspects of agility are often neglected in TQM frameworks also. The socio-technical approach in the production systems relevant to the relationships amongst humans and organizational technology demonstrates how technology influences structure, authority, relationships and design. However this view has only more recently been considered in the implementation of agility (Crocitto and Youssef 2003). Stahl (2005) emphasized that while

implementing agility the cyclic nature of the drivers should be taken care of so that the pivotal mode of organizational desires is never by passed as competition is fierce, pace has to be fast and the need for change and agility is relentless.

Lee and Runge (2006) have also highlighted that the firm's innovativeness is the strongest determinant for adopting traditional information systems. They present a structural equation model to demonstrate how social expectations influence indirectly the level of IT adoption. However, the same is contradicted by Lewis *et al* (2003) as they found no significant impact of social influences emanating from multiple sources. Top management commitment influencing individual factors and employee beliefs proved to be of critical value to IT acceptance for improved agility. Endorsing the proposition is the empirical study of Agarwal and Prasad (1999) concluding that beliefs and attitude which happen to be the main constructs of the Technology Acceptance Model (TAM) also mediate the relationship between individual differences and IT adoption.

A parallel stream suggests that a successful IT system with highest chances of acceptance is that which adheres to good technical design principles and receives usage opportunities in businesses (Malhotra and Galletta 2004). Failing to put the IT implementation process into the proper social context of economic, socio-political and cultural dimensions can inhibit the success of the process and increase the risks of failure as most technology is designed and produced in developed societies with their cultural values in mind (Gahtani 2004). Perceived usefulness and ease of use construct the right type of behavioral attitude in the firms that is successful in IT acceptance (Brown *et al* 2002).

2.3.1 TAM – the technology acceptance model

Mediated by perceived usefulness and perceived ease of use, the technology acceptance model was first proposed by Davis (1989). Since then different theoretical approaches for example the Innovation Diffusion Theory (IDT), the intention based theories

implementing agility the cyclic nature of the drivers should be taken care of so that the pivotal mode of organizational desires is never by passed as competition is fierce, pace has to be fast and the need for change and agility is relentless.

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Mediated by perceived usefulness and perceived ease of use, the technology acceptance model was first proposed by Davis (1989). Since then different theoretical approaches for example the Innovation Diffusion Theory (IDT), the intention based theories

of IT adoption, the theory of planned behavior (TBP), social cognitive theory (SCT) and triandis model. Literature reviews suggest that TAM has been empirically proved to be parsimonious and robust across a range of end user computing technologies and user groups (Han 2003).

However, some studies suggest further integration of TAM with more parameters or other proposed models (Bahli and Saade 2004). The Unified Theory of acceptance and use of technology model (UTAUT) proposed by Venkatesh (2003) integrates TAM with eight models. As TAM has not been tested in all business environments it also needs to be examined whether it holds true for other cultures where firm ground business does not exist. For example it has not found to be holding true for Japan but its applicability has been proved in countries like UK and Switzerland (Gahtani 2001, 2005).

2.3.2 Surveys related to IT acceptance

The body of research available on this topic focuses mainly on the level of acceptance, the various IT tools available for integration into business processes and making them dynamic for future survival, and factors affecting acceptance. The emergence of acceptance literature was simultaneous with the technology acceptance model first formulated in 1989 by Davis. Since then various studies have investigated the various aspects of acceptance and concluded almost unanimously that user perception, costs and cultural contexts are the drivers that mediate IT acceptance. The finer contours of the same have been analyzed in many empirical studies and later models have been proposed. A summary of literature on technology acceptance is presented in table 2.7. with their respective main propositions and implications for managers and researchers.

2.3.3 The return on investment debate

Contemporary popular and scholarly literature suggests that today IT - the potentials of which, the world was unaware of even in the eighties, has become a critical factor in

achieving success in business (Ives 1994, Dewett and Jones 2001)). Companies are allocating large slices of the budgetary pie to inculcate and develop computer based work culture. However, it has also been felt that the impacts of IT on organizations are not universally positive. Although it has been shown that announcements of innovative IT investments do have positive effects on the announcing firm's stock price it is also felt that actual returns to organizations from investment in IT are not sufficient to back up claims of their performance-enhancing advantages. This lack of perceived increased output resulting from investments in IT is the "Productivity Paradox" succinctly described by Nobel Laureate Robort Solow: "we see the computers everywhere except in the productivity statistics"(Bryjnolfsson and Hitt 1993).

Huber (1990) promulgated that the use of IT and IS plays an important role in improving an organization's functions, business processes, competitiveness in striking and conducting a deal and living up to achieve its aims of profits and growth. The classical *standard production theory* of economics (Sircar *et al.* 2000), propounds that the firm's output is the direct function of the inputs it uses. However, building upon the extensive work produced on the infamous 'Productivity Paradox' (Bryjnolfsson and Hitt 1993) where the findings are inconsistent and contradictory, there is a debate.

Use of technologies such as Local Area Network (LAN), teleconferencing through Wide Area Network (WAN) and electronic mail has increased the quantum of communication. This way it is easier to hit fruitful collaborations and co-ordinations. Advances in IT have greatly facilitated organizational memory and the ability to capture and integrate explicit knowledge by making it easy to codify, communicate, assimilate, store and retrieve (Anand *et al.* 1998, Rockart and Short 1989). Benefits from knowledge leveraging include the development of synergies and delivery to customers of value added services and

products, resulting in competitive advantage in the form of product or service differentiation (Venkatraman, 1994).

Nevertheless, it has been demonstrated that investments in certain efficiency enhancing techniques may be expected to decrease the productivity of profit maximizing firms (Thatcher and Oliver 2001) yielding conflicting results about the firm's performance. A positive relationship between the internal measures of a firm's performance such as market share or profitability is rejected by some authors and they suggest that the capital spent on IT investment be better allocated elsewhere. For example Hitt and Brynjolfsson (1996) empirically demonstrated that increase in productivity does not necessarily translate into increases in profitability. In another study Floyd and Wooldbridge (1990) found no overall connection between ATM adoption and performance among banks. Ragowsky *et al.* (2000) have shown that the relationship between the benefits of an IS and an organization's operating characteristics was stronger for a specific IS application than for the entire IS applications portfolio considered as a whole. Roach (1991) concludes that computers had not contributed to the productivity of information workers drawing from his study documenting large increase in IT capital while productivity growth rate of production workers far exceeded that of the information workers who were also increasing in numbers. Mitra and Chaya (1996) have come up with counterintuitive findings in their study with no evidence of IT reducing labor costs and average overhead costs, where as higher IT investments were found to be associated with lower average production costs and lower average total costs.

Despite the fact that the productivity paradox is an international phenomenon most of the existing studies in this area are firm level and limited to the developed countries. It is important that international dimensions from developing countries be added to research concluding upon the matter of IT investments-Performance relationships. Perhaps more solid conclusions could be drawn with much larger databases and multivariate analysis with

variables and sampling units expanding over vast extremes and the study spanning over a long period of time (Mahmood and Mann 2000).

Firms operate in an exceedingly complex environment, with myriad factors influencing their operations. Their performance is also multi dimensional, measurable by many different gauges. Although this complexity cannot be modeled completely the frame work should be reasonably comprehensive (Sircar *et al.* 2000). Also the reliance of traditional research on financial data fails to recognize the hidden costs and benefits associated with human resources. Ideally the investigations based on quantitative as well as qualitative data should complement each other. IT investment benefits are best realized when they are coupled with other organizational reforms such as organizational reengineering, redesign and restructuring (Hitt and Brynjolfsson 1996).

2.3.4 Gaps identified for future research on IT acceptance

There is evidence that corporate managers are beginning to sense that shifting capital spending from IT to non-computer capital may be in their better interest. The non-IT variables – noncomputer capital and labor – consistently display the strongest correlations with firm performance. Businesses have been eager buyers of the latest and greatest in high tech since the 1980s, spending billions on upgrades with each new generation of Intel chips and Microsoft software. But as the economic expansion ages, some companies are starting to shift technology spending to other needs. And some big spenders seem to have reached a point of exhaustion. They have plenty of gear capable of getting the job done and are beginning to question why they need much more (Zeigler and Weber 1996). But a major problem in cumulative research on the productivity paradox is the unavailability of sufficient data to perform reasonable statistics. The quality of the data has also been a suspect in many cases. These problems need to be handily addressed with size of data sets far exceeding previous ones, before a cogent is arrived at.

2.4 Significance for future research

Tables 2.1 to 2.9 of this study provide a bibliography of research papers corresponding to the categories of classification identified. This might prove to be helpful resource for both academics and agility practitioners searching for papers in a specific area. Yet for all the study on advanced manufacturing technology, employee work teams, empowerment and quality, we have little empirical work on how organizations attain the agility crucial to their success (Macaulay 1996). Perhaps due to the long-term nature of such studies they are not found in abundance. This literature review enumerates the main factors of the papers surveyed and arranges them in order of their significance for an organization to be agile and incorporate the IT/IS for improved performance. For future researchers this study can be helpful in synergizing the agile functions and IT/IS in the new age market.

2.5 Conclusion

More work is needed to identify the conditions under which managers should expect IT investments to contribute to productivity (Thatcher and Oliver 2001) Rich research potentials lay ahead indicating new levels of enquiry into these synergies competence, communication, information sharing, creativity, growth and additional theory testing (Chau and Hu 2001).

Many empirical studies on assessing the relationship between IT acceptance and organizational agility, organizational characteristics enabling agility for change management and case studies on agility and technology acceptance are found in literature. This chapter summarizes the findings and synthesizes a model for need of agile organization, its criteria and its enablers in IT/IS. The gaps in literature have been identified and directions for the research under investigation of this study have been taken which are reported in the proceeding working chapters.

Table 2.1: Definitions of organizational agility

S. No.	Author	Definition
1	Iacocca Institute (1991)	Agility means a manufacturing system with extraordinary capabilities (internal capabilities: hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness). A system that shifts quickly (speed, and responsiveness) among product models or between product lines (flexibility), ideally in real-time response to customer demand (customer needs and wants).
2	Goldman (1994)	Agility is a comprehensive strategic response fundamental and irreversible changes that are taking place in the dominant system of commercial competition in ``first world'' economics.
3	Goldman *et al.* (1994)	An agile organization is dynamic and has the potential to achieve a competitive advantage. To be dynamic, an organization's competitive strategy focuses on knowledge development and flexible processes that enable it to respond to these changing circumstances.
4	Youssef (1994)	A manufacturing system with extraordinary capability to meet the rapidly changing needs of the marketplace. A system that can shift rapidly amongst product models or between product lines, ideally in real time response to customer demands.
5	Kidd (1994)	Agility is a synthesized use of the developed and well known technologies and methods of manufacturing. That is, it is mutually compatible with lean manufacturing, CIM, TQM, MRP, BPR, employee

		empowerment, and OPT.
6	Goldman *et al.* (1995)	Agility means delivering value to customers, being ready for change, valuing human knowledge and skills, and forming virtual partnership.
7	Booth (1996)	Agile manufacturing is a vision of manufacturing that is a natural development from the original concept of ``lean manufacturing''. In lean manufacturing, the emphasis is on costcutting. The requirement for organisations and facilities to become more flexible and responsive to customers led to the concept of ``agile'' manufacturing as a differentiation from the ``lean'' organization.
8	Cho . (1996)	Agile manufacturing can be defined as the capability of surviving and prospering in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets, driven by customer-designed products and services.
9	Devor *et al.* (1997)	Agile manufacturing is a new expression that is used to represent the ability of a producer of goods and services to thrive in the face of continuous change. These changes can occur in markets, in technologies, in business enterprise. It requires one to meet the changing market requirements by suitable alliances based on core competencies, organising to manage change and uncertainty, and leveraging people and information.
10	Fliedner &Vokurka, (1997)	Agility is an ability to produce a broad range of low-cost, high quality products with short lead times in varying lot sizes, built to individual customer specification.
11	Gould (1997)	Agility is about casting off those old ways of doing things that are no longer appropriate - changing patterns of traditional operation. In a changing competitive environment, there is a need to develop organisations and

		facilities to be significantly more flexible and responsive than current existing ones.
12	Bullinger (1999)	Agility means mobility in an organisation's behaviour towards the environment and can therefore be understood as an extensive answer to continually changing markets. Agile companies are in a process of constant re-determination, or self-organisation, selfconfiguration, and self-teaming.
13	Katayama & Bennett (1999)	Agility relates to the interface between the company and the market. Agility acts as a pillar to improve competitiveness and the business prospects.
14	Sharifi and Zhang (1999)	The ability to cope with unexpected challenges, to survive unprecedented threats of business environment, and to take advantage of changes as opportunities.
15	Yusuf *et al.* (1999)	Agility is the successful exploration of competitive bases (speed, flexibility, innovation, pro-activity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast-changing market environment.
16	Christopher (2000)	Agility is defined as the ability of an organization to respond rapidly to changes in demand, both in terms of volume and variety.
17	Kidd (2000)	An agile enterprise is a fast moving, adaptable and robust business. It is capable of rapid adaptation in response to unexpected and unpredicted changes and events, market opportunities, and customer requirements. Such a business is founded on processes and structures that facilitate speed, adaptation and robustness and that deliver a coordinated enterprise that is capable of achieving competitive performance in a highly dynamic and unpredictable business environment that is unsuited to current enterprise practices.
18	Mason-Jones *et*	Agility means using market knowledge and virtual corporation to exploit profitable opportunities in a

	al. (2000)	volatile market place.
19	Tolone (2000)	Agility implies effectively integrating supply chain and forging close and long term relationship with customers and suppliers.
20	Van Hoek *et al.* (2001)	Agility is all about customer responsiveness and market turbulence and requires specific capabilities that can be achieved using 'lean thinking'.
21	Aitken *et al.* (2002)	Agility is an ability to have visibility of demand, flexible and quick response and synchronized operations.
22	Stratton & Warburton (2003)	Innovative products and unstable demand typify agile supply drivers.

Table 2.2: Attributes of agility illustrating the innate element of IT/IS

S. No.	Agility attributes	References
1	Environmental scanning	Weick (1969), Prahalad and Hamel (1990) and Van Oyen *et al.* (2001)
2	Responsiveness to change	Duncan (1972) and Huang (1999)
3	Skills assessment and development	Cohen and Levinthal (1990), Prahalad and Hamel (1990), Goldman and Nagel(1993), Kidd (1994), Gehani (1995), Sharifi and Zhang (1999) and Yussuf *et al.* (1999)
4	Employee empowerment and autonomy in decision making	Goldman and Nagel (1993), Gehani (1995), Sharifi and Zhang (1999), Yussuf *et al.* (1999) and Van Oyen *et al.* (2001)
5	Information and knowledge access	Goldman and Nagel (1993), Kidd (1994) and Strader *et al.* (1998)
6	Collaboration and virtual organization	Goldman and Nagel (1993), Burgess (1994), Gehani (1995), Sharifi and Zhang(1999) and Van Oyen *et al.* (2001)
7	Business process integration	Burgess (1994), Sharifi and Zhang (1999) and Van Oyen *et al.* (2001)
8	IS integration and work flow	Burgess (1994), Kidd (1994), Gehani (1995), Yussuf *et al.* (1999) and Van Oyen *at al.* (2001)
9	ICT	Burgess (1994), Kidd (1994), Yussuf *et al.* (1999) and Van Oyen *et al.* (2001)
10	Mobile technology	Kraft and Truex (1994) and Panteli and Dibben (2001)

Table 2.3: Tools of IT to bring dynamic capabilities and competitive advantage

S. No.	**IT Tools**	**Impact on agility**	**References**
1	Common IT tools such as office applications (video and audio clips, graphics images, CAD and CAM designs, word processing documents, spreadsheets, data base tables), internet and intranet, E-mail	Data base management, quick decision making, planning and analysis	Metes *et al* 1998, Agarwal and Prasad 1999, Breu 2001 McGaughey (1999), Pablos (1998)
2	Mobile communication	Better communication between customer, employee, manager and supplier	Alberti and Frigo-Mosca 1990, Pablos (1998), Earls (1994)
3	Smart cards, Electronic Data Interchange	Identification of spatio-temporal coordinates between carrier and provider, organizational data tradeoff in standardized formats for business transactions	Alberti and Frigo-Mosca 1990, McGaughey (1999)
4	Global positioning systems, and Geographical information system	Exact Locations of components of supply chain, tracking and routes	Mittal and Shankar 2002

Table 2.4 Case study/ survey oriented empirical studies on agility and use of IT/IS

S.No.	Focus	Sample Size Respondents/Industry profile	Remarks	Reference Region
1	Organizational responsiveness	66 responses from 66 companies Top executives of automotive suppliers, instrumentation equipment and semi-conductor components. $12 million to $50 million annual sales	Scales to measure responsiveness are few. It is enabled by environmental scanning, strategic planning, flexible manufacturing infrastructures, supply chain governance mechanism and multi-skilled workers	Hoyt *et al* (2007) USA
2	Future trends for Human resource professionals	Not stated. Thought leaders in organizations creating & distributing products/services in the global businesses	Two critical capabilities identified for executives to build upon in organization of the future – first is agility and the second is innovation	Eichinger and Ulrich (1994) USA
3	Adoption and migration towards agility without altering basic of functionality	Single case study Financial statements of organization and the company index. Interviews with company executives and those of client companies	An IT services company that was behind the schedule and floundering for a multi billion dollar deal could regain its financial position with agile enterprise strategy coupled with improvements in the area of	McDougal (2004) USA

			sales and contract management	
4	Improvement in the performance using web-based tools and CTs for agility	First 100 firms with better results. Sample consists of 33% of total volume Insurance sector, specially companies implementing information CTs	IT adoption specially web-based technologies influence financial performance and business gains of insurance sector in a positive manner	Pablos (1998) USA
5	Relationship of attitudes for IT acceptance and development of agility	600 questionnnaires distributed, 343 returned and 329 usable responses considered. Managers and executives from 2000 large and small manufacturing firms located in the Klang Valley	Perceived usefulness and perceived ease of use of technological systems directly impacts technology acceptance in a firm leading to its agile capabilities that help in turn to survive competition	Zain *et al* (2004) Malaysia
6	Analysis of AM and its role in increasing a firms competitiveness	1234 firms employing over a hundred workers 9 Manufacturing firms with two manufacturing strategies and the remaining ones with a single plant	Managers should implement integrated manufacturing practices for developing manufacturing strength and beating competition in turbulent business environments	Vazquez-Bustello *et al* (2007) Spain
7	Proposal to firms for	Manufacturing firms with high	In order to achieve agility manufacturing	Sharifi and

	achieve agility by adopting agile manufacturing practices	ranks amongst European manufacturers working with long supply chain and retailers as customers. Fact sheets and opinion polls of executives from two companies	firms require best practices and tools. Agility drivers and agility providers constitute agile capabilities	Zhang (2001) UK
8	Impact of using IT and IS in firms for achieving organizational agility	Primary data collected from 200 respondents, secondary data from publications. Systematic random sampling from the list of 425 members on the Malaysian International Chamber of Commerce and Industry Directory 2000	Firms need to invest more in IT/IS and generate information necessary for management decision making and strategic development so that firms may gather facts about customers, competitors, investors and employees to remain agile	Zain *et al* (2003) Malaysia
9	Defining the exact constituent dimensions of agility and leanness	First sample set 57 and second sample set 224. Manufacturing plant managers from past award winners and finalists of the 'America's Best' competition	Agility represents a higher level of abilities and performance indicators since plants with agile manufacturing outcome meet or exceed most performance measures	Narsimhan *et al* (2005) USA

10	Management and impact of flexibility and agile production in development of integrated circuits	391 usable responses out of 1000 mailed questionnaires. 500 EPLD designers and 500 ASIC designers; both designing systems with integrated circuits for over a decade	Adoption of flexible technologies management processes modified to progressively lockdown requirements, sound tradeoff decisions, improved reaction time and leveraging design architecture	Thomke and Reinertsen (1998) USA
11	Viable systems models and modern business process thinking for agility management	3 cases studies: Liquor making firm with multinational approach, Floppy diskette manufacturing firm with market in Europe, Engineering and technical consultancy firm	As management flows through the overriding factors of business, units, processes and constituent activities a viable business structure needs to be cybernetic in all recognized units.	Bititci *et al* (1999) UK
12	IT enablers and IT/IS infrastructure restructuring for strategic agility planning	180 business initiatives, 118 businesses, 89 enterprises from 1990 to 2001. Top three enterprises performers in the industry with return on assets, revenue growth and margins	The strategic abilities of all types in all units of an enterprise require a separate type of facility regarding IT infrastructure and companies serious about providing these enablers are likely to invest in IT/IS goods and services	Weill *et al* (2002) USA
13	Measures of agility and their assessment used with IT/IS in an	200 randomly selected from list of 425 firms from Malaysian Int. Chamber of Comm. and Industry.	Managerial decisions may be based on effective communications in locations far and wide so as to reallocate money, and	Kassim and Zain 2004 Malaysia

	organization	40 usable surveys from 45 returned. All kinds of businesses	compete globally in changing business environments	
14	Role of IS in reaping max. benefits for the organization AM	400 interviews of employees in two companies for a multiple case study Two organizations in the automotive and aerospace sector	Having an IT strategy aligned to business strategy ensures benefits and human skills and expertise play a critical role in making AM work	Coronado (2003) UK
15	Alignment between VE and IT and its impact on business performance	102 Manufacturing organizations in industrial machinery and equipment, construction, mining and materials handling, refrigeration, industrial and commercial	Alignment between VE and IT has a positive impact on business performance exceeding the individual positive impacts of either VE or IT. Managers need to focus on specific IT dimensions in order to enhance or achieve dimensions of VE.	Cao and Dowlatshahi (2004) USA
16	Strategic sourcing for supply chain agility and firms performance	128 SCM practitioners in Automobiles, textiles, pharmaceuticals, rubber and tube industries, paints, metals, chemicals, engineering, papers and leathers, food and airy products	Strategic supplier partner ship is the strongest area of strategic sourcing to consider when organizations plan to make their demand management and distribution effective, having high impact on supply chain responsiveness and its agility	Khan & Pillania (2008) India

17	Resilience as a source of survival strategy for high-tech firms in mega-competition	54 companies over the period 1979 - 1998 Pharmaceutical and electric machinery firms	Pharmaceutical sector in Japan is more resilient than electrical machinery against fluctuations of the economic cycle and uncertainty.	Watnabe *et al* (2004) Japan
18	Assessing the value of IS in supporting agility in high tech manufacturing	Case study of four companies Electronics, automotive and aerospace	IT/IS plays an important role in making companies agile but not a prerequisite ofAM They work only when other systems and practices of agility are in place	Mondragon *et al* (2004) UK
19	Role of IS in improving workforce agility through knowledge management	515 Private and public sector enterprise from all businesses	In order to develop an agile workforce, organizations should direct their attention to intelligence, competencies, collaboration culture and IS	Breu *et al* (2001) UK
20	IS flexibility leads to outsourcing contract flexibility and end user satisfaction	48 firms Public sector companies	Firms need to consider both, their internal organizational stability and contract flexibility when developing outsourcing contracts in the IT/IS areas.	Harris *et al* (1998) USA
21	Agile manufacturing augmented by IT and virtual enterprise	Single firm based Case study Software	Communication is the key for agility and VE. Information differs from knowledge which is required for cultural changes and	Alan (1994) USA

			proper deployment of communication tools	
22	Dispersed manufacturing networks and the improved agility of production	Single firm based case study Optical instruments and lenses	Electronic production network is the new concept of FOD Factory on demand where customers can participate in ordering, designing, engineering, assembly and production of products	Lee & Lau (1999) Hong Kong
23	Technology Integration and standards associated with it	Single firm based case study Electronics	Min. regulation, technological innovation, customer benefits, consider conflicting view points, protected IPR, organizational cooperation and nurturing creativity.	Koga (1998) Japan
24	Integration of IT in product development and after market activities	Single firm based case study Automobile Industry	When faced with trade-offs between long-term best change models and JIT based short term changes good enough for now is reached.	Ebrahimpur & Jacob (2001) Sweden
25	Evaluation of leanness & agility in business performance	45 firms with >35 employees Vitreous china and earthen china kitchen and table ware	Strong relationships between investments on manufacturing infrastructure and actual changes towards lean principles	Soriano-Meier & Forrester (2002) UK

Table2.5: Summary of literature on models and frameworks for agility

S. No.	Focus	Model parameters	Underlying philosophy	Reference
1	Mass customization, object oriented modeling	Internet based technology and object oriented planning	Agile responses to customers facilitating rapid interaction. Quick delivery of products and services. High volume interaction. Low cost.	Frutos and Borenstein (2003)
2	Leanness and agility for effective supply chain management	Covers agility throughout the product introduction process and the product delivery process	Agility is an organization wide shift in culture and cannot be restricted to a few activities. Leanness and agility are not mutually exclusive and can be married to advantage. Quick responses and similar initiatives win orders in volatile markets.	Aitken *et al* 2002
3	Strategic partnerships for logistic chains and virtual organizations	Quality, cost, delivery, flexibility, entrepreneurial cooperation in the logistics network	Automated information technology expedites strategic cooperation amongst virtual organizations for effective supply management, supply chain management and logistics network. This happens on a	Schlonsleben (2000)

			longer term and intensifies product innovation.	
4	Configurational methods for organizational strategies towards agility	Configurational theory and the evolutionary classification method called cladistics used in linguistics and biological sciences	Evolution occurs in economic, technological and sociological systems too and can promote enhanced understanding of transfer of agility between configurations	McCarthy and Tsinipoulos (2003)
5	Cumulative improvement model	Order of Quality, dependability, Flexibility, Agility, and cost efficiency	Firms may build cumulative and lasting improvements in strategic competitive capabilities including agility. Suggests trade-offs which occur in competitive priority	Vokurka and Fliedner (1998)
6	Using IT/ IS do deliver agility in organizations	Prices to play: quality and efficiency; factors that differentiate amongst enterprises: visibility, velocity and flexibility.	New technologies and better applications of existing technologies will push CIOs into prominence. Current IT limitations place constraints on agility but new technologies make agility attainable.	Malarkode *et al* (2004)
7	Agility enablers in a production	Trends, dimensions, product related change capabilities, change	Mass customization is the biggest trend in the market and production systems should	Jackson and Johanson

	system	competency, internal and external co-operation, people, knowledge and creativity	keep agile capabilities at hand to meet changing requirements, price based competition and changes I delivery dates	(2003)
8	Contribution of internet technology to agility	The agility framework: customer enrichment, cooperation, master change and uncertainty, leveraging people and information	Companies share organizational data through internet and intranet as video graphics, computer aided design and manufacturing and makes a company agile and competitive	McGaughey (1999)
9	IT use for production, management and socio-technical views of the human side of organizational agility	Suppliers, organizational members and customers united through information technology	IT based unification of suppliers, employees and customers is crucial to organizational competitiveness and these connections can be sustained with a relationship between people and technology when supported by leadership, a favorable organizational culture and an employee reward system.	Crocitto and Youssef (2003)
10	Priority areas for small and medium enterprises to stay	Agile manufacturing reference model – I) Agile strategy, II) Agile processes, III) Agile linkages IV) Agile people	Organizations can become agile if they rely on the integration of multiple factors related to the model parameters. SMEs	Meredith and Francis (2000)

	agile and meet changing demands of global markets		with limited sets of resources may find it difficult to respond proactively to changes in global markets but this may be translated into opportunities if deft and active responses are given	
11	Impact of Web-based technologies on financial institutions	Agility is as a combination of different adaptations: A) Capacity of adaptation B) Shorter answer times, C) Ubiquity D) Task integration through IT	Information technology adoption specially web-based tools improve organizational performance if agility is considered as a measure of performance.	Pablos (1998)
12	Clear framework of agility distinguished from flexibility	Business, network, organization, core process and resource	Agility is characterized by range and response flexibility, at levels of organization and business network, and flexibility at process and resource levels	Baker (1996)
13	Explanation and benefits of agile manufacturing, and identification of critical factors	Design, manufacturing assembly, distribution process, customer issues	For the successful implementation of AMchanges in five areas are required: Government regulation, business cooperation, information technology, reengineering, employee flexibility	Hormozi (2001)
14	Introduction and	Polyvalency, apparent flexibility,	The unawareness of flexibility and its	Bucki and

	explanation of the concept of flexibility as a means to achieve agility	dedicated activity and their mutual relations	concept might lead to a failure of implementing the flexible manufacturing systems. Learning makes a flexible workshop appear like a service company although it is oriented towards production	Pasqueux (2000)
15	RAM (Real Agile manufacturing) purpose and processors	Multiple winners (manufacturers, customers, suppliers), integration of resources, methods, technologies, departments, suppliers, Information technology, core competency	IT as powerful tool promoting innovation as the basis of an enterprise's information resources. Acting as a bridge between partners it is an elemental platform for KM to a learning oriented organization	Hai *et al* (2003)
16	Enablers of agile manufacturing	Integrated business information systems, virtual enterprising tools, e-commerce, quick partnering tools, rapid prototype formation metrics, team work, concurrent engineering	Future research directions for developing AM processes involves customization and system integration with the help of business process redesign, legal issues, cost management, TQM and IT.	Gunasekaran (1998)
17	Error recovery and conflict resolution measures for networked	Distributed Parallel Integration Evaluation Model for business organizational, operational & logistics agility using Paralellism theory of	i. For systems prone to error disability Error Detection and Recovery (EDR) are essential for agility ii. Costs of Conflict resolution are	Huang *et al* (2000)

	enterprises	computation & communication.	reduced if supported by IT	
18	Organizational development: agile learning	SWOT, interpersonal skills, emotional intelligence, developmental support, their transformation in performance	Learning agility can be honed as a skill if quick learners are identified and placed in the right job	Williams (1997)
19	Product Life Cycle Model for maintaining competitive agility with legacy IS	Four phases of IS in an organization described as Introduction, Growth, maturity and decline to architectured with User interface, application logic, business rules, database logic	System development should be undertaken to over come organizational rigidities in IT like ownership relations, attention to maintenance rather development, tight budgets impeding cross-functional consensus and outdated business processes embedded with IS	Reddy and Reddy (2002)
20	Requirements of agile information systems manufacturing	Organizational development, proficiency characteristics, agility attributes as the basic components of IT/IS support proactive proficiency in creation, augmentation, comparison, migration and modification, and reactive proficiency in correction, variation, expansion and	Agile information systems contribute to close supplier relations, enterprise integration, cross functional teaming, concurrent execution of business activities, customer satisfaction, rapid development cycles, customer driven innovations, use of flexible production technology, learning organization and	Coronado *et al* (2002)

		reconfiguration	multi-skilled and flexible workforce	
21	Strategies for enhancing agility of make-to-order manufacturing	Performance measures, manufacturing systems, system development, concurrent and integrated management of MTO environment	Concurrent and integrated management of Make to order manufacturing can work with IT/IS as an essential element towards the enhanced agility of MTO environment	Babu (1999)
22	Agility for multiproduct systems sans complicated flows	Multiple product assembly lines, flow of products and their types to develop an algorithm for identification and elimination of backtracking flow	The concept of agility has an impact on design of products and control of manufacturing systems.	Dhanalaskshmi *et al* (2006)
23	Integration of agility, innovation and quality in products	ITQFD: agile innovative total quality Function deployment with matrices absorbing customer voice and involving all concerned departments	Agile firm considers customer concerns and infuses the knowledge contained in taking into account all the departments involved to give work instructions.	Vinodh *et al* (2008)
24	Evaluation of agility and its existing level in an organization	DESSAC (Decision Support System for quantifying Agility Criteria) 20 criteria of the agile model adapted with the quantification techniques	Developing and using an IS reduces the time consuming job of implementing agility quantification model. Simple processes facilitate learning	Vinodh *et al* (2008)
25	Measuring supply chain agility in	Graph theoretic approach used to visualize interdependency at system	Transformation of a supply chain into an agile one needs the correct understanding	Faisal *et al* (2007)

	SME	and sub-system level vis-à-vis their contribution to agile SCM	of agility attributes and their interdependencies	
26	Manufacturing agility with the help of time based competence management	Strategic distinctive competencies, organizational competencies, individual competencies	A competence organization structure with an agile infrastructure offers more stability than current products and market characteristics. Full advantage is attained by building and leveraging renewed competencies faster than competitors	Assen (2000)
27	Measures of agility in SCM	Range and adaptability of procure and sourcing, manufacturing and distribution	Limited information sharing where suppliers can not anticipate change accentuates the advantages of a flexible supplier over those providing lowest cost	Swafford *et al* (2005)
28	Decision making for flexibility in manufacturing organizations	Decision support system using Strategic flexibility and core competence with comparator competitors and cost benefit analysis	Changes in corporate strategy are incumbent with customer demands and it is possible for the company to bring such flexibility only when the information systems are capable of helping the company meet new pressures	Price *et al* (1998)
29	Agility of IS	Component based development with	Information systems engineering can be	Andrade &

	through synergy of software and engineering	superposition of coordination mechanisms in coordination contracts	significantly enhanced by adopting coordination technologies through which systems can be made more agile.	Fiadeiro(2002)
30	Build, design and implementing flexibility in a manufacturing enterprise	Identification of flexibility needs, measuring the current and target flexibility levels, addressing the economic viability of proposed flexible manufacturing solutions	FM solutions must be designed by the people closely involved in operating the facility and a variety of factors including what type of flexibility is needed, stress issues when working under changing conditions, the skill level of the workers and the available capital must be considered.	Abdel-Malek *et al* (2000)
31	Virtual enterprise enablement by communication and information technology	Distributed Virtual Factory a simulation model in the virtual enterprise environment using Time Bucket Algorithms for introducing Activity Based Costing	Manufacturing system simulations should deal with material and information flow as well as detailed product cost analysis to facilitate profitable factory management in an agile environment. Distributed Virtual Factory integrated with Activity Based Costing provides effective material for discussing product	Fujii *et al* (2000)

			cost.	
32	Evaluation of IT/IS investment and advantage appraisal techniques	Economic, strategic, analytical and integrated returns on IT/IS investments.	Traditional evaluation techniques view the organizational investment in a static environment where not accommodating intangible and non-financial benefits, and indirect cost applications. IT/IS evaluation is justified by tailorable information systems	Patel & Irani (1999)
33	Agile manufacturing and vertical integration using CALS'	Strategies, approaches, standards and technologies to enterprise integration. CALS' is an approach developed the US Department of Defense adapted by industry to help reduce costs, lead times and improve flexibility	Functions are improved by Promotion of information sharing, using digital data, creating data only once and using it throughout the product life cycle, providing a data management environment, using standard neutral data formats to maximize the ability for disparate users and systems to use the information, provide a system – transparent, user friendly operating environment	Ross (1994)

34	Digital options and their potential in making firms agile	I: organizational capabilities – agility, digital options and entrepreneurial options II: strategic processes – capability building, entrepreneurial action and co evolutionary adaptation	Dynamic capability and strategic process enabled by information technology impact the ability of firms to launch many and varied competitive actions which act as antecedents of organizational performance	Sambamurthy *et al* (2003)
35	Achieving workforce agility for world class management	I: Creating the conditions of employee involvement to flourish II: Starting EI pilot programmes III: evaluating the results of the pilot program IV: extending the EI program to the rest of the company	Employee Involvement is the participation of the entire firm's workforce to to improve the working environment, product quality, equipment productivity and eventually the company competitiveness. This participation occurs through cooperative relationships, open communication and group problem solving and decision making through participative management approach	Owusu (1999)
36	Value chain agility and IT capabilities	Ranges, adaptabilities and flexibilities of IT product development. IT-procurement sourcing, IT-	Where agility and flexibility are not interchangeable Value chain flexibility integrated with IT improves Value chain	Swafford *et al* (2006)

		manufacturing, IT distribution logistics.	agility. Such a Value Chain scores high in performance and impacts the organizational performance positively.	
37	Open automation architecture for flexible manufacturing systems	Developing logical manufacturing shops, partitioning the shop floor into distinct logical setups	FMS environment requires information system support to provide control of automated processes and facilities and generate information to support decision making	Kaula (1998)
38	Positive and negative impact of IT on flexibility	Dimensions of flexibility – i: temporal – short to long-term, ii: Range – foreseen to unforeseen circumstances, iii: Intention – offensive to defensive, iv: Focus – internal to external	Organisational and technical flexibility are concepts of paradox where IT itself remains inflexible yet use of IT contribute to organizational flexibility	Golden & Powell (2000)
39	Web-to-host access tools for information access in agile management	Web browser interface, legacy applications, messaging system, enterprise application integration tools – document management systems, client server applications, business intelligence systems	Implementation of web technology enhances information access for agile management. This eliminates all inefficiencies in accessing, exchanging and dissemination all kind of information. Encryption for security of data and size of	Bajgoric (2000)

			applets however need special vigilance	
40	Changes in organizational relationships by IT	Mutli-disciplinary project teams, extensive use of outsourcing and retaining only core activities, establishing long term partnership with suppliers, having core work force and access to a large network of specialist and ancillary staff	The new age firm is a networked organization which is an open system with long and short term alliances to add value to specific activities or projects. Technology makes the identification of possible partners and effective dialogue between them easier	Baines (1998)
41	Agile practices in successful firms for reference	Concurrent engineering, people issues, legal barriers, virtual enterprise, process and equipment, information and control system	Proficiency at change is the only qualifier for agility in a firm. Each agile practice is to be studied as a closed system to be scaled to enterprise. Merely, putting all the agile practices on place will not ensure an agile enterprise.	Dove (1995)
42	Knowledge management with technological inputs	I: Collective knowledge reservoirs II: Knowledge depositories III: Internal dissemination of knowledge	Technology is a knowledge based intangible asset for which deployment of a supportive knowledge based culture within innovative organizations is the need for knowledge managers	Perez-Bustamante (1999)

43	Workforce agility	Task: collaborative/ non-collaborative Equipment: general/ specialist Workforce: high/low skilled	Managers can get significant logistical benefit from workforce agility in systems with high variability.	Oyen *et al* (2001)
44	IS for responding to global market changes	Three phases of global market change • Initial market entry • Local market expansion • Global rationalization	Focus on organizational structure and resource deployment informed by IS helps organizations respond to the challenges of globalization namely Change, complexity, competition and conscience	Craig & Doulas (1996)
45	Computer aided acquisition and logistic support	Process improvement, adopting international standards, creating a shared information environment	Digital data can be maintained, updated and documented over geographically diverse environments hence adopting CALS gives competitive advantage and improves agile management	Lyu (1999)
46	IS collaboration through agents	Design team of intelligent agents, marketing team, sales team, MIS department suppliers and head quarters	Information sharing between partners, suppliers, top management and various departments through internet and extranet facilities in the agent based collaboration has potential and promise for future	Liang & Huang (2002)

			agility of the firm	
47	Human capital in an agile workplace	Situational awareness, process design, artifact design	Characteristics of an agile organization with readiness are moving towards mainstream motivated by business demands and encouraged and tutored through publications, conferences, workshops and consultations.	Joroff *et al* (2003)
48	Internet based agile manufacturing	Electronic catalogue, intelligence selection, details, devices, manufacturing database, design module	A: The system can be automatically resized based on application requirements. The system can be accessed globally on the internet. C: Dynamic web pages provide an interactive and friendly HCI. D: AI technology offers a convenient and natural way to support design agility and manufacturing responsiveness	Cheng *et al* (2000)
49	Intentions of entrepreneurs in creating ventures	Decisions which structure resources including i) time, vision and focus ii) flexibility of focus, iii) flexible	Entrepreneurs of different types and in different context may rely on different process competencies and relationships.	Bird & Jelinek (1988)

		behavior iv) temporal agility v) interpersonal influence	The outcomes of the processes may differ based on these variables.	
50	Organizational culture for an agile firm's IS	A: technical and financial feasibility B: Reinforcement of informational culture C: reconsidering information system implementation D: change of informatics culture	Organizational behavior needs to improves for maximizing the efficiency of IS. When cultural change is needed the bubble like cultural implementation is the best choice.	Claver *et al* (2001)
51	Three pronged approach for Supply Chain	I) Agility II) Alignment III) Adaptability	The best supply chains are not just fast and cost effective they are also agile and adaptable and they ensure that all their company's interests stay aligned	Lee (2004)
52	Information systems integration	i)Technical - , ii) systems iii) Strategic iv) Organisational – structural, social and historical, power and politics and cultural analysis	Successful integration of IS requires careful analysis of technical, strategic and organizational domains and organizational analysis should inform technical integration	Wainwright & Waring (2004)

Table 2.6: Identification of gaps in scholarly work on agile management

S. No	Area/Approach	Researcher/Proponent	Research/Main Idea-Postulate	Gap Identified/ Comments
1	Agile Practice reference models	Dove (1995)	Identifying a agile practices from the survivor companies	Each reference base to put together an agile enterprise needs to be studied individually as a closed system and then recommended for scaling
2	Agility and TAM (Technology Acceptance Model)	Zain *et al* 2004	Exploring the relationship between IT acceptance driven through beliefs and the achieved agility in Malaysian firms.	Continuing turbulence in the manufacturing industry makes organizational success more complicated and access to timely information is critical to success.
3	Internet technology and Agility	McGaughey (1999)	Contribution of internet technology through organizational intranets and the world wide web to organizational agility and increased competitiveness	Firms are missing significant opportunities to use internet and intranets in ways that would help them to become more agile. Internet technology is underutilized by many firms striving for agility. There is a need for study that

				meld research on agility with research on internet technology and provide practitioners with guidance on how to use internet technology to become more agile
4	Measuring organizational responsiveness	Hoyt *et al* 2007	Environmental scanning, flexible planning, strategic manufacturing infrastructures, supply chain governance mechanisms and multi skilled workers improve performance	Few measurement scales exist that can currently be utilized to measure and predict rates of organizational responsiveness
5	Agile strategies	McCarthy and Tsinopoulos (2002)	Strategic analysis, choice and information for	Limited efforts at examining the value and utility of configuration as a method for realizing manufacturing studies.
6	Agile manufacturing in practice	Zhang and Sharifi (2000)	Agile drivers and agile capabilities	Measures need to be developed to help companies realize their capabilities and identify the non-existent ones.

Table 2.7: Literature on technology acceptance

S.No.	Author(s)	Main propositions/ implications
1	Davis (1985), Legris *et al* (2002), Hu *et al* 2003	Technology Acceptance Model TAM for the mediating role of perceived ease of use and perceived usefulness in their relation between system's characteristics (external variables) and the probability of system use (an indicator of system success). A highly prominent path exists from job relevance, to perceived usefulness and then technology acceptance exists.
2	Grover and Segar (1995) Kearns and Lederer (2003)	Industry contextual factors have a positive impact on the use of IT for competitive advantage. Practices for Strategic information systems planning (SISP) are IT participation and alignment in business plans in environmental uncertainness and information intensity.
3	Dhebar (1996)	Smart product policy concerns stem from design facility, flexibility and economy with right product line, established products use standards & regular product change
4	Agarwal and Prasad (1997), Lee and Runge 2001	Drivers explaining IT acceptance behaviors are owner's innovativeness, owner's perception and social expectancy in the given order. Innovation characteristics and external pressure do have an impact on user intention and future use as a matter of routine.
5	Straub *et al* 1997	TAM should be tested across cultures and countries as it held true for USA and Switzerland but not for Japan
6	Baines (1998), Segarra 1999	Open systems theory: a networked organization / manufacturing enterprise integrated with IT tools for enterprise change management in organization

7	Michelis (1998), Thong 1999	Continual change handling can be enabled by change related issues of IS in systems, group collaboration and organization impacting the practical, managerial and operational perspectives. The extent of IS adoption is determined by organizational characteristics.
8	Kang (1998), Deng *et al* 2004	Belief and social network model of IT acceptance extension with parameters of perceived enjoyment, pressure for use, knowledge / value of available substitutes forming the attitudes and group dynamics shaping behavioral intention for usage behavior.
9	Dias 1998	Manager's motivation for using information technology comes from perceived enjoyment and ease of which have collective impact together on perceived usefulness
10	Malhotra (1999) Malhotra and Galetta (2004)	Personal and social constructs of individuals in their organizational position offers understanding of user acceptance. User commitment and motivation is indispensable for best designed IS stemming from strategic and behavioral disconnects in the business.
11	Agarwal and Prasad (1999)	Individual differences, beliefs about innovation and attitudes existing in variables mediated by the TAM have a significant effect on IT acceptance
12	Karahana *et al* 1999	Pre adoption beliefs of technology relate to perceptions of usefulness, ease of use, result demonstrability, visibility and trialibility where as post adoption attitude is based upon instrumentality beliefs of usefulness and perceptions of image enhancement.
13	Maguire (2000)	Business focused information system development instead of taking into only one subset. These approaches should be supported by education and training, change management, user reaction to IS, flexibility of IS, return on investment, environmental scanning, impact and

		use of IS on organization, decision making, evaluation and review.
14	Hidding 2001	Competitive dynamics differ across business ecologies and sustainability of IS depends on which key success factors they support or enable in strategy as well as focus
15	Gahtani 2001, Pijpers (2001) Bahli and Saade (2004),	TAM has been found useful for assessing acceptance of technology in developed societies (in this case UK) where perceived usefulness has the largest influence on acceptance. Its core constructs are supported by senior executives acceptance of IT also. In assessing the attitudes toward web-based instructional systems also it has been found applicable. TAM can be enhanced including social cognitive theory for web-based learning.
16	Misiolek 2002, Lu 2003. Marshall *et al* 2003, Shih 2003	WIMD (wireless internet via mobile devices) and software tool acceptance is determined by individual differences, technology complexity, facilitating conditions, social influences and wireless trust environment. Trust in technology, institutional trust and social trust should be included in acceptance models of future. Training on the device or tool influences acceptance.
17	Brown *et al* 2002	In mandatory environments where employee use of IT is more their attitude may be negative. However voluntary use is mediated by the constructs of TAM
18	Venkatesh (2003)	Unified theory of acceptance and use of technology model (UTAUT) a unified model integrating elements across TRA (theory of reasoned action), TAM, motivational model, TPB (theory of planned behavior), model of PC utilization, innovation diffusion theory and social cognitive theory. Four moderators namely experience, gender, voluntariness and age

		are confirmed to account for dynamic influences including organizational context, user experience and demographic characteristics.
19	Teo and Ranganathan (2003), Lewis 2003	Synergy of IT resources (technology and applications), Human resources (top management commitment to IT, managerial knowledge and training of IT) and business resources (IT planning and integration with strategic planning, IT-based process redesign, flexible organization and cross functional orientation and IT driven inter organizational relationships); leads to improved organizational performance
20	Sher and Lee 2003, Pillania 2008	Management of both endogenous and exogenous knowledge through IT applications significantly enhances dynamic capabilities and there is a rise of adopting IT for KM in companies across Taiwan and India.
21	Gahtani (2004), Murugan (2002)	Failing to put the IT implementation process into the proper social context of economic sociopolitical and cultural dimensions can inhibit the success of the process and increase the risk of failure. Social pressure is an important factor in IT acceptance of under developed countries which recognize the importance of IT where systems remain unused
22	Peppard (2004), Smaczny (2001)	With a strong IS capability IT opportunities will be incorporated in the business strategy and IS/IT investment thus aligned. Focus of Strategic Information System should be on means IS/IT can be used to enable change and not inherent IT capabilities.
23	Ma and Liu (2004), Bokhari (2005), Igbaria and Tan (1997),	Meta analysis of empirical studies and surveys on technology acceptance and user satisfaction reveal a positive relationship exists between user satisfaction and system usage

	Gelederman 1998	but it is not very strong. Both system and information quality contribute to use which impacts the individual and the organization. The relationship between ease of use and acceptance is weak
24	Akmanligil and Palvia (2004)	The maturity and staff skills of IS departments in multinationals with global operations form the GIS strategies of parallel and central development, outsourced custom and joint development
25	Robinson (2004)	TAM can be used by sales force in whom support services and personal innovativeness impact perceived ease of use of technology
26	Yi (2005), Sun and Zhang 2004, Chau and Hu (2002)	Integration of TAM, theory of planned behavior and innovation diffusion theory in the PDA (Personal Digital assistant) context. Propensity of individual to experiment with IT is the main distinguishing variable between technology adoption levels. User perception by the organization impacts user's acceptance of technology with time. Technology acceptance is not exactly predicted as it also depends on random events like culture, technology and time.
27	Carayanis and Turner (2005)	Security technology implementation research model where security and organizational task characteristics along with organizational capability influence compatibility and security technology complexity. Together they determine the adoption and infusion for security technology implementation

Table 2.8: Gaps in literature on IT acceptance

S. No.	Area/Approach	Researcher/ Proponent	Research/ Main Idea-Postulate	Gap Identified/Comments
1	IT acceptance	Agarwal and Prasad (1999)	Identification of individual difference variables with significant effects on TAM beliefs.	Additional laws impacting IT acceptance and yielding individual difference variables
2	IT adoption	Lee and Runge (2006)	Survey of entrepreneurs for testing drivers of adoption of information technology in small businesses	Longitudinal data to explore the actual process through which IT adoption is innovated and diffused in small organization
3	IT use	Lewis *et al* (2003)	Influences on beliefs of knowledge workers regarding IT use in American organizations	Empirical study to assess the overall overlap between social, organizational and individual factors related to technology acceptance and its successful use
4	Technology acceptance	Hainbuchner and Hasenaeur (2003)	Innovation and diffusion study	The category of goods in the industry called complex products and systems has been ignored in literature
5	Digital	Chau and Hu	Technology acceptance model and theory	Additional modeling is required by

	Assistance for professionals	(2002)	of planned behavior	reexamining results from model comparisons.
6	Voluntary and mandatory use of IT	Brown *et al* 2002	Behaviour in a mandated setting is more complex than technology use	More research is needed to incorporate various attitude-behaviour response modes that may provide a richer characterization of mandatory environments

Table 2.9 Classification of literature reviewed according to the constructs of IT/IS functions enabling agility in an organization operating in the 21st century market environment

S. No.	Focus Area	Criteria	References
1	**Market**	Fragmentation	Bird & Jelinek (1988), Harris *et al* (1998), Babu (1999), Owusu (1999), Cheng *et al* (2000), Schlonsleben (2000), Claver *et al* (2001), Hormozi (2001), McCarthy and Tsinipoulos (2003), Cao and Dowlatshahi (2004), McDougal (2004), Wainwright & Waring (2004), Swafford *et al* (2005), Swafford *et al* (2006).
2		Customization	Ross (1994), Baker (1996), Craig & Doulas (1996), Gunasekaran (1998), Pablos (1998), Thomke and Reinertsen (1998), Vokurka and Fliedner (1998), McGaughey (1999), Golden & Powell (2000), Oyen *et al* (2001), Coronado *et al* (2002), Coronado (2003), Hai *et al* (2003), Sambamurthy *et al* (2003), Khan & Pillania (2008).
3		Heterogeneity	Bajgoric (2000), Fujii *et al* (2000), Liang & Huang (2002), Crocitto and Youssef (2003), Joroff *et al* (2003), Zain *et al* (2003), Zain *et al* (2004), Kassim and Zain (2004), Dhanalaskshmi *et al* (2006).
4		Globalization	Alan (1994), Dove (1995), Baines (1998), Kaula (1998), Koga (1998), Patel & Irani (1999), Perez-Bustamante (1999), Reddy and Reddy (2002), Lee (2004), Vazquez-Bustello *et al* (2007).
5		Growth	Eichinger and Ulrich (1994), Price *et al* (1998), Lee & Lau (1999), Breu *et al* (2001), Ebrahimpur & Jacob (2001), Aitken *et al* (2002), Soriano-Meier & Forrester (2002),

			Frutos and Borenstein (2003), Watnabe *et al* (2004).
6		Convergence	Williams (1997), Abdel-Malek *et al* (2000), Huang *et al* (2000), Meredith and Francis (2000), Sharifi and Zhang (2001), Weill *et al* (2002), Mondragon *et al* (2004), Narsimhan *et al* (2005), Hoyt *et al* (2007).
7		Shrinking Product life	Eichinger and Ulrich (1994), Bucki and Pasqueux (2000), Malarkode *et al* (2004), Zain *et al* (2004), Faisal *et al* (2007), Vinodh *et al* (2008).
8		Cooperation & competition	Bititci *et al* (1999), Lyu (1999), Assen (2000), Meredith and Francis (2000), Sharifi and Zhang (2001), Jackson and Johanson (2003).
1	**IT/IS functions**	Strategic information KM	Baines (1998), Agarwal and Prasad (1999), Segarra (1999), Legris *et al* (2002), Shih (2003).
2		Smooth collaboration	Davis (1985), Lee and Runge (2001), Pijpers (2001), Brown *et al* (2002), Lewis (2003), Bokhari (2005).
3		Virtual manufacturing services	Davis (1985), Karahana *et al* (1999), Smaczny (2001), Misiolek (2002), Kearns and Lederer (2003), Lu (2003), Sher and Lee (2003), Deng *et al* (2004), Sun and Zhang (2004).
4		Enterprise integration management	Davis (1985), Dhebar (1996), Igbaria and Tan (1997), Gelederman (1998), Michelis (1998), Lewis (2003), Akmanligil and Palvia (2004), Robinson (2004), Bokhari (2005), Yi (2005), Pillania (2008).

5		Virtual enterprise	Straub *et al* (1997), Dias (1998), Thong (1999), Gahtani (2001), Marshall *et al* (2003), Bahli and Saade (2004), Carayanis and Turner (2005).
6		Speeding of activities	Grover and Segar (1995), Kang (1998), Malhotra (1999), Maguire (2000), Andrade & Fiadeiro(2002), Hu *et al* (2003), Malhotra and Galetta (2004).
7		Intelligent autonomous decision making	Agarwal and Prasad (1997), Agarwal and Prasad (1999), Malhotra (1999), Hidding (2001), Chau and Hu (2002), Murugan (2002), Venkatesh (2003), Peppard (2004), Teo and Ranganathan (2003), Gahtani (2004), Ma and Liu (2004).
1	**Agile organization**	Short response time	Williams (1997), Harris *et al* (1998), Koga (1998), Bititci *et al* (1999), Ebrahimpur & Jacob (2001), Soriano-Meier & Forrester (2002), Dhanalaskshmi *et al* (2006), Faisal *et al* (2007).
2		Partnership	Ross (1994), Pablos (1998), Vokurka and Fliedner (1998), Weill *et al* (2002), Reddy and Reddy (2002), Coronado (2003), Kassim and Zain (2004), Malarkode *et al* (2004), Swafford *et al* (2005).
3		Outsourcing	Dove (1995), Lyu (1999), Bajgoric (2000), Breu *et al* (2001), Frutos and Borenstein (2003), Cao and Dowlatshahi (2004), Mondragon *et al* (2004), Watnabe *et al* (2004), Khan & Pillania (2008).
4		Schedule sharing	Alan (1994), Lee & Lau (1999), Assen (2000), Hormozi (2001), Liang & Huang (2002), Crocitto and Youssef (2003), Lee (2004), Wainwright & Waring (2004), Vazquez-Bustello *et al* (2007).

5		Postponement	Bird & Jelinek (1988), Thomke and Reinertsen (1998), Meredith and Francis (2000), Zhang (2001), Hai *et al* (2003), McCarthy and Tsinipoulos (2003), Sharifi and Zain *et al* (2003), Narsimhan *et al* (2005), Vinodh *et al* (2008).
6		Teamwork	Baker (1996), Craig & Doulas (1996), Baines (1998), Gunasekaran (1998), Kaula (1998), Pablos (1998), Joroff *et al* (2003), Sambamurthy *et al* (2003), Zain *et al* (2004).
7		Supply chain improvement	Price *et al* (1998), Abdel-Malek *et al* (2000), Bucki and Pasqueux (2000), Meredith and Francis (2000), Jackson and Johanson (2003).
8		Business process reengineering	Eichinger and Ulrich (1994), Babu (1999), McGaughey (1999), Perez-Bustamante (1999), Golden & Powell (2000), Schlonsleben (2000), Coronado *et al* (2002), Swafford *et al* (2006), Hoyt *et al* (2007).
9		Employee training and education	Owusu (1999), Patel & Irani (1999), Cheng *et al* (2000), Fujii *et al* (2000), Huang *et al* (2000), Claver *et al* (2001), Oyen *et al* (2001), Aitken *et al* (2002), McDougal (2004).

Chapter 3

Research Methodology and Design

In this chapter the methods adapted for of data collection to justify the objectives of the study, validation of variables and analytical procedures have been presented. The measures used for deriving the descriptive statistics of the sample, analyses for hypotheses testing and approach for modeling of agile drivers to support decision making and outranking agile organization have also been explained. The results from the ensuing analysis and the relevant data pertaining to the same have been presented in the proceeding working chapters the observations of the survey, test of hypotheses with its outcome and the synthesis of the agile organization outranking model.

3.1 Introduction

The basic methodology taken up for this study was a questionnaire based survey, the results of which were subjected to different analyses for drawing inferences pertaining to the hypotheses described in the first chapter. The procedure that was adopted to collect data is explained in the first section. This also includes a description of the sample characteristics, variables and the structure of the questionnaire. Validation of questions and calculation of non-response bias before accepting the questions and their responses for building upon the research and industry implications of this study have also been duly taken in this chapter. The second section details the statistical analyses to which the observations were subjected so as to recover the underlying trends in the industry sample regarding use of information

technology for organizational agility in Indian firms. With the mention of a particular analysis for either extracting the priority components or testing significant associations/differences the justification of selection regarding the statistical mode is also given.

3.2 Data collection

Primary data for this research was collected while using a self-administered questionnaire designed to serve the purpose of the research objective. Characteristics of the research data are presented in Table 3.1. A selection of a representative sample of Indian firms operating in the fast changing business environment was made and interviews were conducted by a mail survey. The questionnaire form is annexed in appendix I and a sector wise breakup of the companies is given in appendix II. However a list of the companies is not made public in withstanding the pact of confidentiality made with the respondents.

Table 3.1: Main features of the Research data collected for analyzing technology acceptance for organizational agility

S.No.	Variable	Feature
1	Research population	Private firms in all kinds of businesses
2	Firm unifying factor	More than 100 employees
3	Population standard	ISO certified
4	Population census	Business Today Top 500 private sector companies
5	Geographical area	India
6	Method of data collection	Questionnaire based survey
7	Time frame	April 2007 to Jan 2008
8	Respondent's profile	Managers and executives
9	Sample size	76

Depending on the availability, mail survey was conducted preferably by email. However, in case of non-availability of the same, survey questions were dispatched to the respondents by post. Each mail survey comprised of a covering letter explaining the objectives and rationale of the survey. Following the first invitation for the participation in the survey, follow-up phone calls were also made before classifying the respondent in the list of non-respondents, who did not participate in the survey on account of any reason peculiar to them.

The questionnaire was initially sent to 400 companies. These firms complied with the features mentioned in table 3.1. However, since the purpose of this study is purely academic and pertains to contribute to research alone it was deemed proper not have any bearing of the results of this study on the corporate or public image of the firm. Owing to this a covenant of deliberately concealed identity of the individual respondent as well as the proper identity had been maintained throughout the survey period. This was stated in the covering letter of each questionnaire mailed and the choice made by the respondent was evident under the complete awareness of this fact. Further, it was also envisaged that an assurance of strictly confidential identities would ease the participants in expressing their opinions and responses thus received would be devoid of biases. Therefore a list of organizations which participated in the survey cannot be provided instead of which the sector wise composition of those BT 500 firms to whom the invitation to participate in the survey was sent is furnished in the Appendix II. Further the covering letter addressing the executives is also appended with the questionnaire in Appendix I. Responses from 102 companies were received. 26 questionnaires were found to be unusable because either they were incomplete or the information supplied was not making any sense. Finally 76 responses were short listed. Secondary data for the study is furnished from material published in newspapers, journals, magazines, books and databases. Resource information sheets were also filled from the publications of the representative

companies such as Annual Reports, communications to the share-holders and releases meant for private circulation. These information sheets sifted from the information in these sources, answers to some of the broader questions challenging this study at the onset. For example 'How is the current level of agility or its need analyzed in the operations of a company?' and/or 'Can agility possibly occur in a particular industry?'

Respondents were chosen from all kinds of business activities through systematic random sampling of the list of BT 500 companies published by the Business Today (Nov 19, 2006) such that 80% of the population was covered in the study. As the focus of this research is on the best practices and performance indicators, it was important to include in the sample, such Indian firms which scored high on performance ratings and excelled in at least several of the key parameters. Suitability of the respondents was ensured as the respondents occupied a managerial or executive position and bore similar responsibilities in the firm hence it was safely assumed that they possessed access to the information required in the questionnaire. Their position and experience can confirm that the information obtained in the form of opinions for this study was reliable and appropriate. It was also seen that most of the respondents had over a decade of work experience with the same firm in a managerial or executive position also ensured the internal validity of the source of data.

Personal contact was made with the representatives of the firm who happened to be in most cases from the top management or one of the executives requesting and inviting them to participate in the study. In the covering letter for invitation some managerial implications of the study were also highlighted to make evident the utility of the study for the industry. Most of the questionnaires were responded to and returned – some after reminder and others without reminders, however in follow-up call made to the respondents who could not return the questionnaire, lack of time was stated as the reason. The usable responses from all the respondents were pooled to form a complete data set to serve as the principle sample for

further analysis. This spanned over a variety of industries, sizes, processes and magnitude of technology usage.

3.2.1 Questionnaire Design

Pertaining to the objectives of the study the questionnaire has been divided into four subsections each seeking original opinion from the respondents about the contribution of IT/IS in enhancing organizational *agility*. The first section poses questions to assess the level of agility in the company. Broadly classified into four agile capabilities, the answers are deemed to be indicative of the trends that are and will be impacting the company, the strategy of the company adopted to meet competition, the agile capabilities of product/service related change to improve quality and the level of human resource, their knowledge and creativity. The second section is for measures of level of Information technology acceptance for organizational agility in the firm from the top management and the employees. In the third section opinion has been secured on the organizational performance. This has also been beefed with secondary literature revealing performance indicators. The last section is on company demographics and respondent' profile and obtains details of background, turn-over and data on the respondent.

3.2.2 Questionnaire validation

The questions included in the survey are validated from available literature and other relevant studies regarding the same variables. A pre-questionnaire was also prepared and reviewed by managers from industry and academics. Wording with potential misunderstanding was identified and rectified in an attempt to improve the objectivity of the questionnaire. For analyzing the current level of agility of the company interview questions proposed by Jackson and Johansson (2003) to assess agility of manufacturing were incorporated after some modification to make them applicable for the representative sample from all industries. To take responses on the performance indicators of the company

respondents were asked to give their ratings to a framework of questions suggested by Narasimhan *et al* (2006) after some standardization according to the objectives of this study. Some omissions and additions were made to the set of questions used by Zhang and Sharifi (2000) and Zain *et al* (2004) to take the opinions and ideas of executives and managers on the usefulness and perceived ease of use of Information Technology and Information Systems in making their firms agile in Indian businesses. While framing the questions on company demographics those already used in similar studies for example Jharkharia (2004) were consulted. A mix of questions from these sources with modifications specific to this study cross referred and checked before inclusion in the questionnaire validates the use of this questionnaire (Appendix I) for investigating upon the objectives of this study.

The structure and content validation of the questionnaire was also performed by testing two main types of validity.

i) Content validity

ii) Construct validity

The questionnaire instrument developed in this study has a content validity as the selection of measurement items is based upon an exhaustive review of the available literature and evaluations by academicians and practicing managers. The construct validity was verified through exploratory factor analysis. It was aimed at testing the uni-dimensionality of the multi-items perceptual measures. As per the suggestion of Kim and Mueller (1978) only those items with a factor loading of more than 0.40 were retained in the questionnaire. As a result of that the questionnaire was further pruned.

3.2.3 Removing non-response bias

Considering the removal of non-response bias essential for the valid assumption from questionnaire responses a test comparing the answers of the early and the late respondents was carried out based on (Lambert and Harrington 1990). The main of assumption of this test

is that responses coming in at the later stage bear a higher degree of similarity to the non-responses as compared to early responses. This is to say that data from late respondents is data from non-respondents (Armstrong and Overton 1977).

Drawing from this some of the first few responses that were received without any reminder (in this case 52) or only after a single reminder were compared to those responses received late (in this case 24) at the end of the response receiving period only after several reminders (in this case two reminders and a follow-up call). The key variables of these comparisons were tested for significant differences with the help of the independent t-test. The results of this test suggested that the variables of the early and late responders did not differ significantly at $P<.05$ level of significance in terms of size and predominant business statistics. Therefore, on the basis of this result for all further analyses and inference the possibility of non-response bias is ruled out for this study.

3.2.4 Questionnaire survey reliability

After receiving the responses on the completed questionnaire sheets the survey was tested for internal consistencies and reliability. A pretest was conducted on a group of 10 students from the sixth semester pursuing their Masters in Computer Science at the Computer Science Department of the Aligarh Muslim University. These were MCA students having graduation in engineering who were given sufficient briefing and literature before attempting the questionnaire. Brain storming session was also conducted for these ten students so that they were made aware of the research implications of the study and ensure reliability. In the sixth semester these students were pursuing their project dissertations in the corporate sector as trainee or apprentice towards partial fulfillment of their PG degree in computer science. Working alongside executives in their relevant companies they had a fair idea of the thought process of an executive. Earlier every section of the questionnaire consisted of eighteen questions. Yet after the pre-test for reliability analysis those constructs which were found to

be not so relevant to the given parameter were discarded. Thus the total no. of questions excluding those on respondent and company profile was reduced to 125 from 216.

Where ever possible for each of the survey question the Cronbach's coefficient (Alpha, α) and the composite reliability coefficient were calculated in order to analyze reliability. Table 3.2 depicts the value of Cronbach's Coefficient for each of the survey question as positioned in the questionnaire (Section 3.1.1 of this Chapter) with the number of relevant factors under the same.

Table 3.2: Survey reliability as calculated by the Cronbach's Coefficient (α) for the questions positioned in the questionnaire

Question No	**No. of Items**	**Cronbach coefficients** (α)
Section I A	11	0.729
Section I B	09	0.753
Section I C	11	0.742
Section I D	08	0.729
Section II A	10	0.713
Section II B	09	0.769
Section II C	09	0.700
Section II D	09	0.796
Section III A	09	0.712
Section III B	09	0.751
Section III C	07	0.714
Section III D	09	0.739

The postulate of Nunally (1978) was held conclusive for this study according to which the developed index reflects the degree of internal consistency of the variables observed. This is held similar to the extent to which they represent the latent common variable. The minimum recommended level for Cronbach α in exploratory studies for internal consistencies is 0.6 as per the criterion established by Hair *et al* (1998) and the same value of 0.6 has been postulated by Bagozzi and Yi (1988). Hence, when the value of alpha and was found to be more than 0.6 then it was considered appropriate for further exploratory work.

3.2.5 Variables and measures

A variety of variables and measures addressing best practices, performance, technology acceptance and demographic variables were included so as to approximate those dimensions discovered in the literature survey. The scales were built on the basis of the previous literature and therefore include items used in scales that had already been validated for measuring similar concepts. Prior assessment by case studies and the questionnaire pre-test, confirmed that each item had the necessary content validity. The scales and variables were derived from other theories encountered during literature review, previous case studies and a formal pre-test from managers and academics. Multi-item scales were used in all cases. The data on agility practices–enriching the customer, cooperation to enhance competitiveness, mastering change and uncertainty and leveraging people and information, were obtained by asking respondents about the degree of adoption of such practices on the basis of a five point scale. In order to measure the turbulence in the business environment, the respondents were asked to identify, on a five-point scale, to what extent they agreed (1 – strongly agree, 5 – strongly disagree) with certain statements measuring the degree of dynamism and hostility in their respective businesses. To measure the strength achieved through agile practices, managers were asked to indicate on a five-point scale, the strength or advantage developed regarding the industry average (or relative to primary competitors) for

each of the objectives considered. To measure outcomes, perceptual data were used with regard to operational, market and financial performance. As in the previous cases, respondents were asked to indicate, on a five-point scale, their performance level compared to the industry average.

Respondents were asked to include information about external variables (demographic characteristics, user involvement, task characteristics, systems characteristics, user experience, information quality, and top management support), IT acceptance, and organizational agility. The responses were based on nominal, Likert and semantic differential scales. Demographic measures assessing the nature of operations and processes, included measures like continuous flow of products, need based service or production, standardized or customized service, number of products or services on offer, sales, marketing, number of employees, investment in equipment and information systems. The measures for assessing the benefits of IT/IS, to enhance agility and meet competition, the unforeseen disadvantages of IT/IS, enablers and drivers of agility by use of IT/IS and those areas where use of IT and IS can help achieve agility were incorporated as variables on which data was collected.

The suitability of the measurement scales adopted for assessing the agility of a firm as achieved by use of IT/IS was guaranteed before proceeding further to test the hypothesis. To evaluate the dimensionality, reliability and validity for each of the scales used for measuring concepts regarding agility, IT/IS acceptance, turbulence in the environment, and business performance, Cronbach alpha was calculated to determine the dimensions underlying the set of variables in each scale. Table 3.3 shows these variables as they constitute the respective areas and affect the movement of the agile wheel in an industry through the use of IT/IS.

Table 3.3: Variables for measuring use of IT/IS in a company's performance in competitive environment

S.No.	Benefits of IT/IS	Disadvantages of IT/IS	Agility providers	IT/IS in Performance	Barriers for IT/IS
1	Responsiveness	Disparity in trading partners' IT capability	Supply chain wide IT strategy	Accounts and finance	Security threats
2	Inventory reduction	Resistance to change to IT enabled SCM	Profit sharing due to IT-enablement	Sales and service	Insufficient bandwidth
3	Reduced Order fulfillment time	Low supply chain integration	High level of supply chain integration	Purchasing	Lack of trained manpower
4	Customer service	Threats of information security	Top management commitment	Logistics operations	Poor service level
5	Improved SCM	Lack of trust and faith	Security of online information	Forecasting and planning	Higher operating costs
6	Low working capital	Fear of information system breakdown	Trust in SCM linkages	Inventory tracking in supply chain	
7	Reduced material acquisition costs	Low management priority	Collaborative planning	Manufacturing scheduling	
8	Edge over new entrants	Inability to negotiate online	Reliable IT infrastructure	Administrative affairs	
9	Access to world class suppliers	Fear of supply chain breakdown	Funds for IT-enablement	Data sharing for design purposes	
10	Accurate forecasting	Lack of funds	Awareness about use of IT in a supply chain	Collaborative information sharing	
11	Better capacity utilization	Poor infrastructure		Promotion campaign	
12	Reduced unit cost of product service	Lack of awareness about IT			

For this study it was assumed that in case of manufacturing agile processes take place through the dimensions of agile human resources, agile technologies, value chain integration,

concurrent engineering and knowledge management. As an outcome to this the strength of production is identifiable in competitive costs, flexibility, improved quality, smooth and on time delivery, better service and environment. In case of other agile attempts for the service sector were considered to be the integration of information technology and management of information assets and tools for improved customer relation and employee cooperation.

Table 3.4 gives a schematic representation of the operational measures of the study variables to explore the scope of technology acceptance and agility in Indian firms. At last business performance is considered as that single dimension that determines the business competitiveness in a turbulent atmosphere and responsiveness to consistent change.

3.2.6 Response ratings

A standardizing approach was adhered to in taking opinions from the respondents to acquire a representative data set. Most of the opinions are rated under various degrees such as strongly agree, agree, neither agree or disagree, disagree & strongly disagree. As given in Appendix I measurements of performance and practices along with their psychometric properties were taken on five point Likert type scale. Where opinions were to be taken to measure the best practices of production or service, the extent to which the practice statement applied to their firm was given to be rated against the industry average. When asked to rate their performance against the principal/closest competitor in the industry a qualitative scale was put up. However data on respondent profile and demographic details were taken either in predetermined in categories of range or values.

Selection of variables was made by forming an experts group from the subject experts, academia and the industries which was asked to review the variables segregated from the literature – the relevant references of the same have been provided in Table 3.4, and identify as many more possible variables. 44 operational variables were thus finalized under eleven scales. According to their relevance to each scale they have been clustered roughly as

groups of four variables. These were used in determining the questions of the questionnaire. Opinions regarding these very variables were taken from the executive respondents of the study.

Table 3.4: Operational measures of study variables

S. No.	Scale		Variables	References
1	Demographic characteristics	I	Age	Lewis *et al* (2003), Jharkharia (2004)
		II	Gender	
		III	Organizational level	
		IV	Functional location	
		V	Number of years in business	
		VI	Number of employees	
2	User experience	I	Years working in their firm	Hormozi (2001), Narasimhan *et al* (2006)
		II	General experience in using computers	
		III	Computer literacy	
		IV	Skill level with electronic mail	
		V	Typical use of the IS	
3	Top management support	I	Top management encouragement	Jackson and Johansson (2003), Lewis *et al* (2003)
		II	Allocation of resource	
		III	MIS staff support	
		IV	Incentives for performance	
4	Information quality: time	I	Timeliness	Sharifi and Zhang (2001), Zain *et al* (2003)
		II	Currency	
		III	Frequency	
		IV	Time period	
5	Information quality: Content	I	Accuracy	Sharifi and Zhang (2001), Zain *et al* (2004)
		II	Relevance	
		III	Completeness	
		IV	Conciseness	
		V	Scope	
		VI	Performance	
6	Information quality: Form	I	Clarity	Zhang and Sharifi (2000), Zain *et al* (2004)
		II	Detail	

		III	Order	
		IV	Presentation	
		V	Media	
7	Over all usefulness	I	Giving control over work	Grover and Segars (1996), Gunasekaran (1998), Vazquez-Bustello (2007)
		II	Enabling quick tasks accomplishment	
		III	Making work easier	
		IV	Supporting critical aspects of work	
9	Attitude towards using	I	Behavior	Narsimhan *et al* (2006), Vazquez-Bustello (2007)
		II	Feeling	
		III	perseverance	
10	Actual systems use	I	Actual time spent	Gunasekaran (1998) Zain *et al* (2004)
		II	Frequency of computer use	
		III	Number of tasks dependent on computer	
11	Agility	I	Enriching customers	Gunasekaran (1998) Lewis *et al* (2003)
		II	Cooperating to compete	
		III	Mastering change	
		IV	Leveraging people and information	

3.3 Data Analysis

Data analysis was performed in three progressive stages of this study. With the preliminary draft of the questionnaire a pre-test survey was first conducted for the reliability and validity of the questionnaire. The analysis of the pretest was performed using SPSS. In the second stage original data from the root sample was analyzed for testing the hypothesis set (Chapter 1) using SPSS. Finally, while modeling the synergy of for agile drivers and IT/IS the model was developed with the use of ANP. The various analytical tests used at each of these stages are described in the ensuing sections.

3.3.1 Hypothesis testing

As already clear by the questionnaire parameters the data received in responses is qualitative instead of quantitative. After being regularly grouped on a spread sheet the information was subjected to processing and analysis using the Statistical Package for Social Science SPSS 16.0. Further for testing the significance of associations between the variables belonging to different constructs of the study a statistical test of goodness of fit was applied and hence the hypothesis will be discussed under the light of the results achieved in a fairly comprehensive manner as far as the scope of the study is defined. The statements regarding the benefits of the four pillars of agility in organizations are tested for significant differences by the independent t-test.

Figures were obtained from analyzing the opinions to financial and other gains of the organizations. These were tested for correlation with investments on IT and IS with the help of Pearson's Product Moment Correlation Analysis. The survey form comprised of some statements pertaining to the firm's investment on IT/IS infrastructure. These were standardized to provide an increasing order of investment on the 5 – point Likert type scale on which the respondent's opinion was sought. Also the information sought under company demographics contained an MCQ on the increasing or decreasing trend of profits made by the firm in the last five years. The points gained on the scale were treated as loadings for these two important variables and a test of correlation between them was conducted using PMCA. The test statistics and ensuing results have been delineated in Chapter 4 under survey observations. Besides, an interpretation of the PMCA results thus obtained has also been discussed in Chapter 7 under the conclusions of the study.

Further the MLR (Multiple linear stepwise regressions) have been conducted to test each of the hypotheses mentioned in chapter 1. The results of testing each hypothesis by this method are presented with relevant data set achieved from the root sample in Chapter 5 on hypotheses testing. It is essential for the validity of MLR that the independent variables in any regression equation are mutually independent and do not have a strong dependence or correlation amongst themselves. A linear regression equation between the independent and dependent variables is possible if there is no linear dependency among the predictor independent variables.

3.3.2 Model and testing

During the extensive literature survey on agility and information technology acceptance the enablers, drivers and determinants of responsible for making organizations agile were identified from published work. On the basis of these a model has been proposes for outranking organizations for their agile capabilities and possible competitive advantage over others.

An Analytic network process (ANP) model has been performed to outrank an agile organization for effective business management. In a separate chapter analytic network based approach for outranking an agile organization that is capable of managing effective business management has been presented. Analytic Network process (ANP) has a potential to ascertain the relative importance that captures all the indirect interactions in a network thus provides easy access to various hierarchy. ANP is based on relative measurement of a general theory to deduce composite priority ratio scales by using individual ratio scales to represent relative influence of each element that interact with respect to control criteria.

ANP thus leads to supermatrix with column priorities which may be used to capture the outcome of dependence and feedback within and between clusters of elements (Layers). This method was preferred over other methods for example the AHP for the following reasons

- ANP is being considered as superior to Analytic hierarchy process (AHP) as AHP fails to capture the influence among the attributes which affecting the objective function.
- As per Saaty (2001), it is a special case of the AHP with its dependence assumptions on clusters and elements.
- AHP permits one-directional hierarchical structure with the assumption of mutual independence of elements, while ANP considers interdependence as well as feedback in the hierarchy.
- Both the methods employ synthesizing process to establish final goal viz. AHP considers global priorities resulted from hierarchic structure, whereas, ANP derives the overall priority by employing supermatrix formation.

Also since ANP provides the advantage of a 'system approach' it can take into account each of the attributes that operate in their contribution to making an organization agile. Being a multivariate approach it was preferred for a model on agility because the concept of agility itself contains some tacit dimensions which can otherwise be difficult to quantify and hence would not figure in outranking.

Empirical data was used in formation of this model subjected to formulation in two stages. First the variables were tested for internal consistency by calculating the Cronbach's alpha. The complete structure of the framework was worked upon in the second stage.

3.4 Conclusion

In this chapter the detailed methodology observed for data collection and analysis for investigating upon the postulates of this research work are discussed. A questionnaire based survey was planned for primary data collection. The constructs were subjected to a pretest on a group of students using Cronbach's alpha. Mail survey was sent to 400 companies that figured in the BT 500. 102 forms were returned out of which 26 were discarded. Descriptive statistics were calculated on the responses received and hypotheses were tested on SPSS 16.0. ANP approach was adapted to prepare and test a model for outranking agile organizations. Observations from the sample and results of analyses are presented in the forthcoming chapters.

Chapter 4

Observations from Survey

The responses received on various parameters of the survey revealed certain trends about the sample. In this chapter observations made about the sample characteristics regarding their type of industry, demographics and respondent's profiles have been sorted and presented. Further the descriptive statistics based on the opinions taken on the Likert type scale for various constructs related to the variables of the questionnaire are also explained with reference to the calculations using SPSS 16.0 analytical package.

4.1 Sample characteristics

The sampled population of surveyed executives and managers belonged to all types of industries in the Indian private sector. Based on the sector of the industry to which the companies belonged, their annual turnovers in classes of range and the type of agile attempt being made by the company sample characteristics have been calculated and grouped accordingly.

4.1.1 Related to sector of industry

The largest portion of the companies emerging from the root source for the data belonged to the various types of manufacturing firms from which 39 of which composed the sample. 13 types of firms such as automotives, chemicals and petrochemicals and computer machinery etc are represented in this segment. This was followed by service industry from which 33 responses were received and another 13 services including banking, finance and software development figured in the sample. Some three other industries namely those from

the retail, hospitality and builders and colonizers sector were also included in the sample from which four responses were received. Table 4.1 explains the sample characteristics as selected for survey. A break up of the companies coming from various kinds of businesses can be seen at a glance in figure 4.1. As per the response received from the sample the manufacturing (36%) and auto (27%) sectors occupied the largest portion of the root sample, respectively. The share for the FMCG and process industries was almost equal at 20% and 17% respectively.

4.1.2 Related to annual turnover

According to annual turnover only 8% companies figured in the group Less than 5 Crore INR followed by 10% in the class of more than 500 crore INR. Between these two extremes of turnover the largest representation (35%) was that of companies with an annual turnover within 100 to 500 crore INR. Figure 4.2 provides a breakup of the sample regarding their annual turnover. Companies with turnovers between 5 to 25 crore INR and 25 to 100 crore INR figured at a percentage value of 19 and 28 respectively (Figure 4.3). This statistic about the annual turnovers of the companies within the samples suggests that managers of middle segment of firms according to the financial performance showed a greater interest in the concept of IT/IS acceptance for organizational agility.

4.1.3 Related to agile attempt

Four types of operations contributing to agility were enquired about in the existing practices of the firm. Termed as agile attempts these were AT – agile technology, KM – knowledge management, CE – concurrent engineering and Virtual integration. KM was attempted by the largest number of companies at a percentage value of 34. This was followed by AT - 20, CE – 19% and VI – 8%, respectively. 19% of the companies in the sample were found to be performing a mix of all the agile attempts. Figure 4.3 provides a breakup of companies attempting various practices pertaining agility for gaining competitive advantage.

4.2 Descriptive statistics

Calculations were performed to obtain the descriptive statistics of the sample according to the mean value of each construct relevant to the operation. The opinions were sought for four subsections under each of the three sections. Each operation was related to obtaining agile functions in the firm namely dynamic capabilities, IT/ IS acceptance for agility and best practices for competitive advantage. Enquiries were made on a scale of agreement from the respondent managers about the implementation of the constructs responsible for the operation of the agile attempt.

4.2.1 Related to current capabilities towards maintaining agility

Trends affecting the company for maintaining agility were foreseen as flexibility, readiness to adapt to new technologies, organizational relates of new products and new market, cooperative and multifunctional teams working towards gaining efficiency in customer relationship.

4.2.1a Related to dynamic trends

The overall weightage for the dynamic trends that includes implementation of customer demands in product/ service processes, introduction of changes in order quantities and flexible order in house order time etc shows that all the respondents admitted to their companies possessing the dynamic capabilities for agility (Table 4.2a). Organizational change scored the mean value of 4.32 followed by new technologies adoption at a value of 4.30. However Customers' confidence for rapid-response requirements scored the lowest value of 3.86 (Figure 4.4a). Discouraging trend revealed from the survey was that most managers agreed to maintenance of monopoly and secrecy which scored a mean value of 3.86 on a scale of 1 to 5 where I is strongly disagree and 5 is strongly agree in their organizations. This serves as an impediment to agile functioning of a starfish firm.

4.2.1b Related to Product improvement

The constructs of agile capabilities related to product improvement and customization such as improvisation in the potential current system, measures to adopt quality control, changes for quality improvement and preparedness to adopt enterprise wide information system were enquired about. The mean value of 4.30 was obtained for improvisation and consistent reinvention, redesign and reengineering (Table 4.2b). Facilitation of concurrency throughout the enterprise through coordination and interaction scored the highest value of 4.31 and virtual integration scored the comparative lowest value for μ. This is nonetheless to conclude that virtually company model is not adapted by firms for product improvement. However other strategies for quality improvement are considered more important in the companies of the sample (figure 4.4b). Protection and sharing of intellectual property also scored a considerable μ which is a positive sign for the free flow and exchange of information in the companies.

4.2.1c Related to customer relationship efficiency

Efficiency in managing customer relationships with quick responses is one of the key agile capabilities functioning in a highly competitive environment. Respondents were asked if their firms pay attention to measuring customer satisfaction and its progress. Emphasis was laid on customer management efficiency through involvement of customers in product development, increase of knowledge in content of products and market research. The main philosophy of this operation veered around the concept of selling a total solution to a customer and not just a product according to the virtual organization's principle for enriching the customer (Goldman et al 1995). These and other variables such as quality and customization sustainability, introducing and developing configurable products, flexibility and adaptability of customers and dynamism to adopt changes and opportunities scored mean values between 4.07 to 4.26. The only customer focused agile capability to have scored 3.86

(Table 4.2c) as its mean was the one on eliminating those organizational walls which created hurdles in accessing the customer. These statistics (Figure 4.4c) reveal an upward trend about the realization of the pivotal role played by customer satisfaction in achieving a dynamic capability.

4.2.1d Related to cooperation in workforce

Workforce agility has been defined as one of the most vital dynamic capability of an organization (Breu 2001). Literature on this topic warns that mere introduction of agile technologies would not translate into financial gains unless existing workforce is aligned with technology. Information the technology assists in forming innovative alliances within the corporation and endows smooth communication in a manner never done earlier. Respondents were asked to express their opinions on the existence of interdepartmental multifunction teams and suppliers' participation in product development. Company's commitment to two-way communication, encouragement for creative thinking of employees and protection system for information asset and sharing of intellectual property were also rated by the respondents. The mean values for all the constructs in table had an almost equal score oscillating on both the sides of $\mu = 4.2$ (Table 4.2d). The standard deviation remained between .7 and .9 for all the constructs (Figure 4.4d). The descriptive statistics given here indicate that Indian companies score fairly high in the agile capability of its workforce.

4.2.2 Trends of information technology acceptance

The level of information technology acceptance was seen in the perspective of the four dimensions of agility. Since the main premise of this research is agility gained by accepting technology that means IT enablement of business processes. Here those constructs that lead to a firms improved capabilities of enriching the customer, mastering change, cooperating to compete and leveraging resources with the use of IT /IS have been stated.

4.2.2a Related to Customer enrichment

A number of business processes like decision making, understanding customer requirements, meeting customers' target, ease in value addition, Individual customization, training customers in effective product utilization, access of customers' needs pertaining to product information, customer responsiveness, reduction of lead time, better production through supply chain management can be improved by support of IT /IS (Jharkharia 2004).

Respondent's opinions were taken on the potential of use of IT/ IS in facilitating and improving access to customers and their enrichment. The general verdict of this survey goes heavily in favor of IT enablement of customer enrichment because mean value of agreement with all the ten statements figured at a value above 4.2 and an SD of less than .8 (Table 4.3a and figure 4.5a)

4.2.2b Related to Mastering change

In an earlier section on dynamic capabilities respondents had agreed to organizational change placed on a premium to respond to competition. IT/ IS proficiency has been acknowledged for continuous change in organization considered as one of the major factors contributing to mastering change (Coronado et al 2002). Table 4.3b and Figure 4.5b suggest that all the respondents strongly agree to the positive effects of IT/IS for betterment of changes, accessing current information, in collaboration extension, having flexible and multi disciplined, information sharing and respective changes, forecasting the changes in the market and competitive advantage

4.2.2c Related to leveraging resource

Between the customer and the firm IT can serve as that tool which enhances the productivity of the existing resources to the end user without any other investments from the company (Dove 1995). Top management commitment to decentralization of management decisions, linked multifunctional teams, relation building in managers and subordinates,

improving core competencies, company wide information system for tracking product information for compatibility and accuracy, products possessing automated documentation, products with automatic self-diagnosis capability in case of malfunction, system for product updating, assistance or additional services for the client can be leveraged if employees are given in house training to use information technology. Trends shown in Table 4.3c and Figure 4.5c suggest that these were strongly agreed upon by the respondents with high mean values for the total responses.

4.2.2d Related to IT based linkages for cooperation

Workforce agility is enhanced by collaborative attempts coming from top management support and vision (Oyen et al 2001). Use of IT/IS enables organization in achieving inter and intra organizational cooperation by breaking time barriers, geographical barriers, structural barriers and cost barriers. It facilitates quick disposal of quotations if done online, communication with partners for changes in policy for products/ services, centralized structured demand information system with partners, accessing departmental information and supplier enrichment for technological know how and this was endorsed by the opinions expressed in this survey as most constructs scored a high mean value of 4.30 where the maximum could have been 5.0 (Table 4.3d and Figure 4.5d).

4.2.3 Best practices for accepting IT to achieve agility

Potential for further integration of IT /IS with to achieve organizational agility exists in the current practices towards this focus. Effective management and growth of the human capital, assets of IT and their optimum utilization, company wide IS strategy for integration of business processes with and accessing the customer can be capitalized for competitive advantage in future. Assessment of the future potentials of the current practices and the barriers in IT enablement of business processes have been made on the basis of responses from the managers.

4.2.3a Related to human dimension

Synergies of IT/ IS with human can improve agility which draws heavily on education and training of not only using technology but also cross training of employees for learning effective business processes. Periodic reviews of employees preference to use IT/IS towards organizational goals, sharing and rotation of responsibilities with the help of IS, keeping all processes open for quality improvement, TQM (Total Quality Management) of Information Systems contribute to organizational agility and can be achieved by employees' trust linkages and collaborative information sharing facilitated by IT. Respondents agreed that their organizations use balanced scorecards for performance measurement and give preference for collaborative planning for IT enabled business. The high mean scores above 4.25 achieved for all the statements in this regard (Table 4.4a, Figure 4.6a) reveals a positive sign from the Indian private sector where management paradigms for workforce are skewed in their favor and use of IT /IS is encouraged.

4.2.3b Related to customer service

Agility being a customer focused concept of competitive advantage where traditional mass production is dumped against customization requires an organization to bring in many changes in the way it perceived the customer (Goldman 1995). Respondents agreed that with the commitment of the top management their organizations adopted use of IT-enabled business processes for customer responsiveness, sales and service, high level of information sharing for customers, practices of virtual customer servicing, interaction between business and IT staff for designing the business processes and technology and Target costing for better customer service. However they also admitted that despite trying to become a customer focused organization there are barriers of security in sharing customer information. For the firms surveyed these findings (Table 4.4b and Figure 4.6b) are conducive to a change efficiency in future.

4.2.3c Related to IT based asset management

Common IT tools and advanced software are a major investment in a company and they have been reported to contribute to change efficiency (Agarwal and Prasad 1999) but owing to the productivity paradox some practitioners (Bryjnolfssonand Hitt, 1993)are skeptical. To resolve this issue respondents of this survey were asked to rate the benefits of various information technologies which manifest agility. Benefits from Bar-coding software, hosting own website, using Enterprise Resource Planning (ERP), availability of reliable IT infrastructure, ability to keep online secured information, influence of forecasting uncertainties for IT enabled business processes and practices of IT enabled purchasing were rated as very high by this sample unanimously (Table 4.4c and Figure 4.6c).

4.2.3d Related to information technology strategy

IT based asset management can be practiced for accruing financial gains only through an IS strategy that is supported by top management. Strategic integration of agile attempts in a volatile environment have been stressed upon by Burgoise (1985). The respondent companies of this survey scored high on having a organization wide IT strategy, communication with the trading partners, computer enabled network for manufacturing scheduling, practices of vendor management inventory system (VMI), use of third-party logistics (3PL) system, and use of IT/IS by warehouse and logistics service providers. They also feel that an improvement in overall efficiency, maintaining quality and warranty of product and services is an outcome of IT/IS strategic integration. This shows that there is an increase of computer use in various business processes and IT acceptance has a strategic support in the private sector of the Indian industry. This finding is also in accordance with Pillania (2008). The overall weightages for these strategies can be seen in Table 4.4d and Figure 4.6d.

4.3 Business performance and IT acceptance

Test of correlation between investments on IT and IS in a firm and the trends of financial gain or business performance as perceived by the respondents were conducted with the help of Pearson's Product Moment Correlation Analysis. Two tailed analysis of the data set revealed a significant correlation between the two variables at 0.01 level, where the value of correlation coefficient was found to be -.724 as N remained 76. The scatter graph depicting the result of PMCA in Figure 4.7 shows a trend of high degree of co-relatedness as established by this test. Figures 4.8 a and b give a sector wise break-up of executives belonging to firms which are increasing the share of the budgetary pie allocated to IT/IS infrastructure and a break-up of firms in the root sample which are making agile attempts in their business operations with an aim of improving performance, respectively.

4.4 Conclusion

In this chapter the sample characteristics and descriptive statistics observed from the survey have been given. These observations are a result of statistical analysis of the responses and profiles. It is seen that questionnaires were returned at a rate of one fourth of the total mails sent, another fourth of which had to be discarded due to ambiguity of responses. Manufacturing sector has the highest presence in the sample and companies represented are those that have a large turnover. A majority of the firms comprising the sample practiced a mix of agile technologies. The survey reveals that according to the participant's opinion the companies making higher investments in IT/IS infrastructure of the firm have also registered an increasing trend of growth and profit making in the last five years.

The survey findings on the agile capabilities of the sampled organizations suggest that Indian firms from the private sector are continuously bracing up for unexpected changes and bringing a paradigm shift in the focus of the strategies. Information technology and information systems with their innovative uses are increasingly being accepted for better

performance on fronts of customer enrichment, workforce accomplishments and asset management. This has been endorsed with the emerging fact that IT/IS investments that might be bringing about agility in the firm are also helping the firms to reap dividends.

This survey has been conducted by including both manufacturing and service sector and indicates the emergence of agile manufacturing aided and abetted by the top management with special emphasis on employee enrichment resulting in customer support and innovations for product improvement. This is a positive development taking place very fast because Saxena and Sahay (2003) reported a poor level of CIM in the Indian manufacturing firms. Ratings received in this survey have been used for hypotheses testing in the next chapter.

Observations for a difference in the profiles and responses of various sectors are related to the difference amongst the manufacturing, process and FMCG sectors, that make variable investments in IT/IS infrastructure. The outcome distinguishes the manufacturing sector as the one making highest investments and showing technology acceptance. Further, within the sectors of the root sample it is found that with consistent, albeit slight variation the companies are making agile attempts in their business operations where the food and beverage industry score above all as the real estate and entertainment industries remain dismal. More inter-sector differences amongst the firms sampled have been discussed in the following chapter as the hypotheses testing has been conducted.

Table 4.1: Sample characteristics based on the type of industry to which the total number of firms in the sample belonged

	INDUSTRY	TYPE	NUMBER
A	**Manufacturing**	**Sector**	
A-1		Chemicals/petrochemicals	3
A-2		Automotives	3
A-3		Hardware	2
A-4		Computer Machinery	2
A-6		Textiles	4
A-7		FMCG	4
A-8		Telecom instruments	3
A-9		Food & beverage	5
A-11		Heavy Machinery	4
A-12		Building material	4
A-13		Pharmaceuticals	5
B	**Service**	**Sector**	
B-1		Banking	4
B-2		Finance	3
B-3		Insurance	4
B-4		Housing	2
B-5		Real estate	1
B-6		Software developers	3
B-8		Hospitality	4
B-9		Telecom	3
B-10		Tourism	3
B-12		Consultant	2
B-13		Entertainment	4
C	**Others**	**Sector**	
C-1		Retail	2
C-2		Hospitality	1
C-3		Builders/colonizers	1

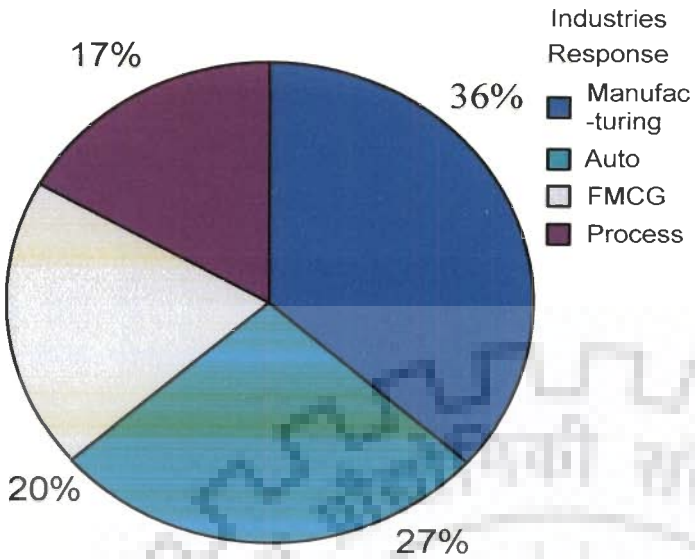

Figure 4.1: Industry responses

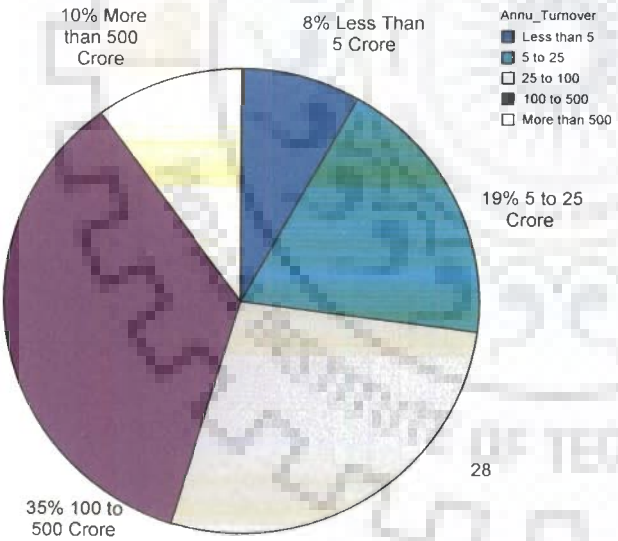

Figure 4.2 Annual Turnovers of companies in the root sample

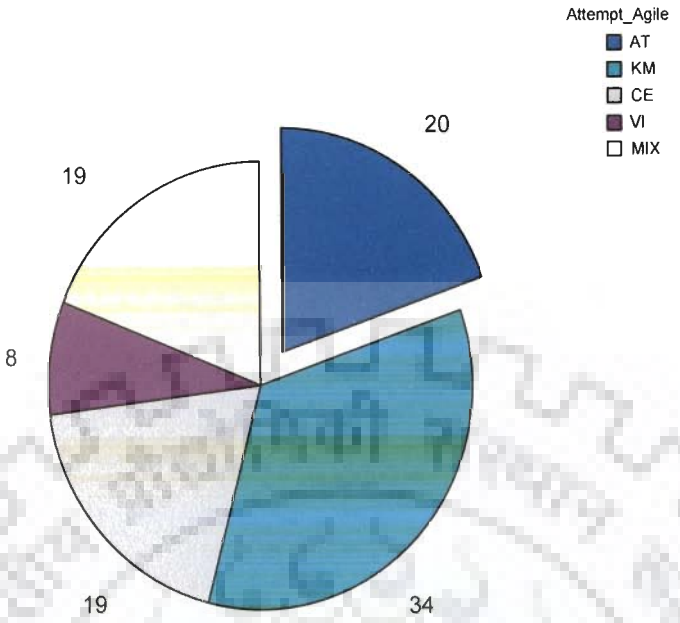

Figure 4.3 Organizations Attempting Agile Strategy

Table 4.2a Agile capabilities related to dynamic trends

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Implementation of customer demands in product/ service processes.	4.30	0.812
2	Introduction of changes in order quantities	4.27	0.788
3	Flexible order time (in-house)	4.28	0.765
4	New technologies adoption	4.30	0.769
5	Diversified Production line	4.29	0.776
6	Organizational change	4.32	0.730
7	Entry in to the new market	4.25	0.781
8	New product introduction	4.29	0.749
9	Relationship management	4.26	0.768
10	Monopoly and secrecy maintained	4.23	0.927
11	Customers confidence for rapid-response requirements	3.86	0.980

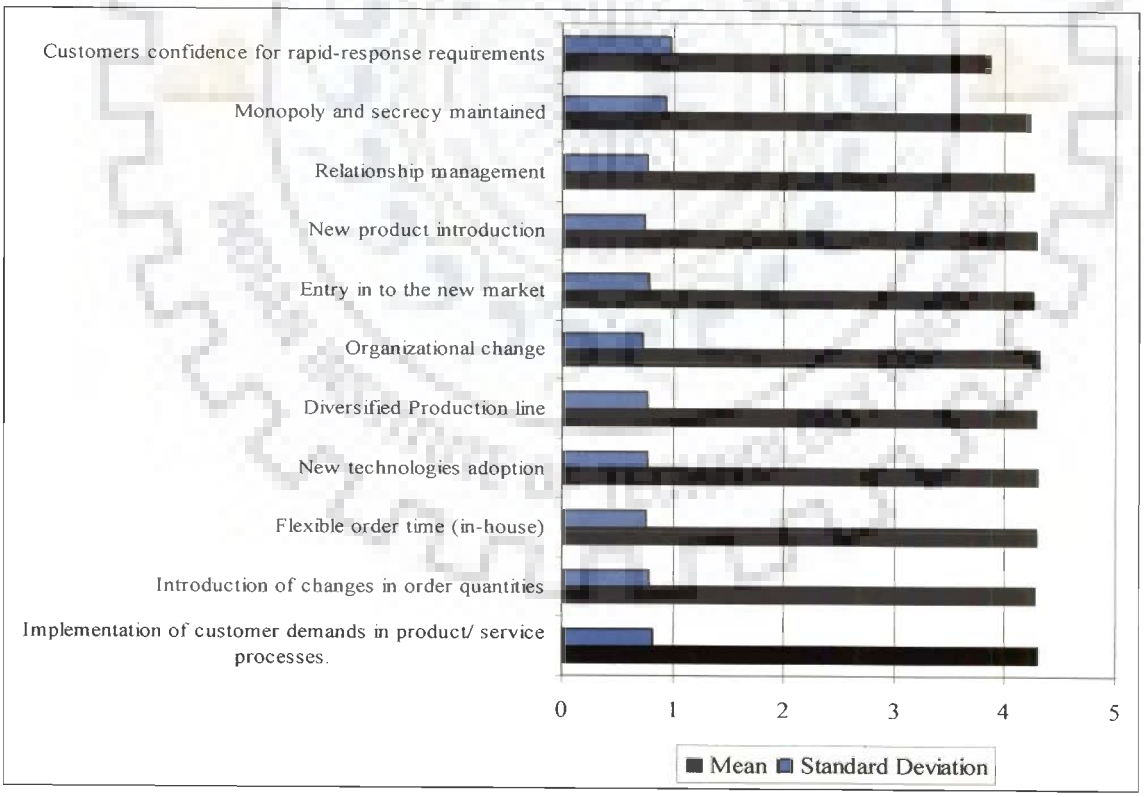

Figure 4.4a Agile capabilities related to dynamic trends

Table 4.2b Agile capabilities related to product improvement

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Improvisation in the potential current system	4.30	0.812
2	Measures to adopt quality control	4.27	0.788
3	Changes for quality improvement	4.29	0.767
4	Attempt for consistent reinvention and reengineering	4.30	0.769
5	Possibility of implementing changes in design	4.26	0.803
6	Facilitatation of concurrency throughout the enterprise through coordination and interaction	4.31	0.755
7	Preparedness to adopt enterprise wide information system	4.25	0.807
8	Protection and sharing of intellectual property by each players	4.29	0.758
9	Use of virtual company model to achieve vertical integration	4.24	0.788

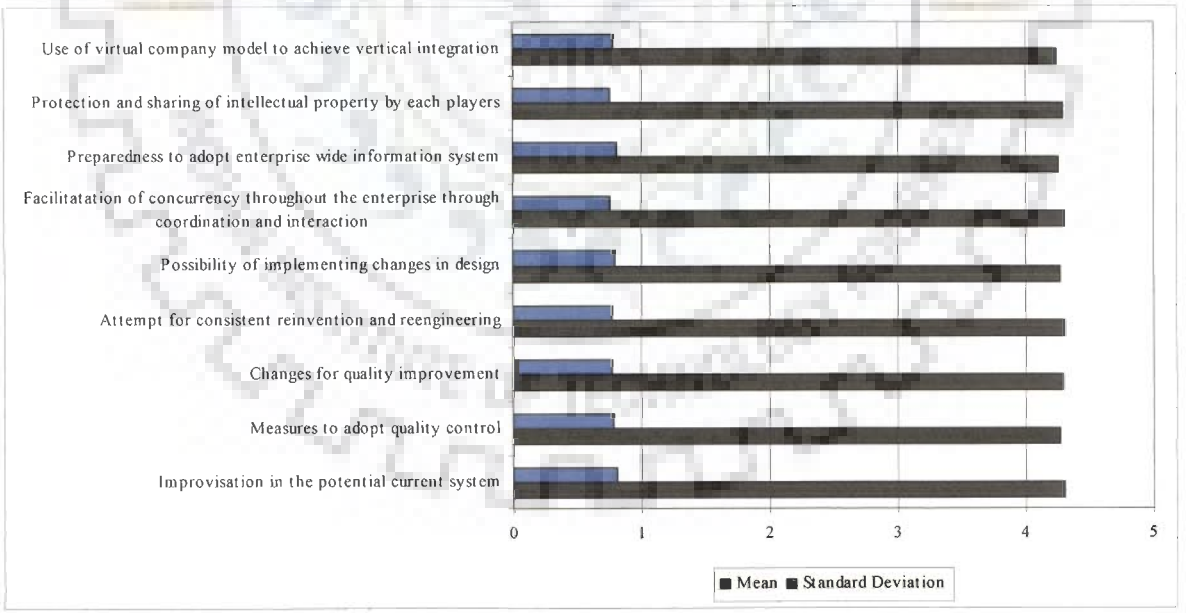

Figure 4.4b Agile capabilities related to product improvement

Table 4.2c Agile capabilities related to customer relationship efficiency

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Measurement of customer satisfaction	4.25	0.848
2	Progress of measuring customer satisfaction	4.17	0.860
3	Quality and customization sustainability	4.23	0.809
4	Increase in knowledge content of products	4.20	0.849
5	Introduction and developing of configurable product	4.16	0.871
6	Provision of total solution to customers	4.26	0.794
7	Customers involvement in product development	4.24	0.803
8	Research based market assessment	4.29	0.758
9	Flexibility and adaptability of customers	4.07	0.886
10	Dynamism to adopt changes and opportunities	4.13	0.978
11	Elimination of organizational walls that impede your efforts to meet customer needs	3.86	0.983

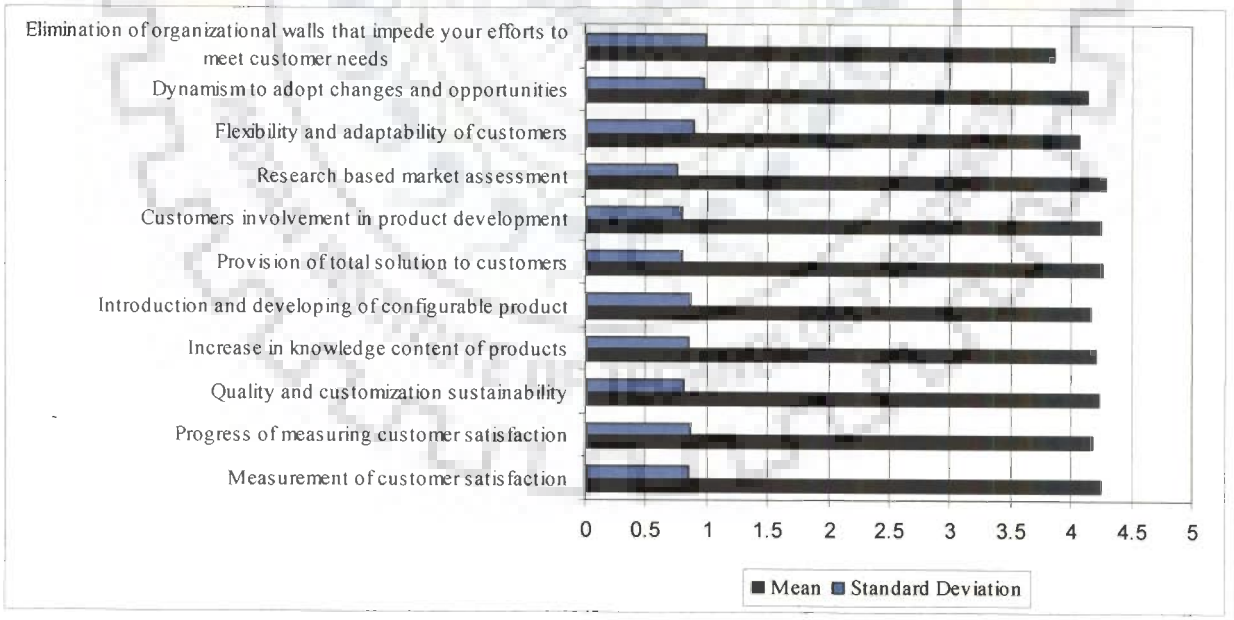

Figure 4.4c Agile capabilities related to customer relationship efficiency

Table 4.2d Agile capabilities related to cooperation in workforce

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Micro-cosm functions of all the functionaries of development projects	4.22	0.902
2	Suppliers participation in product development	4.22	0.856
3	Inter-departmental alliance existence	4.23	0.767
4	Two-way communication	4.29	0.840
5	Encouragement for creative thinking of employees	4.25	0.803
6	Design cost recovery from customers	4.26	0.864
7	Assets management to sell information	4.18	0.857
8	Protection system for asset information asset and share intellectual property	4.15	0.899

Figure 4.4d Agile capabilities related to cooperation in workforce

Table 4.3a Level of IT acceptance related to Customer enrichment

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Support of IT/IS in decision making	4.32	0.802
2	Understanding customer requirements better by use of IT/IS	4.26	0.792
3	Meeting customers target by using IT/IS	4.32	0.765
4	Ease in value addition through IT/IS	4.30	0.769
5	Individual customization through IT/IS	4.26	0.803
6	Use of IT/IS to train customers in effective utilization	4.30	0.753
7	Access of customers' needs pertains to product information	4.25	0.807
8	Use of IT/IS in towards responsiveness	4.29	0.758
9	Use IT/IS to reduces the lead time	4.20	0.808
10	Better management through IT/IS based supply chain management	4.24	0.750

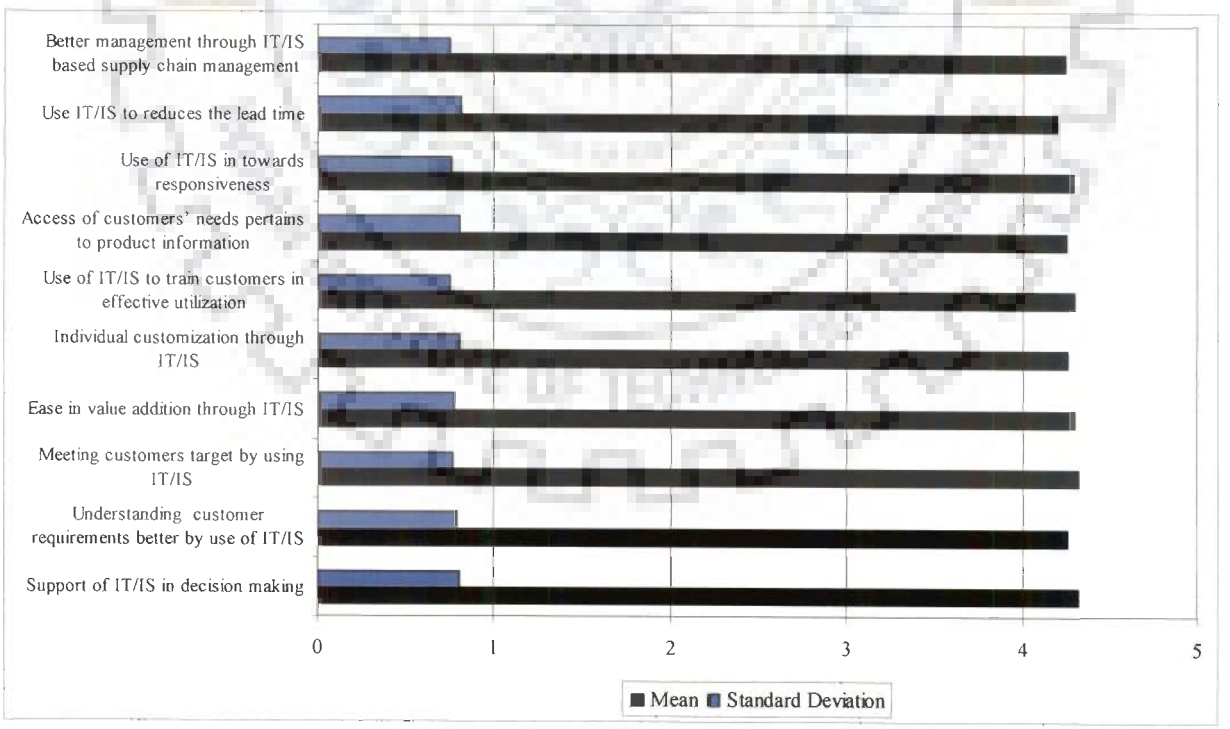

Figure 4.5a Level of IT acceptance related to Customer enrichment

Table 4.3b Level of IT acceptance related to Mastering change

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Continuous change in organization	4.31	0.781
2	Help of IT/IS for betterment of changes	4.27	0.788
3	Accessing current information using IT/IS	4.27	0.788
4	Use of IT/IS in business processes pupation	4.30	0.769
5	Effective use of IT/IS in collaboration extension	4.24	0.822
6	Our employees are flexible and multi disciplined	4.28	0.783
7	Use of IT/IS in information sharing and respective changes	4.25	0.807
8	Use of IT/IS in forecasting the changes in the market.	4.27	0.788
9	Use of IT/IS as source for competitive advantage	4.23	0.809

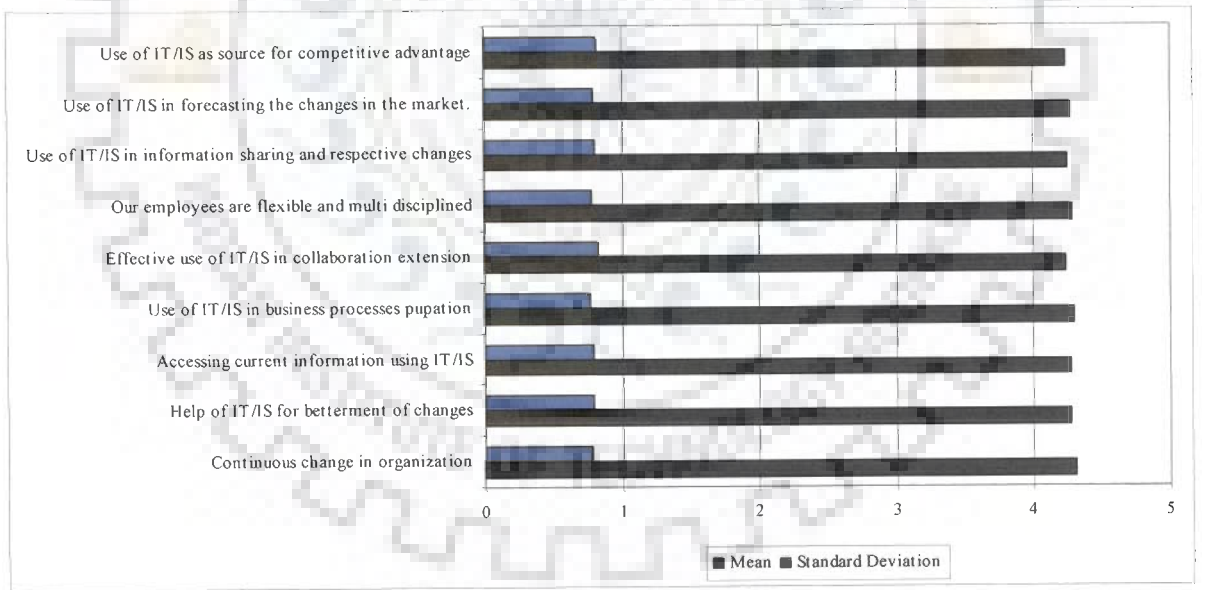

Figure 4.5b Level of IT acceptance related to Mastering change

Table 4.3c Level of IT acceptance related to leveraging resource

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Decentralization of management decisions using IT/IS	4.26	0.828
2	Ease in multifunctional teams linkage using IT/IS	4.24	0.822
3	Use of IT/IS relation building in managers and subordinates	4.27	0.796
4	Use of IT/IS for core competencies	4.34	0.752
5	Employees participation in in-house training to use IT/IS	4.25	0.799
6	Company wide information system for tracking product information for compatibility, accuracy and pupation	4.29	0.776
7	Products possessing automated documentation	4.26	0.801
8	Products with automatic self-diagnosis capability in case of malfunction	4.26	0.792
9	System for product updation, assistance or additional services for the client	4.26	0.784

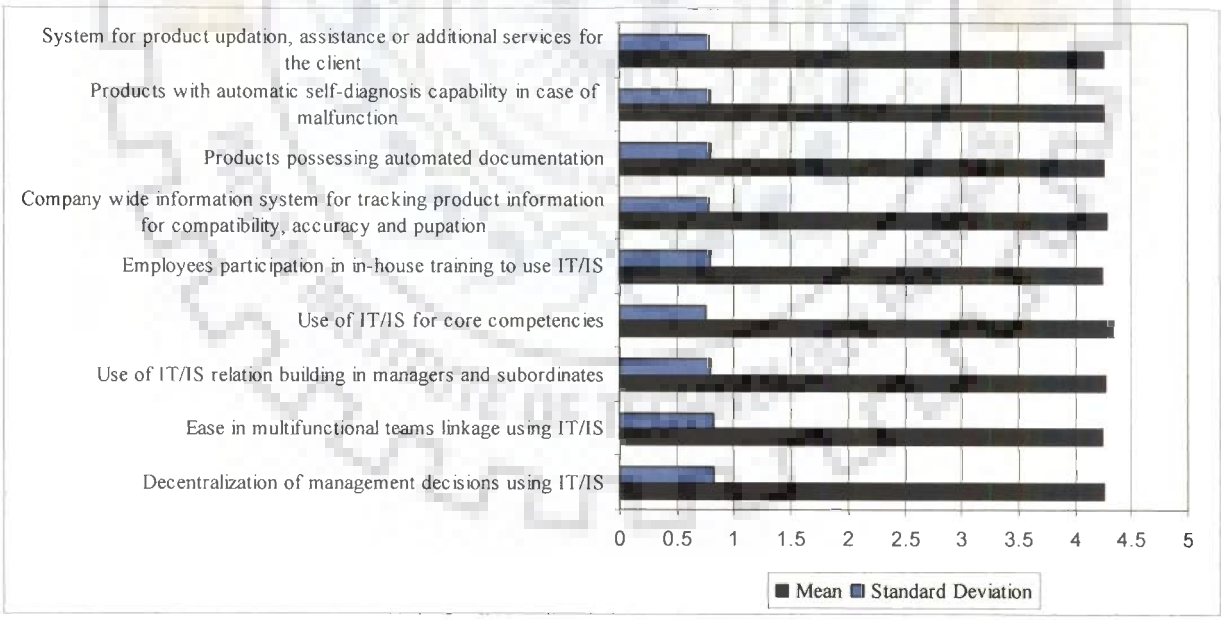

Figure 4.5c Level of IT acceptance related to leveraging resource

Table 4.3d Level of IT acceptance related to IT based linkages for cooperation

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Use of IT/IS enables my organization in breaking time barriers	4.30	0.812
2	Use of IT/IS enables my organization in breaking geographical barriers	4.27	0.788
3	Use of IT/IS enables my organization in breaking structural barriers	4.29	0.767
4	Use of IT/IS enables my organization in breaking cost barriers	4.30	0.769
5	Quick disposal of quotations online	4.26	0.803
6	Use of IT/IS in communication with partners for changes in policy for products/ services	4.30	0.744
7	Centralized structured demand information system with partners	4.30	0.742
8	Use of IT/IS for accessing departmental information	4.29	0.758
9	Use of IT/IS for supplier enrichment for technological know	4.26	0.711

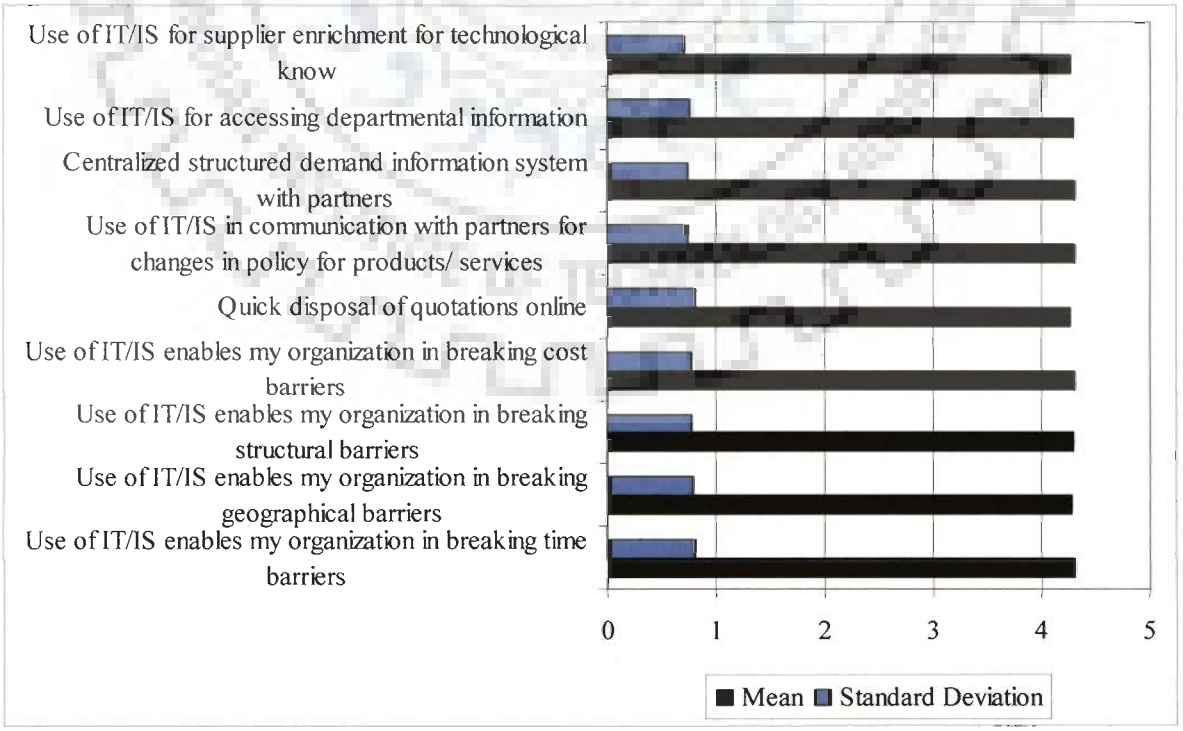

Figure 4.5d Level of IT acceptance related to IT based linkages for cooperation

Table 4.4a Best practices related to human dimension

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Cross training of employees takes place regularly	4.30	0.812
2	Employees preference to use IT/IS towards organizational goals is reviewed periodically	4.26	0.818
3	Responsibilities are shared and can be rotated with the help of IS	4.28	0.798
4	All processes are open for quality improvement using IT/IS	4.29	0.769
5	TQM (Total Quality Management) practices for IT/IS	4.26	0.809
6	Use of IT/IS in employees trust linkages	4.28	0.783
7	Sue of IT/IS in collaborative information sharing	4.25	0.807
8	Use of balanced scorecard for performance measurement	4.27	0.788
9	Preference for collaborative planning for IT enabled business	4.23	0.809

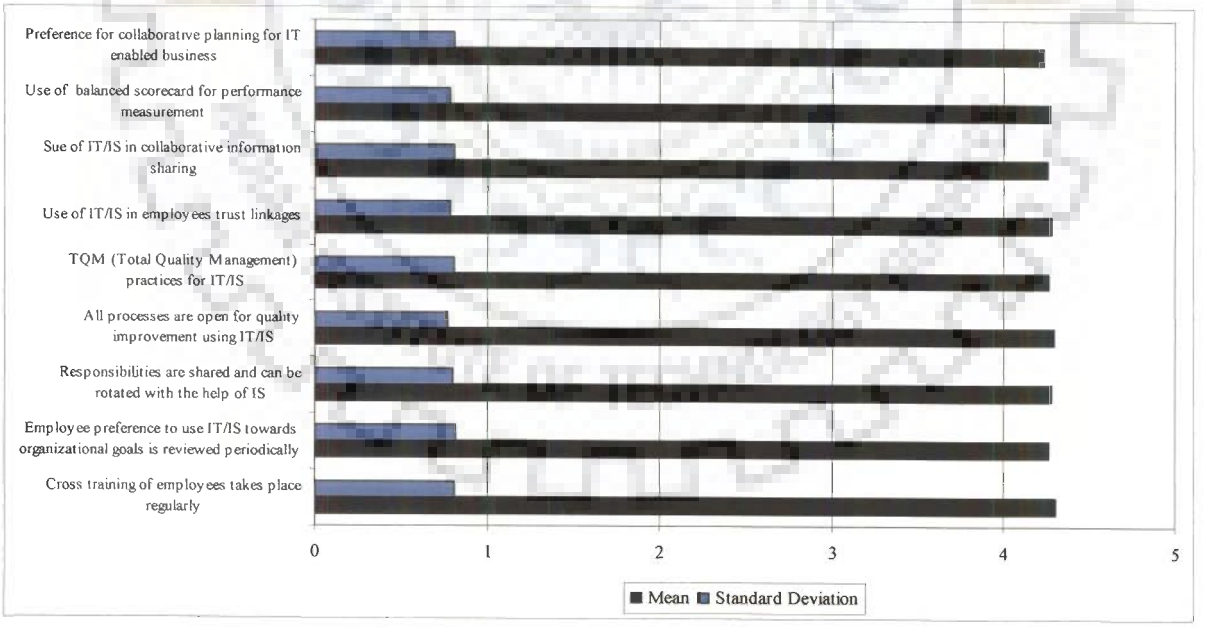

Figure 4.6a Best practices related to human dimension

Table 4.4b Best practices related to customer service

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Barrier of security in sharing customer information	4.27	0.813
2	Sue of IT-enabled business process for customer responsiveness	4.24	0.788
3	Top management commitment for useful information	4.26	0.766
4	Use of IT/IS in sales and service	4.27	0.770
5	High level of information sharing for customers	4.26	0.801
6	Practices of virtual customer servicing	4.27	0.743
7	Interaction between business and IT staff for designing the business processes and technology	4.24	0.770
8	Target costing adoption	4.29	0.758
9	Customer focused organization	4.21	0.785

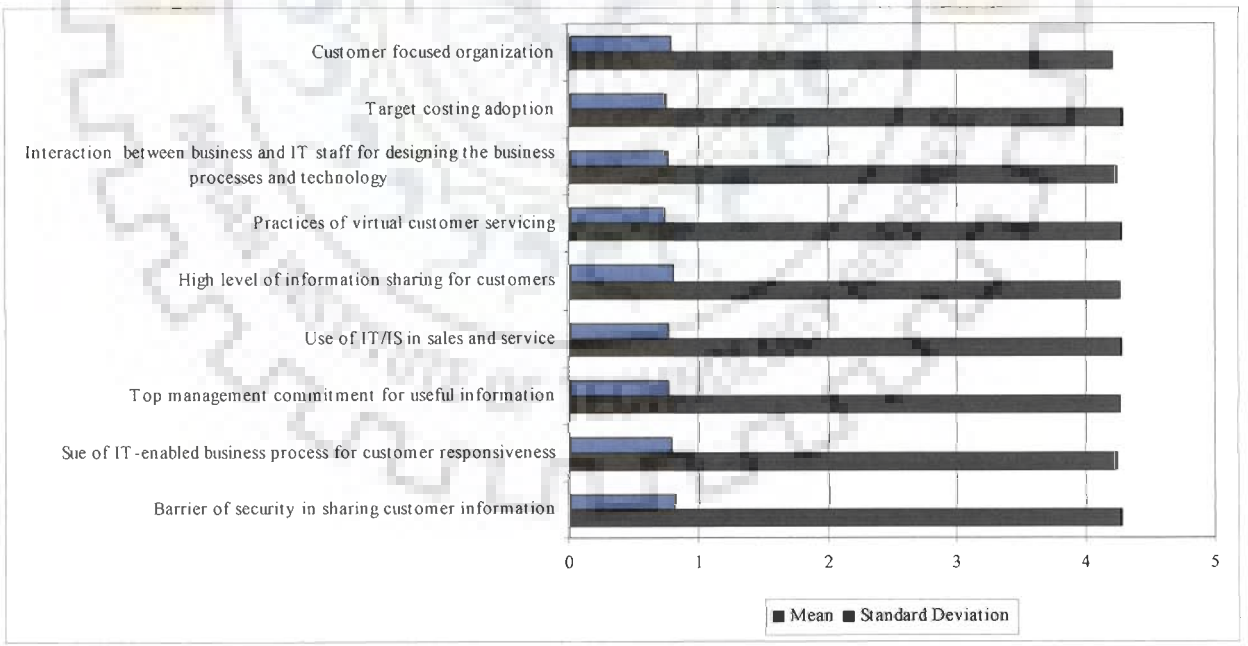

Figure 4.6b Best practices related to customer service

Table 4.4c Best practices related to IT based asset management

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Benefits from Bar-coding software	4.26	0.820
2	Benefits from hosting its own website	4.22	0.787
3	Benefits from using Enterprise Resource Planning (ERP)	4.25	0.773
4	Availability of reliable IT infrastructure	4.25	0.807
5	Ability to keep online secured information	4.21	0.802
6	Influence of forecasting uncertainties for IT enabled business processes	4.28	0.783
7	Practices of IT enabled purchasing	4.25	0.807

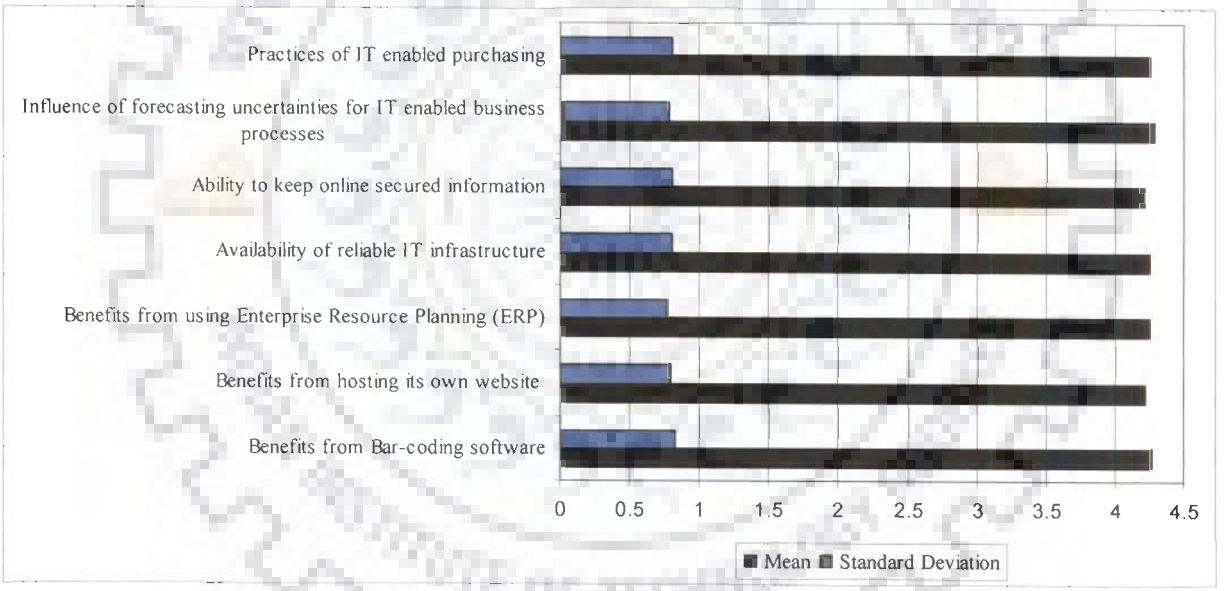

Figure 4.6c Best practices related to IT based asset management

Table 4.4d Best practices related to information technology strategy

Sr. No	Descriptions	Mean Value (μ)	Standard Deviation (σ)
1	Use of organization wide IT strategy	4.30	0.812
2	Communication with the trading partners boosts IT enabled business processes	4.26	0.786
3	Improvement of overall efficiency is an outcome of IT/IS	4.27	0.784
4	Use of IT/IS in maintaining quality and warranty of product/services	4.28	0.772
5	Use of computers in business activities pertains to accounts and finance	4.26	0.803
6	Computer enabled network for manufacturing scheduling	4.31	0.755
7	Practices of vendor management inventory system (VMI)	4.24	0.820
8	Use of third-party logistics (3PL) system	4.28	0.763
9	Use of IT/IS by warehouse and logistics service providers	4.17	0.777

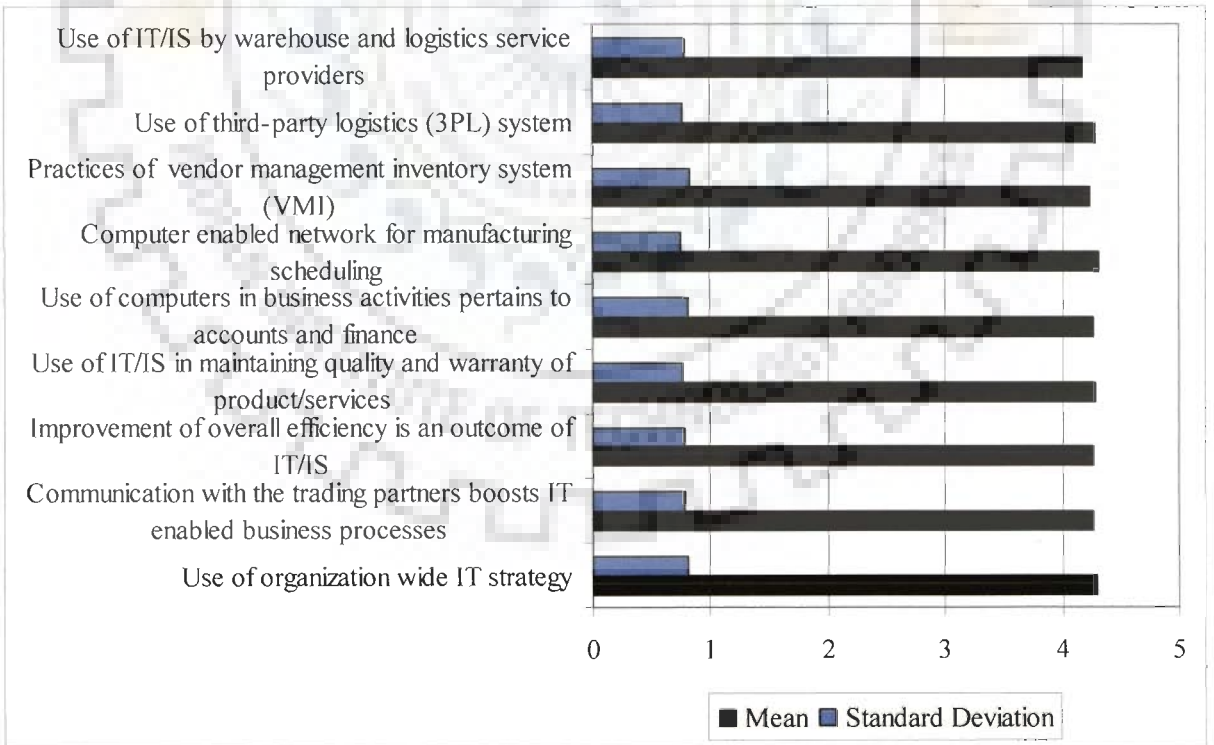

Figure 4.6d Best practices related to information technology strategy

Figure 4.7: Correlation between financial gain and standardized investment on IT/IS in the firms included in the survey (N=76)

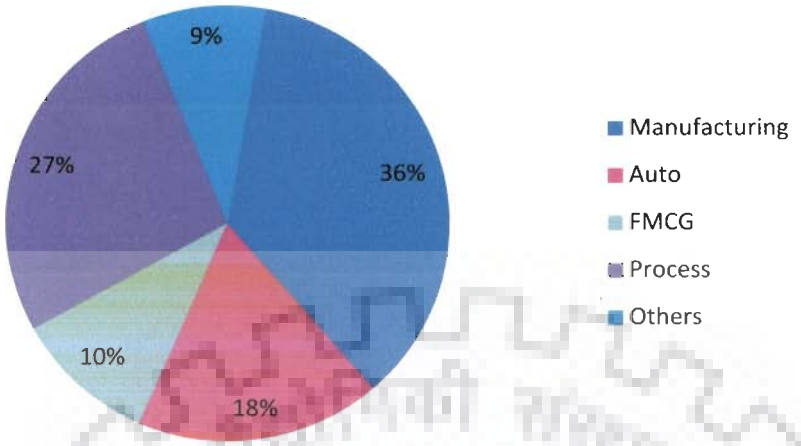

Figure 4.8a Sector wise break-up of executives from firms admitting to an increased investment in IT/IS infrastructure

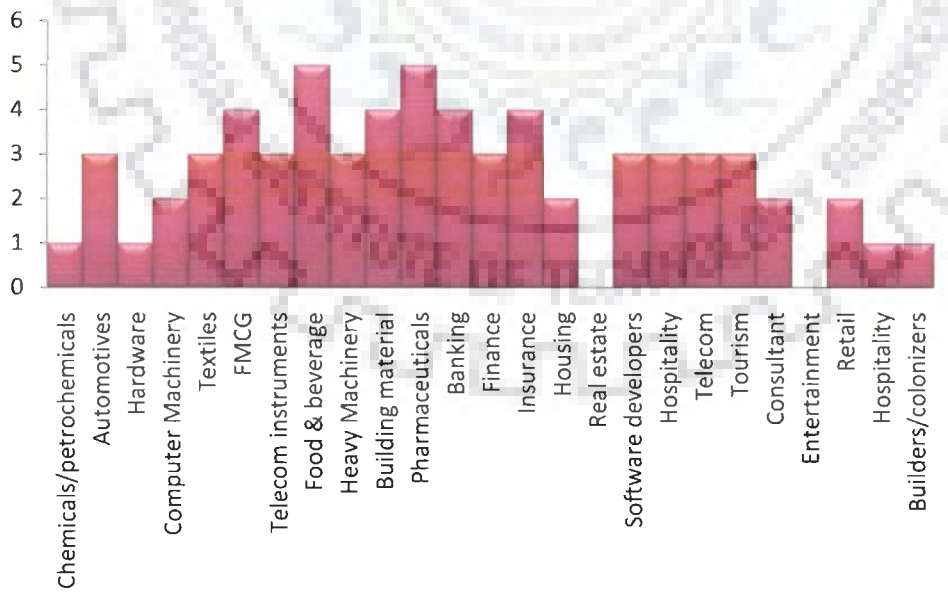

Figure 4.8b Sector wise breakup of executives from firms attempting agile technologies by accepting IT/ IS and its use for business operations

Chapter 5

Hypotheses Testing

In this chapter, validity of various hypotheses, which have been formulated in the previous chapter have been tested. These hypotheses have been tested using SPSS 16.0 software. Regression analysis and Independent sample t-test have been used to test these hypotheses. The result of regression analysis and Independent sample t-test reveal various important considerations and their importance in maintaining agility in organizations.

5. Hypotheses Testing

Multiple linear stepwise regressions have been conducted to test the hypotheses on SPSS 16.0 software. To check the validity of multiple linear regression, the independent variables belonging to the regression equation are always mutually independent and thus don't have either strong dependence or correlation among themselves. The linear regression equation between the dependent and independent may be formulated there is no linear dependency among the predictor variables (George and Mallery, 1999). Variables that correlate higher than 0.5 should be analyzed carefully before they are taken in regression calculation.

The regression analysis for testing the hypotheses have been conducted, the Pearson correlation coefficients for the independent variables have been calculated and used. The correlation coefficients indicate that a negligible interaction exists between the independent

variables. Therefore, linear stepwise regression analysis can be used in testing of the hypotheses. The hypotheses formulated earlier are presented as quick reference.

5.1 Hypothesis 1

Customer demands are met with (i) Adopting new technology, (ii) Bringing changes in the organization, and (iii) Launching new products.

A multiple linear stepwise regression analysis using SPSS 16.0 software is employed to test this hypothesis (Table 5.1). In the analysis the dependent variable I "Meeting customers' demands" whereas the independent variables considered are: "Change in order quantity", "Adopting new technology", and "Launching new products". The result of this analysis have been presented in Table 5.1

Table 5.1 Regression Analysis for Hypothesis 1

	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constants)	0.516	0.402		1.562	0.223
Adopting new technology (CI:4)	0.374	0.069	0.486	5.562	0.000
Bringing changes in the organization (CI:6)	0.347	0.68	0.356	4.421	0.002
Launching new products (CI:8)	0.202	0.61	0.256	3.618	0.000

R^2 =0.417 Dependent Variables: Meeting customers' demands (CI-1)

The regression model derived from this analysis is: Increased customer satisfaction relationship =0.516 + 0.374 *sustainable quality and customization* + 0.347 *reconfigurable product* + 0.202 *flexibility and adaptability*.

5.2 Hypothesis 2

Customer satisfaction increases with agile capabilities of organization by (i) Sustainable quality and customization (ii) Introduction of reconfigurable products (iii) Offering total solution, and (iii) Flexibility and adaptability

A multiple linear stepwise regression analysis using SPSS 16.0 software is employed to test this hypothesis (Table 5.2). In the analysis the dependent variable I "customer satisfaction" whereas the independent variables considered are: "sustainable quality and customization', "Introduction of reconfigurable products", "Offering total solution" and "Flexibility and adaptability". The result of this analysis have been presented in Table 5.2.

Table 5.2 Regression Analysis for Hypothesis 2

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constants)	0.196	0.462		0.421	0.621
Sustainable quality and customization (CIII:3)	0.486	0.106	0.406	4.723	0.000
Introduction of reconfigurable products (CIII:5)	0.245	0.85	0.289	3.132	0.002
Offering total solution (CIII:6)	0.179	0.75	0.198	2.231	0.021
Flexibility and adaptability (CIII:9)	0.156	0.61	0.174	2.219	0.025

R^2 =0.417 Dependent Variables: Improved customer satisfaction (CIII-1)

The regression model derived from this analysis is: Increased customer satisfaction relationship =0.196 + 0.486 *sustainable quality and customization* + 0.245 *reconfigurable product* + 0.179 Offering total solution + 0.156 flexibility *and adaptability.*

From the above regression equation, it is evident that the coefficient of "Sustainable quality and customization" has value of 0.486 which is eventually maximum thus it can be concluded that it has the maximum influence on the dependent variable of "Improved customer satisfaction". However the influence measured by considering only the coefficient

value will be unfair hence the consideration of Beta coefficients will give more comparable results with improved accuracy hence the Beta values are compared.

From table 5.2, it is evident that the "Sustainable quality and customization" (beta=0.406) is the most influencing one than the others. The t-statistics also leads to a relative importance of constant of each variable considered in the present model. The t- value corresponding to the "Sustainable quality and customization" is found to be 4.723 whereas for Introduction of reconfigurable products" is 3.132 which may be regarded as higher values considering the other t- values of the variables. The present model with four independent variables gives R^2=0.417. The R^2 value implies 41.7% variability in the customer satisfaction. As all the independent variables influence the "customer satisfaction" at a high significance level (p value less than 0.025) the hypotheses is accepted.

5.3 Hypothesis 3

Manufacturing sector and Auto sector exhibit more agility as compared to other sectors in the organizations of the root sample.

In the question related to this hypothesis, respondent were asked to assign weightage while considering their organization as "Agile". Five-point likert scale was used to measure the responses. The value 1 and 5 correspond to very low and very high weighatge respectively. The following table (Table 5.3) shows the descriptive of the four sectors:

Table 5.3 Descriptive Statistics related to Hypothesis 3

Issue of comparisons	Sector	Mean	N	Standard deviation
Weighatge to Agility prevailing in the sector	Manufacturing	3.1956	54	1.1597
	Auto	2.5689	40	1.0775
	FMCG	1.9856	29	0.9394
	Process	1.7521	25	0.7895
	Total	2.4574	148	1.1345

It is observed from the descriptive statistics that "Manufacturing "sector companies are more agile than the others in the market.

Table 5.4 Independent sample t-test for Agility in Organization

(Manufacturing versus rest)

Issue of comparisons	Test Results	Mean value
Weighatge to Agility prevailing in the organization	2.754[a] 100[b] 0.005[c]	3.1985[d] 2.451[e]

Where [a] t value , [b] degree of freedom , [c] 2-tailed significance , [d] mean of manufacturing sector and auto sector, [e] mean of rest of the sector .

The test result reveals that the manufacturing sector and auto exhibit agility and behaves significantly different (at p=0.006 level) among the other sectors i.e. FMCG and Process sectors. The result of the t-test as shown in Table 5.4, the result obtained is valid at a significant level of 0.005 therefore the hypothesis is accepted.

5.4 Hypothesis 4

Manufacturing sector and Auto sector continuously change strategy to remain competitive.

In the question related to this hypothesis, respondent were asked to assign weightage to in use of strategy to be a competitive organization. Five-point likert scale was used to measure the responses. The value 1 and 5 correspond to very low and very high weighatge respectively. The following table (Table 5.5) shows the descriptive of the four sectors:

Table 5.5 Descriptive Statistics related to Hypothesis 4

Issue of comparisons	Sector	Mean	N	Standard deviation
Weighatge to use of strategy prevailing in the sectors	Manufacturing	2.0331	54	1.1132
	Auto	1.9140	40	1.0725
	FMCG	1.6956	29	0.9500
	Process	1.6010	25	0.8962
	Total	2.0364	148	1.1223

It is observed from the descriptive statistics that "Manufacturing "sector companies are more agile than the others in the market.

Table 5.6 Independent sample t-test for changing Strategy to be competitive (Manufacturing versus rest)

Issue of comparisons	Test Results	Mean value
Weighatge to strategy use prevailing in the organization	2.231[a] 100.952[b] 0.004[c]	2.1081[d] 2.011[e]

Where [a] t value , [b] degree of freedom , [c] 2-tailed significance , [d] mean of manufacturing sector and auto sector, [e] mean of rest of the sector .

The test result reveals that the manufacturing sector and auto exhibit often changes strategies to remain competitive thus behaves significantly different (at p=0.004 level) among the other sectors i.e. FMCG and Process sectors. The result of the t-test as shown in Table 5.6, the result obtained is valid at a significant level of 0.004 therefore the hypothesis is accepted.

5.5 Hypothesis 5

Process sector believes in following liberal agile strategy.

In the question related to this hypothesis, respondent were asked to assign weightage in using agile strategy. Five-point Likert scale was used to measure the responses. The value 1 and 5 correspond to very low and very high weighatge respectively. The following table (Table 5.7) shows the descriptive of the four sectors:

Table 5.7 Descriptive Statistics related to Hypothesis 5

Issue of comparisons	Sector	Mean	N	Standard deviation
Weighatge to use of strategy prevailing in the sectors	Manufacturing	2.8312	54	0.8412
	Auto	2.4621	40	0.8310
	FMCG	2.6956	29	0.8111
	Process	2.3120	25	0.8162
	Total	2.985	148	0.9871

It is observed from the descriptive statistics that "Process" sector follows a liberal agile strategy. An independent sample t-test is conducted to test this hypothesis (Table 5.8). The process sector is compared against rest of the sectors.

Table 5.8 Independent sample t-test for using agile strategy (Process versus rest)

Issue of comparisons	Test Results	Mean value
Weighatge to follow liberal agile strategy	2.201^{a} 0.43^{b} 0.043^{c}	2.9081^{d} 2.811^{e}

Where [a] t value , [b] 2-tailed significance , [c] mean of process sector , [d] mean of rest of the sectors.

The result reveals that the process sector behaves significantly different (at p=0.043 level) among. The result of the t-test as shown in Table 5.8, the result obtained is valid at a significant level of 0.043 therefore the hypothesis is accepted.

5.6 Hypothesis 6

Manufacturing Sector pays more attention in technology utilization for competition.

The importance to various IT/IS related activities practicing in each sector i.e Manufacturing, Auto, FMCG and Process was confirmed by asking the respondent about their usage. Their preference of using the following activities were recoded on five-point Likert Scale, where one corresponds to very low and five corresponds to very high. The mean value of the importance assigned by the different sectors for ach of such activities involving the use of IT/IS toward becoming more competitive, thus measured and shown in Table 5.9.

Table 5.9 Descriptive Statistics for Hypothesis 6

Issue of comparisons	Sector	Mean	N	Standard deviation
Organization wide IT strategy	Manufacturing	4.2312	54	0.8412
	Auto	2.4621	40	0.6310
	FMCG	3.6956	29	0.9111
	Process	2.5120	25	0.8162
Effective communication with the trading partners using IT for high business performance	Manufacturing	4.0312	54	0.8912
	Auto	2.0411	40	0.9310
	FMCG	3.5956	29	0.9111
	Process	2.0120	25	0.7162
Practicing IT/IS and boosting overall efficiency	Manufacturing	4.1312	54	0.8472
	Auto	2.8621	40	0.8410
	FMCG	2.9956	29	0.8191
	Process	2.1120	25	0.8562
	Total	2.985	148	0.9871
Maintaining quality and warranty of product/services using IT/IS	Manufacturing	4.1312	54	0.9412
	Auto	2.9621	40	0.7310
	FMCG	3.9956	29	0.88111
	Process	2.1120	25	0.9162
Computer assisted accounts and finance	Manufacturing	4.1342	54	0.9412
	Auto	3.1621	40	0.7350
	FMCG	3.7956	29	0.8911
	Process	2.3820	25	0.8262
Use of computer enabled manufacturing scheduling	Manufacturing	4.0312	54	0.9412
	Auto	2.4551	40	0.8380
	FMCG	2.6456	29	0.8711
	Process	2.3350	25	0.7162
	Total	2.1985	148	0.9871

Issue of comparisons	Sector	Mean	N	Standard deviation
Use of VMI (Vendor Managed Inventory) system	Manufacturing	4.8312	54	0.9412
	Auto	3.4621	40	0.9310
	FMCG	3.9956	29	0.7911
	Process	2.3120	25	0.7162
Use of 3PL (Third party logistics) system	Manufacturing	4.8312	54	0.8412
	Auto	2.4621	40	0.6310
	FMCG	4.6956	29	0.7111
	Process	2.8120	25	0.8162
Use of warehouse and LSP (logistics service providers) share information through IT/IS	Manufacturing	4.0312	54	0.8412
	Auto	2.4621	40	0.5310
	FMCG	4.1956	29	0.5111
	Process	2.3320	25	0.8162

Where [a] t value , [b] 2-tailed significance , [c] mean of manufacturing sector , [d] mean of rest of the sectors.

Table 5.10 Independent sample t-test for paying more attention in technology utilization (Manufacturing versus rest)

Items	Test Results	Mean value
Practicing IT/IS and boosting overall efficiency	3.291[a] 0.002[b]	4.2081[c] 3.1801[d]
Effective communication with the trading partners using IT for high business performance	4.401[a] 0.000[b]	4.2081[c] 3.1121[d]
Practicing IT/IS and boosting overall efficiency	4.211[a] 0.003[b]	3.2985[c] 2.8125[d]
Maintaining quality and warranty of product/services using IT/IS	4.201[a] 0.001[b]	3.2081[c] 2.9457[d]

Items	Test Results	Mean value
Computer assisted accounts and finance	3.002[a] 0.004[b]	4.2081[c] 2.1245[d]
Use of computer enabled manufacturing scheduling	3.351[a] 0.005[b]	3.1271[c] 2.8701[d]
Use of VMI (Vendor Managed Inventory) system	3.201[a] 0.002[b]	3.2001[c] 3.1471[d]
Use of 3PL (Third party logistics) system	3.331[a] 0.000[b]	3.8801[c] 2.9871[d]
Use of warehouse and LSP (logistics service providers) share information through IT/IS	3.701[a] 0.001[b]	3.9087[c] 2.911[d]

Table 5.9 shows a difference between the manufacturing sector and other sectors on employing technology to be more competitive. To test the particular hypothesis, the importance assigned by the respondent to usage of new technology having IT/IS in various business activities to be more competitive, an independent sample t-test has been carried out which is shown in Table 5.10.

The result of the t-test indicate that for all the items, which have been practiced by various sectors, out of which the manufacturing sector shows more mean value assigned to their business related activities. From the respondent point of view the manufacturing sector also exhibit significant value (p value of 0.05 or less). Therefore, the given hypothesis is accepted.

5.7 Discussion

In this chapter, an attempt has been made to examine the current practices of IT/ IS and Technology by various sectors in India. Four broad sectors namely Manufacturing, Auto, FMCG and Process have been targeted for the in-depth study. A questionnaire based survey was administered which reveals the important outcome from the prevailing practices.

From the survey it is evident that the various sectors have adopted agile practices in order to be a competitive. The sectors have also invested in IT/IS and Technology to remain agile and competitive in the global market. An agile organization meets the customer demand by various agile practices. The respondent revealed various agile practices in manufacturing, auto, FMCG and process sectors. The various practices like adopting new technology, brining changes in the organization and launching new products influence the customers demand and satisfaction.

Customers' satisfaction may be boosted by practicing for sustainable quality and customization, introducing new configurable products and adopting flexibility and adaptability in the organization. The various hypotheses are tested. Among the various sectors manufacturing and auto sectors propagates more agility in comparisons to FMCG and Process sectors, thus sectorial change pervades in the industry which lead them to adopt various strategy to remain agile to remain in the global market

Hypothesis pertaining to process sector was tested in following a liberal agile strategy. On the basis of respondent's reply, t-test was carried out to check the influence of the same. The t-test so conducted revealed that the process industry does follow the liberal policy compare to other sectors like manufacturing, auto and FMCG.

5.8 Conclusion

In this chapter a questionnaire- based survey has been conducted to understand agile practices in Manufacturing, Auto, FMCG and Process sectors. Various hypotheses have been proposed and tested usefully for its validity. The results reveal that all the four sectors Manufacturing, Auto, FMCG and Process behave in distinct manners in practicing Agile.

Chapter 6

Model to outrank an Agile Organization for Effective Business Management

In this chapter an Analytic network process (ANP) model has been proposed to outrank an agile organization for effective business management. The present chapter deals with analytic network based approach for outranking an agile organization that is capable of managing effective business management. ANP is used to form outranking model for the effective business management considering all the attributes of the agile organization. ANP approach provides the advantage of 'system approach'. It enables to form network of hierarchy in order to ascertain the influence of each attributes influencing an organization to become an agile one.

ANP model is prepared based on the feedback from experts which is an additional part. Pairwise decision matrix were obtained through discussion and verified. The decision matrices were checked for its consistency. It was assumed that:

a) Organization **A** has an ability to innovate faster and in novel way and has ability to achieve high performance, while **B** has less ability to innovate at faster pace to exhibit required ability to achieve high performance. Whereas organization **C** doesn't have ability to accommodate the changing requirements from customer thus succumbs to customer change pressure.

b) Hierarchy of the ANP model was based on the factors obtained through literature survey and was cross checked with the experts.

6. Introduction

Agile organization is a relatively new research topic. Although few academic studies have been carried out this explores the organizational adaptation to the environment in the strategic and organizational literature. An organization adopting an agile practice successfully can prosper as a dynamic organization capable of delivering the highest business value in a hyper-efficient way. As per Bourgeois (1980 & 1985), an organization may fails to control an environment possessing sources of opportunity and threats because of the set of external contextual elements that falls outside the management control. Empirical research has successfully proved that those organizations which have been able to adapt to their external environment more quickly exhibited good results than the others with poorer results. Agility has therefore been considered as an essential capability for operating in turbulent business environments (Goldman *et al.*, 1995; Sharifi and Zhang, 1999; Maskell, 2001; Yusuf and Adeleye, 2002; Adeleye and Yusuf, 2006).

According to Vázquez-Bustelo *et al.*, (2007), the concept of turbulence in the environment is misleading as few studies correlate turbulence with dynamism, irrespective of its creation. The turbulent environment is considered as the survival situation which is generally the worst in business scenario. It is the firm which shows successful working which meets the high levels of agility. Such an organization adapts itself to the prevailing market situation.

6.1 Modeling of Agility using ANP

The analytic hierarchy process (AHP) is a simple mathematically based multi-criteria decision-making tool to deal with complex, unstructured and multi-attribute problems. AHP represents a framework with a uni-directional hierarchical relationship, whereas ANP allows for more complex interrelationships among decision levels and attributes. The ANP feedback

approach replaces hierarchies with networks to solve problems in which the relationships between levels are not easily represented as higher or lower, dominated or being dominated, directly or indirectly (Meade and Sarkis, 1999).

Although AHP is capable of dealing with outranking problem of agile organization by generalizing subjective judgment of experts; it cannot deal with the inter-relationship among factors precisely. Moreover, ANP is a comprehensive decision-making technique that has the capability to include all the relevant criteria, which have some bearing, in arriving at a decision. To take care of the direct and indirect relationship among the variables ANP model may be incorporated.

In order to outrank agile organization for the business effectiveness using ANP approach, various Determinants, Dimension and Enablers of agile organizations for business effectiveness may be incorporated. However modeling with more number of Determinants, Dimension and Enablers warrant the need of customized software taking care of pairwise comparison at various levels. Increase in variable results in more number of pairwise comparison matrices as in the present case where 162 matrices have been formed. A balancing between number of criteria inclusion and accuracy of results required could be the decisive factors in such situations. Intensive literature review revealed many researchers modeling different number of criteria for instance Meade and Sarkis (1999) modeled 28 criteria; Agarwal et al., (2005) modeled 20 criteria, Raisinghani and Meade (2005) modeled 16 criteria. Looking at the capability of Excel and complex calculations involving number of pairwise matrices 25 criteria have been identified for model preparation using ANP approach.

6.1.1 General advantages of Analytic Network Process (ANP) over Analytic Hierarchy Process (AHP)

ANP has been preferred over AHP due to the following reasons:

(i) AHP is largely based on a strict hierarchical structure and relationship among factors, which does not allow for the possibility of having top-to-bottom and bottom-to-top interdependent relationships among group of factors, or for interdependent relationships within a cluster of factors. Whereas ANP goes beyond linear relationships and pervades through factors to permit interrelationships among them. AHP hierarchy is replaced by a network in an ANP based system thus permitting multi directional relationships with dependence and feedback. Therefore, ANP is more powerful than AHP in the decision environment with uncertainty and dynamics (Saaty, 1999; Taslicali and Ercan, 2006).

(ii) In the ANP rank reversal problem may be appeased, hence it is more accurate and useful (than the AHP) as a decision support system for complex scenario. While the ANP and the AHP are based on user supplied preferences among the factors and provide utility weights for the alternatives, they differ from each other in the number and types of pairwise comparisons, and also in the manner in which utility weights are actually computed (Cheng and Li, 2004).

(iii) According to Taslicali and Ercan (2006) managerial advantages also prevails in using Analytic Network Process over Analytic Hierarchy Process for instance ANP process facilitates inter-functional and inter-level discussions thus the group of managers (or decision makers) evaluating the factors may have liberty to consider many operational aspects as well. ANP also provides a structured decompositional method for addressing the wide array of factors, instead of relying purely on intuition to evaluate all the intangible factors. Thus quantification of such factors yields more advantages and justifies the use of ANP despite being a network of complex

relationship and time consuming calculations. However, managers may use spreadsheet to solve complex computation of ANP up to some extent. Managers may reduce the complexity of calculations by restricting the number of determinants, dimensions and enablers. The number of pairwise comparisons generated depends upon the size of determinants, dimensions and enablers.

Based on the conceptual model by Vázquez-Bustelo and Avella (2006), various enablers can be grouped in to the following four groups:

- Human resource practices to develop highly-trained, motivated and empowered people working as a team;
- Systematic implementation and integration of advanced design, manufacturing and administrative technologies;
- Practices related to internal organization and external relations, including the development of mechanisms for integrating and coordinating the value chain, based on cooperation and integration of operations amongst departments in the firm and between the firm and external agents (suppliers, customers, partners, stakeholders, etc.);
- Practices relating to product development and/or design processes leading to concurrent engineering; and
- Practices relating to knowledge management and learning.

The determinants of agile organizations for business effectiveness found in literature are Flexibility, Quality, Cost, Delivery, Service, environments etc. Various dimensions obtained from the body of literature are (1) Agile human resources (2) Agile technologies (3) Value chain integration (4) Concurrent engineering and (5) Knowledge management. Various enablers to these dimensions are presented in Table 6.1.

ANP hierarchy structure used in Figure 6.1 is devised based on the criteria which are identified in literature. Determinants, Dimensions and Enablers for the structure are selected based on the discussion with experienced managers from MNCs holding key posts. However, some of the elements which deserved to be included in the structure were bypassed as they occurred less frequently in literature and discussions. These may be enlarged to provide more comprehensive coverage yet they would increase the complexity in computational process.

Table 6.1 Classified 25 Criteria (Determinants, Dimensions and Enablers) for Outranking Agile Organization

Determinants	Dimensions	Enablers
1. Flexibility (F)	5. Agile Technologies (AT)	9. Advanced design technologies (ADT)
		10. Advanced manufacturing technologies (AMT)
2. Quality (Q)		11. Integrated customer/supplier information systems (ICIS)
3. Cost (C)		12. Integrated manufacturing information systems (IMIS)
4. Delivery (D)		13. Planning systems (PS)
	6. Knowledge Management (KM)	14. Organizational systems to support experimentation (OSSE)
		15. Accessible databases (AD)
		16. Working teams that access, apply and update knowledge (WT)
		17. Formal mechanisms to disseminate best practices (MDP)
		18.Tacit Knowledge (TK)
	7. Concurrent Engineering (CE)	19. Inter-departmental cooperation (IDC)
		20. Cooperation with suppliers (CS)
		21. Cooperation with customers (CC)
	8. Value chain Integration (VCI)	22. Simultaneous product and process development (SPPD)
		24. Early involvement (EI)
		25. Close collaboration throughout the process (CCP)

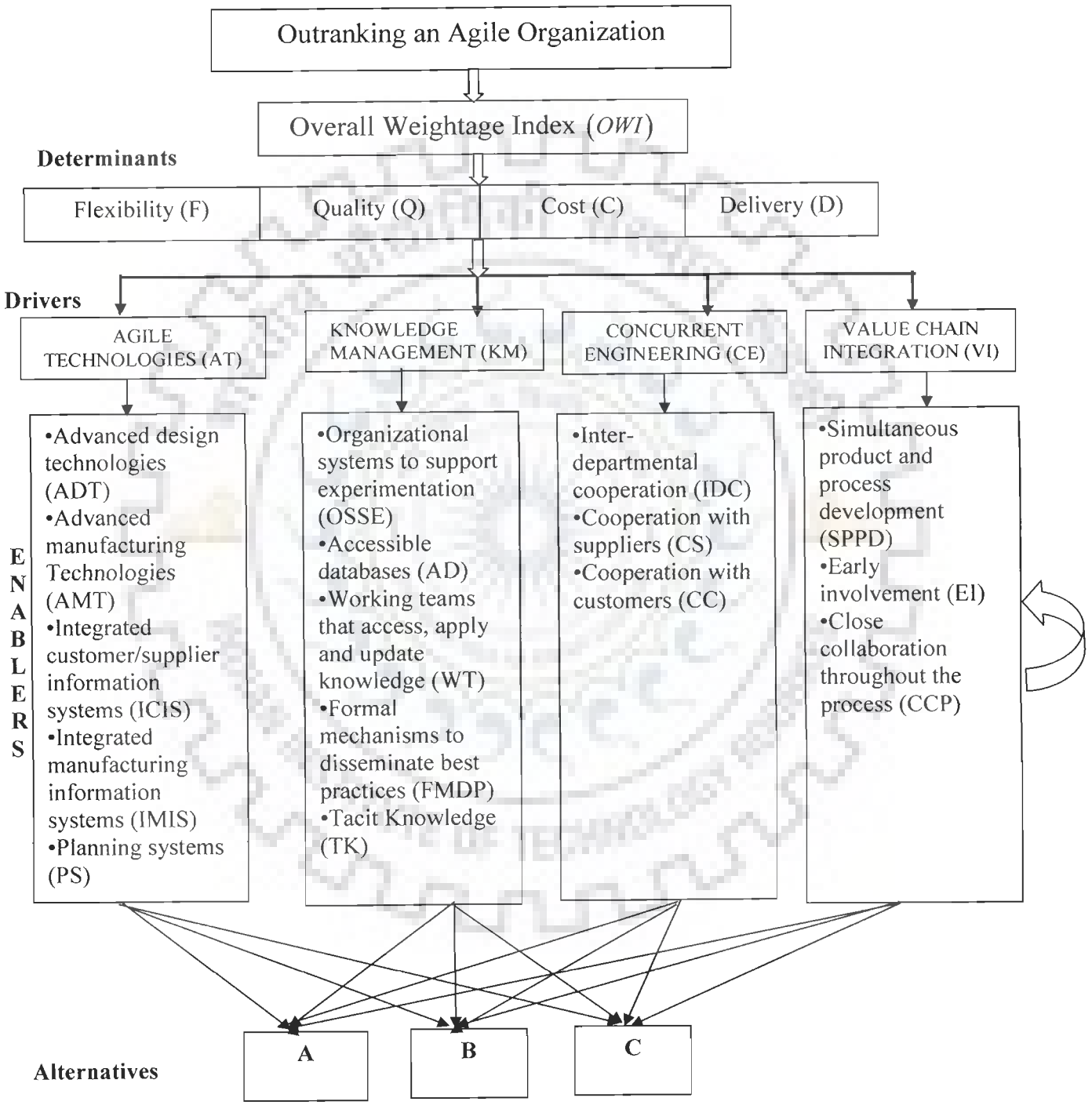

Figure 6.1 ANP Model for Outranking an Agile Organization

6.2 Introductions to Analytic Network Process (ANP)

Analytic Network process (ANP) has a potential to ascertain the relative importance that captures all the indirect interactions in a network. Thus provides easy access to various hierarchies. ANP is based on relative measurement of a general theory to deduce composite priority ratio scales by using individual ratio scales to represent relative influence of each element that interact with respect to control criteria (Saaty, 1999). ANP thus leads to a supermatrix with column priorities which may be used to capture the outcome of dependence and feedback within and between clusters of elements (Layers).

ANP is being considered as superior to Analytic hierarchy process (AHP) as AHP fails to capture the influence among the attributes which affecting the objective function. As per Saaty (2001), it is a special case of the AHP with its dependence assumptions on clusters and elements. AHP permits one-directional hierarchical structure with the assumption of mutual independence of elements, while ANP considers interdependence as well as feedback in the hierarchy. Both the methods employ synthesizing process to establish final goal viz. AHP considers global priorities resulting from hierarchical structure, whereas, ANP derives the overall priority by employing supermatrix formation.

6.3 ANP Methodology

The ANP problem involves 162 matrices as shown in table 6.2. A sincere attempt has been made to cover the process of ANP considering one Determinant, Dimension and Enabler, Alternative. All matrices are prepared and presented based on the methodology presented by Meade and Sarkis (1998,1999), Agarwal et al., (2005). The suggested ANP based methodology contains five-step process as described in Figure 6.2.

Determinants	4
Dimensions	4
Enablers	16
Alternatives	3
No of Matrices	
PWC of Determinants	*1*
PWC of Dim	*4*
Enablers(16*4)	*64*
Enablers –Dimensions for Determinants	*16*
PWC of Enb-Altre	*64*
Supermatrix before before Convergence	*4*
Supermatrix after Convergence	*4*
Final Matrix	*4*
Comparisons of Alternatives	*1*
Total Matrix	***162***

Table 6.2: The matrices involved in ANP problem using one enabler, determinant, dimension and alternative.

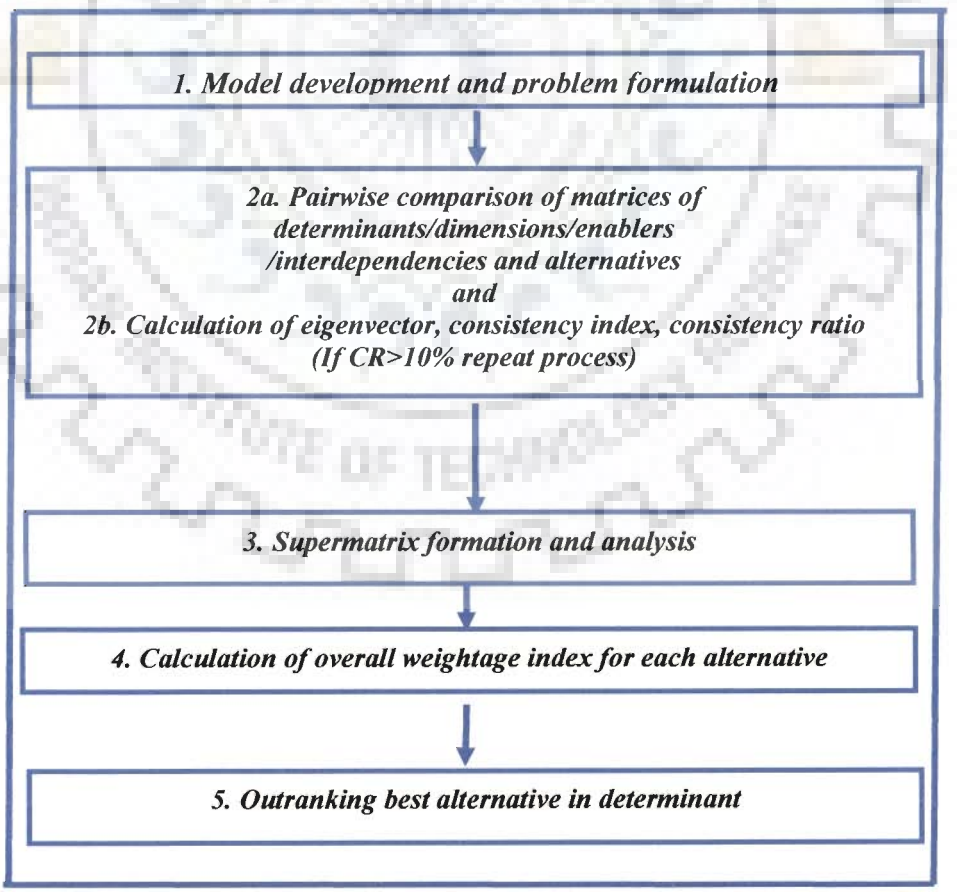

Figure 6.2: ANP Methodology Adopted to Outrank Agile Organization

Step 1. Model development and problem formulation

Many researches (Vázquez-Bustelo and Avella, 2006; Gunasekaran, 1998, and 1999; Sharifi and Zhang,1999; Maskell, 2001;Gunasekaran and Yusuf, 2002, Zhang and Sharifi, 2000) have recommended various criteria for an agile organization. A group of Decision Makers (DM) has been involved for the decision making for outranking an agile organization for business effectiveness. ANP model has been developed based on the criteria identified. The criteria have been classified in to various levels for instance determinants, dimensions, and enablers as depicted in Figure 1.

Higher level criteria or the determinants play a vital role in strategic decision making thus the criteria of *Flexibility* (F), *Quality* (Q), *Cost* (C) and *Delivery* (D) of agile organization are of utmost importance, hence grouped in highest level. In the middle-level criteria are termed as dimensions, these are *Agile Technologies* (AT), *Value Chain Integration* (VI), *Concurrent Engineering, Knowledge Management* (KM). The third-level criteria in the ANP model are termed as enablers. The enablers support the respective dimensional criteria as well as other enabler. Hence interdependencies persist amongst the enablers which are also shown in the figure 6.1.

The various organizations alternatives for business effectiveness are placed at the bottom for the required decision making. In the ANP approach, with the allowance of interdependencies occurring among criteria and criteria levels, the graphical representation may include two way arrows (or arcs) among levels. A looped arc is used to show the interdependent relationships that occur within the same level of analysis. The directions of the arcs signify dependence and arcs emanate from an attribute to other attributes that may influence it. The developed model is in

accordance to other models found in the literature (Meade and Sarkis, 1998; Agarwal *et al.*, 2005; Jharkharia and Shankar, 2007).

Step 2 (a &b). Pairwise comparison and Consistency Checking

A pairwise comparison will give the relative importance of the criteria. Hence using the Saaty scale (Saaty, 1980) various comparisons may be made with consistency check as described below:

(i) Construct a pairwise comparison matrix using a scale of relative importance. The judgments are entered using the fundamental scale of the AHP proposed by Saaty (1980). Using pairwise comparison, intensity of relative importance between two criteria can be established as shown in Table 6.3.

Table 6.3 Saaty's scale (1980)

Intensity of relative importance	Definition
1	Equally preferred
3	Moderately preferred
5	Essentially preferred
7	Very strongly preferred
9	Extremely preferred
2, 4, 6, 8	Intermediate importance between two adjacent judgments

Assuming M criteria, the pairwise comparison of criterion i with criterion j gives a square matrix Al_{MXM} where a_{ij} denotes the relative importance of criterion i with respect to criterion j. In the matrix, $a_{ij} = 1$ when $i = j$ and $a_{ji} = 1/a_{ij}$.

(ii) Find the relative normalized weight (W_i) of each criterion by calculating the geometric mean of ith row and normalizing the geometric mean of rows in the comparison matrix.

$$GM_i = \left(\prod_{j=1}^{M} a_{ij} \right)^{1/M}$$

and

$$W_i = GM_i \Big/ \sum_{j=1}^{M} GM_j$$

(iii) Calculate matrix $A3$ and $A4$ such that $A3 = A1 * A2$ and $A4 = A3/A2$, where $A2 = [W_1, W_2, \ldots, W_i, W_N]^T$.

(iv) Find out the maximum eigenvalue λ_{max} which is the average of matrix $A4$.

(v) Calculate the consistency index C.I. $= (\lambda_{max} - M)/(M-1)$. The smaller the value of C.I., the smaller is the deviation from the consistency.

(vi) Obtain the random index (R.I.) using Table 6.4, according to the number of criteria used in decision making.

Table 6.4 Average R.I. based on matrix size

N	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

(Source: adapted from Saaty, 1980)

(vii) Calculate the consistency ratio C.R. = C.I./R.I. usually, a C.R. of 0.1 or less is considered acceptable as it reflects an informed judgment which could be attributed to the knowledge of the analyst about the problem under study.

Step 2.1. Pairwise comparison of determinants

Table 6.5 shows the relative importance among the *Flexibility* (F), *Quality* (Q), *Cost* (C) and *Delivery* (D). The e-vectors calculated would be used in the calculation of overall weighted index (OWI).

Table 6.5 Pairwise Comparisons of Determinants

Determinants	F	Q	C	D	e-vector
Flexibility (F)	1.00	2.00	4.00	2.00	0.413
Quality (Q)	0.50	1.00	4.00	3.00	0.327
Cost (C)	0.25	0.25	1.00	0.33	0.079
Delivery (D)	0.50	0.33	3.00	1.00	0.181

λ_{max} = 4.1603, C.I.=0.053, R.I.=0.900, C.R.=0.059

The e-vectors (Local priority vector) are the weighted priorities obtained as under:

(i) Column total is obtained

1.0+0.5+0.25+0.5 =2.25 similarly 3.58, 12.00 and 6.33

(ii) Each entry in the column is divided by the respective column total

1.0/ 2.25+2.0/2.25+4.0/2.25+4.0/2.25=1.652

(iii) Row total so obtained is normalized to obtain e-vectors for further comparisons.

1.652/4=0.413 similarly 1.308/4=0.327, 0.317/4=0.079, 0.723/4 = 0.181

Thus the e-vectors corresponding to each row is 0.413, 0.327, 0.079, and 0.181. These e-vectors will be used in the calculation of OWI for alternatives

λ_{max}, C.I., R.I. and C.R. may be obtained to verify the acceptance of the decision matrix as shown below:

1.00x0.413+ 2.00x 0.327+4.00x0.079+2.0x0.181= 4.2271 similarly 4.2581, 4.0963, 4.0596 and

(4.2271 + 4.2581+ 4.0963+ 4.0596 =16.6411/4= 4.1603)

C.I.= (4.1603-1)/ (4-1)=0.053 whereas RI =0.900

(Refer Table 6.3 at n= 4 RI= 0.900)

Hence CR =0.053/0.9=0.059 which is less than 0.080 hence decision matrix is accepted

Step 2.2. Pairwise Comparison of Dimensions

Pairwise comparisons of various dimensions for a determinant can be derived using the AHP methodology described earlier. In outranking an agile organization, there are four matrices for the dimensions. One such matrix for the *compatibility* is shown in Table 6.6. Similar table for *cost of service*, *quality* and *reputation* can be derived. The results of this comparison (e-vectors) are carried as P_{ja} in Table 6.12.

Table 6.6 Pairwise Comparisons of Dimensions

Dimensions	AT	VCI	CE	KM	e-vector
Agile Technologies (AT)	1.00	3.00	4.00	3.00	0.492
Value chain Integration (VCI)	0.33	1.00	3.00	3.00	0.269
Concurrent Engineering (CE)	0.25	0.33	1.00	2.00	0.135
Knowledge Management (KM)	0.33	0.33	0.50	1.00	0.104

$\lambda_{max} = 4.2128$, C.I.=0.071, R.I.=0.900, C.R.=0.079

Step 2.3. Pairwise Comparison of Enablers

Generally, enabler influences the various dimensions and determinants in considered network with varying degree; therefore the impact of each enabler may be ascertained by pairwise comparison. The pairwise comparison of enabler can be carried out at various levels with respect to the upper level dimension and determinants.

In this step, the pairwise comparison of elements at each level is conducted with respect to their relative influence towards their control criterion. The pairwise comparison for a determinant is done among the applicable enablers within a given dimension cluster. One such pairwise comparison matrix for *Agile Technology* (AT) dimension under *Flexibility* (F) determinant is shown in Table 6.7.

Table 6.7 Pairwise Comparison Matrix for Agile Technologies under the Flexibility

Enabler	ADT	AMT	ICIS	IMIS	PS	e-vector
Advanced Design Technologies (ADT)	1.00	3.00	3.00	3.00	3.00	0.394
Advanced Manufacturing Technologies (AMT)	0.33	1.00	3.00	5.00	2.00	0.260
Integrated Customer/Supplier Information Systems (ICIS)	0.33	0.33	1.00	3.00	2.00	0.155
Integrated Manufacturing Information Systems (IMIS)	0.33	0.20	0.33	1.00	0.33	0.066
Planning Systems (PS)	0.33	0.50	0.50	3.00	1.00	0.125

$\lambda_{max} = 5.3850$, C.I.=0.0962, R.I.=1.12, C.R.=0.0859

Further calculation of Table 6.7 is explained below and in the form of Table 6.7 a

Table 6.7 a: Further calculation for pair-wise comparison matrix for AT under F

AT	ADT	AMT	ICIS	IMIS	PS	e-VECTOR	5		
ADT	1.00 (D41)	3.00 (E41)	3.00 (F41)	3.00 (G41)	3.00 (H41)	**0.394** (I41)	5.6236	RI	**1.12**
AMT	0.33 (D42)	1.00	3.00	5.00	2.00	**0.260** (I42)	5.5438	CI	**0.096251**
ICIS	0.33 (D43)	0.33	1.00	3.00	2.00	**0.155** (I43)	5.2948	CR=CI/RI	**0.085938**
IMIS	0.33	0.20	0.33	1.00	0.33	**0.066** (I44)	5.1681	<	**0.1**
PS	0.33	0.50	0.50	3.00	1.00	**0.125** (I45)	5.2947		
Col Tot	2.33	5.03	7.83	15.00	8.33	**1.000**	5.385002		

=(D41*I41+E41*I42+F41*I43+G41*I44+H41*I45)/I41 = 5.6236

=(D42*I41+E42*I42+F42*I43+G42*I44+H42*I45)/I42= 5.5438

=(D43*I41+E43*I42+F43*I43+G43*I44+H43*I45)/I43= 5.2948 and so on

CI= (5.385002-5)/(5-1)= 0.096251 , RI from table for n=5 RI =1.12 and so on

For the pairwise comparison, the question asked to the decision-maker is: 'what is the relative impact on *Agile Technology* (AT) by enabler a when compared to enabler b in improving *Flexibility* (F) of an organization for being agile for business activities? It is observed from Table 6.7 that the relative importance of *Advanced Design Technologies (ADT)* when

compared to *Planning Systems* (PS) with respect to *Agile Technology* (AT) in achieving *Flexibility* (F) is three times effective. It is also observed from Table 6.6 that enabler *Advanced Design Technologies (ADT)* has the maximum influence (0.394) on *Agile Technology* (AT) in achieving *Flexibility* (F) for being an agile organization for business activities. Similarly, *Integrated Manufacturing Information Systems* (IMIS) has the minimum influence (0.066) on *Agile Technology* (AT) in achieving *Flexibility* (F).

The number of such pairwise comparison matrices depends on the number of determinants and dimensions in the ANP model. In this model, 16 such pairwise comparison matrices are formed, which include four matrices for each of the four determinants. The e-vectors obtained from these matrices are imported as A^{D}_{kja} in Table 6.12.

Step 2.4. Pairwise Comparison Matrices for Interdependencies

Pairwise comparison matrices for interdependencies may be prepared for each enabler with reference to the determinant and dimension. One such pairwise matrix is shown in Table 6.8

Table 6.8 Pairwise Comparison Matrix for Agile Technology (AT) under the Flexibility (F) for Advanced Technology (AT)

Enabler	AMT	ICIS	IMIS	PS	e-vector
Advanced Manufacturing Technologies (AMT)	1.00	0.14	0.33	0.20	0.07
Integrated Customer/Supplier Information Systems (ICIS)	7.00	1.00	1.00	0.33	0.26
Integrated Manufacturing Information Systems (IMIS)	3.00	1.00	1.00	0.50	0.21
Planning Systems (PS)	5.00	3.00	2.00	1.00	0.46

$\lambda_{max} = 4.1957$, C.I.=0.0652, R.I.=0.90, C.R.=0.0724

Further calculation of Table 6.8 is presented below and in the form of Table 6.8 a

Table 6.8 a: Further calculation on Pair-wise comparison matrix for AT under F for advanced technology

ADT	AMT	ICIS	IMIS	PS	e-VECTOR	4		
AMT	1.00 (D31)	0.14 (E31)	0.33 (F31)	0.20 (G31)	**0.07** (H31)	4.0227	**RI**	**0.9**
ICIS	7.00	1.00	1.00	0.33	**0.26** (H32)	4.2474	**CI**	**0.06523**
IMIS	3.00	1.00	1.00	0.50	**0.21** (H33)	4.2004	**CR=CI/RI**	**0.072477**
PS	5.00	3.00	2.00	1.00	**0.46** (H34)	4.3123	**<**	**0.08**
	16.00	5.14	4.33	2.03	**1.00**	4.1957		

=(D31*H31+E31*H32+F31*H33+G31*H34)/H31=4.0227

=(D32*H31+E32*H32+F32*H33+G32*H34)/H32=4.2474

=(D33*H31+E33*H32+F33*H33+G33*H34)/H33=4.2004

CI= (4.1957-4)/(4-1)= 0.06523, RI from table for n=4 RI =0.9 and so on

It presents the result of an *Agile Technology* (AT)-*Flexibility* (F) cluster with *Advanced Design Technology* (ADT) as the controlling attribute over other enablers. In the formation of this table, the question asked to the decision-maker is: 'when considering *Advanced Design Technology* (ADT) with regard to increasing *Flexibility* (F), what is the relative impact of enabler a when compared to enabler b?' For example, 'when considering *Advanced Design Technology* (ADT), with regard to increasing *Flexibility* (F), what is the relative impact of *Advanced Manufacturing Technology* (AMT) when compared to *Planning System* (PS)?' From Table 6.8, it is observed that *Planning System* (PS) (0.460) has the maximum impact on *Advance Technology* (AT) – *Advanced Design Technology* (ADT) cluster with *Flexibility* (F) as the control enabler over others. The e-vectors from these matrices are used in the formation of a

super-matrix. For example, the e-vectors from Table 6.8 have been used in the sixth column of the super-matrix in Table 6.10. For each determinant, there will be 16 such matrices at this level of relationship. As there are four determinants, 64 such matrices would be formed.

Step 2.5. Pairwise Comparison of Alternatives

The final outranking of agile organizations (A, B, and C) need to be identified for effective business activities. The performance of each organization is judged on the enabler. One such pairwise comparison matrix is shown in Table 6.9.

Table 6.9 Matrix for alternatives' impact on enabler Advanced Design Technology (ADT) in influencing the Flexibility (F) determinant

Agile Organisation	A	B	C	e-vector
A	1.00	3.00	5.00	0.633
B	0.33	1.00	3.00	0.260
C	0.20	0.33	1.00	0.106

$\lambda_{max} = 3.0387$, C.I.=0.019, R.I. =0.58, C.R.=0.033

In this table, the impacts of three alternatives are evaluated on the enabler Advanced Design Technology (ADT) in influencing the determinant *Flexibility* (F). The e-vectors from this matrix are used in the third row (corresponding to *Advanced Design Technology*) of columns 6, 7, and 8 of the *Flexibility* desirability indices matrix in Table 6.10. The total enablers are 16 hence 16 matrices for each determinant will be prepared.

Step 3. Supermatrix Formation and Analysis

The super-matrix allows for a resolution of interdependencies that exist among the elements of a system. It is a partitioned matrix where each sub-matrix is composed of a set of relationships between and within the levels as represented by the decision-maker's model. The

super-matrix M, as shown in Table 6.10, presents the results of the relative importance measures for each of the enablers for the compatibility determinant.

The elements of the super-matrix have been imported from the pairwise comparison matrices of interdependencies (Table 6.10). As there are 16 such pairwise comparison matrices, one for each interdependent enabler in the *compatibility* determinant, there will be 16 nonzero columns in this super-matrix. Each of the non-zero values in a column is the relative importance weight associated with the interdependent pairwise comparison matrices.

In the next stage, the super-matrix is made to converge to obtain a long-term stable set of weights. For convergence to occur, the super-matrix needs to be column stochastic. In other words, the sum of each column of the super-matrix needs to be one. Raising the super-matrix M to the power $2K+1$, where k is an arbitrarily large number, allows convergence. In this example, convergence is reached at M^{28}. The converged super-matrix is shown in Table 6.11.

Table 6.10 Super-matrix *M* for *Flexibility* (F) before Convergence

Enablers	ADT	AMT	ICIS	IMIS	PS	OSSE	AD	WT	FMDP	TK	IDC	CS	CC	SPPD	EI	CCP
ADT	0.00	0.09	0.15	0.28	0.24											
AMT	0.07	0.00	0.28	0.12	0.06											
ICIS	0.26	0.13	0.00	0.55	0.10											
IMIS	0.21	0.47	0.52	0.00	0.60											
PS	0.46	0.31	0.06	0.05	0.00											
OSSE						0.02	0.08	0.51	0.06	0.08						
AD						0.06	0.02	0.14	0.15	0.17						
WT						0.16	0.14	0.02	0.49	0.51						
FMDP						0.50	0.50	0.05	0.03	0.22						
TK						0.26	0.26	0.28	0.28	0.02						
IDC											0.00	0.00	0.33			
CS											0.25	0.25	0.67			
CC											0.75	0.75	0.00			
SPPD														0.00	0.25	0.75
EI														0.20	0.00	0.25
CCP														0.80	0.75	0.00

Table 6.11 Super-matrix *M* for *Flexibility* (F) after Convergence

Enablers	ADT	AMT	ICIS	IMIS	PS	OSSE	AD	WT	FMDP	TK	IDC	CS	CC	SPPD	EI	CCP
ADT	0.16	0.16	0.16	0.16	0.16											
AMT	0.13	0.13	0.13	0.13	0.13											
ICIS	0.23	0.23	0.23	0.23	0.23											
IMIS	0.35	0.35	0.35	0.35	0.35											
PS	0.11	0.11	0.11	0.11	0.11											
OSSE						0.1	0.1	0.1	0.1	0.1						
AD						0.12	0.12	0.12	0.12	0.12						
WT						0.28	0.28	0.28	0.28	0.28						
FMDP						0.31	0.31	0.31	0.31	0.31						
TK						0.21	0.21	0.21	0.21	0.21						
IDC											0.21	0.21	0.21			
CS											0.35	0.35	0.35			
CC											0.44	0.44	0.44			
SPPD														0.38	0.38	0.38
EI														0.22	0.22	0.22
CCP														0.39	0.39	0.39

Step 4. Calculation of Overall Weightage Index for Each Alternative

The outranking of an agile organization depends on the values of various desirability indices. These desirability indices indicate the relative importance of the alternatives in supporting a determinant. In the present case, for each determinant, there are three desirability indices, one each for the three alternative organizations A, B, and C. The desirability index, D_{ia} for the alternative i and the determinant a is defined as:

$$D_{ia} = \sum_{j=1}^{J} \sum_{k=1}^{K_{ja}} P_{ja} A^{D}_{kja} A^{I}_{kja} S_{ikja.}$$

In this equation, P_{ja} is the relative importance of dimension j in influencing the determinant a. A^{D}_{kja} is the relative importance of an enabler k in influencing the determinant a through

dimension j for the dependency (D) relationships. A^{I}_{kja} is the stabilized importance weight of the enabler k in the dimension j and determinant a cluster for interdependency (I) relationships. These values are taken from the converged super-matrix. $S_{ikja.}$ is the relative impact of alternative i on enabler k of dimension j for determinant a. K_{ja} is the index set of enablers for dimension j of determinant a, and J is the index set for dimension j.

Table 6.12 shows the desirability indices (D_{ia}) and their normalized values ($D_{ia\,N}$) for the compatibility determinant. These are based on the *compatibility* hierarchy using the relative weights obtained from the pairwise comparison of alternatives, dimensions, and weights of enablers from the converged super-matrix

Table 6.9 shows the matrix for alternatives' impacting on enabler Advanced Design Technology (ADT) in influencing the Flexibility (F) determinant whereas the Table 6.12 shows the combined effect of all enablers hence the trends shown by the values of the e-vector in Table 6.9 is reflected by the final values reported in Table 6.12.

Table 6.12 Compatibility Desirability Indices

Dimensions	Criteria	P_{ja} Table 6.6	Agile Technology Table 6.7	From Converge Matrix Table 6.11	Agile Organization Alternatives			Final Values of Agile Organization Alternatives		
					A	B	C	A	B	C
AT	ADT	0.492	0.394	0.160	0.633	0.260	0.106	0.0196	0.0081	0.0033
AT	AMT	0.492	0.260	0.130	0.085	0.701	0.213	0.0014	0.0116	0.0035
AT	ICIS	0.492	0.155	0.230	0.106	0.633	0.260	0.0019	0.0111	0.0046
AT	IMIS	0.492	0.066	0.350	0.602	0.315	0.082	0.0069	0.0036	0.0009
AT	PS	0.492	0.125	0.110	0.737	0.186	0.077	0.0050	0.0013	0.0005
KM	OSSE	0.269	0.472	0.100	0.669	0.243	0.088	0.0085	0.0031	0.0011
KM	AD	0.269	0.109	0.120	0.680	0.251	0.069	0.0024	0.0009	0.0002
KM	WT	0.269	0.067	0.280	0.746	0.134	0.120	0.0038	0.0007	0.0006
KM	FMDP	0.269	0.041	0.310	0.701	0.213	0.085	0.0024	0.0007	0.0003
KM	TK	0.269	0.310	0.210	0.656	0.265	0.080	0.0115	0.0046	0.0014
CE	IDC	0.135	0.633	0.210	0.633	0.260	0.106	0.0114	0.0047	0.0019
CE	CS	0.135	0.260	0.350	0.669	0.243	0.088	0.0083	0.0030	0.0011
CE	CC	0.135	0.106	0.440	0.615	0.319	0.066	0.0039	0.0020	0.0004
VI	SPPD	0.104	0.096	0.380	0.690	0.161	0.149	0.0026	0.0006	0.0006
VI	EI	0.104	0.251	0.220	0.648	0.230	0.122	0.0037	0.0013	0.0007
VI	CCP	0.104	0.653	0.390	0.581	0.309	0.110	0.0154	0.0082	0.0029
Desirability indices D_{ia}								0.1086	0.0655	0.0241
Normalized Desirability indices D_{iaN}								**0.5477**	**0.3307**	**0.1216**

In Table 6.12, the values of the third column are the relative importance of the dimensions in influencing the *Flexibility* determinant. These values have been imported from Table 6.7. The values in the fourth column are the relative importance of the enablers in influencing the *Flexibility* determinant through their respective dimensions. The relative importance values of the enablers (in column 4) corresponding to the dimension *Agile Technology* (AT) have been imported from Table 6.7. The values in the fifth column are the stable independent weights of enablers obtained through a converged super-matrix (Table 6.11). The next three columns (sixth, seventh, and eighth), which correspond to alternatives A, B, and C respectively, are from the pairwise comparison matrices giving the relative impact of each of the alternatives in influencing the enablers. For example, the values corresponding to *Agile Technology* (AT) in the sixth, seventh, and eighth columns of Table 6.12 have been imported from Table 6.9. The final three

columns represent the weighted values of the alternatives $\left(P_{ja} * A^{D}_{kja} * A^{I}_{kja} * S_{ikja}\right)$ for each of the enablers. For the purpose of illustration, the value corresponding to alternative A for *Agile Technology* (AT) is 0.0196 (0.492 ∗ 0.394 ∗ 0.160 ∗ 0.633). The summations of these values for each of the alternatives provide the values of desirability indices, D_{ia}. These desirability indices, D_{ia}, and their normalized values, D_{iaN}, are presented in the last two rows of Table 6.12. These results indicate that provider A with a normalized desirability index of 0.5477 has maximum influence on *Flexibility*. It is followed by organization B (0.3307) and C (0.1216). Till this step, the analysis has been conducted only for the *Flexibility* (F) determinant. Similar analysis is carried out for the other three determinants i.e. *Quality* (Q), *Cost* (C), and *Delivery* (D). In the next step, *OWI* would be calculated to incorporate the results of all the four determinants.

Step 5. Outranking best alternative in determinant

The *OWI* for an alternative *i* (OWI_i) is the summation of the products of the normalized desirability indices (D_{iaN}) and the relative importance weights of the determinants (C_a). In the calculation of *OWI* the use of normalized values of D_{ia} ensures that the *OWI* values of the alternatives do not change with a large range of absolute values of D_{ia} for different determinants. In other words, it may be said that the values of *OWI* using normalized values of D_{ia} are unit invariant. The normalized values of desirability indices also ensure that the sum of *OWI* values is equal to 1.00. *OWI* is mathematically represented as

$$OWI_i = \sum D_{iaN} C_a$$

$$OWI_A = \left[\left(0.413 * 0.5477 + 0.079 * 0.6428 + 0.327 * 0.6650 + 0.181 * 0.6343 = 0.6093\right)\right].$$

Similarly OWI_B and OWI_C may be calculated. Overall weighted index (OWI) for all organization alternatives is depicted in Table 6.13. Figure 6.3, displays pictorial view of all weighted index for agile organizations. It is evident that organization A displays the highest performance of 0.5477, 0.6428, 0.6650 and 0.6343 with reference to various determinants of *Flexibility* (F), *Quality* (Q), *cost* (C) and *Delivery* (D)

Table 6.13 Overall weighted index (OWI) for Agile Organizations

Agile Organisations	*Flexibility* e-vector 0.413	*Quality* e-vector 0.079	*Cost* e-vector 0.327	*Delivery* e-vector 0.181	Normalized OWI_i
A	0.5477	0.6428	0.6650	0.6343	0.6093
B	0.3307	0.2624	0.2300	0.2291	0.2740
C	0.1216	0.0948	0.1049	0.1366	0.1168

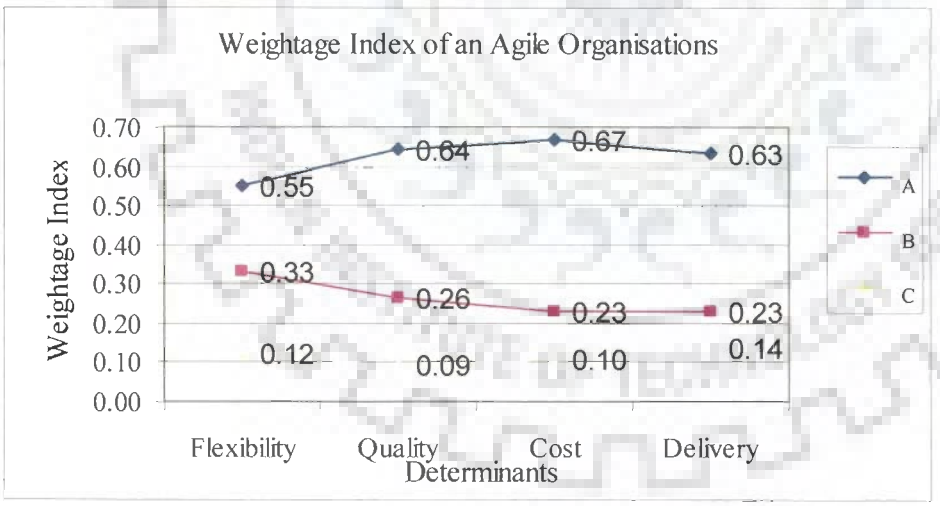

Figure 6.3: Weighted Index for Agile Organizations

6.4 Discussion and Managerial Implication

Outranking an Agile Organization for business effectiveness is vital as it influences the whole organizations working. The efficacies of organization depend upon the response from agile organization so that the customers changing requirements are met quickly and effectively. The Organization may consider various determinants, dimension and criteria which may fulfill their needs in best possible manner. We have considered four determinants *Flexibility* (F), *Quality* (Q), *cost* (C) and *Delivery* (D) based on the feedback of DM. The customized decision model has been developed using Excel. The customized decision model may be modified to accommodate more alternatives, determinants, dimension and criteria so that comprehensive goal of organization can be realized.

In the present study, the best agile organization can be adjudged easily using decision support model. The overall weighted index of various agile organizations i.e. OWI_A, OWI_B and OWI_C obtained are as follow:

$OWI_A > OWI_B > OWI_C$ *as* $0.6093 > 0.2740 > 0.1168$
A > B > C ('>' means preferred Agile Organization.)

Thus organization A displays a high agility and may be outranked as an agile organization. The above result derived is based on the weightage of four major determinants considered in the present case. The resultant weightage of four determinants are found as *flexibility* (F) (0.413) > *Quality* (Q) (0.327) > *Delivery* (D) (0.181)> *Cost* (C) (0.079).

The determinant flexibility is vital for any organization as it provides responsiveness to the worthy customers. Flexibility also enhances ease of working and enables compatibility with the customer leading to customer satisfaction. The quality determinant is also playing an important role as the quality of service may influence the service level and markets share of the organization. The third determinant of delivery if maintained smoothly will enhance overall

sound position of organization to prosper. The determinant of cost of service also influences the organizational agility, however business organization prefer high flexibility, superior quality and smooth delivery over cost.

6. 4.1 Ranking contributors of agile organization

It is also pertinent to this work that the same methodology be used for helping an organization in identifying the major contributors to agility instead of outranking an agile organization. In work entailing from this study such attempts will be made. For this instead of ANP, AHP may the right approach to resolve such an issue. In AHP all criteria (contributors) may be set in a hierarchy as shown in figure 6.4.

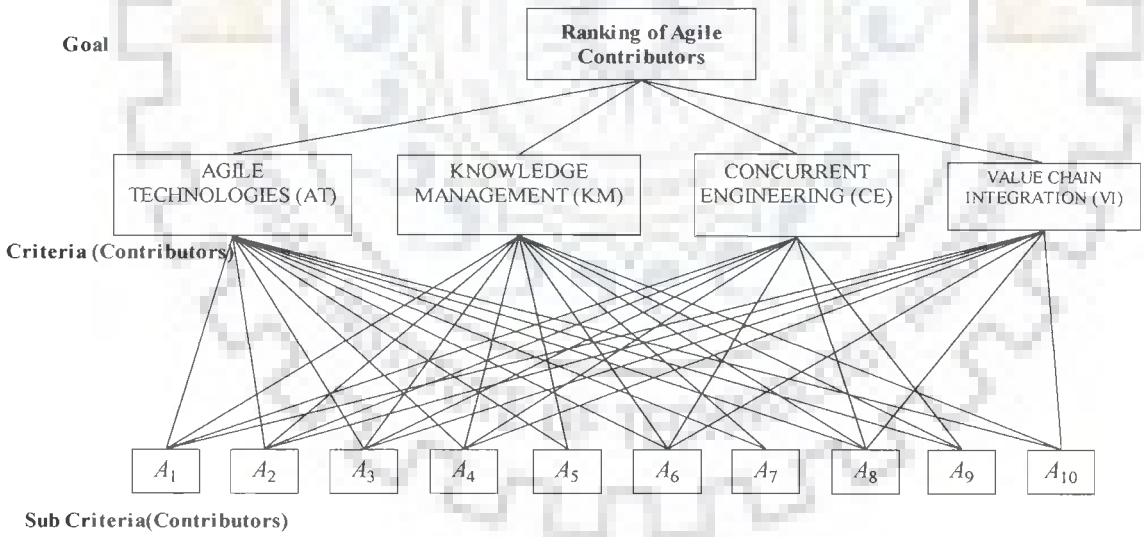

Figure 6.4: Ranking of contributors of agile organisations

AHP methodology comprising of pairwise comparisons may be adopted and each contributor may be evaluated for its weightage. Rearranging contributors on obtained weightage in decreasing order will result in ranking of contributors of agility in an organization.

6.5 Conclusion

Decision support model using ANP has been developed for outranking an agile organization. The developed model will help the organization to outrank agile organization for business effectiveness. ANP permits interactions amongst the criteria and their resultant influence, hence the decision making process becomes more accurate and acceptable to the mentors. The developed decision model also helps decision makers (DMs) to understand the influence of each criteria and their impact on the final decision making.

Future attempt will be made to use this method for an organization which wants to identify the major contributors to its agility in addition to outranking an agile organization.

Chapter 7

Research Summary, Conclusion and Scope

7.1 Introduction

In the wake of growing attempts to make changes into opportunities in the new business environment, there is extensive research on organizational agility. The vital role played by information technology for agility is also well acclaimed. This research is an attempt to focus on the acceptance of information technology, adoption of information systems and their utilization to achieve agile capabilities. Its motivation is to evaluate Indian private sector industries for their relative potential in agile capabilities. Insights are provided after investigating the complexities for IT enablement of business processes so as to deliver the services and products under the dimensions of agility which are customer enrichment, mastering change, leveraging resources and cooperating to compete.

7.2 Summary of research done

This research was carried out during the years between 2005 and 2008 to explore the trends, issues and challenges of information technology acceptance for organizational agility. The sample was drawn from the Indian private sector industries and enquiries were made to build insights in the use of information technology and its orientation with the dimensions of agility. The research was carried out through exploring the concept of agility and its compatibility with information technology in the existing relevant literature, questionnaire based survey for evaluating its prospects in the Indian private sector and an ANP based model for outranking agile organizations.

7.2.1 Agility and technology acceptance

The new world economy where organizations have to be future agile as they expect the unexpected businesses are reforming them to being more lean, flexible an adaptable. The adoption of technology leads to more information sharing, shorter lead times and just in time production achieved through virtual enterprise. In order to translate investments in financial gains there is a growing interest in agility. This research has focused primarily on the underlying trends of the various sectors of the Indian business firms in terms of technology adaption and readiness to embrace agility. Inter-sector differences have been detected in this regard while testing the various hypotheses and analyzing results from the survey. Analysed results have also been discussed to explain the interconnections of financial gains achieved y the firm and its growing investment on the IT/IS infrastructure. If use of IT/IS is presumed to be enabling agile capabilities this improved business performance as perceived by the respondents may be attributed to agility through its four cardinal principles.

7.2.2 Literature survey

Extensive literature survey was done to identify the frameworks offered to make organizations agile, various models of technology acceptance and existing gaps in the body of literature. Considerable amount of empirical data has been conducted on organizational agility as well as technology acceptance. Some literature reviews and meta-analyses on the subject are also available. A total number of 206 papers were retrieved from online research sources and analysed for their contribution to the body of knowledge on the relevant fields of this research.

The scholarly work surveyed has been analysed for the following:

i. Definitions of agility

ii. Technology acceptance concept

iii. Method wise contribution of research papers where Type I, II and III are empirical studies on organizational agility, conceptual models on agility and technology acceptance analysis respectively.

iv. Period-wise contribution where the time line has been broken into pre-1990, 1990-2000 and post 2000

v. IT/IS functions enabling agile organizations

vi. Agile enablers

vii. Attributes of the new business environment

The papers were used to extract the factors of IT/IS-use in an organization which provide enablers of agility to an organization giving it an edge to perform in the new business environment. A working model has also been synthesized from the available literature for an agile organization. It was found that many published studies have investigated upon the probable definitions of technology acceptance and agility and provided comprehensive discussions. Minute differences between agility and flexibility etc have also been worked upon. More work pertaining to modeling various aspects of agility is found in literature as compared to industry trends from empirical studies. The contribution of scholarly work on these topics is rising during the first decade of the 21st century and many functions of IT/IS are being recognized that enrich an organization with the enablers of agility to compete and survive in the fast changing business environment.

Most of the studies were found to be of descriptive and empirical in nature. In a bid to make this work a comprehensive one contradictory views on the technology debate which includes views from various authors on increasing spend on IT notwithstanding the decreasing cost of computer hardware. Studies depicting skepticism on the return on IT investment have been entertained in this section in terms of productivity paradox. Further the gaps in literature have also been identified for future research.

7.2.3 Hypotheses formation and testing

Six hypotheses were formed to be tested in this research. These were formulated after consulting literature and having discussions with academicians and industry personnel. The hypotheses were set to seek the inter-sector differences in technology acceptance and readiness to bring organizational improvements with agility reforms. It was found true that the manufacturing and auto sectors exhibit more agility. They also do this by continuously changing strategy to remain competitive in a business environment that was never before. Here the manufacturing sector represented in the root sample was also found to be paying more attention to technology utilization for beating competition. It was also accepted during the survey that the process sector believes in following liberal strategy.

7.2.4 Questionnaire design

A detailed questionnaire was designed with the help of literature and discussions with experts. In a survey based empirical study of 76 companies from the Indian private sector a questionnaire was used to take opinions on a five point Likert-type scale. Contents of the questionnaire were divided into reliable constructs on the four pillars of agility along with an additional fifth section on the respondent's profile and company demographics. The questions were framed after due consultation with literature and experts from the field.

7.2.5 Analysis of questionnaire

Initially the questionnaire was subjected to a pre-test for reliability and internal consistency amongst the constructs. A sample consisting of students who were management graduates with field experience were given the questionnaire for test of internal consistency after providing them the relevant literature to read and brainstorming sessions. The number of questions was thus reduced to 125 from 216 as the tests of reliability and validity were

conducted. Once the survey was completed descriptive statistics of the organizations were calculated and the responses were used to test the hypotheses after due analyses. Conclusions were drawn on the basis of the results.

7.2.6 Observations from survey

The survey reveals that the sample consisted of a large number of companies from the manufacturing sector. This fact indicates the responsiveness of this traditional sector in India over other relatively new sectors such as IT and software. Most of the organizations in the root sample were found to be trying agile technologies as an endeavor to make agile attempts. However, knowledge management, concurrent engineering and value chain integration were also attempted. Some organizations were found to be trying a mix of all these agile strategies. The real estate and entertainment sectors however were found to be lethargic in adopting agile technologies. The support of the respondents to each of the statements in the questionnaire was found to be in accordance with other relevant work. An important observation of the survey is that respondents were in agreement that higher investments in IT/IS infrastructure of the firm also translated in growing trends of profits.

7.2.7 ANP model for outranking agile organization

Enablers of agility were derived from existing literature and a model was developed for outranking agile organizations while using the ANP approach. Empirical data collected from survey was analyzed for testing this model. Hierarchy of the ANP model was based on the factors obtained through literature survey and cross-checked with the experts. Outranking of three organizations A, B and C was done assuming that A has an ability to innovate faster, B has a little less ability for novel improvements and C is unable to innovate in novel ways

hence succumbs to pressure. Pair-wise matrices have been formed for comparing determinants, drivers, enablers and alternatives in firms A, B and C.

It is envisaged that in future AHP method will be used for evaluating the criteria of agility within an organization if it is desired to be done by the organization.

7.3 Overview of research framework

The main postulates and findings of the research and their implications have been summarized in table 7.1

Table 7.1 Summary of research framework and main observations

S. No.	Methodology	Outcome	Implication
1	Literature survey: Large amount of empirical work exists on organizational agility and information technology utilization in scholarly journals and business publications.	More and more ways of assessing, evaluating and developing organizational agility are being proposed from industry surveys. IT surfaces as an integral part of the agile attempts.	Indian companies have IT enabled business processes and more research is needed for orienting IT / IS with achieving agility.
2	Hypothesis 1: *Customer demands are met with (i) Adopting new technology, (ii) Bringing changes in the organization, and (iii) Launching new products.*	Accepted with a highly significant R^2 of 0.417 for three independent variables to the dependant variable of meeting customer demands on MLR	Technology acceptance in organizations makes them more customer friendly and agile
3	Hypothesis 2: *Customer satisfaction increases with agile capabilities of organization by (i) Sustainable quality and customization (ii) Introduction of reconfigurable products (iii) Offering total solution, and (iii) Flexibility and adaptability*	Accepted with a high significance of R^2=0.417 hence all the independent variables impact the dependant variable customer satisfaction. However, Sustainable quality and customization with a coefficient of .486 and high t-value of 4.723 has the greatest influence on the dependant variable.	Sustainable quality and customization increase customer focus but with R^2 being only 41.7% other measures for enhanced customer efficiency must be considered.
4	Hypothesis 3: *Manufacturing sector and Auto sector exhibit more agility compared to other*	Accepted with a high mean value of 3.1956 and 2.5689 respectively where significance level of t-test is	Manufacturing and auto sector work with short lead times and concentrate on core

	sectors in the organization	.006	competencies
5	Hypothesis 4: *Manufacturing sector and Auto sector continuously change strategy to remain competitive*	Accepted at .004 level of significance of the independent sample t-test	Competitive advantage thus endowed makes these two sectors more agile
6	Hypothesis 5: *Process sector believes in following liberal agile strategy*	Accepted at .043 level of significance of the t-test	Strategic linkages are quickly made and dissuaded
7	Hypothesis 6: *Manufacturing Sector pays more attention to technology utilization for competition*	Accepted at p value of .05 or less as in the result of the independent sample t-test	Information technology with its innovative uses enthuses agile manufacturing
8	Survey observation 1: Indian industry is rising to the needs of being agile and moderating its traditional business methods to make it self more and more change efficient	Respondents agree to the queries on the changing business processes of their organizations	For competitive advantage similar firms have to become agile and survive in the new environment
9	Survey observation 2: Integration of Information technology and its uses is considered acceptable for better customer focus, workforce performance and managing change	Most constructs pertaining to agile capabilities are seen in the positive interest of the firm for realizing organizational goals	Information technology acceptance in Indian firms has the potential workforce to implement agility
10	Survey observation 3: Practices related to Information technology integration of business processes lead to organizational agility	Positive responses received in favour of IT-based asset management to achieve the principles of agility	IT acceptance has an important role to play in organizational agility
11	Model: An ANP based model designed for outranking agile organizations on the bases of the overall weightages assigned to the agile determinants, agile drivers and enablers present in the organization	A total number of 25 factors of agile capabilities have been layered in the ANP based model for outranking agile organizations. Stepwise weightages to these determinants calibrates that organization A is most agile	Managers and practitioners can assess the agile capabilities of organizations and outrank firms on the basis of their agility

7.4 Implications of research

In a final perspective this research work holds the premise that integration of Information technology with business processes provides organizations with better customer

efficiencies which can ultimately boost performance and bear financial gains. The study bears significance for the academicians as well as the practitioners with useful insights.

7.4.1 Implications for academicians

Similar to the numerous studies both empirical and meta-analytical that have contributed to the formulation of the postulates of the present research this study is also a contribution to the existing body of literature on technology acceptance and organizational agility. Future researchers can draw perspectives from the extensive literature survey done under this research. The questionnaire designed and used after validity analysis can also be used as a ready reference for similar studies. ANP is a relatively new technique used for modeling agile capabilities of organizations and further research can take leads from the method adapted. The determinants and drivers of agility have also been identified in this research.

7.4.2 Implications for managers

Practical approaches can be derived from the findings of this study for implementing the principles of agility through accepting information technology and ultimately improving organizational performance. Suggested measures of strategic alignment of organization wide IS strategy with the agile functions can boost operations in an organization. Inferences drawn from the general observations of the survey and results of hypotheses testing can also be valuable in selection of organizations for linkages and virtual enterprise. Managers can also draw decision support from the ANP model for outranking agile organizations. Finally, barriers like security concerns and bureaucratic management in IT enablement of business processes that are identified to be overcome.

7.4.3 Comparison with other published studies

The main presumption overriding all the investigations of this study is that along with quality, dependability and cost efficiency, agility remains an important for organizational performance in the 21st century (Nagel and Dove 1993, Goldman et al 1994, Tidd et al 1997, Vokurka and Fliedner 1998, Sohal 1999). The empirical significance of using information technology and information systems for organizational agility in Indian firms has been the main premise of this research. Analyses of observations from the survey of Indian firms reveals that executives feel computer aided decision making helps an organization to become more agile and more and there is a growing trend in the Indian industry towards technology adaption to bring in agility in response to the unprecedented changes in the market. The trend has also been established in other places (Sharifi and Zhang 2001, Zain et al 2003, Zain et al 2004, Kassim and Zain 2004).

Survey findings also indicate to a better response of the manufacturing sector as compared to other sectors comprising the root sample. This finding is also in agreement with research conducted elsewhere for instance Vazquez-Bustello et al (2007) found that in case of Spanish firms the use of agile manufacturing practices promotes financial performance in a turbulent business atmosphere. In future research this can be related to the ease of implementing computer integrated manufacturing; hence the higher readiness detected in the manufacturing firms for adapting IT/IS for agility.

The customization and system integration for agile manufacturing that has surfaced in this research has also been supported by Gunasekaran (1998) where computer aided manufacturing and information technology have been taken into account for organizational agility. The methodology for agility analysis proposed by Jackson and Johansson (2003) and tested in a case study stresses upon product innovation and change capabilities which have been the key criteria for the ANP based model to outrank an agile organization in this study.

Similarly evaluation of leanness in manufacturing firms done by Soriano-Meier and Forrester (2002) attributes agility to change competencies and Meredith and Francis (2000) include rate of innovation and rapid responsiveness in their criteria for order-winning.

However, the results of analysed opinions in this study from Indian firms do not hold full compliance with the concerns of the productivity paradox – the paradoxical relationship between investment in IT and gains in productivity (Roach 1991, Hitt and Bryjnolfsson 1996). A widely postulated explanation of this relationship is the aphorism that systems that are not used provide little value (Agarwal and Prasad 1998) and existing IT/IS infrastructure should be coupled with adequate amount of acceptance to translate into better performance. Nevertheless, there are counterintuitive studies to this premise where although Mitra and Chaya (1996) have found no evidence of IT reducing labor and average overhead costs but report IT investments to be associated with lower average production cost and lower average total cost. Similarly the present study has found a directly proportional relationship between IT investments and profit making in the last five years in Indian firms. This might be due to the implication expressed by Mahmood and Mann (2000) that studies on IT investments and performance should include multivariate variables from many firms and spread over long period of time.

7.5 Limitations of research and scope for future work

There are two major limitations of this study as it is mainly based on a questionnaire survey. Primary data collected for principle observations and hypotheses testing are in the form of opinions expressed by the respondents. Although respondent bias has been statistically dealt with, a general prejudice in favor of IT upgrades amongst managers can not be ruled out. Secondly since respondent organizations do not readily spill tacit organizational goals and data secrets to hold power, they have not been taken in to account. Future scope of

research exists in the extension of technology acceptance theories to information technology adoption vis-à-vis competitive advantage gained through being agile. Contexts of culture, society, financial status, gender and age may also be included for effective modeling. It would also be fruitful if possible to study the direct correlation of investment on information technology to integrate with business processes for achieving agility and financial returns. However, since most audit facts would not be divulged in a survey for research purposes, an alternative approach of collecting secondary data from audit sheets is suggested.

For future research the topic of identifying criteria for evaluating an organisation's agility can be taken up and the method of AHP modeling can be used where data collected in this study has analyzable potential.

7.6 Conclusion

In essence this research throws light on the complexities of information technology acceptance and achieving the goals of agility. It is investigated and brought to the fore that agility as a concept has bright potentials in the Indian industry and it has been picked up with readiness by some sectors like the manufacturing industries. Drivers, determinants and enablers of agility have been found to be adapted by Indian firms as the sectors included in this study are making agile attempts. These are in the form of knowledge management, agile technologies, concurrent engineering and value chain integration. Important hypotheses that were formulated and put to tests highlight the impact of adoption of technology and agile virtues on various sectors of the Indian industries and set apart the manufacturing and auto sector in this regard.

However, to be implemented for boosting organizational performance integration of the existing resources and processes with information technology has pivotal importance. With companies that already possess business performance benefits such as quality,

flexibility, dependability and cost efficiency agility is emerging as an essential attribute to survive in the turbulent business environment of the 21st century which is more fragmented than ever and posing challenges like never before. On a bright side Indian managers are more than prepared to bring such paradigm shifts in their organizations which keep them future agile as they see these investments being returned in the form of financial performance. Yet this study culminates in bringing forth its academic limitations as the findings are reported and scope for future work is discussed. Areas in academia and industry management where the results and discussions presented here can be put to productive use are also highlighted.

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DEPARYMENT OF MANAGEMENT STUDIES
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE

Research Supervisor: **Prof. J.P. Singh** Telephone: 01332 285081
Co-Supervisor: **Dr. Zillur Rahman** Fax : 01332 285081

Subject: Survey on technology acceptance for organizational agility

Dear Sir,

The latest developments in Information Technology have been directed towards making firms agile so as to enable quick responses to unpredictable market changes. IT facilitates information sharing and thereby reduces the uncertainty in supply. As a part of Ph.D. research we are conducting a survey to assess the status and readiness of Indian industry in exploiting information technology to make their firms agile and respond to competition. To make it possible the industry and academia must share their views. Your feed back in this regard will form a significant input to this study. We request you to spare some time in responding to the enclosed questionnaire.

This questionnaire is divided into the following three sections

- Technology acceptance issues
- Performance measurement issues
- Organization profile

We would be grateful if you kindly fill it in and send it in about a month's time from now. A self addressed envelope is enclosed for the purpose. The objective of the survey is purely research and academic therefore all responses will be kept strictly confidential and will be used only for this academic work. We are aware that you have a busy schedule of work but we do hope that you would be able to spare some of your precious time in the fulfillment of this task.

Yours faithfully,

(Jamshed Siddiqui)
Research Scholar

Correspondence address:
Department of Computer Science
Aligarh Muslim University
Aligarh-202002

Enclosure: Questionnaire

Questionnaire

Please rate your answers on the given scale where points 1 to 5 denote following:

1. Strongly Disagree
2. Partially Disagree
3. Neither Agree nor Disagree
4. Partially Agree
5. Strongly Agree

Section I: Current capabilities towards maintaining agility

A: Agility capability I - Trends affecting the company

		Strongly disagree				Strongly agree
		1	2	3	4	5
1	Customer demands are being included in product/ service processes.					
2	The company is bringing changes in order quantities.					
3	Order time is being made flexible in the company					
4	We are adopting new technologies					
5	The line of production is being diversified					
6	There are changes in the organization of the company					
7	New markets are being constantly explored					
8	New products are being launched					
9	You sell skills, knowledge and information in a relationship over time and not just products in sale transactions					
10	Are all your intellectual property and data secret, or do you sell some for profit?					
11	Do your customers turn to you for rapid-response special requests?					

B: Agility capability II - Strategies for changing to compete

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Potential areas are explored to improvise the current system					
2	Measures are being adopted for quality control					
3	Are any changes needed for quality improvement?					
4	Is the organization under consistent reinvention and reengineering?					
5	Can suggested design changes be incorporated in your organization?					
6	Does your organizational structure facilitate concurrency throughout the enterprise interacting with maximum communication and coordination?					
7	Is information readily available to those who need it through an enterprise wide information system?					
8	Do you and your partner protect and share intellectual property?					
9	Are you using the virtual company model to achieve vertical integration?					

C: Agility capability III -Product/service related change to improve quality

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Do you measure customer satisfaction?					
2	Can this be maintained /increased in the future?					
3	Is your quality and customization sustainable?					
4	Do you increase knowledge of contents in products?					
5	Are you introducing and developing reconfigurable products?					
6	Are you providing total solutions to customers?					
7	Do you consult customers before product development?					
8	Do you assess the market through research?					
9	Do your customers find you flexible and adaptable?					
10	Is the company dynamic enough to perform with changing goals and opportunities					
11	Are you eliminating the organizational walls that impede your efforts to meet customer needs?					

D: Agility capability IV - Cooperation, knowledge and creativity of staff

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Do functionaries of development projects form a micro-cosm of all the functions?					
2	Do you allow suppliers participation in product development?					
3	Does inter-departmental alliance exist in your company?					
4	Communication is not only downward but two-way?					
5	Do you encourage employees to think creatively?					
6	Do you charge customers explicitly for design activity, or do you recover design cost by allocation to production parts?					
7	How do you treat, manage and value the assets in your organization, which allow to sell information?					
8	You protect the information asset of your organization and protect and share intellectual property.					

Section II: Information technology acceptance for organizational agility

A: For enriching customers

		Strongly disagree 1	2	3	4	Strongly agree 5
1	IT/IS supports me in decision making.					
2	My company may understand customer requirements better by using IT/IS.					
3	We can reach our target customers fully by using IT/IS.					
4	Value added products/ services happen easily by using IT/IS.					
5	IT/IS helps you customize a product for an individual customer.					
6	You make use of IT/IS to provide the user with instruction and/or assistance in how to use the products effectively.					
7	You systematically determine what information products and/or services your customer(s) need or would benefit from.					
8	Your company benefits from using IT/IS in becoming more responsive to customers					
9	Using IT/IS reduces the time taken in fulfilling orders from customers					
10	Supply chain management with IT/IS facilitates better customer service					

B: For mastering change

		Strongly disagree 1	2	3	4	Strongly agree 5
1	This organization changes all the time					
2	IT/IS makes available such information with the help of which I can manage change better					
3	I can always access current information from IT/IS in my organization					
4	IT/IS helps in updating the business processes					
5	Extending collaboration with suppliers through IT/IS will help manage change					
6	Our employees are flexible and multi disciplined					
7	The level of information sharing for responding to change increases with IT/IS					
8	Using IT/IS helps you in accurately forecasting the changes in the market.					
9	IT is being used as a source of Competitive advantage					

C: For leveraging resources

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Management decisions are decentralized by using IT/IS					
2	We find problem solving easier through multifunctional teams linked by IT/IS					
3	IT/IS builds committed relations between managers and subordinates					
4	We use IT/IS in achieving our core competencies					
5	Employees take regular training in using IT/IS sponsored by the company					
6	You have a system with which to track the content of your information products to keep versions, compatibility and accuracy issues under control					
7	Is automated documentation part of your product?					
8	Your products have automatic self-diagnosis capability when they malfunction or begin to fail					
9	Do your products communicate with your facilities all or part of the time to get updates, assistance or additional services for the client?					

D: For cooperating to compete

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Use of IT/IS enables my organization in breaking time barriers					
2	Use of IT/IS enables my organization in breaking geographical barriers					
3	Use of IT/IS enables my organization in breaking structural barriers					
4	Use of IT/IS enables my organization in breaking cost barriers					
5	Receiving quotations online speeds up their disposal					
6	Changes in policies and products/ services are communicated to the partners easily with IT/IS					
7	Centralised demand information with the partners is structured by using IT/IS					
8	Your company keeps relevant departmental information on line through use of IT/IS					
9	You make available the technological know how to the suppliers from IT/IS					

Section III: Best practices for use of IT/IS in organizational performance

A: Human dimension of IT/IS for organizational performance

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Cross training of employees takes place regularly					
2	Performance of employees in using IT/IS towards organizational goals is reviewed periodically					
3	Responsibilities are shared and can be rotated with the help of IS					
4	All processes are open for quality improvement using IT/IS					
5	TQM (Total Quality Management) principles for IT/IS of firm are practiced					
6	The employees trust linkages through IT/IS					
7	IT/IS is used for collaborative information sharing					
8	We use balanced scorecard for performance measurement of organization					
9	Collaborative planning for IT enabled business is preferred					

B: Performance indicators in customer satisfaction vis-à-vis IT/IS

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Security threats to data on the internet are an obstacle in keeping useful customer information on the internet					
2	Quick response to customer needs is a driving force for IT- enabled business processes					
3	Top management is committed to reaching out customers with useful information					
4	Sales and service make use of IT/IS					
5	High level of information sharing exists between customers and the company					
6	My company practices virtual customer servicing					
7	There is interaction of business and IT staff for designing the business processes and technology					
8	We have adopted target costing (planning to achieve a predetermined cost)					
9	In addressing the issues of the organization your company gives an overall weightage to customer focus					

C: IT based asset management

		Strongly disagree 1	2	3	4	Strongly agree 5
1	Your company benefits from using Bar-coding software					
2	Your company benefits from hosting its own website					
3	Your company benefits from using Enterprise Resource Planning (ERP)					
4	We possess reliable IT infrastructure					
5	We are capable of keeping online information secure					
6	Forecasting uncertainties is a driving factor for IT enabled business processes					
7	Purchasing in the company is IT enabled					

D: Technology for responding to competition

		Strongly disagree 1	2	3	4	Strongly agree 5
1	An organization wide IT strategy is in place					
2	Communication with the trading partners acts as a driving force for IT enabled business processes					
3	Improvement of overall efficiency is an outcome of IT/IS					
4	Quality and warranty of product/services is maintained by IT/IS					
5	Accounts and finance are maintained on computer based data sheets					
6	Manufacturing scheduling is done and shared by computer					
7	We have vendor management inventory system VMI					
8	We use third party logistics system 3PL					
9	Warehouse and logistics service providers share information through IT/IS					

Section IV: Company demographics and respondent' profile

A: Organisation Profile

1. Name of Company

2. Type of Business (es)

3. How old is your organization

4. Number of years company has been in the current business(es)

5. Total number of employees

6. Approximate annual turnover in crore INR

7. What has been the approximate trend of profits during the last five years

a. Increasing
b. Constant
c. Decreasing
d. Can't say

B: Respondent Profile

1. Name (optional)
2. Age:
3. Gender:
4. Designation:
5. Area of work in the organization (Please tick)

(a) IT/MIS ☐ (b) Operations ☐

(c) Supply chain ☐ (d) Marketing ☐

(e) Technical ☐ (f) Any other .....

6. Duration of employment with the organization

7. Duration of employment on the present position

8. Your level of computer literacy

a. Negligible
b. Basic
c. Moderate
d. Excellent

Survey on Information Technology Acceptance and Organizational Agility

Thank You Very Much for Your Valuable Feedback

Appendix - II

Sector wise composition of 400 companies from the BT 500 firms of Indian business which were selected to participate in the survey

SECTOR	% COMPOSITION
IT	16.2
OIL & GAS	13.3
TELECOM	12.6
FINANCIAL SERVICES	10.9
REAL ESTATE	8.5
DIVERSIFIED	6.4
AUTOMOTIVE	5
NON-FERROUS METALS	3.5
PHARMA	3.1
FMCG	2.8
ENGINEERING	2.6
STEEL	2.4
WIND	2
CEMENTS	2
INFRASTRUCTURE	2
OTHERS	2
POWER	1.4
MEDIA & ENTERTAINMENT	1.3
LIQUOR	1
CONSUMER DURABLES	0.6
CHEMICALS	0.4

POINT WISE REPLY TO QUERIES RAISED BY THE

EXAMINER

INCORPORATED SUITABLY IN THE THESIS

BY

JAMSHED SIDDIQUI

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प्रो० जे० पी० सिंह
Prof. J.P. Singh
M.Sc. (Phy. & Maths.), Ph.D., AMIE, FCA, FCS, AICWA, LL.B., Grad. Dip. Op. Res., PGDip, MBFS

Date: 25.08.2010

CERTIFICATE

This is to certify that **Mr. Jamshed Siddiqui**, Research Scholar, Department of Management Studies, I.I.T. Roorkee has revised his Ph.D. thesis titled "*Information Technology Acceptance And Organizational Agility: Application In Indian Firms*" in the light of the comments and suggestions made by the thesis examiner.

Furthermore, all the revisions suggested by the thesis examiner have been incorporated in the revised thesis by Mr. Jamshed Siddiqui.

A separate sheet, which includes the point-wise answers to all the questions raised by the thesis examiner, has been enclosed with the revised Ph.D. thesis.

Sincerely,

(Prof. J. P. Singh)

Supervisor

ANSWERS TO QUERIES OF EXAMINER

CHAPTER 2

Query:

1. The literature review has consumed about 70 pages (19-87) which is about 40% of the thesis. Still the discussions presented in the Chapter 2 are short of proper analysis. Usually one would expect a more rigorous treatment in a Ph.D. thesis. The way the tables are presented at the end of this chapter makes reading very difficult, and this issue should be taken care of in the final thesis.

Answer:

In a positive response to the above comment the entire chapter on Literature survey (Chapter 2) has been revised and the total length has been brought down to 66 pages (Pg 19 to 84) by editing the text suitably without compromising with the original content. Fresh analysis of the surveyed papers has been done under a new scheme of classification by drawing common themes from the papers. The factors of the 21st century market bringing in change and variables of IT/IS enabling agility were identified. A model demonstrating the interplay of these elements has been presented (Figure 2.6, Page 27) and elaborated upon in the discussions (Section 2.1.3, pg 23 to 27). Literature retrieved has also been analysed on the basis of the nature of research done, objective addressed and period-wise contribution. Statistical graphs showing the trends ((Figures 2.3, 2.4 and 2.5 on pages 23, 24 and 25 respectively) have also been incorporated in the relevant sections of the chapter (sections 2.1.3, Page 23 to 27). A new table (Table 2.9) has been added at the end of the chapter (Pg 81 to 84) giving the source of the variables identified for the functions and agile attributes of IT/IS in the new business environment. All the references from which a common theme has been derived are credited for a particular theme encompassing the whole model.

However, the tables presented at the end of the chapter remain as such because the abortive attempt of inserting the tables at the relevant location in the text resulted in broken tables as well as text and figures, disturbing the format of the entire chapter. This was also burdening the chapter with more pages than required as a lot of empty space had to be left blank in order to start a new table or a new figure or a new table from a fresh page.

CHAPTER 3

Query:

2. In Chapter 3 the summary of the survey conducted present in table 3.1 should be supported by the list of organizations responded in the appendix.

Answer:

The list of organizations was covenanted to be kept confidential hence it cannot be made public. To improve confidence in this aspect of the work a sector wise breakup of the BT 500 firms to which the sample request was mailed has been appended at the end of the thesis (Pg 216 Appendix II). The letter sent to the respondents clearly stated that, "The objective of the survey is purely research and academic therefore all responses will be kept strictly confidential and will be used only for this academic work". In the revised version of the thesis this covering letter that had been mailed with the questionnaire has also been attached to the Appendix I (Pg 206).

Query:

3. Chapter 3 should be improved with the details of the following exercises supposed to have been carried out. In order to improve the confidence in the work, relevant data/ information should be provided.

a) Questionnaire validation

Answer:

> *The structure and content validation of the questionnaire was also performed by testing two main types of validity.*
>
> *i) Content validity*
> *ii) Construct validity*
>
> *The questionnaire instrument developed in this study has a content validity as the selection of measurement items is based upon an exhaustive review of the available literature and evaluations by academicians and practicing managers. The construct validity was verified through exploratory factor analysis. It was aimed at testing the uni-dimensionality of the multi-items perceptual measures. As per the suggestion of Kim and Mueller (1978) only those items with a factor loading of more than 0.40 were retained in the questionnaire. As a result of that the questionnaire was further pruned.*

The section on questionnaire validation (3.2.2, Pg 89) has been improved with the above explanations added to it.

b) Removing non-response bias

Answer:

Figures achieved by segregating early and late responses have been added to the revised thesis in the section 3.2.3, pg. 90, on removing non-response bias, while taking into consideration the suggestions of the examiner.

c) Testing reliability

Answer:

See explanation to Point 4 of this report.

Query:

4. It is claimed that students were used to check the reliability! Surely, the students cannot reflect the maturity of the executives. Then how does one ensure reliability?

Answer:

Section 3.2.4 on questionnaire survey reliability has been elaborated to fetch the following information for the reader

> *After receiving the responses on the completed questionnaire sheets the survey was tested for internal consistencies and reliability. A pretest was conducted on a group of 10 students from the sixth semester pursuing their Masters in Computer Science at the Computer Science Department of the Aligarh Muslim University. These were MCA students having graduation in engineering who were given sufficient briefing and literature before attempting the questionnaire. Brain storming session was also conducted for these ten students so that they were made aware of the research implications of the study and ensure reliability. In the sixth semester these students were pursuing their project dissertations in the corporate sector as trainee or apprentice towards partial fulfillment of their PG degree in computer science. Working alongside executives in their relevant companies they had a fair idea of the thought process of an executive.* (Pg 91 - 92)

In the light of the above revision made in response to the issue raised by the examiner, ensuring reliability in the method adapted by this research is deemed effectuated.

Query:

5. Table 3.4 (p 100): eleven operational variables listed are identified under four classifications. It is not clear how were these variables used under the study. This should be explained properly

Answer:

Table 3.4 is contained in Section 3.2.6 on response ratings from Pg 97 to 98. The selection of variables has been further explained in the revision in last para of Pg. 96.

> *Selection of variables was made by forming an experts group from the subject experts, academia and the industries which was asked to review the variables segregated from the literature – the relevant references of the same have been provided in Table 3.4, and identify as many more possible variables. 44 operational variables were thus finalized under eleven scales. According to their relevance to each scale they have been clustered*

roughly as groups of four variables. These were used in determining the questions of the questionnaire. Opinions regarding these very variables were taken from the executive respondents of the study.

The table 3.4 has also been improved by adding references from literature which contributed to the provision of these variables. A new column has been added to this table. The variables selected were used in forming the constructs of the questionnaire to seek ratings from the respondents regarding agile functions of IT/IS in their respective firms. The data thus gathered is used for analysis through the investigations of this research.

Query:

6. What is the significance of product moment correlation analysis (p 101) and how was it carried out? Should be explained with sample data.

Answer:

Taking due consideration of this point the following has been elaborated upon in the last paragraph on Pg. 99 in section 3.3 on Data Analysis

Figures were obtained from analyzing the opinions to financial and other gains of the organizations. These were tested for correlation with investments on IT and IS with the help of Pearson's Product Moment Correlation Analysis. The survey form comprised of some statements pertaining to the firm's investment on IT/IS infrastructure. These were standardized to provide an increasing order of investment on the 5 – point Likert type scale on which the respondent's opinion was sought. Also the information sought under company demographics contained an MCQ on the increasing or decreasing trend of profits made by the firm in the last five years. The points gained on the scale were treated as loadings for these two important variables and a test of correlation between them was conducted using PMCA. The test statistics and ensuing results have been delineated in Chapter 4 under survey observations. Besides, an interpretation of the PMCA results thus obtained has also been discussed in Chapter 7 under the conclusions of the study.

The sample data and its analysed interpretation has been discussed in Section 4.3 on Business performance and IT acceptance (Pg. 112)

Test of correlation between investments on IT and IS in a firm and the trends of financial gain or business performance as perceived by the respondents were conducted with the help of Pearson's Product Moment Correlation Analysis. Two tailed analysis of the data set revealed a significant correlation between the two variables at 0.01 level, where the value of correlation coefficient was found to be -.724 as N remained 76. The scatter graph depicting the result of PMCA in Figure 4.7 shows a trend of high degree of co-relatedness as established by this test. Figures 4.8 a and b give a sector wise break-up of executives belonging to firms which are increasing the share of the budgetary pie allocated to IT/IS infrastructure and a break-up of firms in the root sample which are making agile attempts in their business operations with an aim of improving performance, respectively.

As a result of the analysis the scatter gram achieved has been illustrated in Figure 4.7 (Pg 129), chapter 4 (Pg 103 to 130).

Query:

7. Similarly MLR (p 101) also should be explained.

Answer:

The Multiple Linear Correlation was conducted for testing the hypothesis set in Chapter 1. The tests and the results for each of the hypotheses have been explained in Chapter 5 on Hypotheses testing. The methodology and data for these tests have been discussed in chapter 3 on research methodologies and design on page 100.

CHAPTER 4

Query:

8. The result presented in chapter 4 is silent about the possible differences among the different sectors.

Answer:

Recognizing the value of this point raised by the examiner fresh insights into the data were made to detect possible inter-sector differences among the firms of the root sample. The methodology adapted pertaining to the same has been explained in chapter 3 and results have been explained in the observations made on the sample in Chapter 4. The following paragraph on Pg 113 is a sample of such observations in the same chapter

> *Observations for a difference in the profiles and responses of various sectors are related to the difference amongst the manufacturing, process and FMCG sectors that make variable investments in IT/IS infrastructure. The outcome distinguishes the manufacturing sector as the one making highest investments and showing technology acceptance. Further, within the sectors of the root sample it is found that with consistent, albeit slight variation the companies are making agile attempts in their business operations where the food and beverage industry score above all as the real estate and entertainment industries remain dismal. More inter-sector differences amongst the firms sampled have been discussed in the following chapter as the hypotheses testing has been conducted.*

In the revised thesis a pie chart in Figure 4.8a (Pg 130) provides a sector wise break-up of executives from firms admitting to an increased investment in IT/IS infrastructure and a bar graph in Figure 4.8b (Pg 130) presents the sector wise breakup of executives from firms attempting agile technologies by accepting IT/ IS and its use for business operations.

Further as the hypotheses have been tested in chapter 5 the intrinsic inter-sector differences are substantiated from the results of the tests.

Query:

9. It is surprising to find that the mean values presented in all tables 4.2a to 4.4d (p110-130) are consistently more than 4. Why? Therefore there are enough reasons to suspect the power of discrimination of the respondents or perhaps the data itself. How was this aspect checked?

Answer:

The mean values of the tables under observations were derived from ratings marked by respondents. While there is a possibility that the respondents discrimination may not be reliable on the five-point Likert type scale it was withstood as a presumption and has been already stated in the limitations of the research (Section 7.5 limitation of research, Chapter 7 on Conclusions). Nevertheless, Cronbach coefficient (Alpha) was checked for the respondent's consistency to avoid any inconsistency (Table 3.2, Pg 92). Albeit, this method was adhered to owing to its wide applicability in the literature, hence the mean values.

CHAPTER 5

Query:

10. In chapter 5 the results of MLR are presented? It is not clear with what data this exercise was carried out? It is mandatory for presenting the data sets used in the thesis.

Answer:

MLR was conducted with the data standardized to the effect of the variables in the hypothesis from the questionnaire. This explanation has been incorporated in the section 3.3 Pg 100 in Chapter 3 on research methodology and design.

Any major modifications have not been made in this revision exercise pertinent to this issue because as this research was planned after its inception, carrying data was not perceived as an aim of substance. The research design relied on descriptive stats instead, to achieve the objectives set, as the make the data more comprehensible and communicate meaning easily. Besides, providing all the data in lengthy tables and graphs would make the thesis unnecessarily bulky without adding any substantial value to it. The descriptive statistics are elicited in Chapter 5 from Pg 131 to 142.

Notwithstanding the above suggestion, in this revision data has not been provided as it would require a lot of time, leaving practically very little time for incorporating the rest of the corrections that have been duly incorporated. Moreover, as this data would be presented in one chapter it would be required to be cross checked through-out the thesis right from beginning to end amounting to a literal rewriting of the entire thesis and addition of many presentations.

Query:

11. In Table 5.1 (p 132) the value of the constant dominates the value of all coefficients. How was this behavior analysed vis-à-vis the behavior captured by the results presented in other tables.

Answer:

In the table in question the constant value was derived through analysis using SPSS.16 software. However if referred to Table 5.1 and 5.2 the coefficient is not found to be dominating consistently. As far as analyzing this behavior with respect to the behavior captured by the results in other tables is concerned, it was presumed that this will not have a bearing on y = the hypothesis or its result. Hence, any analysis pertaining to this has not been conducted.

Query:

12. Page 132: Lines 1 and 2: what is the justification for making this statement? Similar statements are also made in respect of other tables. Proper proof should be presented.

Answer:

The first line in question is the conclusion of the discussion on the previous page. Line 2 has been removed from its location and the ensuing tables in revised thesis. The test result of the hypothesis is to be treated as evidence for accepting or rejecting the aphorism.

Query:

13. Check the veracity of the mean values presented in table 5.9 (p 138) by comparing Tables 4.2a to 4.4d.

Answer:

The values presented in Table 5.9 are pertaining to a single hypothesis whereas tables 4.4a to 4.4d represent the response ratings on the various parameters of the constructs in the questionnaire. However, the veracity of mean values for confidence limits of respondents has not been checked in this thesis owing to time and space constraints which would be incorporated in the future publications.

CHAPTER 6

Query:

14. Chapter 6 discusses the application of the methodology of ANP. Although it is a good attempt there are several missing links which prevent better understanding of the attempts made in the thesis. This chapter should be rewritten by responding to the following questions/ comments.

Answer:

Chapter 6 has been rewritten to cover all the points suggested. (143 to 170)

Query:

a) What advantage did he derive by using ANP instead of AHP?

Answer:

The following advantages of ANP found from literature have been incorporated (section 6.1.1, Page 146):

(i) AHP is largely based on a strict hierarchical structure and relationship among factors, which does not allow for the possibility of having top-to-bottom and bottom-to-top interdependent relationships among group of factors, or for interdependent relationships within a cluster of factors. Whereas ANP goes beyond linear relationships pervades through factors and permit interrelationships among them. AHP hierarchy is replaced by a network in an ANP based system thus permits multi directional relationships with dependence and feedback. Therefore, ANP is more powerful than AHP in the decision environment with uncertainty and dynamics (Saaty, 1999; Taslicali and Ercan, 2006).

(ii) In the ANP rank reversal problem may be appeased, hence it is more accurate and useful (than the AHP) as a decision support system for complex scenario. While the ANP and the AHP are based on user supplied preferences among the factors and provide utility weights for the alternatives, they differ from each other in the number and types of pairwise comparisons, and also in the manner by which utility weights are actually computed (Cheng and Li, 2004).

(iii) According to Taslicali and Ercan (2006) managerial advantages also prevail in using Analytic Network Process over Analytic Hierarchy Process. For instance ANP process facilitates inter-functional and inter-level discussions thus the group of managers (or decision makers) evaluating the factors may have liberty to consider many operational aspects as well. ANP also provides a structured decompositional method for addressing the wide array of factors, instead of relying purely on intuition to evaluate all the intangible factors thus quantification of such factors yield more advantages and justifies the use of ANP in spite of being a network of complex relationship and time consuming calculations. However, managers may use spreadsheet to solve complex computation of ANP up to some extent. Managers may reduce the complexity of calculations by restricting the number of determinants, dimensions and enablers. The number of pairwise comparison generated are depends upon the size of determinants, dimensions and enablers.

Query:

b) Instead of outranking an agile organization, if an organization itself wants to identify the major contributors to its agility, how would the method be used?

Answer:

Future attempt will be made to address the problem identified. Instead of ANP, AHP may be the right approach to resolve such issue. In AHP all criteria (contributors) may be set in a hierarchy as shown in Figure 6.4.

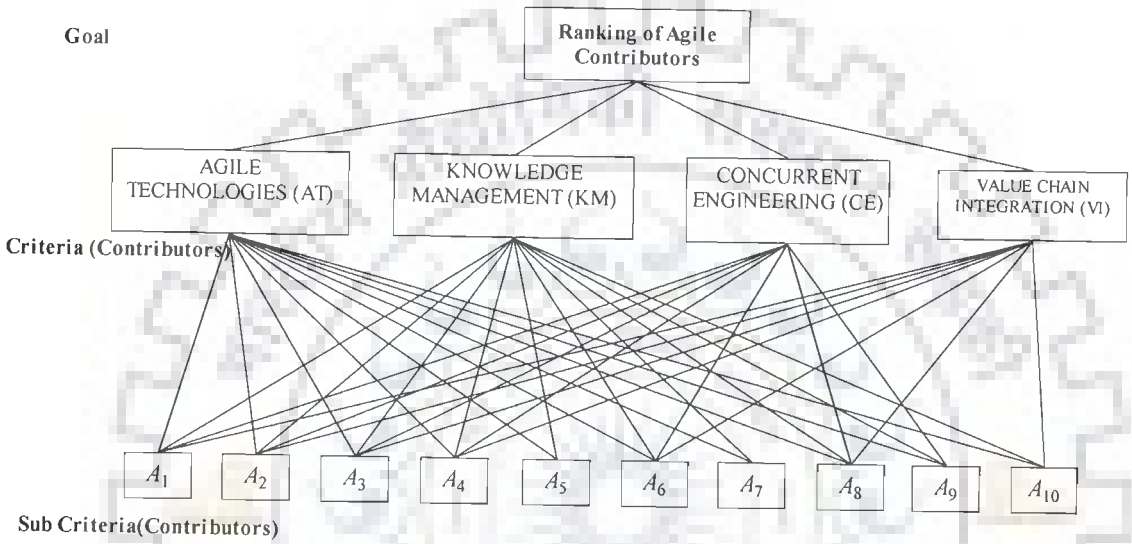

Figure 6.4: Ranking of Contributors of Agile organization

AHP methodology comprising of pair-wise comparisons may be adopted and each contributor may be evaluated for its weightage. Rearranging contributors on obtained weightage in decreasing order will result in ranking of contributors.

The due clarification has been incorporated in the chapter in section 6.4.1 on page 169.

Query:

c) What is the rationale for the hierarchical structure shown in Figure 6.1? There are many more elements which deserve to be included under each of the dimensions.

Answer:

ANP hierarchy structure is devised based on the criteria which are identified in literature. Determinants, Drivers and Enablers are selected based on the discussion with experienced managers from MNCs holding key posts.

Determinants, Drivers and Enablers may be enlarged to provide more comprehensive coverage. However the increase in Determinants, Drivers and Enablers increases the complexity in computation process. So, these are more relevant elements in the current context.

Query:

d) All the tables used to obtain the super matrix should be presented in the thesis. Many tables related to step 2.4 (Pg 154 onwards) are missing. It is difficult to ascertain the correctness of the method.

Answer:

The ANP problem involves 162 matrices as shown in the Table 6.2, Pg. 152.

Determinants	**4**
Dimensions	**4**
Enablers	**16**
Alternatives	**3**
No of Matrices	
PWC of Determinants	*1*
PWC of Dim	*4*
Enablers(16*4)	*64*
Enablers – Dimensions for Determinants	*16*
PWC of Enb-Altre	*64*
Supermatrix before Convergence	*4*
Supermatrix after Convergence	*4*
Final Matrix	*4*
Comparisons of Alternatives	*1*
Total Matrix	*162*

Table 6.2: The matrices involved in ANP problem using one enabler, determinant, dimension and alternative.

A sincere attempt has been made to cover the process of ANP considering one Determinant, Dimension and Enabler, Alternative. All matrices are prepared and presented based on the methodology presented by Meade and Sarkis (1998,1999), Agarwal et al., (2005).

Query:

e) Consider Table 6.6 and 6.7 Pg (154/155).

The row and the column entities are the same but they relate to two different measures. And the numbers in the matrix are different. The candidate should properly articulate the logic involved and use the opportunity to highlight the essential difference between AHP and ANP.

Answer:

Steps pertaining to e-vector calculation are shown in text below Table 6.4 (In the beginning of AHP comparisons). Calculation of λ_{max}, C.I., R.I. and C.R. is also shown. Further, calculation of Table 6.6 and 6.7 is explained here (now tables 6.7 and 6.8 on pg 158 and 159 for step 2.3 and 2.4 respectively in the revised thesis).

Table 6.7a: Further calculation for pair-wise comparison matrix for AT under F

AT	ADT	AMT	ICIS	IMIS	PS	e-VECTOR	5		
ADT	1.00 (D41)	3.00 (E41)	3.00 (F41)	3.00 (G41)	3.00 (H41)	**0.394** (I41)	5.6236	**RI**	**1.12**
AMT	0.33 (D42)	1.00	3.00	5.00	2.00	**0.260** (I42)	5.5438	**CI**	**0.096251**
ICIS	0.33 (D43)	0.33	1.00	3.00	2.00	**0.155** (I43)	5.2948	**CR=CI/RI**	**0.085938**
IMIS	0.33	0.20	0.33	1.00	0.33	**0.066** (I44)	5.1681	<	**0.1**
PS	0.33	0.50	0.50	3.00	1.00	**0.125** (I45)	5.2947		
Col Tot	2.33	5.03	7.83	15.00	8.33	**1.000**	5.385002		

=(D41*I41+E41*I42+F41*I43+G41*I44+H41*I45)/I41 = 5.6236

=(D42*I41+E42*I42+F42*I43+G42*I44+H42*I45)/I42= 5.5438

=(D43*I41+E43*I42+F43*I43+G43*I44+H43*I45)/I43= 5.2948 and so on

CI= (5.385002-5)/(5-1)= 0.096251 , RI from table for n=5 RI =1.12 and so on

CI and RI formula are illustrated in Steps hence not repeated.

Table 6.8a: Further calculation on Pair-wise comparison matrix for AT under F for advanced technology

AD	AMT	ICIS	IMIS	PS	e-VECTOR	4		
AMT	1.00 (D31)	0.14 (E31)	0.33 (F31)	0.20 (G31)	**0.07** (H31)	4.0227	**RI**	**0.9**
ICIS	7.00	1.00	1.00	0.33	**0.26** (H32)	4.2474	**CI**	**0.06523**
IMIS	3.00	1.00	1.00	0.50	**0.21** (H33)	4.2004	**CR=CI/RI**	**0.072477**
PS	5.00	3.00	2.00	1.00	**0.46** (H34)	4.3123	<	**0.08**
	16.00	5.14	4.33	2.03	**1.00**	4.1957		

=(D31*H31+E31*H32+F31*H33+G31*H34)/H31=4.0227

=(D32*H31+E32*H32+F32*H33+G32*H34)/H32=4.2474

=(D33*H31+E33*H32+F33*H33+G33*H34)/H33=4.2004

CI= (4.1957-4)/(4-1)= 0.06523, RI from table for n=4 RI =0.9 and so on

CI and RI formula are illustrated in Steps hence not repeated.

Query:

f) Consider Tables 6.8 and 6.11.

The trends shown by the values of the e-vector in 6.8 is reflected by the final values reported in Table 6.11, which is purely accidental. If all the Tables are presented then one would be in a position to get a better insight about the issues considered here.

Answer:

Table 6.8 (now table 6.9 in the revised thesis Pg. 161, shows the matrix for alternatives' impacting on enabler Advanced Design Technology (ADT) in influencing the Flexibility (F) determinant whereas the Table 6.11 (now Table 6.12 in the revised thesis Pg. 165, shows the combined effect of all enablers.

Query:

15. The details considered in the ANP model do not seem to be related to the survey conducted

Answer:

ANP model is prepared based on the feedback from expert which is additional part. Pairwise decision matrix were obtained through discussion and verified. The decision matrixes were checked for its consistency.

Query:

a) Which are those organizations A, B and C? It appears that they are imaginary.

Answer:

Organization **A** has an ability to innovate faster and in novel way and has ability to achieve high performance, while **B** has less ability to innovate at faster pace to exhibit required ability to achieve high performance. Whereas organization **C** doesn't have ability to accommodate the changing requirements from customer thus succumb to customer change pressure.

Query:

b) The hierarchical factors used in ANP are not discussed in chapter 4 and 5.

Answer:

b) Hierarchy of the ANP model was based on the factors obtained through literature survey and was cross checked with the experts.

Query:

c) The numbers obtained in the tables (pair-wise comparison etc) do not seem to be related to the data collected. If the organizations are imaginary and the tables are obtained using hypothetical data, it should be explicitly stated that the ANP study is hypothetical.

Answer:

The ANP model is based on the feedback received from the executives on the data forms. The opinions have been standardized to arrive to the values in the tables. A, B and C were set according to their change competitiveness and ranked for agility in the model. They are neither imaginary nor the model is hypothetical.

Query:

d) If the ANP study is related to the data collected, then the details of the organization and the corresponding data should be presented. The results also should be discussed in the context of the data presented.

Answer:

The ANP study is nevertheless based on the expert's feedback and survey results. Identification details are not presented in the chapter due to the covenant on confidentiality. Ratings of the three organizations on the scale – where various measures of agile capabilities in the questionnaire are stated, have been used to define the organizations as A, B and C. However, lengthy data tables have not been presented to avoid complexity.

CHAPTER 7

Query:

16. The discussion presented in Chapter 7 is very superficial and should be improved by articulating the contributions, limitations, future work and also how does the work agree and disagree with the contemporary views.

Answer:

The comments of the examiner have been taken into account and suggested modifications have been done in the Chapter 7. Owing to this now the length of the chapter spans 12 pages (Page 171 to 182) instead of the earlier length limited to six pages only. The discussions have been strengthened by giving a comprehensive interpretation of the analysed observations in the working chapters of the thesis i.e. Chapter 4, 5 and 6. Inter-sector differences emerged during the survey amongst the sectors comprising the root sample are discussed in the light of their readiness to adapt to agility. The final contribution of the work has been articulated and appended to the originally existing sections 7.4.1, 7.4.2 and 7.5 on research implications for managers and academics and limitations and scope for future work respectively.

Realising the lacuna on comparison with contemporary views pointed by the examiner, a new section 7.4.3 (Pg 179 to 180) on comparison of the outcome of the present research with the other published studies has been added to this chapter, to fill in this gap. In this section agreements and disagreements of the contribution of this research with views of other scholars in published literature have been elicited with due references. The geographical and academic areas of the research papers whose findings are in compliance with the present research have been mentioned. The analysed observations of this study were also found to be in contradiction with some generally held views for example the productivity paradox. This and similar cases have been presented in a comparative format with this study and the possible reasons behind the standing difference of opinion have also been given space.

17. Some minor typos

Query:

a) The line below Hypothesis 3 needs attention

Answer:

The rephrasing of the hypothesis has been done and other typos found elsewhere have been taken care of.

Query:

b) P 145: fig 1 ?

Answer:

The point has been taken into consideration and the appropriate correction has been made in Chapter 6 (Pg 143 to 170).

Over all an attempt has been made to revise the thesis and improve its quality in the light of the comments and suggestions made by the examiner. Hopefully, in its present form, the thesis would lead to at least another couple of publishable research articles (that can be published in reputed international refereed journals).