Proceedings of GLOGIFT 12
July 30 – August 1, 2012
University of Vienna, Austria
pp. 549-559

Leveraging Cloud Computing for Flexibility and Agility in Business Operations – Select case Studies

Samarth Arora[1]

Abstract

'Cloud Computing' has gathered significant attention globally by Business Organizations, Policy makers, Technology and Service providers and users as a technology for enhanced flexibility and agility in business operations. The concept of 'pay by use' model has shifted the paradigm of cost from Capex (Capital expenditure) to Opex (operating expenditure). The various deployment models i.e. Public/Private/Hybrid clouds and various forms of services i.e. Infrastructure as a Service (Iaas), Platform as a Service (Paas) and Software as a service (Saas) have emerged. The choice of a deployment model and a service type is dependent on trade off with desired flexibility and other requirements like security, cost, ease of access, data control and ownership etc. for various business processes/applications. This paper comparatively evaluates and maps various Cloud Computing applications like social networking, e-governance (unique identification and international trade sector), e-commerce etc. on parameters like flexibility, agility, security, operational benefits like cost saving and strategic benefits. The learnings have been synthesized suggesting a normative Cloud Computing Leveraged business flexibility model.

Index terms- Flexibility, Public/Private/hybrid clouds, Service models (Iaas/Paas/Saas), Data Security, Management, Ownership and Control, Service Oriented Architecture (SOA), Re-engineering', Grid computing, Virtualization, e-governance, Social Networking sites, E commerce Sites, e-trade.

Introduction

Since 2009 there has been a hype about usage of 'Cloud Computing' for reengineering the business process flows for enhanced flexibility. Various surveys indicate that many IT enterprises in India believe that 70% of their products will move to cloud by 2017.

The present cloud market is approximately 100 million dollars which is likely to grow at Survey also shows that only 20% of IT staff is trained for cloud at present and implementation level is about 20%. Compounded Annual Growth Rate (CAGR) of 40% and will become 1 billion dollars by 2015. 'SaaS' will be 65% of this market and balance 35% being shared by 'IaaS' and 'PaaS'.

SMB's and e-governance initiatives are emerging as extremely promising markets as challenges of flexibility requirements are high in these organizations. The growth of Cloud Computing isdepicted in Figure 1.

1. B.E (1st Year) of Manipal Institute of Technology (MIT), Manipal, Karnataka.
Email: arora.samarth@gmail.com

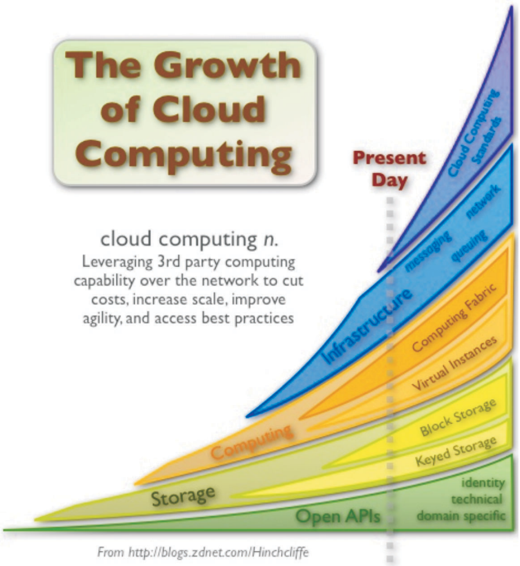


Figure 1: Growth in Cloud Computing

The evolution of Cloud Computing concept can be marked with the web services like Gmail, Yahoo, Facebook, Google docs etc. As the internet penetration and usage of web technology increased, the need to reduce captive cost on hardware and software also increased. Further to have flexibility to ramp up resources with growth, need to mix and match resources and to pay as per use also increased. These requirements for cost reduction by using the shared resources led to the emergence of the Cloud Computing paradigm. The IT experts recognize Cloud Computing as a convergence of various web and IT technologies exploited to create a new computing paradigm, where one can access hardware and software resources sitting on a desktop through these resources are actually not deployed on the user's platform but are tapped/ used from a pooled resources platform called 'Cloud' (Cyber Space). It is infact a 'pay by use' model /concept. The shift is from Capex (Capital expenditure) focus to Opex (operating expenditure). [2] to [5]. Some key elements and applications cloud computing are depicted in Figure 2.

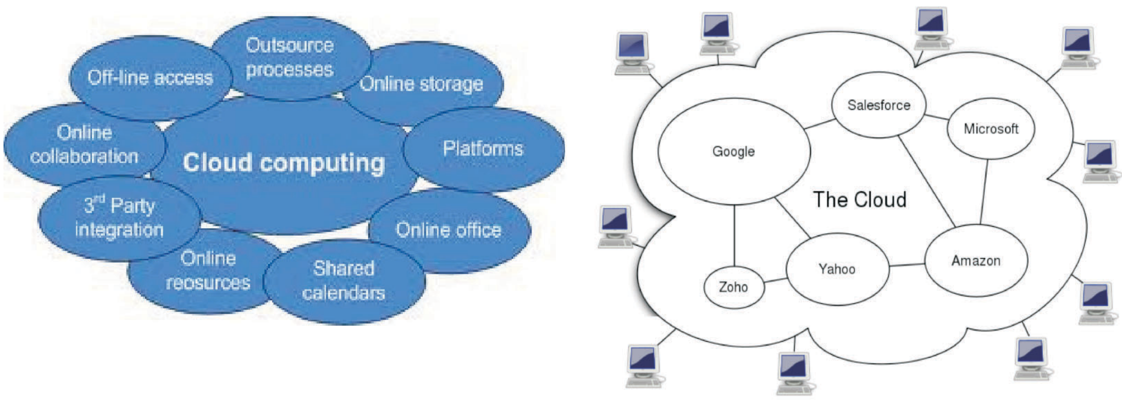


Figure 2: Cloud Computing; Features and Applications

The five characteristics and flexibility drivers of Cloud Computing which are On-Demand Service, Broad Network Access, Resource Pooling, Scalable & Elastic and Metered Services. These characteristics are compiled in Table.1.

Table 1: Flexibility Features of Cloud Computing

On-demand self-service	Unilateral provisioning of computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service's provider.
Broad network access	Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops and PDAs)
Resource pooling	The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is sense of location independence with no control or knowledge over the exact location of the resources except at a higher level of abstraction (e.g. country, state, or datacenter) Example; storage, processing, memory, network bandwidth, and virtual machines.
Rapid elasticity	Capabilities can be rapidly and elastically provisioned, or released to quickly scale out or scale in. The capabilities available for provisioning appear to be unlimited and can be purchased in any quantity at any time.
Measured Service	Cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

The Relevance of a Flexible Cloud Computing Framework

In the present world, technology, process and environment changed rapidly which requires organizations to have flexible systems to respond, adjust and manage these changes dynamically. The main Foundation elements of Cloud Computing includes Virtualization, Grid Computing, Service Oriented Architecture (SOA), Distributed Computing, Broadband networks, Browser as a platform, Free & Open source software and other technologies such as Autonomic systems, Web 2.0, Web application framework and Service level agreements (SLA's).

'Cloud Computing' is in fact a natural extension of integration of various diverse technology and applications.

The three major service categories delivered through Cloud Computing are Infrastructure as a Service (Iaas), Platform as a Service (Paas) and Software as a Service (Saas)[1] are depicted in Table 2.

The three major cloud deployment models, which can be flexibly used, are Private, Public and Community is depicted in Table 3. At present Private model accounts for 75% the total deployment, public and Community account for 20% and 5% respectively.

At present in India about 20 Cloud service enterprises are operating out of which 60% are providing 'Saas' while remaining are equally divided in for 'Paas' and 'Iaas'.

Table 2: Flexibility in Cloud Computing Service Categories

Category	Key Feature
Software-as-a-Service (SaaS)	End user applications delivered as a service, rather than a traditional, on premises software. E.g; Salesforce.com
Platform-as-a-Service (PaaS)	Provides an independent platform or middleware as a service for developers to build and deploy customer application. Common solutions range from APIs and tools to database and business process management system, to security integration, allowing developers to build applications and run them on the infrastructure that cloud vendors own and maintain. E.g; Microsoft windows azure platforms services, Google apps.
Infrastructure-as-a-Service(IaaS)	Hardware and technology for computing power, storage, operating systems or other infrastructure, delivered as off-premises, on-demand services rather than dedicated as on-site resources. The customers can pay for exactly the amount of service they use, like for electricity or water. It, is therefore also called utility computing. E.g.; Amazon Elastic Compute Cloud (Amazon EC 2), Amazon Simple Storage Service (Amazon S 3) and Eucalyptus Open Source Cloud Computing System.

Table 3: Flexibility in Cloud Computing Deployment Models

Type of cloud	Salient features
Private (Internal Cloud)	• Enterprise owned or leased.
	• Dedicated to a particular organization and not shared with other organizations.
	• Not a real example of cloud computing but an emulation.
	• Private clouds are More expensive and more secure when compared to public clouds.
	• The two types On-premise and 'externally hosted' private clouds. Externally hosted private clouds also exclusively used by one organization, but hosted by a third party specializing in cloud infrastructure, and are cheaper than On-premise private Clouds. E.g.; Amazon Books Store.
Community	• Shared infrastructure for specific community
	• Computing infrastructure shared in between organizations of the same community. E.g.; NIC's Cloud for e-Gov projects.
Public (External Cloud)	• Sold to public/any user, large scale infrastructure)
	• Computing infrastructure is hosted by the cloud vendor at the vendor's premises.
	• Customer has no visibility and control over where the computing infrastructure is hosted.
	• Computing infrastructure is shared between any organizations.
	• Resources are dynamically provisioned on a fine-grained, self-service basis over the Internet, via web applications/web services, from an off-site third party provider.
	• Shared resources are billed on a fine grained utility computing basis. E.g.; Social Networking Portals. Amazon EC 2
Hybrid	• Composition of two or more models.
	• Critical applications requiring high security on private clouds and applications with relatively less security concerns on a public cloud.
	• Usage of both private and public clouds together.
	• Cloud bursting organization use their own computing infrastructure for normal usage, but access the cloud for high/peak load requirements ensuring that a sudden increase in computing requirement is handled gracefully.
	• Environment typically consists of multiple internal and/or external providers for most enterprises.

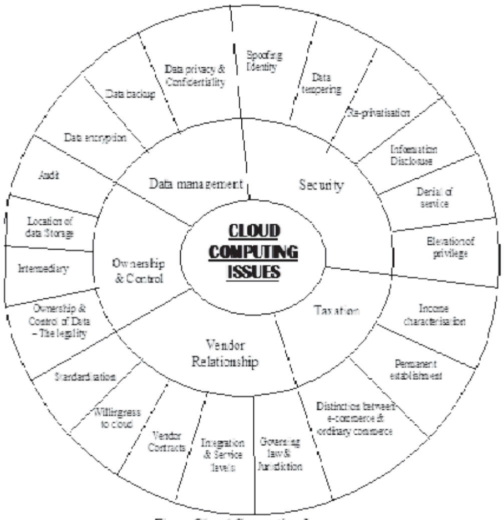


Fig. 3 Cloud Computing Issues.

Figure 3: Cloud Computing Issues

Cloud Computing: Issues and Challenges in Advancing Flexibility

The main issues pertaining to Cloud Computing are related to Data Management, Security, Taxation, Vendor Relationship and Ownership & Control [6], [7] and [12]. As can be seen that data security and management have many aspects which need to be addressed for success of cloud computing. No organization / entity will like to lose control on sensitive data and also there are many legal aspects on residency of data, place where disputes need to be registered and settled etc. The finer details are depicted in figure 3.

Facilitators and Inhibitors for Cloud Computing

The literature survey shows that the key facilitators are operational and strategic cost and flexibility benefits while major inhibitors are lack of security, legal framework and loss of control which increases the business continuity risk. These Facilitators & Inhibitors are tabulated in Table 4.

Table 4: Facilitators and Inhibitors for Cloud Computing

FACILITATORS	INHIBITORS
• Shift from Capex to Opex.	• Low security
• Need to reduce Infrastructure cost.	• Low data privacy and confidentiality
• Emerging convergence, standardisation and harmonisation.	• Lack of legal understanding
• Growing community and network projects; (e-Governance)	• Loss of control and ownership
• Facility of ‘Pay as per use’	• Too much dependence on external entity, hence high risk.
• Quick ‘scale in’ & ‘scale out’ of infrastructure based on need	• Limit to high customization.
• Flexibility to access resources anytime and anywhere.	
• Scalability, interoperability, Efficiency, Virtuality.	

Case Study of Face book, a Social Network Site and Unique Identification (UID) and e-trade (e-governance Projects) – A Comparative Flexibility Attribute Analysis

'Facebook', a Social Networking Portal has been a success story. The SWOT analysis of the same reveals that success of this Site has been due to an open, easy and flexible access with an assured revenue model built on the large user base being targeted by advertisements. However future of this Site lies in securing information, ensuring privacy and confidentiality and establishing legal framework / SLA's and continuously innovating and providing new platform tools to keep the user base intact and remaining ahead the competitive websites.

UID an 'e-Governance' project is an unique mega e-Gov project. Its USP is "Identity Certification as a service". The UID contains both demographic and biometric data. The personal identity information is kept confidential through data encryption while other available is part in public domain. The project is implemented through flexibility in technology, applications portfolio process and governance structures. The application tools deployed are multimodal and modular, the processes have standards and governance is through public-private partnerships. Thus the entire project ensures a balance between flexibility and standardization. Its success depends on having a highly secure environment. The SWOT analysis for the above 2 portals are shown in Figures 4 and 5.

STRENGTHS	WEAKNESSES
• Large user base; 850 million active users. • Established brand name as a most popular Social networking sites. • Open registration & reach • Chat & Video calling facility • Platform tools for customization	• Low of data privacy & confidentiality • Lack of legal protection • Low level of security

OPPORTUNITIES	THREATS
• Business majors attraction for advertisement • Growing need for socializing across the globe • Growing Public opinion gathering collection requirements	• Other emerging competitive websites • IPR wars (recent yahoo litigation) • Hacking • Abuse by children and malafide entities

Figure 4: Facebook – A Social Networking Site; A Swot Analysis

STRENGTHS	WEAKNESSES
• Unique Mega e-Governance initiative • 1.2 Billion biometrics records. • Identity as a service. • Assured revenue stream.	• Continuous Data updation and storage. • Mega Computing capability needs. • Constantly being vigilant on security and privacy
OPPORTUNITIES	**THREATS**
• All transaction / registration need identity. • No comprehensive unique number available so far.	• Substitution by other identity no. • Cumbersome access and Security.

Figure 5: UID: An e-Governance Initiative A SWOT ANALYSIS

'E-trade' is one of the key 'e-governance' community projects in India, whose main network partners are Customs, Banks, Shipping lines, Export Promotion Bodies, Director General of Foreign Trade (DGFT), Freight Forwarders etc. The objective of this project is to establish a seamless EDI connectivity amongst various network partners to facilitate conduct of international trade, as depicted in figure 6 below [13]:

Figure 6: E-Trade Network Partners

All network partners have leveraged process reengineering to harness benefits of EDI technology. 'Flexibility' in operations has been a core driver of all the network partners. According to the CEO and DG of (FIEO), a prime association of exporters and importers, 'Flexibility' is a critical aspect of the 'e-trade' network, as the requirements and readiness of the members of user community are quite diverse. FIEO has also been an active partner in uploading its membership details on DGFT's website. The flexibility has been primarily ensured in the areas of platform and architecture neutrality, options in security access features, message exchange structures, co-existence of EDI & non-EDI documents for all applications etc. The Directorate General of Foreign Trade (DGFT) which is one of the key network partners has adopted a flexible EDI model very effectively with the above key network partners.

This organization issues permissions and authorizations for imports and exports. Its main EDI interfaces are shown in figure 7. The various aspects of DGFT's web based facilitators are deposited in figure 8.

The online application is filed by exporters/importers through DGFT's website. The model has neutrality in platform/architecture, optional security access features i.e. either Digitally signed or password based, offline/ online uploading, applicability of same application module for EDI or non EDI ports, compatibility of different message exchange formats with different network partners, support of all B2G, G2B, G2G forms as the flexibility features as shown in table 5, SWOT analysis of this project is depicted in figure 9.

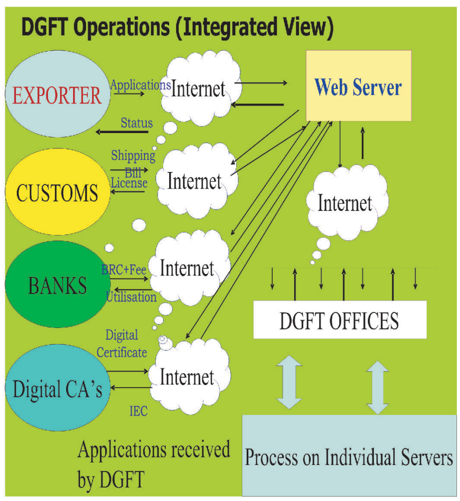


Figure 7: DGFT's e-Interfaces

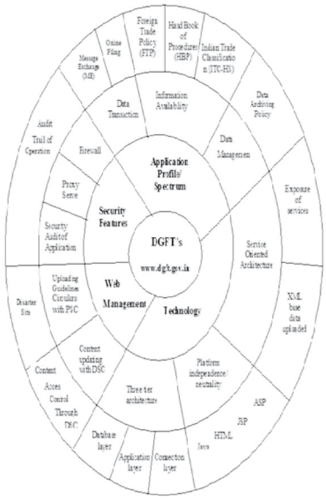


Figure 8: The DGFT's Flexible Portal

Strength	**Weakness**
• Web based reengineering • Win-Win for all • Reduction of transaction lost and time • Neutrality in various processes/features.	• Silo culture constraints • Time consuming agreements
Opportunity	**Threats**
• Process reengineering • Harmonisation • Service oriented Architecture (SOA)	• Turf and domain wars amongst network partners • Lack of agreements • Data errors • Different levels of readiness • Fast changing technology

Figure 9: SWOT Analysis of 'e-trade'

Table 5: The Interface Flexibility with Network Partners

Network Partner	Projects/ Activities	Network Topology	Mode	Security	ME file format
Customs	Authorization, Shipping bill	One to one	Offline	Access control through digital signature	Flat file through FTP
Banks(e-BRC – Bank Realisation certificate)	Foreign Exchange Certificate	One to many	Offline	Access control through digital signature	XML file upload
EPC's(e-RCMC-Registration and membership certificate)	Registration Certificate	One to many	Offline	Access control through digital signature	XML file upload
Banks	Electronic Fund Transfer	One to many	Online	Access control through digital signature	Integration with bank website

The organization endeavors to further enhance flexibility by using the framework of cloud computing and service oriented architecture (SOA). The existing message exchange format creates burden of high level of message exchange integrity for error free transmission. This limits the flexibility in data sharing between two partners as it is contingent on the data exchange in on agreed message exchange format. To enhance flexibility, a service-oriented architecture wherein all the network partners agree to reside their data on a ‘e-trade’ public cloud with agreements on data access through secure access control is a futuristic and an optimal solution. The cloud computing framework promises, a versatile and flexible solution for the ‘e-trade’ project.

Concluding Remarks

The case studies and literature review indicate that various applications of ‘Cloud Computing’ are supported by different and appropriate deployment models and service forms. The matrix of mapping of security and customization requirements in Figure 10 below shows that choice of Cloud delivery model and service form is outcome of combination of these two requirements.

S →

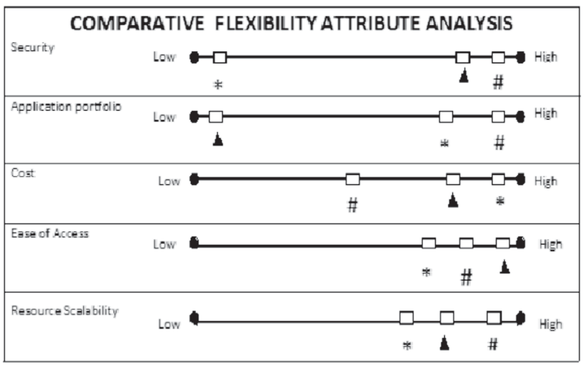
C ↓

	H	M	L
H	Private Cloud: Iaas (e-Governance Projects)	Hybrid / Community Cloud Iaas	Public Cloud: Iaas (Amazon)
M	Private Cloud: Iaas / Pass (Financial Ecommerce transaction like Flip Kart, E-bay)	Hybrid / community Cloud : Iaas / Pass	Public Cloud: Iaas / Pass (Facebook, Twitter, Orkut & other Social networking sites)
L	Private cloud Saas / Paas	Hybrid / Community Cloud: Saas / Paas	Public Cloud: Saas / Pass (Gmail)

S – Security, C – Customization,
H – High,, M – Moderate, L - Low

Figure 10: Levels of Security – Customization Matrix

The three cases have also been comparatively analyzed on various flexibility attributes which are depicted in figure 11.



* Social Networking Site (Facebook)
▲ E-Governance (UID Project)
E-Governance (International Trade)

Figure 11: Comparative Flexibility Attribute Analysis

All three cases are rated high on the flexibility attributes but 'e-trade' project has flexibility rating higher than other two projects. It is due to highly dynamic and complex interplay of interactions between the network partners. It emerges that the Facebook Portal has greatest flexibility limitation of security while for e-trade it is the cost consideration.

Based on the learning's of the three cases studies normative framework on flexibility through cloud computing architecture is depicted in figure 12.

Figure 12: Flexibility through Cloud Computing – A Normative Model

It is seen that generalization cannot be made on the usage of any particular model, service type or architecture. Application Re engineering and 'Security' of transactions would be the main drivers to upscale usage of Cloud Computing. No doubt operational costs and have so far facilitated 'Cloud Computing' growth especially the popularity of social networking sites, and small on line E commerce payment applications, but for large scale usage and mainstreaming of 'Cloud Computing', the strategic benefits of flexibility which will accrue in Mega e-Governance and community projects would catalyze the growth of this technology. This requires 'Re-engineering' of workflows across Organizations and adoption of SOA architecture. High order of security of transactions with 100% privacy and confidentiality, standardization and harmonization of inter organizational processes would be the essential prerequisites. It is the desire to reap strategic benefits of flexibility that would make Cloud computing more relevant in the future years.

Acknowledgements

I am thankful to Professor Dr. Shampa Chakraborty, HOD, Computer Science Department, NSIT, New Delhi, Mr. Ajay Sahai, Director General and CEO of FIEO for encouragement and Mr. A. K. Sinha, Senior Technical Director, NIC, New Delhi for his valuable technical inputs.

References

- [Priya Metri and Geeta Sarote (2011) Privacy Issues and Challenges in Cloud Computing, *International Journal of Advanced Engineering Sciences and Technologies*, 5(1), 001-006.

- Computers and Technology, "Cloud Computing? the future is now;" http://www.technethuancavelica.com, 2011.
- Computers and Technology, "Key Features of Cloud Computing Strategy", http://www.technethuancavelica.com, 2011.
- Computers and Technology, "Is Cloud Computing the future of web hosting?",http://www.technethuancavelica.com, 2011.
- Computers and Technology, "Cloud Computing – The Latest Trend in IT Enterprises", http://www.technethuancavelica.com, 2011.
- A.K. Chakravarti (2010) Cloud Computing – Challenges and Opportunities, www.cdac.in .
- R. Rajeswari, S.A.V. SatyaMurti, M.L. Jayalal and R. Jehadesan (2010) Moving from Grid to Cloud Computing; The Challenges in an Existing Computational Grid Set Up, *International Journal of Computer Science and Communication*, 1(2), 415- 418, July-Dec.
- Torry Harris (2011) Cloud Computing – An Overview, www.thbs.com.
- Sushil (1997) Flexible System Management, An Evolving Paradigm, *Systems Research and Behavioural Science*, 14(4), 259-275.
- Sushil (2000) *Flexibility in Management*, Global Institute of Flexible Systems Management, Vikas Publishing House Private limited, New Delhi.
- Sushil (2005) A Flexible Strategy Framework for Managing Continuity and Change, Department of Management Studies, Indian Institute of Technology Delhi, *International Journal of Global Business and Competitiveness*, 1(1), 22-32, 2005.
- Samarth Arora (2012) Cloud Computing – Issues, Challenges and Road Map, *National Conference on Information Sciences*, Manipal, April.
- Rajiv Arora and D.K.Banwet (2003) E-Commerce Implementation in India – A Study of Select Organizations, *Asia Pacific Development Journal*, 10(1), June.