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Cloud Computing Implementation: An Analysis using Systems Approach

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Abstract

Cloud Computing is an emerging concept which envisage the usage of internet for deploying and delivering business application as pay per use model. Cloud computing is attractive for business owners because it eliminates the need for users to set up ahead for provisioning, and permits enterprises to begin from the little and increase resources only when an increase in demand.

However, despite the actual fact that cloud computing offers vast opportunities to the IT business, the event of cloud computing technology is presently at its infancy, with several problems still to be addressed. If cloud computing is to realize its potential, there has to be a transparent understanding of the varied problems concerned, each from the views of the suppliers and therefore the shoppers of the technology. There is associated equally pressing want for understanding the business-related problems regarding implementation of cloud computing.

Keywords: Cloud Computing, Flexible Systems Approach, Cloud Computing Implementation

SECTION 1

Introduction

Cloud Computing is being conceptualized as a model in congruence with utilities like water, electricity, gas, and telecom. Under this concept computing will be treated just like commodity and will be delivered like any utility. In such a model, users access services based on their necessities while not relevancy wherever the services are hosted or however they are delivered (Buyya, et.al, 2008). Cloud computing is an extension of utility computing model which includes concepts like Cluster Computing and Grid Computing.

Cloud computing is an extension of utility computing concept whereby the aptness of business applications are exhibited as technical services that may be accessed over a network. Cloud service suppliers are incentivized by the profits to be created by charging shoppers for accessing these services. Consumers, like enterprises, are attracted by the chance for reducing or eliminating prices related to ‘‘in-house’’ provision of those services. However, since cloud applications could also be crucial to the core business operations for the adopters, it is essential that the quality assurance on service delivery be provided through Service Level Agreements (SLAs) between the suppliers and adopters. The emergence of this development, usually called cloud computing represents a basic modification in the manner information technology (IT) services are developed, deployed, scaled, updated, maintained and procured (Buyya, et.al, 2008).

A cloud infrastructure is the collection of hardware and software that enables the implementation of cloud computing environment. The cloud infrastructure contains of a physical layer and an abstraction layer. The physical layer consists of the hardware resources like servers, storage components that are essential infrastructure to provide the cloud services. The abstraction layer consists of the software that makes use of the underlying infrastructure, which substantiate the essential cloud characteristics. In theory, Abstraction layer is over and above physical layer (Meel and Grance 2011).

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Computing these days reflects a contradiction in today's times – on one hand, computers continue to become exponentially powerful and also the cost of computing continues to fall speedily, **so** that computing power in itself is currently thought to be largely a commodity (Hackket and Sean, 2008). On the other hand, as computing becomes more pervasive inside the organization, the increasing complexness of managing the total infrastructure of disparate information architectures and distributed and software system has created computing dearer than ever before to a company (Roherig and Paul,2009).

Cloud computing represents a convergence of two major trends in information technology – (a) IT potency, whereby the ability of contemporary computers is employed efficiency through highly scalable hardware and software resources and (b) business agility, whereby IT may be used as a competitive tool through fast preparation, parallel execution, use of compute-intensive business analytics and mobile interactive applications that respond in real time to user necessities (Marston, li, et.al,2011).

However, because the term business agility implies, cloud computing isn't almost cheap computing – it's additionally about businesses having the ability to use computational tools that may be deployed and scaled speedily, at the same time as it reduces the necessity for large direct investments that characterize enterprise IT setups these days.

Many definitions of cloud computing exist. However none appear to emphasize all the factors that are necessary for businesses as they contemplate cloud computing as a part of their IT arsenal. The researcher has taken into consideration the formal definition of cloud computing as proposed by National Institute of Standard And Technology (NIST) due to the fact that this definition is widely accepted by industry.

As per NIST definition, Cloud computing is a model for providing anywhere, anytime, hassle free, on- demand, fast network access to a collective pool of configurable computing devices (e.g., networks, servers, storage, applications, and services) that require exiguous management efforts or service provider interaction (Mell and Grance 2011) . The concept of cloud computing includes five essential characteristics, three service models and four deployment models. The essential characteristics are on-demand self service,accessibility on heterogeneous devices, quick time scalability on demand, resource sharing across multiple applications and users in a non-dedicated manner and resource utilization being tracked for each application and user, typically for billing purpose.

The three service models are Software as a Service (SaaS), in which the consumer access the application typically through a web browser using heterogeneous device and manage user level configuration setting without any control on the underlying cloud infrastructure for providing the services; Platform as a Service (PaaS), in which the consumer can host and control created or acquired application and manage the configuration settings of applications using services and tools supported by the provider without having any control on the underlying cloud infrastructure and Infrastructure as a Service (IaaS)**,**in which the consumer can deploy and run business application like operating systems managing fundamental computing devices like storage, hosted applications and networking components (e.g., host firewalls) but does not manage the underlying infrastructure.

The computing resources are typically hosted and managed by service provider but usage, control and accessibility to resources provides four Models for cloud computing deployment namely; Private Clouds which refers to exclusive usage of computing facilities by a single company; Public Clouds which refers to shared usage of computing facilities by multiple corporations in non-dedicated manner; Community cloud which refers to usage of common platform of computing facilities by organization having identical business needs and Hybrid Clouds which refers to adoption of computing facilities by a corporation in both public and private cloud for single application depending on the state of demand.

Cloud Computing, is the best possible solution in situations, when over the years with different kinds of IT solution being deployed across various department in the company, and also as a result of Mergers and Acquisition, the cumulative portfolio of IT setup in the company is quite varied and non symmetric. In such conditions cloud deployment provide rationalized and standard solution in sync with company policies, to various units in the company customized to their specific requirement. Providing access to advanced networking capabilities via cloud-based solutions will facilitate company providing ubiquitous access to employees.

The establishment of a framework will provide successful implementation of cloud computing environment in any

organization. It is recommended that a phased approach for integration of cloud computing with existing IT setup be employed which includes consolidation, virtualization, automation, utility and finally cloud environment. A firm's migration towards cloud computing begins with increased resource utilization provided by the consolidation of server, storage, and network resources, that decrease redundancy and under utilization of resources. Once consolidation is achieved the components are treated as a pool of resources, permitting the allocation of resources on demand. Companies in pursuit of cloud computing aims to manage service level specification to enhance the application user performance. In this regard, with centralized IT and self-service for end users, automation enable companies to disentangle themselves from repetitive management procedures for assigning IT resources and enabling end users to quickly access what they need. In addition to automation, concept of metering, which indicates the cost of the resource usage is necessary requirements in creating a cloud service. Through cloud internet working, disparate cloud systems can be linked in such a way, so as to accommodate both the unique nature of cloud computing and the running of IT workloads. This internet working allows the sharing of a range of IT resources and capabilities, including capacity, monitoring, and management, and the movement of application loads between clouds.

Cloud solutions may provides opportunities for companies that believes technology as the simplest way to save lots of money , with possibilities of approaching cloud computing as resource of distinctive core competency. Particularly for corporations that may take advantage in off-the shelf solutions enforced in a timely manner, to press for larger business and be more productive. The immediate advantage of cloud solutions are of a tactical nature, providing value in terms of deployment economies. However within the long run, the strategic implications of cloud capabilities are even more valuable, setting the stage for innovative adoption of new technology which will enhance a company's competitive position.

The researcher has proposed a conceptual framework which investigates the factors that contributes towards Cloud Computing adoption in any company. The model also aim to study the impact on the performance of the business, with the adoption of cloud computing. The current position of the company, defined in terms, of its financial health, marketing stature and current stage of technology diffusion and environmental policies. These along with the enablers who can compel company to adapt cloud computing .Enablers are defined in terms of ever changing client preference, competitive setting and government regulatory framework.

The adopters which drive the company towards cloud computing, which include factors like Time to Market, reduced TCO, and Agile Organization etc. All these factors are primarily responsible for adoption cloud computing. The rate of diffusion of cloud computing in any company will further depend on operational flexibility of the task and also the strategic value of that activity. Once implemented cloud computing will be a tool of comparative advantage for companies with advantage such as cost management, resource utilization, process standardization etc.

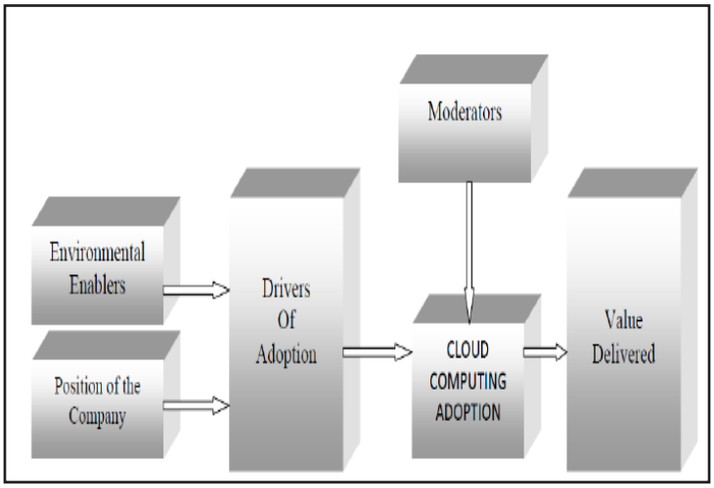
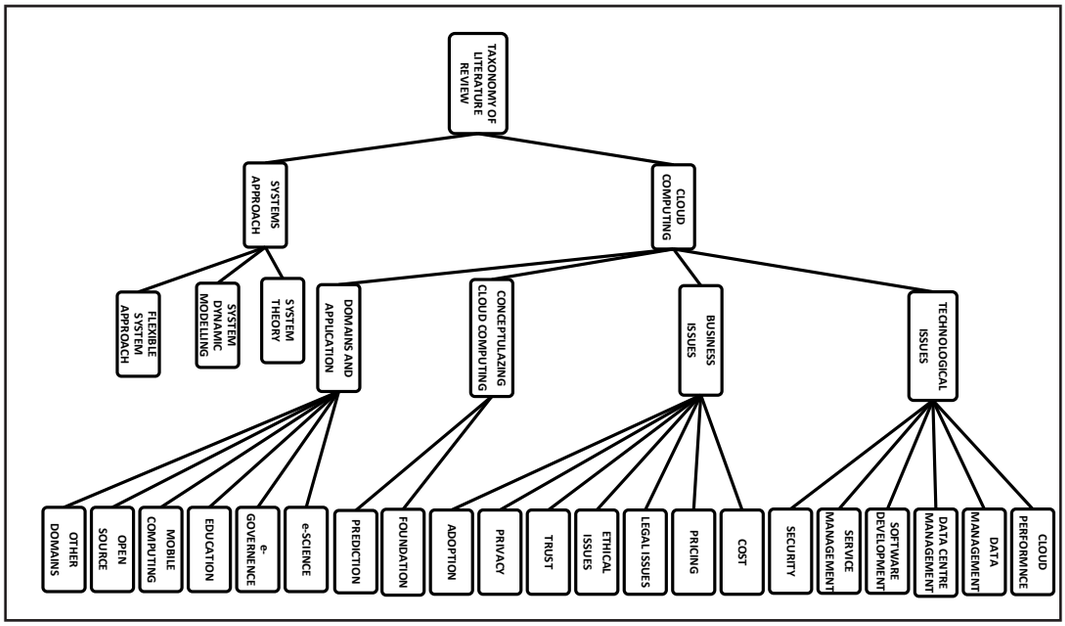


Fig. 1: Proposed by Researcher

SECTION 2

Literature Review

In this section, we present a review of the relevant literature in the current area of research. A taxonomical view of the literature review conducted in this synopsis is given in Figure below.



Cloud Computing

Technological Issues

This category focuses on technology details of cloud computing. Articles in this category are produced by researchers who see cloud computing as a white-box and are interested in its components and mechanisms. Six categories are related to technological issues.

Cloud Performance

This subcategory covers articles focusing on the evaluation and optimization of the performance of the clouds. This includes studies that attempt to quantify and compare performance across different clouds (Iosup et al., 2011), to enhance workflow scheduling and load balancing (Byun, et al., 2011), to improve dynamic resource allocation (Streitberger and Eymann, 2009; Warneke and Kao, 2011), to enable automatic bottleneck detection (Iqbal, et al., 2011), to estimate performance of cloud network with nodes failure (Lin and Chang, 2011), and to improve interoperability across different clouds.

Data Management

This subcategory includes specific issues associated with the large scale, distributed data processing in the clouds. This includes data consistency (Vogels, 2009), data redundancy (Pamies–Juarez, et al., 2011), data mining algorithms and methods (Grossman, et al., 2010), integration of distributed data (Chen, et al., 2011), and parallel RDBMS (Relational Database Management Systems) (Stonebraker, et al., 2010).

Data Centre Management

This subcategory looks into the foundational enabler of cloud computing, the data centres. Articles in this category concentrate on energy efficiency, power conservation, and

environmental considerations in the design of data centres (Beloglazov, et al., 2011; Berl, et al., 2010). In addition, algorithms for energy-aware scheduling are proposed (Mezmaz, et al., 2011).

Software Development

This subcategory represents a stream of software developer-oriented research. Articles in this subcategory range from generic discussions on developing distributed and parallel software in cloud computing environments (Lawton, 2008a;Wang,et al., 2010), to specific analyses of particular cloud-based programming frameworks such as MapReduce (Liu, et al., 2011). Novel studies also look into component-based approaches for developing composite applications (Malawski, et al., 2011) and automation in restructuring traditional applications into distributed/ partitioned cloud-based ones (Böhm and Kanne, 2011).

Service Management

As an emerging research theme focusing on the administration of cloud computing services, this subcategory includes articles exclusively targeting aspects such as service lifecycle in the cloud (Breiter and Behrendt, 2009) and publishing, discovering, and selecting cloud-based services (Goscinski ,et al., 2011).

Security

Cloud security has been a common concern for the public (Bellovin, 2011). Some articles in this subcategory look at general security mechanisms such as restrictions and audits (Spring, 2011a; Wang, et al., 2011), multi-tenancy authorization (Calero, et al., 2010), third-party assurance (Zissis and Lekkas, 2010), and cloud-based security services (Li,et al., 2011). Other articles addressing specific cloud related security issues fall into two categories: data security and network security. The data security category includes papers looking at data encryption (Anthes, 2010), data colouring, and software watermarking for multi-way authentications (Hwang and Li, 2010), and a data-partitioning scheme for implicit security (Parakh and Kak, 2009). The network security category includes papers discussing intrusion detection in the cloud (Vieira, et al., 2010), and cloudlevel defence against HTTP-DoS and XML-Dos attacks (Chonka, et al., 2011).

Business Issues

This category concerns the business implications of cloud computing. Articles in this category treat cloud computing as a black-box technology which can generate business value to both providers and users. Seven categories have emerged in this category.

Cost

This subcategory examines the economic benefit from a cloud-user perspective. Topics in this category include a comparison between the cost of leasing cloud services and that of purchasing and using a local server cluster (Walker, 2009), techniques to estimate and monitor costs for cloud services (Truong and Dustdar, 2010), algorithms for finding minimum cost storage strategy (Yuan, et al., 2011), and more specific ones such as analysing operational costs for hosting online games in the cloud (Iosup, et al., 2010).

Pricing

Articles in this subcategory mainly focus on the pricing strategies of cloud providers. A common approach for studying this topic is to compare different pricing strategies and analyze the pros and cons in terms of acceptance of customers. Comparisons can be made between fixed prices and variable prices (Yeo, et al., 2009), or between piece-rate pricing and flat-rate pricing (Li, 2011).

Legal Issues

This subcategory examines legal issues associated with cloud computing. With rapid advancement in technology, regulators are often in a 'catch-up' mode with regard to policy, governance, and law (Kaufman, 2009). Articles in this category introduce general legal risks of adopting cloud computing (Joint, et al., 2009), as well as addressing specific topics such as digital forensic investigation in cloud computing systems (Taylor, et al.,2010) and uncertain jurisdiction for Internet activities in geographically distributed cloud data centres (Ward and Sipior, 2010).

Ethical Issues

This subcategory analyses the cloud computing phenomenon from an ethical standpoint. It contains

articles which propose that IT professionals, when making decisions about cloud computing deployment, should consider applied ethics methods such as Utilitarian, Deontologist, and Rawlsian (Miller, 2010).

Trust

This subcategory examines approaches for cloud providers to gain trust from prospective users. Articles in this category identified two factors affecting trust in the cloud—transparency (Bret, 2009) and public auditability (Wang, et al., 2010). In addition, an instrument for evaluating the transparency of a cloud provider is proposed (Pauley, 2010).

Privacy

This subcategory specifically addresses privacy issues from either an ethical or legal point of view. With cloud computing, privacy is an inevitable concern, as the cloud users have to upload and store (in some cases sensitive) business and personal information into remote data centres managed by external parties (Katzan, 2010c). Articles in this subcategory propose a method for analysing privacy in cloud computing in the workplace (Barnhill, 2010) and argue that cloud providers need to display clear policies about how user data is used (Ryan, 2011).

Adoption

This subcategory explores topics related to cloud-computing adoption in businesses. Some articles in this category target general businesses by providing ROI (Return on Investment) models for firms to decide on the suitability of adopting cloud computing (Misra and Mondal, 2011). Other articles focus more on SMEs (Small and Medium Sized Enterprises) and look into inhibitors (Truong and Dustdar, 2011) and enablers of the adoption of cloud computing (Yogesh and Navonil, 2010), as well as the benefits of adoption, such as enhanced competitive advantages (Truong, 2010).

Conceptualizing Cloud Computing

This category contains articles that provide a general view of cloud computing practice and research, with an aim to provide a general understanding of this area rather than to focus on any specific facet of it. These articles can be further classified into two subcategories.

Foundational/Introductions

This subcategory contains articles that introduce foundational concepts and components of cloud computing. Such introductory articles provide definitions and outline key features of cloud computing (Armbrust, et al., 2010; Mell and Grance, 2010), reflect the timeline of cloud computing (Pallis, 2010), analyse the related benefits and obstacles, strengths and weaknesses of cloud computing and suggest future research directions (Armbrust, et al., 2010; Marston, et al., 2011). To further articulate the essence of the cloud computing paradigm, some articles make comparisons between cloud computing and other concepts such as grid computing (Buyya et al., 2009; Shiers, 2009; Weinhardt, et al., 2009), cluster computing (Buyya, et al., 2009), virtual computing (Cervone, 2010), and even electricity (Brynjolfsson, et al., 2010). Comparisons are also made between public cloud and private cloud (Grossman, 2009), as well as across public cloud providers, such as Amazon, Microsoft, and Google (Buyya, et al., 2009).

Predictions

This subcategory contains articles focusing on forecasting the future of cloud computing and suggesting potential implications. Some project the technical and managerial effects of cloud computing on network and software vendors (Cusumano, 2010), as well as on HPC (High Performance Computing) systems (Sterling and Stark, 2009), while others speculate the economic prospects of cloud computing for developing nations (Greengard and Kshetri, 2010; Kshetri, 2010).

Domains and Applications

This category consists of articles which discuss the impact of cloud computing on particular domains or applications. They are further classified into six subcategories.

e-Science

This subcategory targets the implications of cloud computing for the e-Science community, which has long been yearning for infinite computing power. e-Science refers to the scientific disciplines (i.e. earth science, bio-informatics, particle physics, etc.) where rapidly increasing volumes of data gathered from sensors and instruments (i.e. the CERN Large Hadron Collider) need

to be processed in a timely manner. Cloud computing, with its tremendous computing power and inexpensive cost, has drawn considerable attention from the e-Science community which has traditionally relied on scientific and academic computing grids. Articles in this subcategory aim at understanding the impact of cloud computing on the current computing infrastructure of e-Science (Armando, 2011). Some look into specific processing of genomic and proteomic data (May, 2010), while others propose generic solutions for managing scientific workflow in the cloud (Yuan et al., 2011).

e-Governance

This subcategory discusses the potential of cloud computing for governments. Governments are more hesitant than businesses to adopt cloud computing services. One of the reasons for this is the associated risks and security concerns (Paquette, et al., 2010). However, utilizing cloud computing for electronic voting solutions has been argued to be beneficial and feasible (Zissis and Lekkas, 2011).

Education

This subcategory focuses on the impact of cloud computing on educational institutes, especially those in the higher education sector. Operating and maintaining IT infrastructure has cost universities enormous amounts of money; hence, some argue that by adopting cloud-based solutions, such money could be saved and used in places more meaningful to the students and teachers (Ercan, 2010). Articles in this category discuss how a variety of educational areas can benefit from cloud computing, such as those for e learning (Doelitzscher, et al., 2011), online library resources (Jordan, 2011; Robert, 2009), and online collaborative writing (Calvo, et.al, 2011). Some articles analyse more generic issues such as the influence of cloud computing on the job roles of IT staff in higher education (Currie, 2008) and the inevitable adoption of cloud computing driven by NetGens 2.0 students who are born digital natives and rely on cloud-based applications for their life and study (Brown, 2009).

Mobile Computing

This subcategory contemplates the potential of combining cloud computing and mobile technologies (Zhang, et al., 2011). Articles in this category have fairly specific focuses, such as implementing a health-monitoring system based on a combination of cloud infrastructure, mobile phones, and sensors (Pandey, et al., 2011) or proposing a 'virtualised screen' which is rendered in the cloud and presented on the mobile phone for enabling graphically Volume 31 Article 2 45 rich services on thin clients (Lu, et al., 2011), as well as arguing that migrating computing and storage capability to the cloud not only enhances the power of mobile systems but also extends the battery lifetimes of such systems (Kumar and Lu, 2010).

Open Source

This subcategory looks into merging the two paradigms—cloud computing and open source-to build open clouds. The key theme is the proposal that to ensure that the Internet becomes an interoperable 'network of networks', cloud platforms should be built on open standards, open interface, and open source software (Nelson, 2009). In addition, some emerging open cloud platforms are introduced, such as Open Nebula (Milojicic, et al., 2011) and Open Cirrus (Avetisyan, et al., 2010).

Other Domains

This subcategory contains articles which each represent a stand-alone topic relevant to the application of cloud computing. Topics include using cloud computing for improving analyzing and reasoning capabilities of semantic search engines (Mika and Tummarello, 2008) for reducing the implementation cost of RFID solutions (Owunwanne and Goel, 2010), for building smaller, cheaper, and smarter robots (Guizzo, 2011), and for developing intelligent urban transportation systems (Li, Chen, and Wang, 2011).

Systems Approach to Problem Solving

Systems Theory

Systems concepts and methodologies are developed as a response to the ever increasing complexity of the socio-technical and managerial systems. Many techniques and approaches based on system philosophy have been developed which help in analyzing various problem situations in multiple ways (Sushil 1993a). In a seminal paper, Satsangi and Ellis (1971) describe the physical system theoretic construction developed to model the Canadian economy. The authors identify national economy as a collection of interconnected components. The approach

taken is that of component-to-system construction. The framework developed is general enough to embrace many "input-output" models in economic literature.

Bertalanfy (1972) has reported extensive developments in the field of General Systems Theory and discussed the trends in System Science, Mathematical Systems Theory, Systems Technology, and Systems Philosophy. General Systems Theory structured sciences and systems and provided answers for a variety of systems such as material systems, informational systems, and conceptual systems (Boulding, 1956). The systems movement has been reviewed by Checkland (1981 a, b). He concludes that the development had been more on the hard systems thinking and recommended that the newer developments should be more on soft systems thinking with a "learning" paradigm. An intriguing review by Troncale (1988) puts the developments in systems sciences together by defining the domains of systems sciences such as General Theory of Systems, Systems Theory, System Analysis, and Systems Applications.

A set of consensus methodologies was suggested by Warfield (1990) while presenting a science of generic design. A subsequent concept of "Total System Intervention" was proposed by Flood and Jackson (1991). Faisal, Banwet and Shankar (2007) discuss the use of ISM approach in information risks management in supply chains. Mohammed, Shankar, and Banwet (2008) discuss the creation of flexible, lean and agile value chain by outsourcing using ISM technique.

System Dynamic Modeling

Forrester (1961) and Sterman (2000) have authored pioneering books in the field of system dynamics. Useful reference texts in this area have been authored by Sushil (1993b) and Mohapatra et al. (1994). Bora et al. (1990) present a system dynamics study to design price stabilization and growth policies in Indian tea industry. Using system dynamics methodology, Jain, Satsangi, and Kothari (1993) examine the effects of urbanization and industrialization on energy-related problems such as high energy demand, air pollution and traffic congestion at urban centres. Impacts of investment in the industrial sector are compared with those due to investment in other sectors and population growth over a period of 20 years. Satsangi et al. (2003) develop a system dynamics simulation model to analyse system behaviour representing city problems in the context of an integrated urban system.

Ge et al. (2004) presents a system dynamics approach for the analysis of the demand amplification problem, also known as the bullwhip effect, which has been studied fairly extensively in the supply chain management literature. The construction of the model is reported using a part of a supermarket chain system in the UK as an example. Sachan et al. (2005) used system dynamics approach to model the Indian grain supply chain involving the dynamic interaction of cost variables that influence the total supply chain cost. The objective is to minimize the total cost of the supply chain.

Flexible Systems Approach

Deriving inspiration from the developments in system methodology in terms of schemes of systems techniques, and a wide applicability of integrated systems in computer based management, Sushil (1993) generalizes the philosophy of integration of techniques over the whole spectrum of system techniques in the framework of Flexible Systems Methodology (Sushil 1993). A specific application of this framework has been recently used in policy and strategy formulation (Saxena et al. 2006). This approach proposes that a flexible policy framework is needed to strategically meet the dynamics of the new era. Flexibility paradigm in this context implies creating more "policy options" in order to have a broader policy choice, thus building "change mechanisms" in policy framework, and providing "freedom of choice" to all the stakeholders (Sushil 2000).

SECTION 3

Methodology

Systems Approach to Problem Analysis

This section provides a brief overview of the systems approach, which will be used to address the current research problem.

Introduction

A system is an integrated set of interoperable elements, each with explicitly specified and bounded capabilities, working synergistically to perform value-added processing to enable a user to satisfy mission-oriented operational needs in a prescribed operating environment

with a specified outcome. The system has various inputs, which go through certain processes to produce certain outputs, which together, accomplish the overall desired goal for the system. Therefore, as system is usually made up of many smaller systems, or subsystems. For example, an organization is made up of many administrative and management functions, products, services, groups and individuals. If one part of the system is changed, the nature of the overall system is often changed, as well -- by definition then, the system is systemic, meaning relating to, or affecting, the entire system (Sharma and Srivastava 2009). Hall (1969) has given seven phases of systems approach as follows: (i) program planning (ii) project planning (iii) system development (iv) production or construction (v) installation and distribution (vi) operation (vii) retirement.

Policy Formulation Model and Process

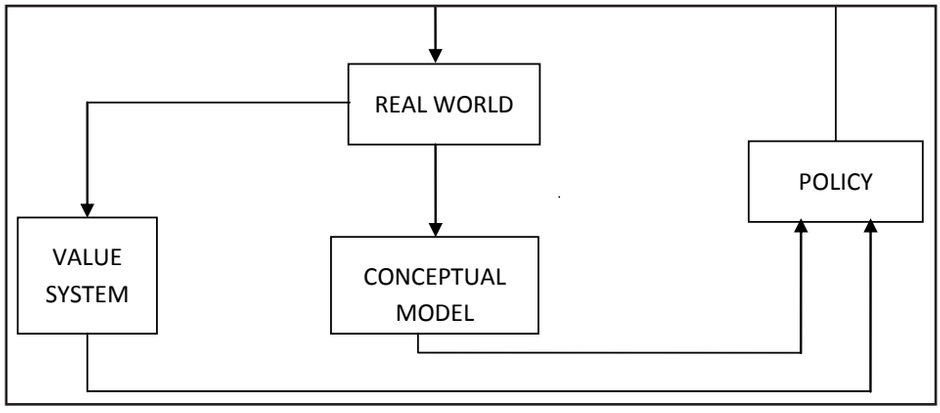
A policy formulation model is as follows. An individual conceives a mental model based on the information from the real world. This conceptual model is used to determine the policy.

Determination of policy is also governed by the value system. Then, the impact of the policy is seen on the real world and again, a mental model is made from the changed world and the cycle continues. This is illustrated in Figure below.

Need for Systems Approach

Cloud computing is complex and large-scale problem in implementation. Some of these are technological decisions, project management, manpower planning, database management, etc. These problems require large amount of resources and are interdependent. Solution to one problem could be at the expense of another problem. Thus, we can say that a systems approach would be effective in dealing with these problems. If the decision maker is unable to understand the structure of the underlying system properly, then it will lead to wrong conclusion regarding problem solution. Sage (1977) has considered three levels: symptoms, institutions, and values for application of technology to societal problems. This approach can be used while dealing with management problems by studying them at three levels to determine the solutions.

Policy Formulation Process



Source: Sage (1977)

An Overview of Tools and Techniques of Systems Approach

Idea Generation

The first step in formulating policies is to generate ideas. Here, a set of people think about the possible ideas related to a particular problem or situation. Then, these ideas are shortlisted and are evaluated in detail. There are various techniques to generate ideas for policy making or problem solving.

Brainstorming

It is a group activity involving experts. They are encouraged to give as many ideas as possible on a particular topic. It focuses on cross-fertilization of ideas given by two or more persons. However, in this method, experts only give ideas rather than evaluating them. The ideas are shortlisted through simple or weighted voting.

Nominal Group Technique (NGT)

In NGT, participants give their ideas by writing on slips. There is no interaction among them which provides an equal opportunity to everyone to express their views. The ideas are generated independently by the participants, recorded and discussed. Once the list of clear ideas is available, participants vote for the most important ideas to be selected.

Idea Writing

This is basically a technique of getting the ideas of the experts written down and collated. Idea writing methodology was propounded by Warfield, but referred to as 'Brain writing'. Usually, a group of 8-10 participants is formulated. Each participant reacts in writing to the possible policy options and performance indicators. Each participant also reacts to the other participants' views in writing. The group discusses the principal idea that emerges from the written interactions and summarizes.

Idea Engineering

This is a more formal and structured approach to idea generation which is used with the help of a structured questionnaire. The participants are provided with a structured worksheet with questions and space for writing ideas below each question. All the ideas are then put together to remove duplications and ambiguities. Collated group idea sheets are circulated for voting and the order of priority is decided.

Program Planning

Program planning considers both directly related and indirectly related aspects of the problem. A program is divided into elements which are further sub-divided into related sub-elements under consideration and then we study the interactions among these sub-elements as well as among the elements. Towards this end, a self interaction matrix represents the relationships among the sub-elements of a particular element. It makes a pair wise comparison and a binary relationship is represented. A cross interaction matrix represents the relationship among the sub-elements of two different elements in the form of binary relationship. All the self interaction matrices, cross interaction matrices and derived matrices put together show the program linkages.

The sub-elements of an element are ranked on the basis of the number of interactions of each sub-element and their percentage share with respect to the total interactions. Based on the value of the total interaction of the sub-element, ranks of all the sub-elements are ascertained to establish the relative importance of each one.

Interpretive Structural Modelling (ISM)

The ISM process transforms unclear, poorly articulated, complex mental models of systems into visible well defined simpler models useful for many purposes. It deals with the interpretation of the embedded object by systematic iterative application of graph theory resulting in a directed graph for the complex system. Each stage of methodology may be viewed as transforming a model from one form to another referred to as model exchange isomorphism. A structural self interaction matrix (SSIM) studies the existence of a relation between any two sub-elements. The experts' responses help in preparing the SSIM. Based on the various matrices data, a graphical depiction ("digraph") is constructed which provides information about hierarchy between the sub-elements in an element. A structural model provides a clearer picture and an understanding of contextual relationships. It is derived from the connected information connected in the digraph.

Indirect Relationships: MICMAC

The MICMAC method is based upon the multiplication properties of matrices. If variable i directly influences variable k and if variable k directly influences variable j, any changes affecting variable i can have a repercussion on variable j. Thus, there is an indirect connection between i and j. The direct relationship matrix as developed is taken as the base to start the process of finding the ranks of the variables considering the indirect relationships.

Fuzzy Considerations

The notion in the basic set theory is that an item is either a member or not a member of a set.

However, in real life situations, certain sets have imprecise boundaries. A fuzzy set is characterized by a membership function, defined as a real number in the interval (0,1). Fuzzy considerations are incorporated in the techniques of systems analysis as well. In addition to the consideration of interaction between elements and sub-elements (binary relationships), it also considers various levels of the possibilities of interaction.

Scenario Building

A scenario is the description of a future situation together with the sequence of events leading from the base situation to the future situation. It tries to conceive the possible future and to explore ways and means to achieve the same, unfolding the present actions and their possible consequences.

Policy Formulation

In a large system, different options relate to different objectives. Thus, there are various diversified policy options associated with various experts which have to be unified to evolve an integrated policy. The option field / profile methodology, introduced by Warfield, is generally used for policy design.

System Dynamics Approach

System dynamics is a conceptual approach that enables to represent the structure and behavior of complex systems over time, providing a method for systems description as well as a useful computational support for simulation (Sterman 2000). The dynamic models thus constructed play a key role for testing the values obtained with the parameterization and comparing them with real data.

Analysis

Need of Study

Cloud computing has recently emerged as a new paradigm for hosting and delivering services over the net. Cloud computing is attractive for business owners because it eliminates the need for users to set up ahead for provisioning, and permits enterprises to begin from the little and increase resources only when an increase in demand.

However, despite the actual fact that cloud computing offers vast opportunities to the IT business, the event of cloud computing technology is presently at its infancy, with several problems still to be addressed. If cloud computing is to realize its potential, there has to be a transparent understanding of the varied problems concerned, each from the views of the suppliers and therefore the shoppers of the technology. There is associated equally pressing want for understanding the business-related problems regarding implementation of cloud computing.

The aim of the research is to interview experts who are either concerned as developers or evaluating cloud computing as associate enterprise user, to spot the strengths, weaknesses, opportunities and threats for the business, the varied problems that may have an effect on the various stakeholders of cloud computing, key problems facing governmental companies who are concerned within the regulation of cloud computing and set of recommendations for the practitioners who can offer and manage this technology.

Objectives of the Study

In view of the discussion presented in the previous sections, the present research is aimed at accomplishing the following objectives:

Objective 1: To propose a conceptual framework for cloud computing implementation.

Objective 2: To identify integrated elements for implementation of Cloud Computing.

Objective 3: To develop a hierarchical structural model under relevant contextual relations of the identified elements.

Objective 4: To determine the optimal strategy and action plan for the highest possible level of satisfaction of the stake holders through cloud computing implementation.

Research Design, Tools and Techniques

The proposed research study will be conducted in the following phases:

Phase 1 - Identifying Integrated Elements for Cloud Computing Implementation

In this phase, the researcher will attempt to identify the relevant factors affecting cloud computing integration. This will be done in an integrated fashion with various interviews at local, regional, national. The researcher will use the system-theoretic tools like Creative Idea Engineering, Brain Writing, Future Projections, etc.

Phase 2 - Development of Hierarchical Structural Model

In Phase 2, the researcher will attempt to develop a hierarchical structural model under relevant contextual relations of the elements identified in Phase 1. Depending upon the nature of identified elements, this may be extended for different contextual relations. The technique of Interpretive Structural Modeling (ISM) would be used in this phase. This phase would require active interactive sessions with the domain experts.

Phase 3 - Finding Optimal Strategy

This phase would involve determination of the optimal strategy and its associated action plan for possible highest level of satisfaction of various stake holders. The technique of fuzzy satisfaction criterion for different strategies may be used for such decisions.

Phase 4 – Developing Dynamic Optimal Strategy

In this phase, the researcher would identify and short-list those elements which have time-based implications. These will then be classified as belonging to stock, flow or auxiliary variables categories. A causal loop diagram would be developed on the basis of the discussion or workshop session with domain experts. The technique of system dynamics would then be used to conduct simulation analysis in order to come up with a time-based optimal policy.

In addition to the above, the researcher may explore the use of related techniques like Analytic Hierarchy Process (AHP), Artificial Neural Networks (ANN), Pareto's Criticality Analysis, etc.

Sampling Plan

In the above phases, various set of respondents would be contacted for data collection. These can be classified as policy makers from the government, domain experts from academia and business, and users. The number of respondents in each category in various workshops may vary from 10 to 20. The sampling technique to be used would be non-probability Judgment Sampling.

Brief Outline of Proposed Series of Workshops

Workshop I:

Title: Workshop on "Cloud Computing Implementation from Flexible Systems Perspective"

Dates: During June-Dec, 2016

Workshop II:

Title: Workshop on "Interpretative Structural Modeling of Cloud Computing in Business Organization"

Dates: During Jan-May, 2017

Workshop III:

Title: Workshop on "Application of Option Profile Methodology for Information Technology Policy in Indian Business Context"

Date: During June-Dec, 2017

Workshop IV:

Title: "Flexible Systems Approach for Cloud Computing Implementation in Business Organization: Review Workshop"

Dates: During Jan-May, 2018

Analysis of Business Model/Case Study Approach

The researcher may incorporate case studies, wherever applicable, as validation tools to support the claim of the reports and its finding. Application, reports and/or reported business model would also be explored as data source.

SECTION 5

Conclusion

In the proposed research framework, the researcher will study the factors that drive the company to adopt cloud

computing, the interrelation between the factors and the cumulative effect of the factors on the value delivered to the company. The researcher will further propose a policy framework for integration of cloud computing depending upon the state of situational factors (macro and micro), company position and current business scenario to provide company a sustained competitive edge. The variables of adoption will further be explored to frame a time based optimal policy to control the problem of technology obsolescence.

SECTION 6

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