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Information System Complexity and Business Value

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Abstract

Complexity of Information system is very subjective and affected by many variations of peoples, tools and processes. Any small variation of the components that form system complexity results in major changes in the intended outcome. It is also seen that one single approach of complexity vs. simplicity does not suffice. This paper will discuss complexity theory and its components. Moreover, different method will be suggested to reduce information system complexity and simplifying its process.

Keywords: Complexity; Information systems; Buisness value; Chaos

Introduction

"Life is really simple, but we insist on making it complicated."
(Confucius 551–479 BC).

From the dawn of computing IS (information systems) have increased in complexity. There have been a number of attempts to develop mathematical models for this and one of them underpins complexity is "Chaos theory". According to Rickles et al. a system is an object which is abstract or concrete; elementary or composite; linear or nonlinear; simple or complicated; complex or chaotic [1]. System complexity increases as these systems evolve into composite ones, built up from very large numbers of mutually interacting subsystems (which may also be composites themselves). Repeated interactions within these systems result in rich, collective behaviour that forms a feedback loop with its individual parts affecting their behavior as well. Simple systems formed from few components and behave according to very simple laws; whereas complicated systems that have many parts can also be guided by very simple rules. Complex systems can be designed such that removing a part or making change does not affect the survival of the whole system. It is also seen that many organisations are stuck in the "complexity trap" which results from legacy systems which have high maintenance costs; which have outlived their contribution to businesses and inhibit future developments. In addition, replacing the existing system with new one may raise additional problems. The solution for these problems goes beyond just technology as they create new organizational form [2].

The Complexity Theory

IS complexity of a system composed of different parts connected with each other in order to exhibit one or more behavior that is not clear from the properties of its individual parts [3].

The complexity theory gives a framework for thinking and seeing the world. It does not predict the event, however it enables the organizations to find the possibilities and understand their risk. The benefit from knowing risk is in allowing the organization to come up with new ideas and find a solution for problems that may arise in the future. The system complexity is not a result of complex rules; but it is a result of "Complex behavior that arises from the inter-relationship, interaction, and interconnectivity of elements within a system and between a system and its environment" [4].

The interrelationship between the IS components enhances communication and creates mutual understanding between businesses. Complexity creates new ways for the organization to communicate, automate that reduce the business process management problems in globalized economies.

Information Systems on their own do not have any value but they have tremendous role in creating value by supporting business. The areas where IS create value are revenue protection and growth, cost control and reduction, improving productivity and efficiency and in creating brand reputation. Information systems also create customer and employee delight, help in compliance, support business survival and provide a supporting infrastructure [5].

On the other hand, organizations are using the complexity to improve their position in the market. Mukherjee points out that, 30% to 40% software project fail due to the lack of good performance resulting from system complexity [6]. For example, London Ambulance Service (LAS) experienced failure in its system. LAS were unable to respond to the emergency calls properly because of the manual method of dispatching ambulance. The call center takes the information from the patient and sends the details to the ambulance driver through telephone or radio. When LAS switched to new system to improve performance no training was provided to the users of the new system. In addition, the lack of training caused some problems such as failing to eliminate the dispatched calls, which resulted in more than one ambulance attending the scene.

However, high complexity doesn't always have negative effect as some times the increase in complexity results in highly flexible and responsive systems that adapt to the changes in the market demand quickly. In order to better understand the complexity, one must be able to measure it. Complexity index measures the complexity of the system based on the types of the products, "the uncertainty in the running system", and the materials and resources used [7]. In addition, there must be analysis on the cost of the complexity in order to help the organizations to reduce the amount of the complexity. Complexity can be analyzed in terms of structural complexity or operational

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complexity. The cost of the structural complexity relates to the predictable production cost, the cost of the manufacturing process, the cost of the raw materials and labors. Products with high complexity have high cost of production. The cost of the operational complexity relates to the unexpected cost associated with the variation in producing the product resulting from the uncertainty in the customer demand. It also results from continuous loss in the organization caused by shortfalls. The business value is affected as the cost of the operational complexity increases.

Source of IS complexity

Using the concepts proposed by Steger, et al. that defines four interacting dimensions of system complexity: diversity, ambiguity, interdependence and fast flux (Figure 1) [8]

Diversity: is considered one of the key factors of complexity. Many global companies face diversity from within the organization and also the outside environment. Diversity arises having large and various number of systems. According to Schwandt the meaning of diversity is "the ability of a system to incorporate a certain number of different states in a given time span" [9].

Ambiguity: is having unclear organisational goals or missions as well as inability in predict the future situation, the amount of information is not complete or invalid which leads to the complexity [9]. This will affect the repeatable activities negatively when the role is not clear reducing productivity of the organization.

Interdependence: Inside the organization interdependence exist by having strong connection in the organization elements to transmit the information. A good example of the interdependence is the service of the communication systems. Because of the complex interdependence when any disaster happens such as Hurricane Katrina in 2005 affects the communication services.

Fast flux: This element is related to the change in the organization and environment. Environmental changes exist when there are changes happening in the market or when the government initiates the changes. The changes in the organizations orientation and having divisiveness

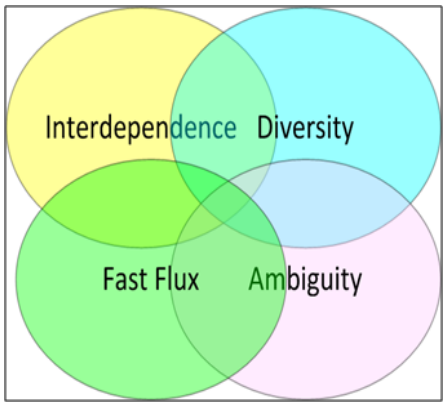

Figure 1: Sources of IS complexity adopted from YMD Model [8].

are considered as internal changes. Therefore, organizations must meet these changes by having a flexible strategy in order to reduce the complexity.

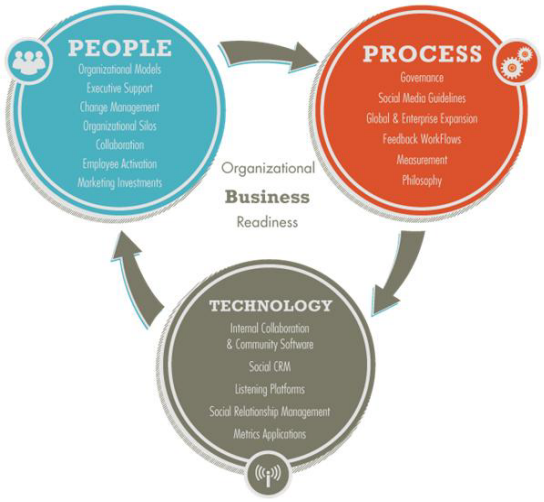

Figure 2: Basic sources of Complexity.

Components of IS complexity: At the elemental level all complex systems can be broken down into the three interacting groups of components i.e. peoples, tools and processes (Figure 2).

Some of the components that contribute towards system complexity are seen in detail in (Figure 3). One can see a big number of components (the list is not exhaustive) that form or are affect organisational information systems in one or more ways.

These components seen above further explained in detail as follows:

Legacy code: There are still many systems in the world that run legacy hardware and or code. The software's used to develop this code are usually, Assembly, COBOL, FORTRAN and PASCAL etc. They at times have exceeded their usefulness to business and must be serviced and managed at a high cost due to lack of support further complicated by missing documentation [10]. It is also seen the legacy applications and architectures have surpassed their limits. Legacy code and systems create additional problems from lack of individuals that are able to support these systems in normal operation or migrations.

Regulation: Information systems are also subject to a high number of regulations, which may be region or industry specific i.e., BASEL 1-3 (regulations put forward by Basel banking committee) applies to finance industry predominantly in Europe where as PCI-DSS (Payment Card Industry –Data Security Standard) is applicable globally wherever an organization process payment by cards. Other regulations such as SOX (Sarbanes Oxley Act), HIPPA (Health Insurance Portability and Accountability Act), various ISO (International Standard Organisation) and data protection act are applicable in certain industries and regions. These regulations also frequently changing as they become stringent as well as complex.

Missing documentation: Information systems frequently suffer from missing, outdated or incomplete documentation. This becomes even more problematic with customized systems. All this adds to high risk for the organization and can also create security risks. Many companies maintain change management databases however the database accuracy is only as good as the updating authority and frequency.

Change management: Information systems are subject to change for one or more reason of fixing bugs, adding new functionality or

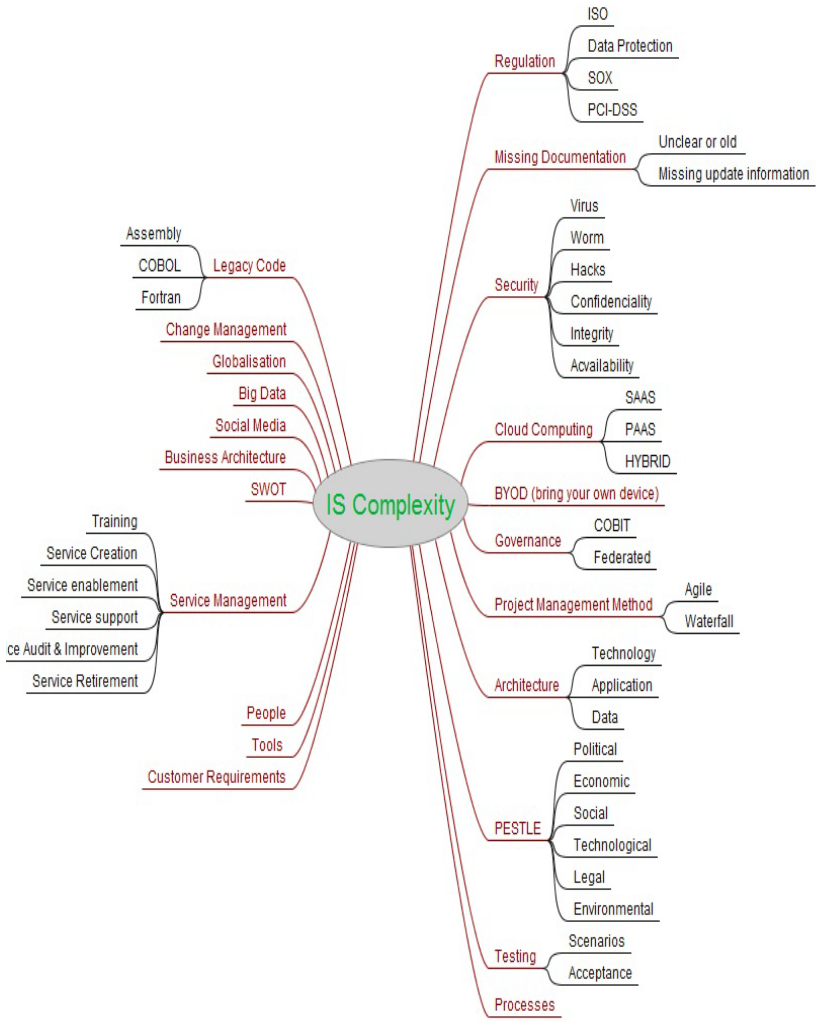

Figure 3: Some components of IS Complexity.

replacing retired hardware and unsupported software. These are complex tasks and no amount of testing is a 100% guarantee to success due to the involved complexity. Not all scenarios are possible to test due to one or the other constraint such as resources and time.

Information security: All information system information must confirm to the triad of CIA (confidentiality, Integrity, Availability and Authenticity). There is a constant war of attrition between the protectors and the attackers who device new methods, find new exploits and methods for attacks and hacks. ISACA Information Systems Audit and Control Association have identified 5 domains and 80 areas for managing security [11]. ISO 27001 specifically deals with organization security.

Globalization: Information systems have become the backbone of global business. This raises the complexity of 24/7 supports across a number of regional and cultural boundaries of languages and legislation. The Information Systems are expected to run nonstop and across global boundaries.

New methods and utility computing: Cloud computing offers new dimension in information systems such as utility computing in form of public, private and hybrid clouds.

Big data: With the increase in size of datasets the traditional on-hand database management tools and data processing applications. The datasets are usually multiple terabytes in size and have useful information not usually visible in smaller datasets such as focusing in the business trends, define the research quality.

BYOD (bring your own device): is the new challenge to the information systems which are accessed using any type of mobile devices including mobile phones, tables and users personal computers. This requires special methods and systems to identify these systems and to control access to organisational systems.

Social media: Many companies have presence on social media such as Facebook and twitter. Some use information gathered from social media in marketing and decision-making and collaboration. This creates requirement for information systems that interact and exploit social media both public and private.

Governance: Information systems are subject to a number of governance, audit and improvement frameworks such as COBIT, TOGAF, CMMI and SIX-SIGMA. They come with varying definition's processes and a degree of overlap that creates waste and further complicates the Information systems landscape.

Project management method: Traditional project management and systems lifecycle methods methodology such as PMP, Prince and waterfall are not as flexible in delivery as compared with SCRUM and AGILE. IS requires a great degree of flexibility and agility to change in delivering value to business.

Business architecture: Business they are subject to many changes such as business process improvement, and other strategies dependent on the vision and outputs from tools such as SWOT, PESTLE etc. This must be further exploited in form of changes in systems and workflows etc. to better align with the changed business requirements and priorities. Tis at times results in new architectures rather than small changes just in technology application and data.

Service management: Information systems require constant support to provide the required services. Some of the tasks at high level within service support are Service Creation, Service enablement, Service support, Service Audit & Improvement and Service Retirement.

Reducing IS complexity

Connor suggests five practices to mitigate the complexity of the information system while simplifying the process detailed as follows [12];

1. **Focus on information that can be actioned:** Tools and solutions in many cases just provide some passive information. This information can be used to take certain actions after analyzing and interpreting the implicit meanings and impacts. This analysis can be used in taking appropriate remedial actions. The new solution should address the issues found.
2. **Leverage existing tools and management platform:** Any new tools should take into account and compliment any existing tools and management systems. New solution should use these tools as baseline for data. Any tools should be apparently replaced or migrated over period of time.
3. **State a clear return on investment (ROI):** All IT investment must be supported by a clear ROI mandate. The value generated by IT must be in excess of the current or as is situation. Even keeping the situation as it has associated costs.
4. **Develop a road map:** The ROI has the implicit requirements of required staff, time, and finance.
5. **Eliminate repetitive tasks by automation:** Solutions should be focused on reducing productivity by reducing human interaction and intervention. This can be done by automating the repetitive tasks such as restarting processes or servers. These tasks

Conclusion

Complexity in the information system can benefit the organization when conducting the business in different geographical regions. Reducing the complexity will add value to the organization and must know that the complexity is not barriers in itself but cost of the structural and operational complexity are the major barriers in reducing the value of the business.More and more organizations are using or one more of the following information systems to run and grow their businesses:

1) Global banks and financial clearing systems
2) Private and public networks such as internet, redundant power sources and transportation
3) Organisations are connected in supply and demand side both with their upstream and downstream value chains.
4) Organisations are connected in supply and demand side both with their upstream and downstream value chains.
5) Connectivity with their consumers through loyalty schemes online marketing and social media and web.
6) Security of their and their clients data present and used in Information Systems

Information systems on their own do not bring value however they support businesses to such an extent that banks can now be said as Complex Information Systems with banking license. For example, Barclay's one of the major global banks worth multibillion dollars has few million worth of Information Systems though it cannot survive for a single day without them.

It is seen that complexity is very subjective and affected by many variations of peoples, tools and processes. Any small variation to the components that form complexity results in major outcome changes. It is also seen that one single approach of complexity vs. simplicity does not suffice.

The organizations that are better able to harness and manage the inherent complexity in the above systems are in a better position than their competitors who fail to use, manage and offer agility in adopting them effectively. In order to reduce the complexity and increase the value in the business organization must be aware about the sources of the complexity and a void it by applying the practices of reducing IS complexity.

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