

**A critical comparison between diffusion of innovation theory and Capacity Maturity Model with relevance to technology management**

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Technology management encompasses planning, directing, controlling and coordinating the advancement of technological capabilities to create and accomplish the operational and strategic goals of any organization. It has been identified that the future development of methodologies on technology management and its applications encompasses the following ideas: (1) TM methodologies are designed based on expert and problem orientation. (2) Qualitative and quantitative methods are to be integrated through technology management studies may expand its limits of applications. (3) The ability to understand the contemporary nature is the power of methodologies relating to Technology management is subject which dealt preliminarily in this paper. This paper tries to explore some critical viewpoints derived from theory relating to technology management and clarifies its implications. It encompasses diffusion of innovation theory and Capacity maturity model to draw certain contextual insights that may be useful to the executives involved in managing human and conceptual skills using technology. This paper tries to give a better understanding on handling the technology with consumer (enduser) and Industry with the help of two theoretical outcomes i.e. diffusion of innovations and Capacity Maturity Model.

Keywords: Technology, innovation, capacity maturity model, management, Diffusion of Innovation.

## **1. Introduction**

Technology management is a combination of management traits and attributes that allows organizations to manage their fundamentals of technology towards attaining competitive advantage in all its endeavors. Typical objectives of technology management are:

- To derive logic on technology application in an organization,
- Identifying possible technologies relevant to the organization.
- Map technology that applies to market needs and business,
- Construct technology portfolio with the set of projects that uses technologies under development and projects that uses existing technology.

Continuous development is the management function that gains significance as long as the customer values it and so the organization should know when to invest in technology development and when to withdraw.

The Association of Technology Management and Applied Engineering defines “technology management as the field concerned with the supervision of personnel across the technical spectrum and a wide variety of complex technological systems. Technology management programs typically include instruction in production and operations management, project management, computer applications, quality control, safety and health issues, statistics, and general management principles”.

In this paper the researcher tried to map technology with consumer in social system and the process in the corporate system.

### **1.1. Implications on Technology management from the theory**

The most prominent theory that gives an understanding of technology is the diffusion of innovations theory developed during twentieth century. It states that all innovations follow a similar pattern of diffusion – which can be in the form of an "s" curve that depicts the concept of a standard distribution (adopters). In general, the "s" curve includes four phases of a technology life cycle - emerging, growth, mature and aging.

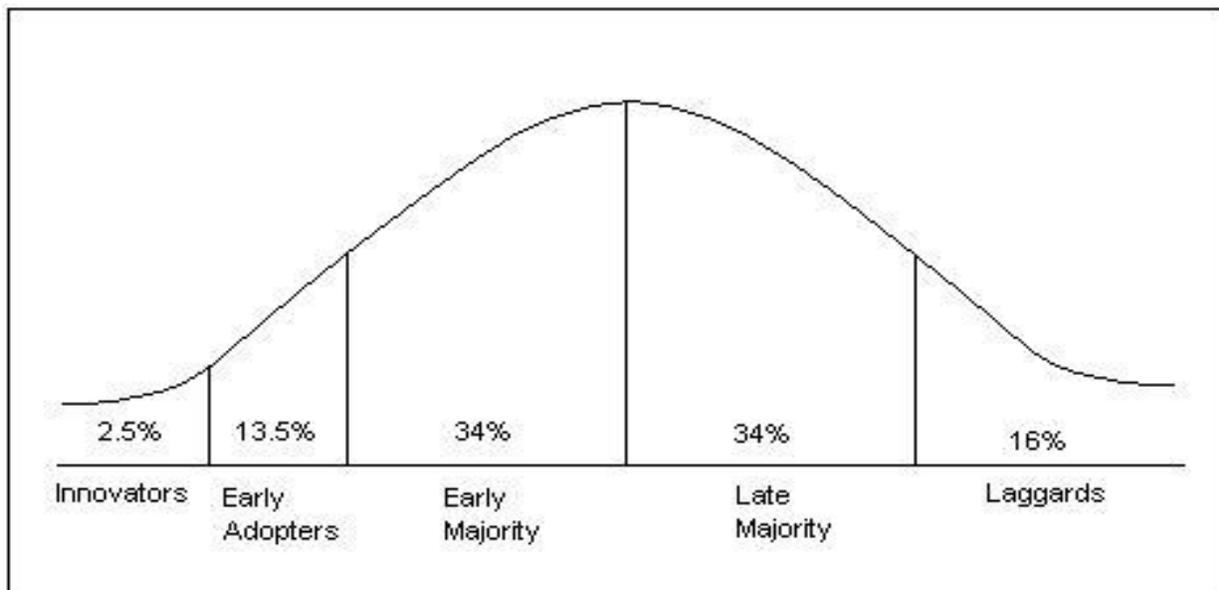
Another significant ideology contributing technology management is the Carnegie Mellon Capability Maturity Model. This model proposes that a series of progressive capabilities that can be applied to derive the state of repeatability, definition, management and optimization. The model recommends that any organization has to master one level before proceeding towards the next level. This paper touches only these two conceptual frameworks and leaves another important conceptual insight i.e. “Hype Cycle” which is not discussed in this paper.

### **Diffusion of Innovation Theory**

Diffusion research emancipates how the ideas are spread among varied groups of individuals or people. Diffusion goes beyond the two-step flow theory, delivering the acceleration or deceleration of the individual preference or likelihood towards the new idea or new product or new service, with relevance to the given culture. In multi-step diffusion, Apart from the opinion leader who exhibit greater influence on the adopters’ behavior there lies the intermediary like

change agent, who stimulate the opinion leader to adopt or reject an innovation (Infante, Rancer, & Womack, 1997).

The new idea is adopted by the inducement of human interactions through interpersonal linkages among the individuals. The above pattern of interactions and linkages result in the binomial expansion. Thereby it can be anticipated that the distribution of adopters inherit a bell-shaped curve over a period of time (Rogers, 1971).



**Source: “Communication of Innovation” – Rogers (1971)**

### **1.2. Adopter Categorization**

The adopters are categorized based on the category called innovativeness. It is the degree of individual adoption upon a new idea which an individual exhibit in relationship with other members of a social system. In this context Innovativeness is a “relative” in which an individual may adopt it more or less than the other members in the social system (Rogers, 1971).

This method of adopter categorization has been widely used in diffusion research (Rogers, 1971).

In this theory the adopters (Rogers, 1971) are categorized as follows

- Innovators – Those have enough financial power to buy and apply any technical innovation or knowledge.
- Early adopters – They are distinct in social system and remain successful users of new ideas. They are highly respected by peers for their abilities to adopt innovations.

- Early majority – They adopt new ideas just before other average members in the social system. The innovation decision making is relatively longer than Innovators and early adopters.
- Late Majority – They face pressures from peers to adopt the utility of an innovation and accept after the average members.
- Laggards – They are the traditionalists who were late to adopt an innovation. They possess no opinion leadership and are isolated from the other adopter categories. They generally doubt the innovators and change agents (Rogers, 1971)

The contributors in the research field use the umbrella concept in which several theories are embedded (Infante et al. 1997). Researchers should try to limit their scope and they should adopt a cultural empirical approach to identify the consumer behavior on cultural products that are highly demanded and available.

### **1.3. Criticalities in Diffusion of innovations theory**

From the critical viewpoints given by the various experts it is observed that this theory is highly individualistic and it avoids the role of media and its influences on the individuals in the society. Audience motive researches based on uses and gratification research on certain cultures and demographic groups, can be made possible by cynical synthesis and integration of research results that facilitates the theory building (Rubin, 1985; Littlejohn, 1996).

Further the following points disclose the practical vitalities in this theory

- This theory gives few allusions on enabling the consumer to accept the new technology. The faster they are able to adopt the new technology, the faster they could gain the real advantage on it.
- This theory depicts the success of technology is dependent upon the acceptance level of the social system. It also categorizes the social system based on their adoptability of innovations.
- Normally the pace of the industrial growth and technological innovations is dependent upon the tendency of the social system in inviting and accepting the same.

The Industries try to make their customer accept their innovations through giving due concentration on processes that can assure the dimensions or the attributes expected on innovations by the consuming segment. The manufacturing concerns interested in process redefinition for meeting the requirements of customers' delight can view through another theory or model i.e. Capacity maturity model (CMM) that lays stress on processes and its applications leading to technical innovations.

## **2. Maturity Models**

A maturity model is the collection the elements in a structured way to elicit the features of effective processes (Gyorgy Schuster, 2012). This model has been considered in this paper because process is the base for ensuring the conformities in the innovation that fit the expectations or desires of the social systems.

A maturity model provides

- Initial platform to begin process improvement
- Advantage over past experiences
- Common understanding of organizational vision shared among individuals
- Identification the priorities to construct strong action plan.
- Definitions to find improvement means in the organization.

And it can even be considered as the reference model for assessing the equivalent comparisons of different organizations (U.S. Department of Defense, 2005).

### **2.1.What Is a CMM?**

A Capability Maturity Model (CMM) is a model for referring the mature practices in a chosen domain or activity in order to improve and appraise the performance with relevance group's capability on the stipulated domain or activity.

CMMs differ by

- discipline (e.g., software engineering, systems engineering)
- structure (e.g., staged, continuous)
- definition of maturity (i.e., process improvement path)

The Maturity Levels

1. Initial – Unpredictable, reactive processes controlled poorly
2. Managed – Processes are featured and oriented as in projects and is frequently reactive.
3. Defined – Process characterized for the organization and is proactive
4. Managed Quantitatively – Processes are controlled and measured.
5. Optimizing – focuses on Continuous Process Improvement

Normally, a maturity level is measured by the attainment of specific and generic goals those are applicable to predefined set of process parameters (Gyorgy Schuster, 2012).

### **2.2. Capacity Maturity Model (CMM) – An implication on Software Company**

As the innovations are quite prominent and highly contemporary in software industry this paper considers the allusions from Capacity Maturity Model which is applied in the software company.

Level 1 - The Initial Level

At Level 1 for those organizations involved in Software business, software process would be changed and modified constantly as work progresses and so it remains unpredictable (i.e., the process is ad hoc). Generally the outcomes of functionality, quality, budgets and schedules could not be predicted at this level. Performance depends on the individuals' capabilities the vary with respect to their knowledge, innate skills and motivation. At this level, the organization has only few stable processes and so the performance would be evaluated based on individuals rather than the organizational capability itself.

#### Level 2 - The Repeatable Level

At the Repeatable Level, Policies would be evolved for managing the software project and procedures for implementing the same can be established. The responsibilities of planning and managing of new projects would be assigned based on the respective experience in the similar projects. Certain Key process areas has been identified a Software configuration management, Software quality assurance, Software subcontract management, Software project tracking and oversight, Software project planning Requirements management (Mark C. Paulk Charles V, et al., 1993)

#### Level 3 - The Defined Level

This level involves the process of standardization, documentation and integration of processes involved in development and maintaining of software for the whole of organization has been executed. This process at this level include Organization process focus, peer reviews, software product engineering, Intergroup coordination, Integrated software management, training program, organization process definition, etc (Mark C. Paulk Charles V, et al., 1993).

#### Level 4 - The Managed Level

In this level, quantitative goals are set for both processes and software products. As a part of organizational measurement program the quality and productivity of the activities are measured for important software programs. Here the company can apply change management in process and technology (Mark C. Paulk Charles V, et al., 1993)

#### Level 5 - The Optimizing Level

At the Optimizing Level, Continuous process improvement in applied in all the software and operation processes to prevent recurrence of defects by appropriate identification of failure modes. The phase of implementation will be faster and the utility of innovations in process is highly experienced in this stage. This level can stimulate the organization to concentrate on Defect Prevention, Quantitative process management and Software Quality management (Mark C. Paulk Charles V, et al., 1993)

### **2.3. Criticalities in Capability Maturity Model:**

A critical difference between maturity level 4 and maturity level 5 is exhibiting the type of process variation. In maturity level 4 special causes for process variation has been notified to provide statistical predictability of the results. There is a drawback in this model the even though the results are predictable, those results may not achieve the established objectives.

At maturity level 5, the process concerning with common causes for change and process variation has been considered (i.e. shifting the mean performance of the process) to improve process performance (on maintenance of predictions through statistical applications) and thereby ensuring the attainment of developed quantitative process improvement objectives.

It is important that Maturity Levels Should Not be Skipped: (but as for me the first one should.) in order to gain the intrinsic advantage of CMM.

- As per CMM, at each maturity level the organization will construct the firm foundation for proceeding toward next level,
- If the discipline of the lower level processes are not up to the mark, then the higher level process will not be successful.
- The effect of innovation will be masked by the strident processes,
- The organizations will perform higher level processes at the lower level with the risk of inconsistent application in a crisis.

In this model innovation in adopted in processes by following and experiential approach towards optimization of the outcomes.

### **3. Discussion**

Both the theories try to contribute their viewpoints that can facilitate the understanding on the application (industry) and acceptance (Customer) of technology. The first theory discusses on the customer acceptance and their categories and the second theory discusses on the model by observing which the company can ensure the proper application of technology in bringing conformity in processes leading the innovations. The former theory follows the normal curve and latter theory follows the linear curve sloping upwards. Similarly the former theory depict the proportion of acceptance of technology (innovations) among the consumer and the latter elicits the proportion of implementation of technology but its objective attainment is in the improving state till the end rather than the former theory which categorizes the normal population.

When we pass on through different types of consumers categorized by the diffusion of innovation theory, the implications of the processes are very important to bring out an acceptable technology. When we think of Research – Innovation (Technology – Both for Industry & Consumer) – Acceptance the processes as well as the categorization gain significance as we need to ensure the attainment of desired objective at every stage.

Even we can map the categories of social systems as stated in diffusion of innovations theory, with industries trying to adopt new technology. Similar kind of interpretation can be made with industries also and hence if the industry is able to define and adopt appropriate CMM at every category they are mapped with then it can attain the desired outcome predetermined for each level. When we compare the innovators and initial level of respective theories, it is observed that both the counterparts i.e. consumers and companies behave in the similar way. Similarly the early adopter goes for adopting the innovation when it has gained its consistent usage among the consumer like repeated level of Capacity Maturity Model. As in the above case early majority will get the defined state of utility of an innovation. So, this paper elicit CMM model of a software organization for the viewer better understanding and implementation.

As discussed above both diffusion of innovation and Capacity maturity model have certain similarities at the first the classification of social system (diffusion of innovation) and first three level of process implementation (Capacity Maturity Model) and contradicting in the later classification and levels of the respective theories. The diffusion of innovation theory follows the normal pattern of classification of social system touching the extremes of customers having opposite behaviors towards adoption of innovation. But the CMM has got the steep projection and progress till the last level of process implementation, which requires technology innovation that caters the attainment of processing objectives.

#### **4. Conclusion**

The researcher draws the contributions from the second theory in order to give the reasonable contextual module to the reader that give the better understanding on the cause of categorizing technology adopters or quantifying the proportion belonging to each category is dependent upon the process management and its success of bringing in the desired conformities on the product or service outcome to consumer. So the Second theory will certainly provide the better model that can very well support the process improvement and in turn aggravate the interest of the society towards the technology adoption as it satisfy their sophisticated needs and desires.

Both the theories has got its own similarities and contradictions, as the former can enable the classification of social system (accepting innovation) and the latter enable the companies to go for process innovations (process implementation) to satisfy customers seeking unforeseen experience in the product and service, they afford to buy. So, the both the society and the corporate sector are interested in accepting and adopting innovation on product or service and process respectively. For bringing the both theories before the eye of clarity, awareness about the utility of technology (diffusion of technology) and managing men and machines using technology (process implementation (CMM), is necessary. Further more studies need to be done in order to gain better understanding on management using technology.

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