



## The Role of Maturity Driven Software Process Improvement in an Industry

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### ABSTRACT

In the current industrial environment, big organizations have adopted maturity driven process improvement efforts. Most of these efforts have been inspired of maturity models like the CMM (Capability Maturity Model) and been guided by the area of Software Process Improvement (SPI). The maturity of an organization's processes is measured through its maturity level. An organization at high maturity level, means, that it possesses mature processes and it is more trust worthy. In this perspective for an ad hoc organization with no experiences of doing SPI and CMM the efforts have mostly been prolonged, expensive, and not often delivered the effects back to the organizations in the same dimension as investigations. In this paper, we investigate the role of maturity driven process improvement in an industry. In order to achieve this goal, literature study was used to learn from the experiences of companies those have experienced maturity based process improvement.

Maturity driven process improvement is suitable for big organizations those can afford consultancy costs and have enough resources to devote for software process improvement team. It seems difficult for smaller companies; one possible reason for many companies to give up software process improvement is that they set their goal to reach a particular certification level or merely achieving a maturity level. The main focus should be on achieving the process improvement instead of achieving a label of specific maturity level.

**Key words :** About four key words or phrases in alphabetical order, separated by commas.

### 1. INTRODUCTION

In this present era it has emerged as a fact that no software organization can last longer in the business competition without improving its processes.

Most of these efforts have been inspired of maturity models like the CMM (Capability Maturity Model) and been guided by the area of Software Process Improvement (SPI). In this perspective for an ad hoc organization with no experiences of doing SPI and CMM the efforts have mostly been prolonged,

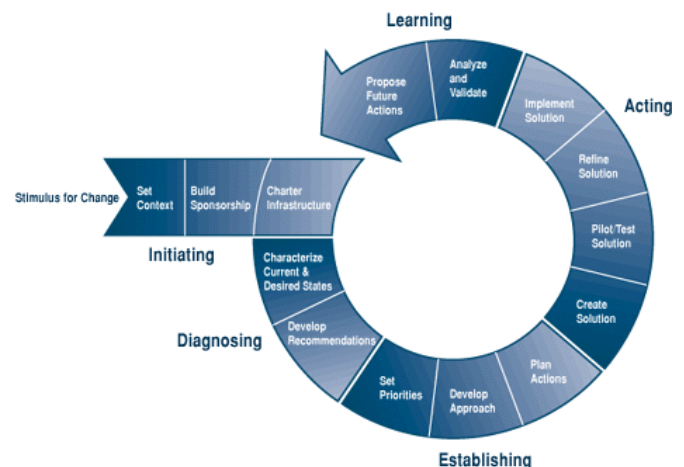
Difficult, expensive, and not often achieved the effects back to the organizations in the same dimension as desired. In this paper we discuss about the appropriate role of maturity driven process improvement effort in an industry and therefore, the research that need to be addressed is:

“What are the facts and challenges faced by maturity driven process improvement efforts for an industry”

In past time SPI has been used in the software industry as a systematic approach toward improving the capabilities of software organizations. SPI was originally developed at Software Engineering Institute at Carnegie Mellon University and is based on ideas presented by Humphrey [1].

Some resources are following SPI in data science and big data [13] which is also an encouraging point since use of proper SPI will lead the project toward successful journey.

An SPI proposal is cyclic in an environment and includes different phases 1) Initiating, 2) Diagnosing, 3) Establishing, 4) Acting, 5) Learning, as expressed in the IDEAL model as shown in figure 1.



**Figure 1:** The IDEAL Model for SPI (Mc Feeley 1996)[1,3]

The 'Starting' stage centers around starting the procedure, it incorporates plans and timetables. The following stage 'Diagnosing' focuses on diagnosing the present development dimension of association. In 'Setting up' stage the data picked up from past stage is utilized for organizing the activities and

in the 'Acting' stage arrangement is executed. The keep going stage centers around exercises gained from programming process improvement.

SPI activities commonly utilize standardizing models to survey current programming practice and give direction how to organize upgrades. The most prevalent model is CMM. [1]

### 1.1 SPI Ideas

SPI Ideas has been taken from Pouya Pourkomeylian's Doctoral Dissertation 'Software Practice Improvement' [2].

SPI offers three arrangements of thoughts for improving practice in programming associations: the administration of SPI exercises, the methodology taken to control SPI activities, and the point of view used to concentrate consideration on SPI objectives.

### 1.2 Managing SPI

SPI the board is impacted by three kinds of components: sorting out, arranging and criticism.

**Organizing:** In request to compose SPI endeavors it is important to appoint somebody answerable by giving essential advices. There are two conceivable approaches to shape SPI groups. The primary conceivable route is to appoint assets for low maintenance; they may take part in SPI exercises alongside different assignments. The second alternative is to shape a different group that is completely dedicated for SPI endeavors.

**Planning:** There is need of activity intend to begin SPI venture.

**Feedback:** The third factor that influences SPI the executives is criticism. Input is required on better than ever forms.

### 1.3 Approaches to SPI

This part of SPI addresses how to structure SPI endeavors. It can likewise be separated into three components: developmental, standards and responsibility.

**Developmental:** In transformative, process upgrades are actualized steadily. These enhancements are nonstop, concentered and aggregated.

**Standards:** Another key component is to utilize best practice models of programming forms as standards for evaluating the ability of the product association.

**Responsibility:** The last key component identified with ways to deal with SPI is responsibility. Every individual participant in SPI process must be focused on objective. The most imperative thing is the dynamic investment of senior

management. The board must be effectively dedicated to the accomplishment of objectives.

### 1.4 Viewpoints of SPI Approaches to SPI

The main point of SPI is on software engineering practice.

**Software Processes:** The principal point of view of SPI is that it is centered around software processes.

**Capabilities:** Another key component identified with viewpoints on SPI is individuals' skills. A fruitful SPI exertion requires competency advancement in connection to the recently made software process. The objective of creating skills is to engage individuals to expertly utilize, adjust, and receive the product forms in their product extends in a route fit to their requirements.

**Setting:** The other key component in SPI points of view is the setting of programming building exercises. This setting gives a ground to progress endeavors on a general dimension, just as for customizations for explicit requirements. The setting gives a situation to clarifying that does what, why, when, and how the software process should be implemented.

## 2. CAPABILITY MATURITY MODEL

Capability Maturity Model (CMM) is a process improvement approach that provides organization five maturity levels to measure its process improvement capability. It has five maturity levels: Initial, Repeatable, Defined, Managed and Optimizing. Figure 2 shows the CMM model.

The following lines provide brief description of each level.

**Initial:** This level has no requirements. Any organization at this level is usually unpredictable. Projects may over run the budget and behind the schedule.

**Repeatable:** Here the focus is on controlling cost and schedule. There exist some processes that usually make it possible to repeat the success stories.

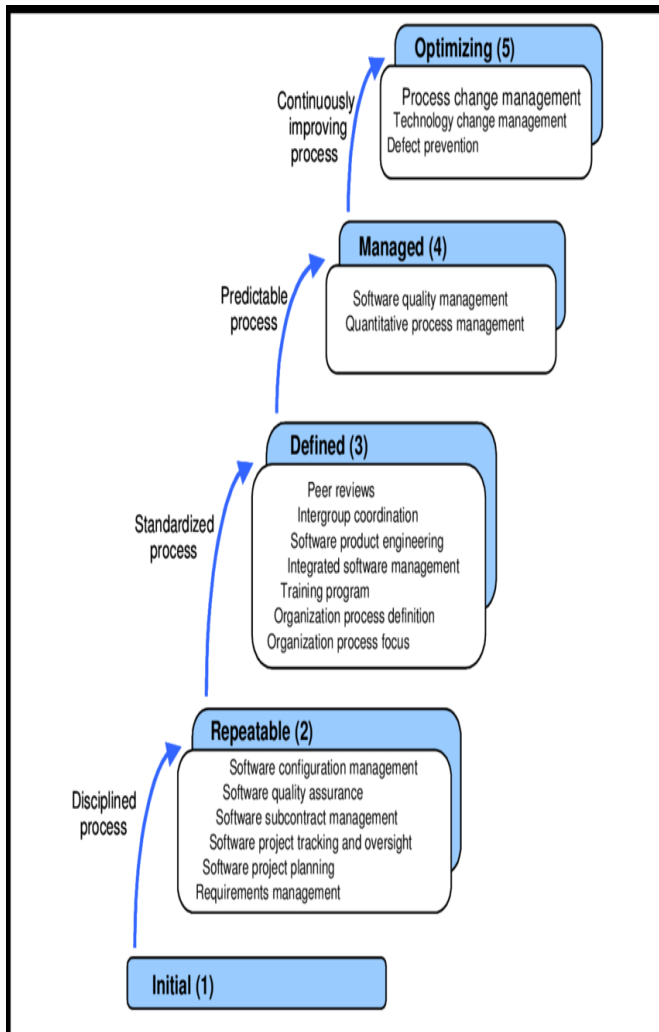
**Defined:** Here the focus is on standardizing the processes. So each project follows a standard process for implementation.

**Managed:** Here we can make quantitative measurements to make sure that processes work within the predictable limits. So through these measurements it becomes easy for management to control.

**Optimizing:** Here focus is on continuous process improvement.

## 3. RESEARCH METHOD

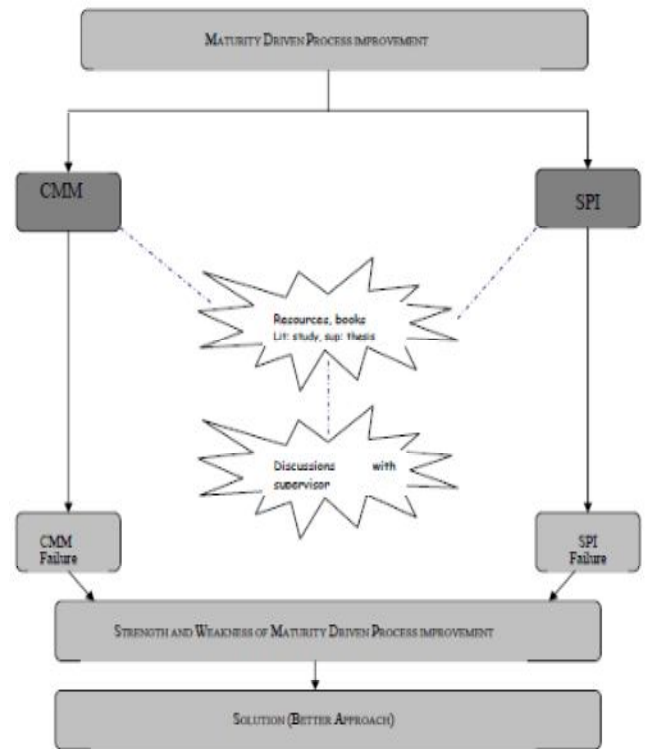
The framework could be defined as overall view of work done in entire project. In other words it could be define as structure for describing the concepts, methods, technologies and so on.



**Figure 2:** The CMM Model and the Five Maturity Levels (Paulk 1993)[4]

In this report the frame work is represented as methodology of research, which shows the steps carried out to achieve the results.

This section is based on steps taken in research methodology. Figure 3 presents the diagram which is showing the clear view of research:



**Figure 3:** Graphical representation of the research methodology[3]

To answer the maturity driven process, initially the detailed study of CMM and SPI will be conducted. After this step all those cases will be considered which are failed in the implementation of CMM and SPI. In other words the research will be consists of failed CMM and SPI projects. This is necessary to know about the weaknesses of maturity driven process improvement efforts. After the consideration of all failed projects of SPI and CMM, the weak points will be measured that includes the strong reasons of failure. Here in this stage we will be able to find out the weaknesses of maturity driven process which causes failure in software projects.

Finally the reasons will be identified which can be the main sources of project failure. Moreover the strength of maturity driven process will also be covered to know about the successful SPI projects that can help in the identification of those mistakes which are being taken by the failed organizations. If that are not enough, then we will come up with better approach which will make able the Adhoc organization to implement the SPI using CMM and this could be our future work.

### 3.1 Qualitative Research Approach

Qualitative Research implicates the use of qualitative information such as interviews, documents and the data which is observed from different research. The aim behind the study of this research is to clarify the concept of qualitative research to the student [5].

This research is qualitative research because it is based on pure study of analysis and observed data. Qualitative research is based on research perspective and method which is used to conduct this approach.

**Research Perspective:** There are three research perspectives widely used in this kind of research that are:

- Positivist
- Interpretive
- Critical

To carry out this research, we need positivist research perspective because we will conduct the test study which will comprise of several reasons of failing and making SPI so hard to understand actual reasons [5].

Positivist research perspectives enable us to measure the weaknesses and strengths of maturity driven process improvement efforts. It allows the understanding of phenomena of study. Including this the positivist research perspective tells you about the assumptions that could be reality observed by researcher.

**Research Method:** There are four kinds of methods which are mainly used in qualitative research approach, that are:

- Action research
- Case study research
- Ethnography
- Grounded theory

To conduct this research, we need the method named **case study research** because we have to investigate the reasons by considering the several organization that why SPI projects are failed, while every organization is not complaining about activities of SPI. The case study research will enable us to examine their current analysis or approach which must be wrong because the organization is claiming that SPI is very hard in implementation while it's not true [5].

#### 4. RESEARCH DISCUSSIONS

**Case 1:** ABC is a \$3 billion openly held administration association with around 12,000 representatives situated somewhere in the world. It chose to go for programming process improvement and picked CMM for direction. The organization played out a CMM self-appraisal that put it at level-1. A SPI group was shaped which was additionally isolated into the workgroups, each workgroup focusing on explicit key procedure zone. It was evaluated to accomplish Level-2 inside 10 months from the date of commencement of SPI venture.

However, soon it was understood that key practices have not been followed in certain zones. So it ends up hard reporting current procedures. Following one year another self-appraisal was directed. The outcomes demonstrated that still organization is at level-1. After these disheartening outcomes, it was chosen to enlist specialist to direct process improvement. Again everything was begun from starting. Following one year again evaluation was made and it came to

realize that organization has accomplished the Level-2. The organization accomplished its objective following two years than its unique due date [6].

**CASE 2:** In 1999, DataStream Content Solution (DSCS) started giving administrations those changes over expansive information records starting with one organization then onto the next. In 2003, it was understood that organization had become excessively substantial and now it has turned out to be hard to deal with business. Business was growing quickly and things were winding up progressively unpredictable.

It was chosen to execute CMM. In the underlying preliminary stage to actualize CMM, three territories were distinguished to that the organization needs to make plans to enable themselves to develop.

The objective was to accomplish Level-3 out of one year. At initial a methodology was created. Four objectives were recognized and ten regions were looked over CMM that may accomplish these objectives.

While accomplishing CMM was the primary main impetus behind these exercises yet center was to improve the practices that would advance the achievement of organization. In the wake of laboring for year and a half in the organization, CMM level-3 was not accomplished but rather it was nearer to accomplishment. [7].

**CASE 3:** This contextual investigation centers on the ERP venture disappointment which is a creating country. The structure—reality hole display connected to a contextual analysis of halfway ERP disappointment in an assembling firm. The model examinations the circumstance both previously and ERP implementation. It finds sizeable holes between the presumptions and necessities incorporated with the ERP framework structure, and the real substances of the customer association. It is these holes and the inability to close them amid execution that underlies venture failure. ERP frameworks are flopping in creating nations. ERP (Enterprise asset arranging) framework incorporates monetary frameworks, HR, coordination, information frameworks over the associations to set aside extra cash and improve basic leadership and client maintenance. These are progressively being utilized by associations in creating countries.

#### 5. AVOIDING FAILURES

Instead of achieving levels, the software process improvement can be modified with clear goals and interaction. To avoid major failures of any project. The best solution is the component software engineering along with maturity driven process improvement efforts. First of all the group of a few people must be distributed according to project life cycle. Let's consider out of five people one student will be project manager and other four will be programmers. Out of four programmers, the one student should also handle responsibility as quality engineer in order to maintain the quality of software process. Before the commencement of project there should be time management for the project

which must be filled and noted by each student, it is the responsibility of the project manager to handle its team and run them according to time slot. The project manager should monitor the time and project work load concurrently in order to know that how the development of project will go on.

In the initial stage of the project, the project manager will collect the system requirements from different resources for requirement plan. After that he must consider the risk analysis because he will have a very less time to solve the problem so it's very essential to assume the upcoming problems as risk. Most of project managers often skip the risk management process because the sponsor wants them to start quickly without wasting time on things like risk management, but the risk management is the most important factor in project construction. Similarly it is a duty of project manager to find mitigation policy of occurred risk as well. For example, table 1 shows the same risk levels.

**Table 1:** Identification of risks

Risk event	Probability of Occurrence			Mitigation
	Medium	High	Low	
Requirement can be changed by the customer	Medium			Accept requirements up to certain level of time
Project staff can be sick			Low	Project Manager it self have to work
Project staff many involve in several projects	Medium			Distribute the time according to importance of project
Any staff member can leave the project in between		High		Higher a new immediately
Lack of the time	Medium			Have to work over time
Lack of resources	Medium			Projects should taken by considering the available recourses
Some developers may not cooperate in common standards and processes.			Low	Quality engineer must discuss with development team of standards

Above is the risk table showing the number of the risk could entertained during the project construction phases or development phases. We introduced the mitigation policy as well in order to avoid the risk. The risk management should be considered after getting the requirement plan because the risk could happen any time and if we have mitigation policy, it will help us to resolve the problem. As it will be done then it is the responsibility of project manager to break the project according to activity plan into different phases. Each phase must be assigned to group according the expertise with

deadline. That deadline will consist the exact time and date of finishing of that phase or component in order to develop the project on time. Similarly the project should monitor the progress of a team to measure the current status of development. Some time if the team is very small then project manager also acts like a programmer or quality assurance engineer to fulfill the requirement of deadline. Including that the most important factor of project development is documentation, it is very essential for a project manager to tell its team that whatever they do that must written on document in order to maintain the work progress. Because if any member left the project then it is very difficult for a new person to understand the work of a previous person. The countermeasure of this problem is the maintenance of proper documentation of each activity developed by each programmer or any other staff, because if they left then any new person can easily cope up their disaster by reading that document to carry out the future work.

If any project member or programmer left during the implementation phase, then the project manager should act himself as a programmer or try to find any other person who knows the programming, as we already discussed above that project manager should maintain the group member's for the documentation of each activity carried out in project, so he himself or any other person will not face any difficulty to carry out the work. If he did not find any other member then the whole project team should work little extra to cope the work. Certainly the time will be consumed more in order to compensate the work but project manager can also distribute small pieces of extra work among other group members. Through this way the project could be accomplish in a very smooth manner.

## 6. RESULTS

This research about the “investigation the role of maturity driven process improvement in an industry.” concludes the following outcome. These discoveries turn out from the writing study and the exercises learned by organizations to actualize development driven procedure improvement.

**Why Failures:** CMM is essentially intended for vast associations; it isn't impeccably perfect for small companies. Unfortunately numerous companies go for procedure improvement, just to accomplish a name of procedure development. This wrong inspiration drives them to disappointment. The principle issue for small companies is absence of assets. Assets include: time, cash and work force. Many small companies make un-practical estimations. They need to get results in all respects early. In reality it requires investment to make software process improvement occur. At the point when top administration don't get results ahead of schedule as it was required then it prompts frustration lastly it results in disappointment. There is need of experienced and expert staff for software process improvement. In the first place things go great, yet after section of some time it end up complex and lead to inflexible methodology. Unpracticed staff will make straightforward things more complex. Assigned staff for procedure improvement efforts must be profoundly energetic and enthusiastic to accomplish their

objective. It is very suggested that participants of process improvement effort should be chosen for longer time . Communication is the way to progress. Continuously convey consequences of procedure improvement to higher specialists. In the event that the best administration is unaware of the process they will lose their advantage.

**Why Success:** When we state that ABC Company has come to on CMM Level-2, at that point its mean the procedures of the organization are develop up to CMM Level-2. It tends to the development of association wide capacity.

The dimension of any association's procedure development demonstrates its dimension of credibility. Any association at abnormal state of development sounds more dependable than others. That is one reason that inspire organizations to improve their procedure development level.

## 7. RELATED WORK

Garousi et al. wrote a survey about TMA/TPI, where authors distinguished 58 distinctive test development models and countless with shifting degrees of experimental proof on this improving the maturity of test processes. [8].

Lee et al. performed investigation by building up an imaginative model for investigating the effect of learning sharing on SPI achievement, the effect of information partaking in explicit hierarchical societies, and how the help of best the board explicitly impacts the way to SPI achievement. To observationally test the model, this investigation receives the measurable method of halfway least squares (PLS) to examine 118 examples gathered from SPIcertified Taiwanese associations. The outcomes recommend that family type hierarchical culture has a more grounded relationship with learning sharing than chain of command type with regards to SPI achievement SPI [9].

Fontana et al. discovered a structure for developing in lithe programming improvement. Author constructed this structure dependent on the investigation of subjective and quantitative information in four Brazilian deft groups. Their hypothetical establishment, in light of complex versatile frameworks hypothesis, drove them to assemble a structure for lithe programming evolvement that considers individuals as operators who assume the key job in the developing procedure. Results in the practices, in the group are performed, in the manner in which necessities are characterized, in the nature of the last item and in the client relationship [10].

Hussain et al. worked on process in connection software project failure was explored and examined. In addition project process success factors and failures were discussed [11].

Khan et al. performed the study which is to distinguish achievement variables and difficulties to help GSD associations for effective execution of SPI program. As needs be, a methodical writing survey approach was embraced to recognize the achievement components and difficulties. A sum of nine achievement components and six difficulties were recognized [12].

Herranz et al. presented Gamiware, a gamification stage intended to expand inspiration in programming ventures.

Grounded on both gamification establishes and in programming process improvement activities, it limits the expense of execution of gamification activities and makes this control nearer and increasingly available for associations expected to improve their product procedure. Beginning outcomes on its usage indicates noteworthy achievement [13].

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## REFERENCES

- [1] Pourkomeylian P. Knowledge Creation in Improving a Software Organisation. In Working Conference on Diffusing Software Product and Process Innovations 2001 Apr 7 (pp. 205-223). Springer, Boston, MA. [https://doi.org/10.1007/978-0-387-35404-0\\_13](https://doi.org/10.1007/978-0-387-35404-0_13)
- [2] Pourkomeylian P. Software practice improvement. rapport nr.: Gothenburg studies in Informatics. 2002(22).
- [3] Shaikh A, Ahmed A, Memon N, Memon M. Strengths and weaknesses of maturity driven process improvement effort. In 2009 International Conference on Complex, Intelligent and Software Intensive Systems 2009 Mar 16 (pp. 481-486). IEEE. <https://doi.org/10.1109/CISIS.2009.182>
- [4] Paulk MC, Curtis B, Chrissis MB, Weber CV. Capability maturity model, version 1.1. IEEE software. 1993 Jul;10(4):18-27. <https://doi.org/10.1109/52.219617>
- [5] IS World, "Qualitative Research in Information System," [Online]. Available: <http://www.qual.auckland.ac.nz/>.
- [6] Hardgrave BC, Armstrong DJ. Software process improvement: it's a journey, not a destination. Communications of the ACM. 2005 Nov 1;48(11):93-6. <https://doi.org/10.1145/1096000.1096028>
- [7] Dangle KC, Larsen P, Shaw M, Zerkowitz MV. Software process improvement in small organizations: a case study. IEEE software. 2005 Nov;22(6):68-75. <https://doi.org/10.1109/MS.2005.162>
- [8] Garousi V, Felderer M, Hacaloğlu T. Software test maturity assessment and test process improvement: A multivocal literature review. Information and Software Technology. 2017 May 1;85:16-42. <https://doi.org/10.1016/j.infsof.2017.01.001>
- [9] Lee JC, Shiue YC, Chen CY. Examining the impacts of organizational culture and top management support of knowledge sharing on the success of software process improvement. Computers in Human Behavior. 2016 Jan 1;54:462-74. <https://doi.org/10.1016/j.chb.2015.08.030>

- [10] Fontana RM, Meyer Jr V, Reinehr S, Malucelli A. Progressive Outcomes: A framework for maturing in agile software development. *Journal of Systems and Software*. 2015 Apr 1;102:88-108.  
<https://doi.org/10.1016/j.jss.2014.12.032>
- [11] Hussain A, Mkpjojiogu EO. Requirements: Towards an understanding on why software projects fail. In *AIP Conference Proceedings 2016 Aug 12 (Vol. 1761, No. 1, p. 020046)*. AIP Publishing.
- [12] Khan AA, Keung J. Systematic review of success factors and barriers for software process improvement in global software development. *IET software*. 2016 Apr;10(5):125-35.  
<https://doi.org/10.1049/iet-sen.2015.0038>
- [13] Manoj B, Sasikanth K.V.K, Subbarao M.V, and Parkash V.J: Analysis of Data Science with the use of big data. *International Journal of Advance Trends in Computer Science and Engineering*, pp. 87-90, Volume 7 No.6,2018