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A Study on the Impact of PMS on the Productivity and Reliability of Software Engineers in IT Sector in India

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Abstract: Information Technology sector in India have rapidly gained momentum in past few years (20-25 years to be precise) due to the incorporation of many encouraging policies such as Globalization and Industrialization. Due to this rapid increase in the IT industry in India, the demand for courses concerned with providing knowledge related to computers and its allied areas has shown a drastic upward swing. Software Engineers are very much the sole responsibility bearer of the growth of this IT industry. They devote their all long tenure for the development of meaningful and user-friendly software products, which benefits the nation as a whole. So, it is of utmost importance to look into the Productivity and Reliability of Software Engineers in IT industry of India. The role of an efficient and friendly Performance Management System (PMS) can enhance the Productivity and Reliability of Software Engineers to a very good extent. In this paper, we have discussed how a well-organized PMS impacts the Productivity and Reliability of Software Engineers. The result shows a very interesting pattern.

Keywords: Information technology, Performance management, Productivity, Reliability, Software engineers.

I. Introduction

A well-defined and designed Performance Management System is the prerequisite for any organization which aims to grow rapidly. In the scenario of global competition, Strategic Human Resource practices are needed in every organization. Performance Management plays a very significant role in any organization as it ensures organizational operations in an integrated manner to achieve its objective effectively and efficiently. Sound performance management system helps an organization to sail smoothly through the turbulence of prevailing competition. It includes planning, implementation, reviewing followed by evaluation of various processes within a department or in an organization as a whole which enables to track the individual performance of employees that aids in the growth of both employees as well as of the organization. It helps in allocating roles and responsibilities to each employee and also helps in identifying the Key Results Areas (KRAs) which helps to build a robust performance management system which further facilitate in rewarding employees.

In today's competitive world it is very challenging for the corporate to maintain its production quality and reliability continuously consistent. The Indian IT segment has likewise manufactured a solid notoriety for its elevated requirements of programming advancement capacity, administration quality and data security in the remote market-which has been recognized all around the world and has helped upgrade purchaser certainty. The job of HR in the current situation has experienced an ocean of change and its attention is on advancing such utilitarian methodologies which empower fruitful execution of the major corporate systems. Today, HR moves in the direction of encouraging and enhancing the exhibition of individuals by establishing a supportive workplace and providing extreme chances to individuals for partaking in authoritative arranging and dynamic procedure. The paper examines about the job execution of the executives in IT industry in the country.

Performance management is the present trendy expression and is the need in the present occasions of vicious competition. Executing the broad includes exercises, for example, joint objective setting, ceaseless advancement audit and continuous correspondence, criticism and instructing for improved execution, usage of worker improvement programs and compensating accomplishments. The procedure of performance management begins with the joining of another incumbent in a framework and finishes when a representative stops the association. Performance management can be viewed as a deliberate procedure by which the general execution of an association can be improved by improving the exhibition of people inside a group structure. It is a method for advancing

unrivaled execution by imparting desires, characterizing jobs inside a necessary skill structure and building up feasible benchmarks.

Information technology (IT) is characterized as the structure, advancement, usage and the executives of PC based data frameworks, especially programming applications and PC equipment. Today, it has developed to cover most of the areas of processing and innovation. The motivation behind the significance launch of Information Technology (IT) is because of the improving openness, mindfulness and utility of innovation. A nation's IT potential is central for its walk towards worldwide intensity, solid Gross domestic product and barrier abilities.

The performance management approach has become a crucial apparatus in the hands of the corporate as it guarantees that the individuals will maintain the corporate qualities and track in the way of achievement of a definitive corporate vision and mission. It is a forward looking procedure as it includes both the manager and the worker through a procedure of joint arranging and objective setting in the beginning of the year.

The reliability and productivity of a Software Engineer in an IT industry largely depends on the PMS adopted. With a better and effective PMS, the Software Engineer may feel secured about the current job and hence the final productivity of the individual will increase considerably. Also, they become more and more reliable of adhering by the regulation of the organization and the chances of their switching becomes a distant possibility.

II. Theoretical Framework

The term performance management was given by Aubrey Daniels in the 1970s. Further, it gained popularity in early 1980, when total quality management program got recognized as of utmost significant for achievement of high standards and quality performance. In addition to it, various managerial tools and functions like leadership development, job design, training and reward system got an equal elevation. By the early 21st century, leading organizations implemented it in their operations. They began estimating operational performance of their employees by incorporating brand new metrics as a fragment of their appraisal process such as group conflicts, problem solving capability, teamwork, communication, etc. and by establishing a link between individual goals with organizational goals.

According to Armstrong and Baron (1998), Performance Management is both a strategic and an integrated approach to delivering successful results in organizations by improving the performance and developing the capabilities of teams and individuals.

It was defined by Alder (2011) as the activities that organization implements with the aim of achieving the goals consistently and efficiently. The scope of PM varies and can be implemented at various organizational levels including individual employees, departments, the entire organization and processes.

Briscoe and Claus (2008) also state that PM is usually described as the system through which organization set work goals, determine performance standards, assign & evaluate work, provide performance feedback, determine training & development needs & distribute rewards.

III. Literature Review

Authors in [1] used Stochastic Automata Networks (SAN) analytical model to study a practical case of an IT company which has various sites and along with that different participants, roles and expertise. The results showed a splendid accuracy when it was compared with the actual project outcome (relative error less than 0.2%). It was easy to predict number of 3,312.98 working hours to execute the project compared to 3,317.22 actual working hours spent in the execution process. An analytical modeling in the particular case model employing SAN is worthy alternative to form teams in software development projects predicting the overall performance. The future study of the paper could be to extend the existing theoretical model to surround the other aspects that are relevant for the project outcome. Another interesting future work is to thoroughly analyze model representations of a global software development project, varying the number of participants with different levels of experience and availability, where a project could be modeled by traditional and agile software development methodologies [2].

The paper [3] aims to analyze and compare Performance Management Components and its use in IT and Information Technology Enabled Services Industry (ITES). A thorough examination has been done on the methods of performance management system. Exploratory along with descriptive research has been used in the study. Non probability convenience sampling is employed and primary data has been collected with the help of two structured questionnaires. Results depicts that retention of employees is most importance while formulating policies regarding PMS in an organization also if poor performance of an employee is found then proper training and coaching should be provided for improvement. Further study can be done to focus on the issues such as employees' turnover, for enhancing performance and so on.

In paper [4] a study has been done with an aim to categorize and briefly express Google's key software engineering practices. At Google employees are allowed to devote their 20% of working hours to the project of their interest. Employees at Google are supposed to note down their goals unambiguously and they are supposed to evaluate their progress towards these goals. Google has a separate career succession plans for both engineering and management. Google provide number of facilities to its employees like games room, ball pits, cafes, cafeterias, gyms, massage parlors. At Google new googlers (Nooglers) have to go through mandatory training session. Each Noogler is appointed a mentor and a buddy to support them in adjusting. Google has a very detailed promotion process. Googlers get their annual performance bonuses based on their performance. All these

help Google to enhance the productivity and reliability of their employees at the workplace. This also helps in retention of employees.

Paper [5] has been presented with an aim to improve the productivity measurements within software companies and evaluated their impressions by random samples of industrial software. Result depicts that software productivity measurements is a learning act and past information related to factors and measures are also needed. For the purpose of continuous improvement of software engineering processes, organizations must regularly list and assemble diverse metrics of the particular project. The result can further be used to guide productivity analysis and can also be employed for developing improved and optimized productivity model.

In [6] a research was conducted focusing on enhancing qualitative appraisal criteria employing quantifiable features with the help of the tools. An open source software systems like Open Project (Project Management Tool), PHP Time clock (Time Clock Software System), Git Hub (Source Code Control System), Jenkins (Continuous Integration Tool) and Sonarqube (Code Quality Tool) were used in the research for a very careful feasible study. The methodology employed provided an amalgamated evaluation engine for getting work performance comparative index, with an amalgamation of project management tool, build server and attendance recording system. The outcome of the study provided a kit to reduce the existing biasness in the employee appraisal tool. The progress report of each employee over a period of time can be generated at any time on a line graph where an employee can self -evaluate his position and ways to improve his work effectively & efficiently.

Paper [7] conducted a study focused on the performance of the employee among executives and their opinions efficiently & effectively. In the research conducted, operative functions of the human resource department were analyzed with the constant support of employees and their opinions about the functions performed by the employees and also about the functions performed by the HR department. For this purpose, the employees were directly interviewed and the relevant data were collected through the questionnaire. Data then were analyzed by the percentage analysis and chi-square method. The result showed that most of the employees of the organization were happy, satisfied and comfortable with the performance appraisal system.

In [8] a research was conducted to present an approach for evaluating and enhancing the performance of an IT support organization in managing the service incidents. The approach focused on the definition of a set of performance metrics and a method for guided analysis which allow us to get the root causes of poor performance and helps to take corrective actions. To validate the application a real case study on a leading IT provider for the airline industry was discussed.

In [9] authors have discussed the role of performance management in IT Sector. Data were collected through questionnaire. The result showed that employees were aware and clear about the performance appraisal system. They also have knowledge about organization's goals, objectives, self-appraisal forms and key performance areas. Employees in the organization are satisfied with the system and they are enjoying the benefits of the system.

Paper [10] conducted a study to clarify the mechanism of how software engineering capabilities are related to the business performance of IT vendors. For this purpose they developed a structural model inclusive of Software Engineering Excellence (SEE) indicator which includes project management, deliverable, process improvement, quality assurance, human resource development, research & development and customer contact. Data were collected through the means of questionnaire from the 100 major IT vendors in Japan. After analyzing the data, result showed that the effort level on human resource development, project management and quality assurance made the performance of research and development, customer contact and process improvement better of the IT vendors in Japan as similar tendency was found in both 2005 and 2006.

Authors in paper [11] have done a study on whether happy software developers are productive developers or not? Developers were supposed to perform two tasks. The Psychology Experiment Building Language (PEBL) was used to gather the constructs that allowed us to calculate the score for the analytic performance. The scores were compared for both the tasks. The outcome showed that the happiest software developers performed exceptionally than the other developers.

IV. Objectives of the Study

- To study the relationship between "PMS" and "Productivity" of a Software Engineer.
- To study the relationship between "PMS" and "Reliability" of a Software Engineer.
- To study the impact of PMS on the both the parameters.
- To provide some meaningful suggestions to the software organizations in general as well as the industry to improve, modify and change the existing systems of performance management.

V. Significance of the Study

In the today's era of cut throat competition, organizations need to understand the significance of Strategic Human Resource practices for obtaining competitive edge over contenders. Performance Management System is a significant tool for collaboration of all the major organizational functions and sub functions for the fulfillment of an organizational goal. The main motive of the research is to study the Impact of Performance Management System (PMS) on the productivity and reliability of Software Engineers. The study enable us to understand the association between PMS and productivity of Software Engineers and also between PMS and reliability of Software Engineers.

VI. Research Methodology

The questionnaire method (Google form) has been employed to gather information and data from the respondents for the purpose of taking research decisions. The other methodology includes research publication, interviews and other research techniques including both present and historical information.

A total of 103 responses were gathered from the respondents of IT sector of India.

Control groups were also used to compare the result. The control group (sometimes called a *comparison group*) is used in an experiment as a way to compare the result of the used Independent variable if and when applied to an experiment. It's a way to make sure that the impact we are estimating is causing the experimental results, and not something outside the experiment.

A. Hypotheses

$H_0 1$: PMS does not impacts the Productivity of a Software Engineer.

Ha1: PMS impacts the Productivity of a Software Engineer.

$H_0 2$: PMS does not impacts the Reliability of a Software Engineer.

Ha2: PMS impacts the Reliability of a Software Engineer.

$H_0 3$: The Impact of PMS on the Productivity and Reliability of a Software Engineer are significantly different.

Ha3: The Impact of PMS on the Productivity and Reliability of a Software Engineer are not significantly different.

VII. Findings and Discussion

The collected survey result where analyzed to test the formulated Hypothesis and get to any conclusion about the impact of PMS on the reliability and productivity of a Software Engineer. We conducted a number of tests such as Correlation, Linear Regression, ANOVA and Box-Plot to analyze the collected data. First a Descriptive Statistics of the parameters Productivity and Reliability is shown.

A. Reliability Analysis

The first step in the analysis process was to check the *Reliability* of the determinants of the Performance Management. Cronbach's Alpha reliability analysis measure was adopted to test the reliability of the scale.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.755	.755	20

It was reported that instrument measuring PMS was reliable as Alpha reported was approximately 0.755. The scale with a value of .755 suggests that the determinants of PM have good internal consistency. Scale was found reliable and used in the study to report the phenomena of PM.

B. Descriptive Statistics

The figures below show the graphical presentation of the collected data for both the parameters.

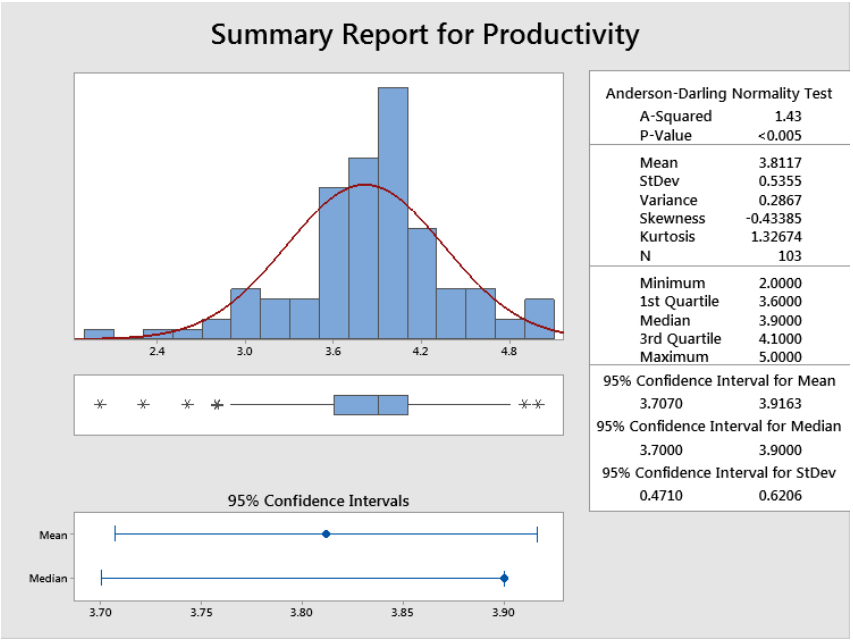

Fig. 1: Descriptive Statistics of the Impact of PMS on Productivity

It can be analyzed from the above Fig. 1 that the mean of the Productivity of a Software Engineer with the deployment of a good PMS lies at about 3.8 which implies Software Engineers in IT industry in India are very much inclined towards their job if a better and proactive PMS is adopted. The graph also shows the presence of some outlier in the collected data. So, we removed the outlier data in order to prevent any discrepancy in the result.

Further, the mean Reliability of a Software Engineer in IT industry in India with the use of a good PMS is 3.6 as can be seen from the Fig. 2 below. This implies that Software Engineers tends to be more reliable towards their job and less prone to frequent switching when a better PMS is adopted in the organization.

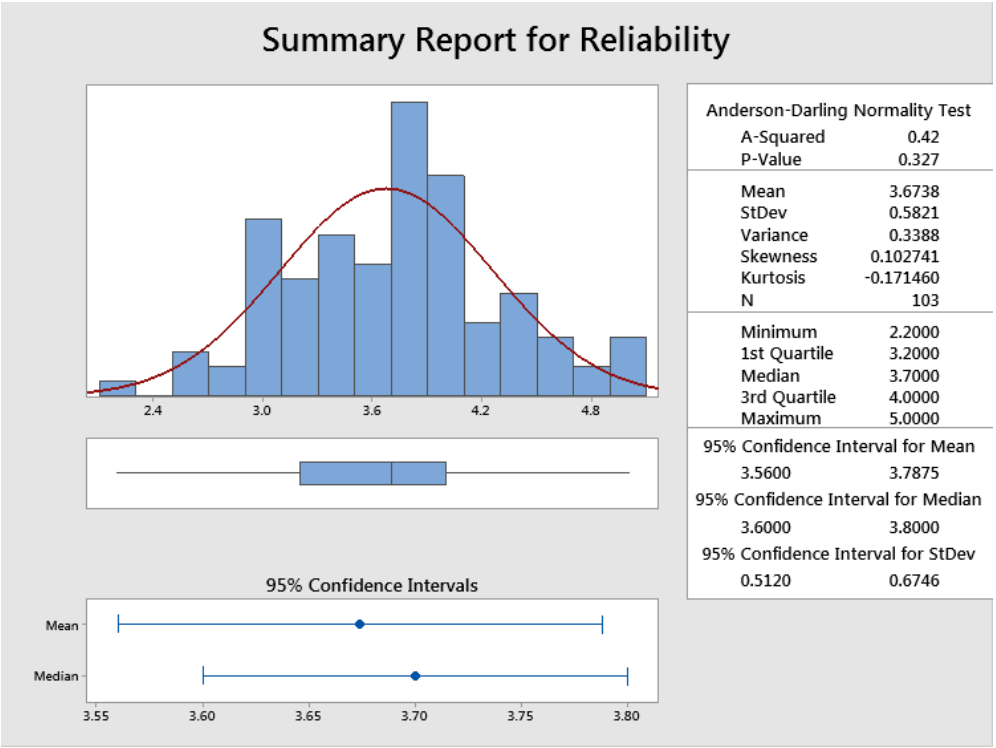

Fig. 2: Descriptive Statistics of the Impact of PMS on Reliability

C. Box-Plot

We used a Box-Plot to check the presence of any outlier data in our collected data. Box-Plot gives the location of an outlier data if any. The Box-Plot for the impact of PMS on the Productivity (Fig. 3) shows the presence of some outliers. So, we have removed those data points from the analysis. The Box-Plot for the impact of PMS on the Reliability showed no presence of any outlier data as shown in Fig. 4 below.

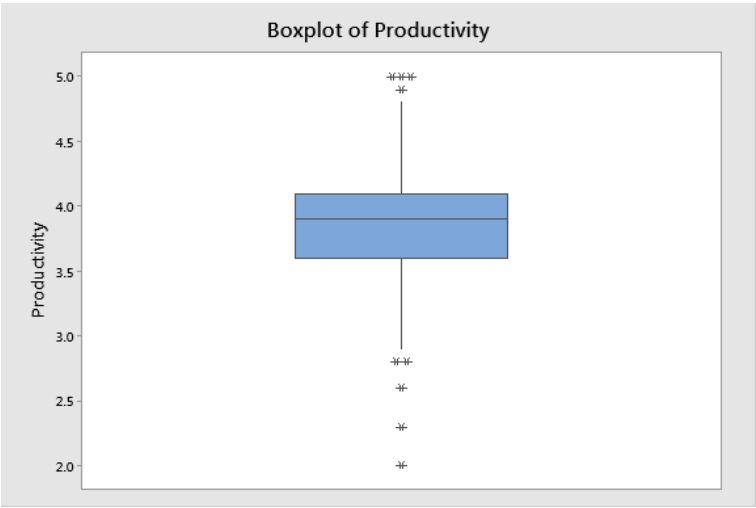

Fig. 3: Box-Plot for Productivity

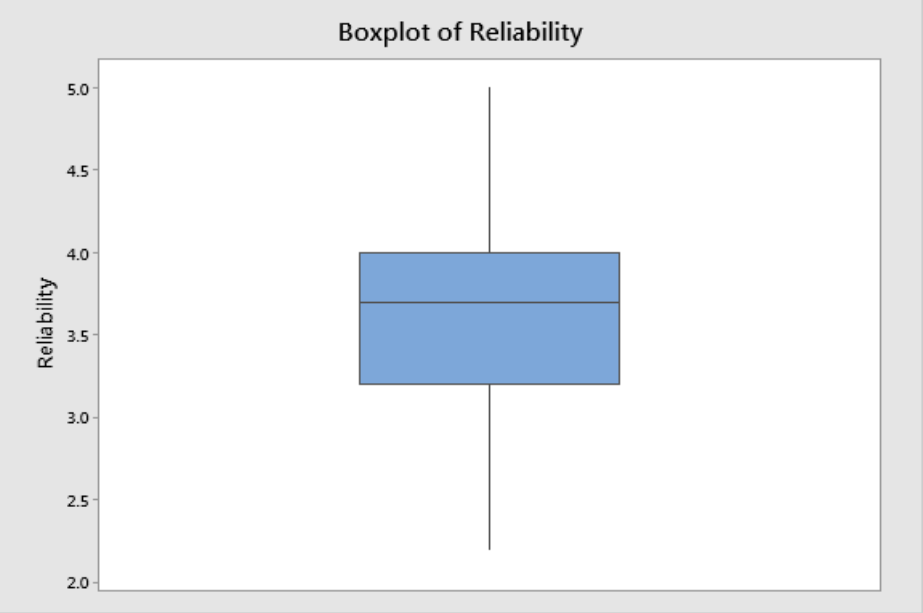

Fig. 4: Box-Plot for Reliability

D. Correlation

We calculated the Pearson Correlation Coefficient 'r' to determine how the two parameters are related with the PMS adopted in the IT sector. We found that both the parameters viz. Reliability and Productivity returns the 'r' value of about +0.24 with respect to the adopted PMS which implies that both Reliability and Productivity are Positively Correlated with respect to the PMS. An increase in the measures to adopt smooth and efficient PMS results in the increase of Reliability and Productivity of a Software Engineer in IT sector in India. Fig. 5 and Fig. 6 below shows the Correlation result between Productivity and PMS and Reliability and PMS respectively.

Correlations

	Productivity
PMS	0.024

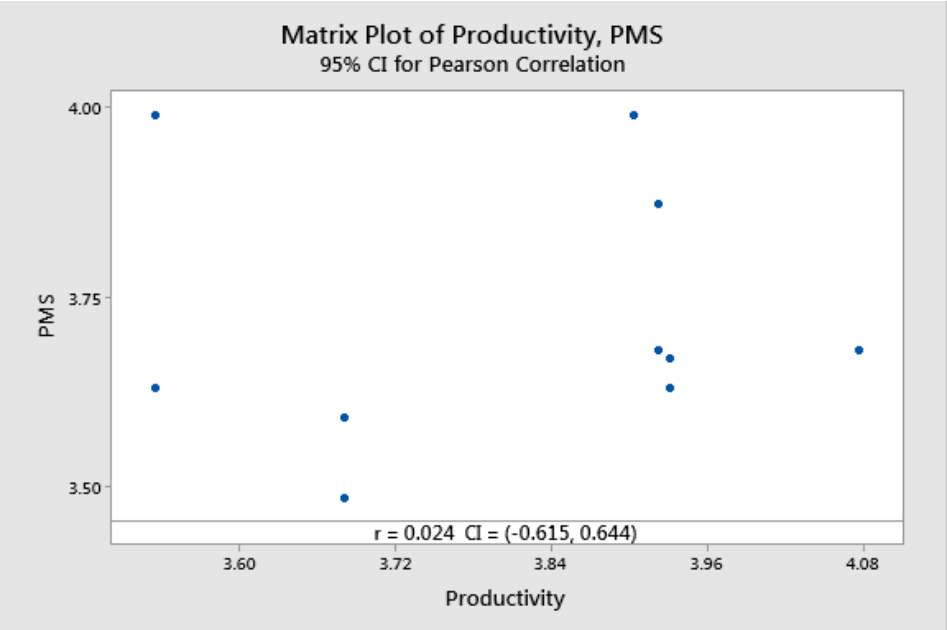

Fig. 5: Correlation of PMS and Productivity

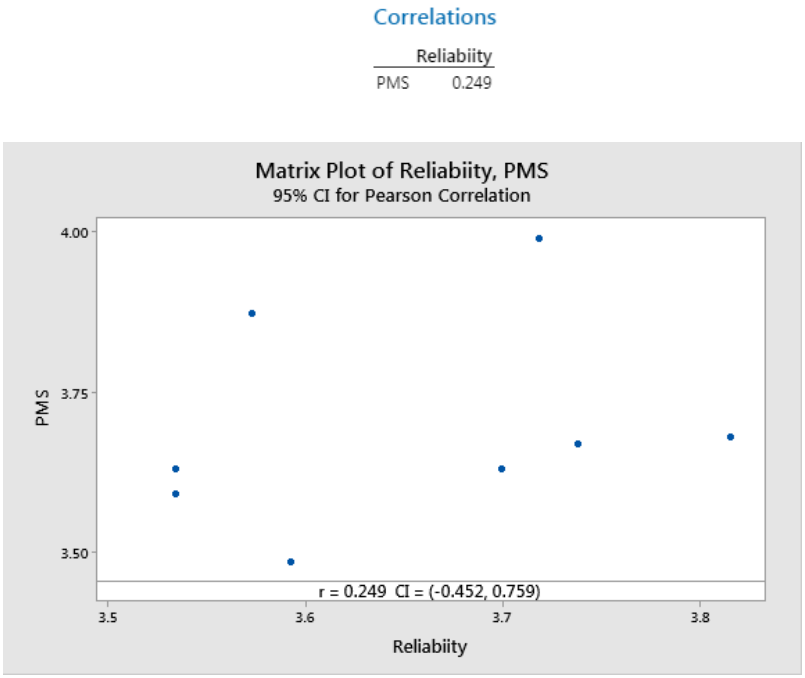

Fig. 6: Correlation of PMS and Reliability

E. Linear Regression

Next, we conducted a linear regression analysis to draw an equation between the two parameters and the PMS. Linear regression mainly shows the impact of an independent variable on a dependent variable. We observed that both the parameters follow a positive steep slope with respect to the PMS which implies a steep increase in the factors adopted in a good PMS increases the Productivity and Reliability of a Software Engineer in IT sector in India. The calculations are shown below in Fig. 7 and Fig. 8.

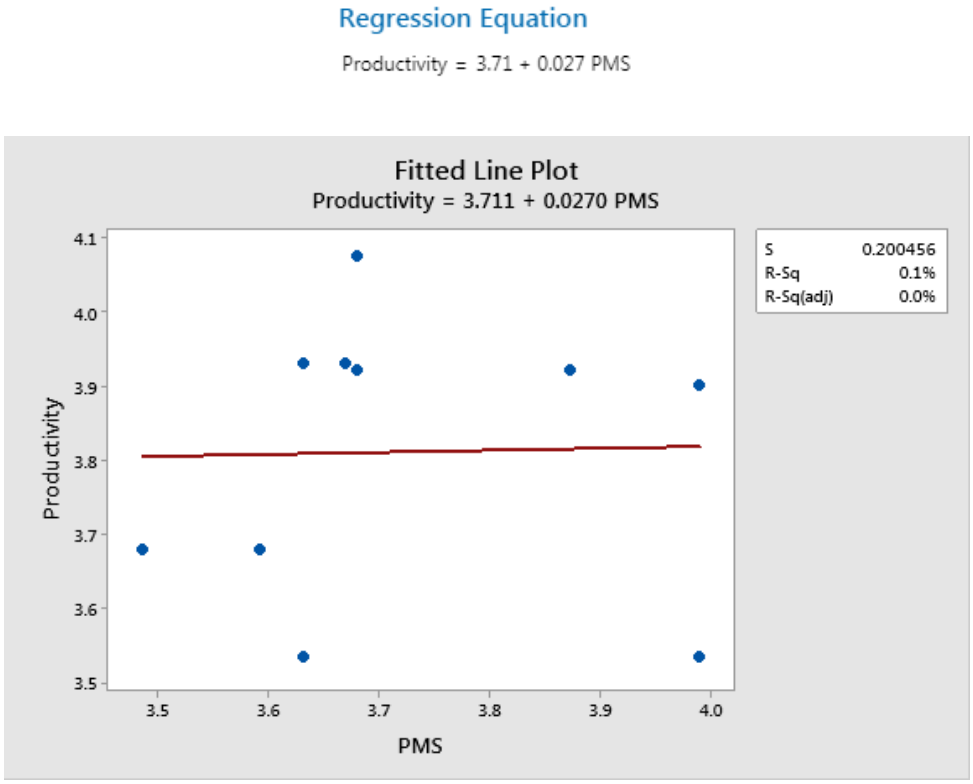

Fig. 7: Regression of PMS and Productivity

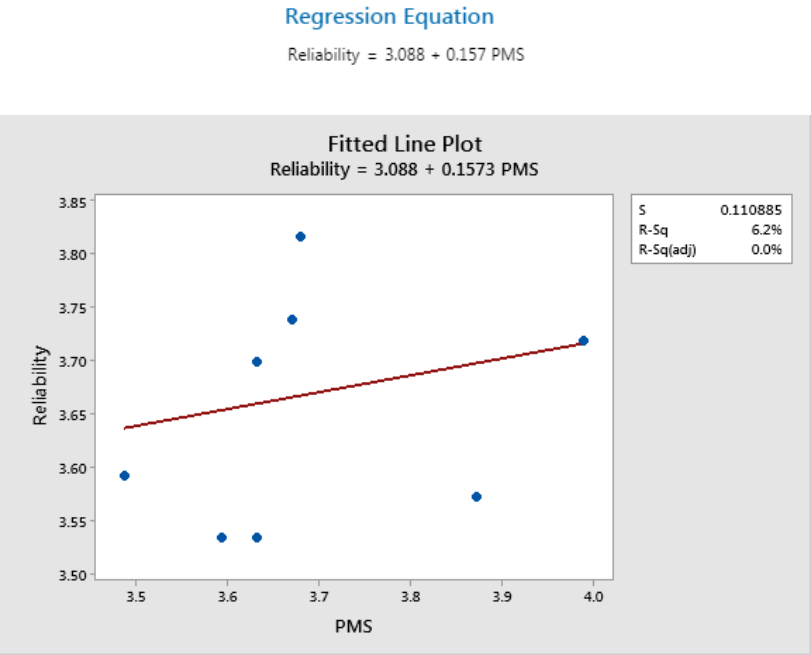

Fig. 8: Regression of PMS and Reliability

F. ANOVA

We used Analysis of Variance (ANOVA) to test our formulated Null Hypothesis Ho1, Ho2 and Ho2.

The first hypothesis Ho1 is formulated to check whether there is any impact of adopting better and effective PMS on the Productivity of a Software Engineer. This implies that the individual mean of the Productivity and Control group are equal. We tested the null Hypothesis at $\alpha = 0.05$.

Table I below shows the test result. The result shows that the calculated test statistics is greater than the tabulated test statistics. So, we fail to accept the null hypothesis and conclude that PMS impacts Productivity of a Software Engineer in IT Industry in India. Fig. 9 shows the interval plot of how PMS impacts the Productivity.

The second hypothesis Ho2 is formulated to check whether there is any impact of adopting better and effective PMS on the Reliability of a Software Engineer. This implies that the individual mean of the Reliability and Control group are equal. We tested the null Hypothesis at $\alpha = 0.05$.

Table II below shows the test result. The result shows that the calculated test statistics is greater than the tabulated test statistics. So, we fail to accept the null hypothesis and conclude that PMS impacts Reliability of a Software Engineer in IT Industry in India. Fig. 10 shows the interval plot of the variation of the Reliability of a Software Engineer with a better and effective PMS.

Method

Null hypothesis	All means are equal
Alternative hypothesis	Not all means are equal
Significance level	$\alpha = 0.05$

Equal variances were assumed for the analysis.

TABLE I: ANOVA TEST OF THE IMPACT OF PMS ON THE PRODUCTIVITY

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Productivity	8	0.32644	0.04080	0.92	0.672
Error	1	0.04436	0.04436		
Total	9	0.37080			

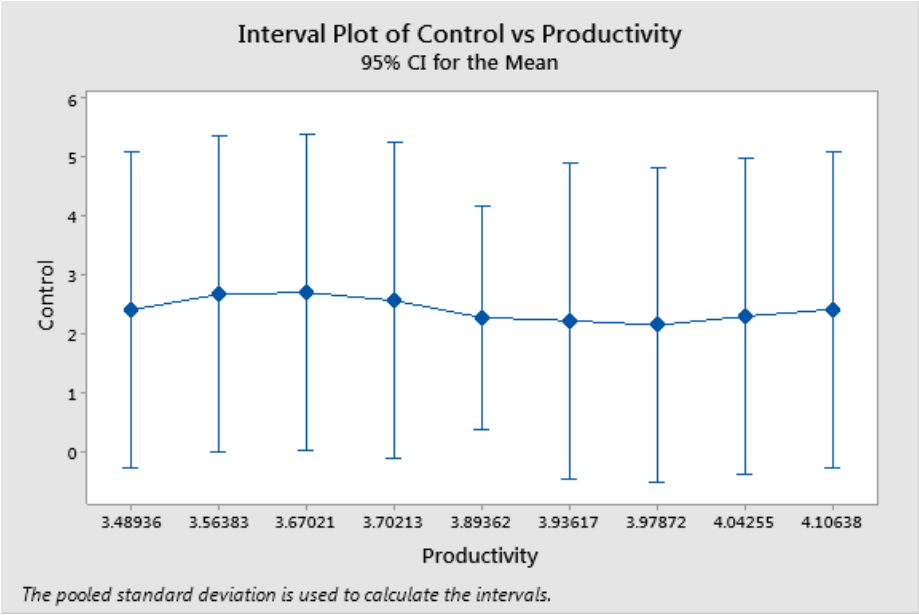

Fig. 9: Interval Plot of the Impact of PMS on Productivity

Table II: ANOVA Test of the Impact of PMS on the Reliability

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Reliability	8	0.35247	0.04406	2.40	0.463
Error	1	0.01833	0.01833		
Total	9	0.37080			

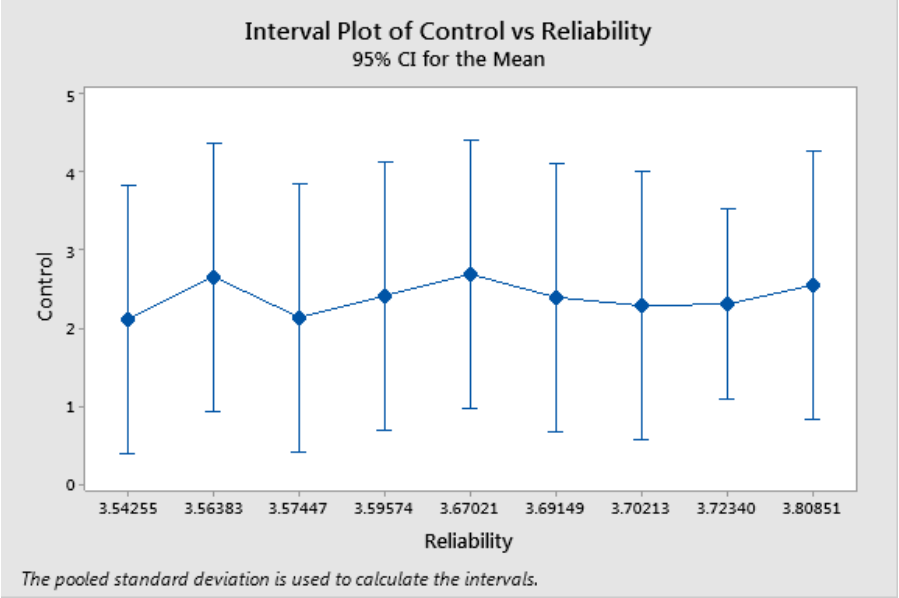

Fig. 10: Interval Plot of the Impact of PMS on Reliability

To test the third Hypothesis Ho3, we used the Tukey method along with a one-way ANOVA to test whether there is any statistically significant difference of the adopted PMS on the Productivity and Reliability of a Software Engineer. The result depicted in Table III shows that both Productivity and Reliability falls in Group A while the Control Group falls in Group B. This implies that the adopted PMS equally impacts the Productivity and Reliability of a Software Engineer in India. So, we fail to accept the null hypothesis and conclude that the impact of PMS on the Productivity and Reliability of a Software Engineer in India are not statistically significant.

Table III. Tukey's Post HOC Test if the Impact of PMS on Productivity and Reliability

Grouping Information Using the Tukey Method and 95% Confidence

Factor	N	Mean	Grouping
Productivity	10	3.8277	A
Reliability	10	3.6596	A
Control	10	2.3872	B

Means that do not share a letter are significantly different.

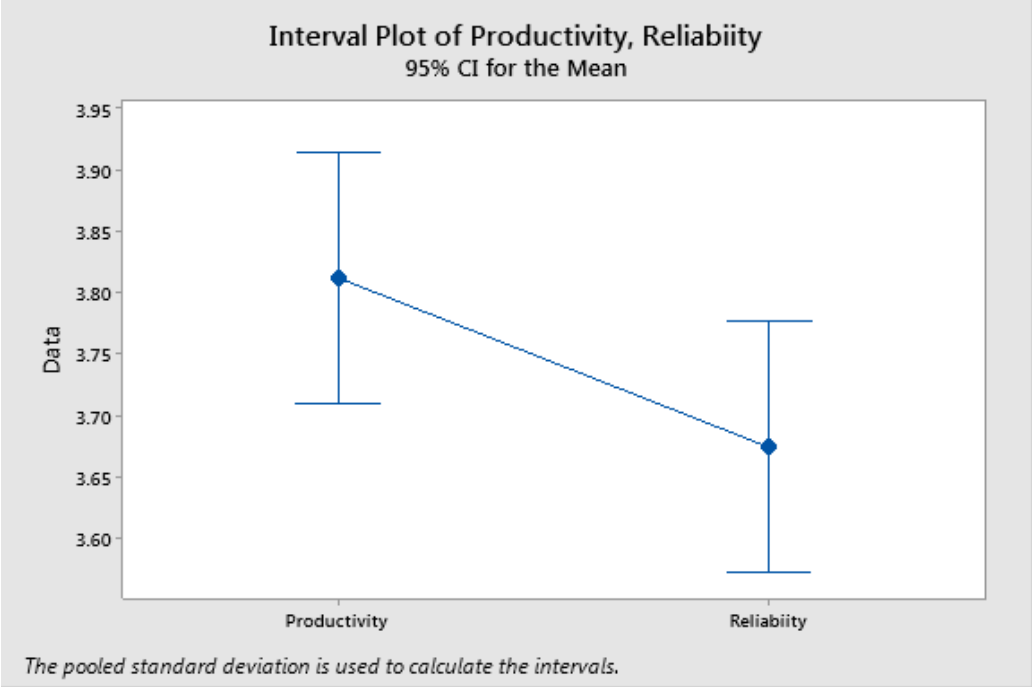

Fig. 11: Interval Plot of the Impact of PMS on Productivity and Reliability

Table IV below shows the result of the entire test hypothesis we constructed.

Table IV: Hypothesis Testing Result

Hypothesis	Result	Interpretation
Ho1 Ha1	Fail to Accept Ho1	PMS impacts the Productivity of a Software Engineer.
Ho2 Ha2	Fail to Accept Ho2	PMS impacts the Reliability of a Software Engineer.
Ho3 Ha3	Fail to Accept Ho3	The Impact of PMS on the Productivity and Reliability of a Software Engineer are not significantly different.

VIII. Suggestions

- To maintain the productivity of the employees, performance should be reviewed twice in a year.
- As we have observed that PMS is very significant for an organization, the organizations must invest in new technologies, software and hardware for improving the performance of the employees.
- Organization should recommend Self-Appraisal system to the employees. This will help management to effectively develop training and development tools.
- Incentive encourages and improves the productivity of employees. So the PMS must focus on to improve the incentive schemes of an organization.
- The focus of PMS should be also shifted towards training and development, career development and succession planning. The organizations should concentrate on these areas to retain the employees for longer period and improve the performance of the employees.

IX. Conclusion and Future Work

In this paper we have studied, the impact of the PMS on the *Productivity* and *Reliability* of Software Engineers in IT industry in India. We formulated a set of questions and distributed them among Software Engineers. The responses were noted and compared with a control group.

Result shows that, with a better and organized PMS in the organization, both the factors show an upward swing. Both the factors are positively and strongly correlated with the PMS. Further, our formulated and tested hypothesis emphasizes that PMS impacts the *Productivity* and *Reliability* of Software Engineers in IT industry in India and the level to be which the PMS impacts these two factors are more or less equal.

In the future, other factors besides PMS, such as demographical factors, job location and salary being paid can be taken into account to compare their impact on the *Productivity* and *Reliability* of Software Engineers in IT industry in India.

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