

UNDERSTANDING SOFTWARE DEVELOPMENT TEAM PERFORMANCE

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Abstract

This paper gives the popular definitions of team, essential characteristics of teams and team development stages. It discusses the previous empirical studies undertaken to investigate the software development team performance. The factors affecting the software development team performance have been explained. It reviews the past research done in finding the performance of software development teams. It also discusses some of the representative research done on team performance in non-software teams as well.

Keywords: Team Performance, Team Productivity, Software Development teams, Team climate

JEL classification: M15

1. INTRODUCTION

A *Team* is a small group in which members have common purpose, complementary skills and interdependent roles [Gondal and Khan, 2008].

Another definition of *Team* is given by Katzenbach and Smith [2005] as follows

“A team is a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable”.

About 2/3rd of the Fortune 500 organizations are using teams or some form of teams in their organizational activities [Sivasubramaniam, Murry, Avolio and Jung, 2002]. For example, Motorola has around 4000 teams working globally in their organization. IBM and Microsoft also have hundreds of software development and maintenance teams in their organizations globally. Indian software services firms such as TCS, Infosys, Wipro and HCL are having hundreds of software development, maintenance and test teams.

Teams are supposed to be better suitable for executing complex tasks because team members share workload, observe behavior of other team members and contribute to the sub tasks of the complex task [Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers, 2000]. Technological advancements have catalyzed the usage of teams in modern software organizations. Based on the literature on teams, less is known about how to improve the team performance [Bolstad and Endsley, 2000]. Large scale software development is a collaborative activity which requires human resources and coordination among them [Espinosa,

Kraut, Lerch, Slaughter, Herbsleb and Mockus, 2001]. Essential characteristics of teams include enough team size, complementary skills, meaningful purpose, mutually accountable, specific goals, and clear working approach [Katzenbach and Smith, 2005].

2. TEAM DEVELOPMENT STAGES

In current organizations, there are four types of teams. They are work teams, project teams, parallel teams, and management teams [Cohen and Bailey, 1997]. Every team undergoes specific lifecycle during its existence. According to Bruce Tuckman a team undergoes *Forming, Storming, Norming* stages before it becomes a *Performing* stage.

According to Katzenbach and Smith [2005] a team has to cross the stages such as *Work group, Pseudo team, Potential team, and Real team* to reach *high performance*. There are certain characteristics exhibited by high performance teams. Those are strong person commitment for one another's growth, more ambitious performance goals, fuller mutual accountability, complementary skills, and mutual trust [Katzenbach and Smith, 2005].

It is difficult to find high performance teams in organizations. Software Organizations such as Motorola and IBM are having these kinds of high performing teams in their global offices.

3. PATH TO TEAM PERFORMANCE

Team performance has both objective and subjective measures [Sawyer, 2001, Bahli and Büyükkurt, 2005, Ong, Tan and Kankanhalli, 2005, Na, Simpson, Li, Singh and Kim, 2007]. Objective measures include team productivity [Bahli and Büyükkurt, 2005]. Examples of objective measures of software development team performance include Function points, time variance, cost variance [Na, Simpson, Li, Singh and Kim, 2007] and complexity metrics [Sawyer, 2001]. Subjective measures of software development team performance include perceptual rating of team performance by team members (self rated) and stakeholders. Example subjective measures of team performance include team effectiveness, system viability and professional growth [Bahli and Büyükkurt, 2005]. User satisfaction, teamwork satisfaction and output quality are also perceptual measures [Ong, Tan and Kankanhalli, 2005]. Perceptual ratings of team performance can be given by the stakeholders such as team members, management and users. Traditional performance measures were based on financial perspectives, where as modern performance measures are based on stakeholder perspectives [Wettstein and Kueng, 2002]. Software performance measurement should include financial and non-financial, subjective and objective, quantitative and qualitative, and short-term and long-term indicators [List, Bruckner and Kapaun, 2005].

Subjective measures of software project performance include product performance and process performance [Wallace, Keil and Rai, 2004, Na, Simpson, Li, Singh and Kim, 2007]. Product performance deals with the successfulness of the developed product. Process performance deals with the successfulness of the software development process using which product has been developed [Wallace, Keil and Rai, 2004].

One should use measures like achieving budgets and developing innovative products in measuring team performance [Ancona and Caldwell, 1992]. While measuring team performance team members are interested in looking at whether there is productive environment in the team, where as management looks at whether team kept to the schedules and budgets of

the project [Ancona and Caldwell, 1992]. According to Ancona and Caldwell [1992], group performance is to be rated by both team members and managers.

4. SOFTWARE DEVELOPMENT TEAM PERFORMANCE STUDIES

Sl. No:	Researchers	Study Description	High Lights
1.	Sawyer, S. and P.J. Guinan [1998]	Studied 40 software development teams at one location to find out the effects of <i>production methods</i> and <i>social processes</i> on team performance and product quality.	The Software Development team performance is measured using 3 factors: Stakeholder rated Product quality, Stakeholder rated team performance and Self rated (developers) team performance.
2.	Sawyer, S. [2001]	Studied 40 packaged software development teams of a global computer hardware and software manufacturer at one location.	The objective is to study the impact of presence of intra-group conflict and level of conflict management on software development team performance. Here, Team performance is measured using perceptual measures of stakeholders on software deliverable quality, ability of the team to work together, user satisfaction of the end product and team efficiency.
3.	Ong, A., G.W. Tan and A. Kankanhalli [2005]	Studied 18 Information Systems student teams at a large public university.	The objective is to study the impact of team expertise and expertise-contribution fit on team performance of software development teams.
4.	Bahli, B. and M.D. Büyükkurt [2005]	Studied 185 undergraduate students majored in MIS and studying 4 th year.	Group performance consists of the constructs such as team building, and group cohesion (which includes task cohesion and social cohesion). Here, Group performance is measured using 3-item subjective scale consists of quality, productivity and whether worked well as a group. Objective measures such as student group project grades are used.
5.	Ramasubbu, N. and R.K. Balan [2007]	Studied 42 project teams working in two locations, one in India and one in US.	The objective of this study is to find the impact of work dispersion on project team performance. Here, Project team performance consists of the constructs such as Development team Productivity and Conformance quality. The con-

			control variables used in the research model include team size, reuse, code size, upfront investment and design rework.
6.	Liang, T, C. Liu, T. Lin and B. Lin [2007]	Studied 30 software development teams in Taiwanese firms between June 2005 and July 2005.	The objective of the study is to show the relationship among team diversity, conflict and team performance. Here, team performance has two constructs such as Product Performance (PO) and Process Performance (PP).
7.	Na, K., J.T. Simpson, X. Li, T. Singh and K. Kim [2007]	Studied 123 software development teams at three software firms in Korea	The objective of the study is to find the impact of risk management strategies and residual performance risk on project team performance. The purpose of the study is to develop a model for the subjective and objective performance measurement of software development teams.
8.	Huckman R.S., B.R. Staats and D.M. Upton [2009]	Studied 543 projects teams at Indian Software Services firm Wipro, which were executed between January 2004 and September 2006.	The objective of the study is to find the impact of team familiarity and role experience on software development team performance. Here, Team performance is measured based on the adherence to schedules and costs of the project and output quality.

Source: [Author]

5. EARLIER WORK DONE IN SOFTWARE DEVELOPMENT TEAM PERFORMANCE AREA

From the study of 40 software development teams, Sawyer and Guinan [1998] found that production methods such as software methodologies and automated development tools did not show any significance in variations in product quality or team performance. According to their study social processes such as informal coordination and communication in the team, degree of supportiveness among team members and the ability to resolve intra group conflicts have impact of up to 25% variation in software product quality. Software development team performance includes three dimensions such as software product quality, team effectiveness and team efficiency [Sawyer and Guinan, 1998].

According to Bahli and Büyükkurt [2005], team building is positively related to task cohesion and social cohesion and task cohesion has impact on group performance. High degree of team cohesion in task completion results into greater team performance [Bahli and Büyükkurt, 2005]. According to Bahli and Büyükkurt [2005], Task cohesion has correlation with team performance where as social cohesion is not correlated to team performance.

According to the research done by Yoo and Alavi, task orientation in teams has positive relationship to team performance. According to Ramasubbu and Balan [2007], work dispersion has effect on software development team productivity. Constructive conflict management in the software development teams improves the team performance and destructive conflict management reduces the software development team performance [Sawyer, 2001]. According to Sawyer [2001], improving intra-group conflict management improves the software development team performance.

According to Huckman, Staats and Upton [2009], team familiarity, that is, the average number of times team member worked with every other team member earlier is positively related to software development team performance. The role experience, that is, the number of years the team member is in that specific role also has positive impact on the team performance [Huckman, Staats and Upton, 2009]. According to Liang, Liu, Lin and Lin [2007], knowledge diversity increases the task conflict, which has positive relationship with team performance in software development teams. Value diversity increases the relationship conflict, which effects the software development team performance negatively [Liang, Liu, Lin and Lin, 2007].

Team expertise and expertise-contribution fit have effect on software development team performance [Ong, Tan and Kankanhalli, 2005]. According to Ong, Tan and Kankanhalli [2005], the factors affecting the information systems project team's performance include project complexity, project size, user support, management support, team composition and team processes. The tasks assigned must match the expertise of the team members in order to get better team performance in software projects [Ong, Tan and Kankanhalli, 2005].

Wallace, Keil and Rai [2004] have studied the dimensions of software project risk and how they impact the project performance. According to their study, technical subsystem risk and social subsystem risk impact the project management risk which in turn impacts the project performance. William B. Rouse [1992] has studied the role of mental models in team performance in complex systems. He has used team coordination and team communication as correlated factors of team performance. To measure the performance of entire IT department in an organization, one can use Kaplan & Norton's Balanced Score Card (BSC) approach [Atkinson, 2004].

6. FACTORS AFFECTING THE SOFTWARE DEVELOPMENT TEAM PERFORMANCE

Software development risk is an important factor which affects the software project performance [Na, Simpson, Li, Singh and Kim, 2007]. According to Chudoba, Lu, Watson-Manheim and Wynn [2003], communication, interpersonal relationships, team member participation, team member commitment and outcomes impact the team performance. Based on their research at Intel, they identified that the three factors that affect the virtual team performance are social interactivity, knowledge networking and work predictability.

Trust between team members, communication effectiveness, comfort level of team members, motivation of team members, and cohesion between team members have impact on team performance when teams are distributed geographically [Sridhar, Paul, Nath and Kapur, 2007]. According to David F. Rico, factors like individual performance, cohesiveness of groups, process improvement, decision quality, customer satisfaction, team member participation and agreement can impact the team performance. Team communication is re-

lated to team performance and the similarity of knowledge structures between two team members can improve the quality of team performance and team process [Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers, 2000]. Team performance is not only about having people with expertise in the team, but also it is about having right people at right time [Hastie, 2004]. Leadership style of the project leader or manager moulds the team performance [Hastie, 2004].

Team climate, which constitutes vision, task orientation, participative safety and support for innovation [Anderson & West, 1998] has impact on team performance and innovativeness in research and development teams [Bain, Mann, Pirola-Merlo, 1999].

7. OTHER TEAM STUDIES (NON-SOFTWARE) OF TEAM PERFORMANCE

Gondal and Khan [2008] have studied the impact of team empowerment on team performance in ten telecommunications companies located in Islamabad. From that study, they have found that there exists positive relationship between team empowerment and team performance in telecommunications teams. Team performance constitutes the variables such as cooperation, coordination, trust, cohesion, effort, mutual support, team conflict, work satisfaction, effectiveness in terms of quality, efficiency in terms of schedules and costs [Gondal and Khan, 2008].

Kirkman, Rosen, Tesluk and Gibson [2004] have studied 35 sales and service teams in a high technology firm and investigated the impact of team empowerment on team performance and the intermediary role of face-to-face interaction. They found that team empowerment is positively related to the two constructs of virtual team performance such as process improvement and customer satisfaction.

Ancona and Caldwell [1992] studied 45 new product teams in five high technology companies and investigated the impact of group demography on group performance. They found that the functional and tenure diversity impact the team performance through their effects on external communication and internal processes. Group demography variables include age, tenure and education of team members [Ancona and Caldwell, 1992]. In Ancona and Caldwell [1992] study, team managers were asked to rate the team performance on the variables such as team efficiency, quality of technical innovations produced, conflict management, adherence to schedules, adherence to costs, etc. The team members were asked to rate the team performance on the items such as efficiency, quality, work excellence, adherence to schedules, adherence to costs, and technical innovations.

Loch, Stein and Terwiesch [1996] have studied the new product development function performance based on the Electronics industry data available from 'Excellence in Electronics' project jointly undertaken by the Stanford University, Mc Kinsey & Company and University of Augsburg. The objective of the study is to find the aspects of development output performance and development process performance. From the study they found that the process performance is an important driver of development output performance.

The human team processes which can be used as measures of team performance in military teams include shared mental models, communication, information exchange, leadership, stress adaptation, supporting behavior, initiative, and situational awareness [Freedy, McDonough, Jacobs, Freedy, Thayer, Weltman, Kalphat and Palmer, 2004].

Sivasubramaniam, Murry, Avolio and Jung [2002] have studied 42 groups of Organizational Behavior students enrolled at a public university in the Northeastern United States. They have examined the impact of leadership within the team on group potency and group

performance. According to them, a team can influence each team member as a leader influences his or her followers.

Mathieu, Heffner, Goodwin, Salas and Cannon-Bowers [2000] have done a survey of undergraduate students enrolled at Pennsylvania State University. They have studied the impact of teammates' shared mental models on team performance and team process.

8. CONCLUSION

Software development project managers can use the assessment techniques to measure their software development team performance [Pattit and Wilemon, 2005], so that timely corrective actions can be taken. Because of limited resources like time and money, majority of the software organizations are under pressure of monitoring and controlling the software development teams' performance. The systematic ways of measuring team performance helps in identifying high performance teams in organizations and useful in rewarding and recognizing the team work in software organizations. This is very much required in current days of developing complex software systems.

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