Examining the Influence of Team Work Factors on Team Performance for Software Development in Telecommunication Industry

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Abstract—**A number of projects have failed in software industry due to exceeding budget and schedule. The main reason for most project failure is poor performance of their development team, in which the team performance is affected by a number of factors. The main objective of this study is to identify the factors that have significant effect on the performance of the software development team. A set of questionnaire has been distributed to a sample of software developers in telecommunication industries in Iraq and Kurdistan Region Government (KRG) using stratified sampling technique. The analysis of the data was carried out using Structural Equation Modeling (SEM) to examine the relationship between the identified factors and the performance on software development team. The results prove that coordination of expertise; communication and mutual support positively affect the performance of software development team.**

Index Terms—**Teamwork; Team Performance; Software Development Team; Software Developer.**

I. INTRODUCTION

Software development is a complex activity and its application is basically based on human commitment. In addition, since software development requires experienced communication and cooperation, thus the team influence on software development in the knowledge organization could support software companies to become more inventive and proficient [1].

Fung and Ali [2] discovered that team performance is always more effective than personal performance. As a result, numerous corporations migrate to using project teams to investigate, create, and dispense items and services or examine issues, particularly on complicated assignments. In such context, the team acts as one of the limited and most significant resources of a project [3].

Despite the reforms and rapid development in software development environment, human issues are negligible [4]. Obviously, software development projects are facing failure [5]. This is due to the many factors including human factors as the main reason [3]. Human factors comprise common skills, activity planning, risk management and lack of teamwork among the team members [5]-[7]. When the human factors are not well-handled, it takes money and time.

Studies will be conducted in future to investigate the way software development projects could be made more successful [8]. Part of the solution lies on the betterment of the teamwork, because the uniqueness of software development is largely based on the team effort [6]. Thus, deeper understanding on factors or characteristics that significantly influence the performance of the team engaged in software development cannot be over-emphasized. There are various factors affecting the performance of the team. In response to that, this paper aims at examining the factors that affect the team performance in software development in telecommunication industry.

II. THEORETICAL BACKGROUND

Software development is a creative process that involves human interaction in the context of a team. Thus, it is important to understand the teamwork factors that influence performance [8]. Various teamwork factors affecting team performance have been discovered. Among the main influencing factors is team work quality model (TWQ) [9].

Hegel and Gemuenden [9] investigated the effect of six TWQ factors – cohesion, balance of member contributions, communication, mutual support, effort, coordination – on the achievement of innovative projects and found that TWQ is significantly associated with team performance as rated by the team members, team leaders, and team-external managers. However, the magnitude of the relationship between TWQ and team performance varies by the perspective of the performance rater, i.e., manager vs. team leader vs. team members. Also, TWQ has a strong association with team members' personal success (i.e., work satisfaction and learning).

Further, Weimar et al. [10] extends the TWQ factors, into cohesion, communication, coordination of expertise, mutual support, value diversity, and trust. It was found that there is a significant relationship between TWQ and the success of software development projects as measured by team performance (effectiveness and efficiency) [11].

Based on the studies described in the previous paragraphs and others, among factors have been identified as affecting team performance include communication [12], coordination of expertise, mutual support [13] and value diversity [14], which are described in Table 1. Accordingly, such factors should be considered in establishing an effective software development team and improving the team performance [10]. However, in current literatures, empirical analysis on factors that affect team

performance [11] and results regarding what the team-related factors that influence project team performance [2] are still lacking. Thus, this paper aims at empirically investigating the relationship between teamwork factors and the performance of the software development team in telecommunication industry.

III. RESEARCH METHOD AND DATA COLLECTION

This study adapts its instrument from Liang et al, [15]. It consists of 31 items. All the items were measured using a five-point nominal scale ranging from (1) - "strongly disagree" to (5) - "strongly agree". It was distributed to the respondents who are software developers using stratified sampling from five telecommunication companies in Iraq.

Prior to the distribution, the instrument was first reviewed by experts to ensure its content validity. The experts were selected on the basis of their expertise in software engineering domain. Considering their recommendations, some minor modifications were made involving paraphrasing, deleting items, rephrasing sentences, and renumbering items.

Further, a pilot study was carried out to ensure reliability. It involved 30 software developers from telecommunication industry in Kurdistan Region Government (KRG). The results reveal a Cronbach Alpha greater than 0.7 [16]. The measurements and structural model were analyzed using SmartPLS. Eventually, the analysis revealed that the instrument has a sufficient validity and reliability.

Table 1
Teamwork Factors

Factors	Definition	Authors
Communication	Sharing of ideas among team members, exchanging information, providing feedback, and coordinating efforts	Kozak [18]; Hoegl and Gemuenden [9]
Coordination of Expertise	Management of knowledge and skill dependencies. This includes knowing where expertise is located within team members.	Faraj and Sproull [19] Hoegl and Gemuenden [9]
Mutual support	Team members support and help each other to perform their mission.	Hoegl and Gemuenden [9]; Weimar [13]
Value Diversity	Team members vary in what they think are the team's mission or goal in the values that pursue in the following of the tasks.	Liang *et al.* [15]; Weimar [13]

Since the main objective of this study is to examine the factors affecting the performance of software development team, PLS is selected as the analysis technique in measuring the measurement and the structural models. This technique is able to predict the theoretical model [17].

IV. RESULTS

A. Measurement Model

The convergent validity of the research model was evaluated using two criteria: (1) the composite reliability (CR) must be significant (greater than 0.05) and (2) the average variance extracted (AVE) is greater than 0.50. Having analyzed the gathered data, the results are sufficient as seen in Table 2.

Table 2
CR and AVE for the factors

Construct	Cronbach Alpha	CR	AVE
Communication	0.7535	0.8430	0.5741
Coordination of expertise	0.8617	0.9005	0.6443
Mutual Support	0.8379	0.8853	0.6077
Value Diversity	0.7542	0.7628	0.5228
Team Performance Effectiveness (TPE)	0.8878	0.7628	0.5228
Team Performance Efficiency (TPC)	0.8553	0.9021	0.6974

Obviously, all factor loadings are greater than 0.7 with CR and AVE and values for each variable exceeds 0.5. Thus, both criteria for convergent validity are fulfilled. For discriminant validity, according to Chin *et al.* [20], the square root of AVE values must be greater than other constructs in the same path. This is also met as seen in Table 3. Hence, the criterion for discriminant validity is also achieved.

B. Structural Model

The results of the structural model are illustrated in Figure 1. The constructs or criteria stated in the figure collectively impact the TPE and the TPC with variant explanations of $R^2=0.572$ and $R^2=0.611$ respectively. TPE is strongly influenced by mutual support ($\beta=0.392$, $t=3.047$, $p<0.05$) followed by coordination of expertise ($\beta=0.328$, $t=2.397$, $p<0.05$) and communication ($\beta=0.150$, $t=1.964$, $p<0.05$). Value diversity ($\beta=-0.032$, $t=0.918$, n.s) is found to be insignificant in influencing TPE. However TPC is strongly influenced by coordination of expertise ($\beta=0.438$, $t=1.948$, $p<0.05$) followed by mutual support ($\beta=0.236$, $t=3.186$, $p<0.05$) and communication ($\beta=0.136$, $t=1.948$, $p<0.05$). Value diversity ($\beta=0.086$, $t=0.521$, n.s) also found to be insignificant in influencing TPC.
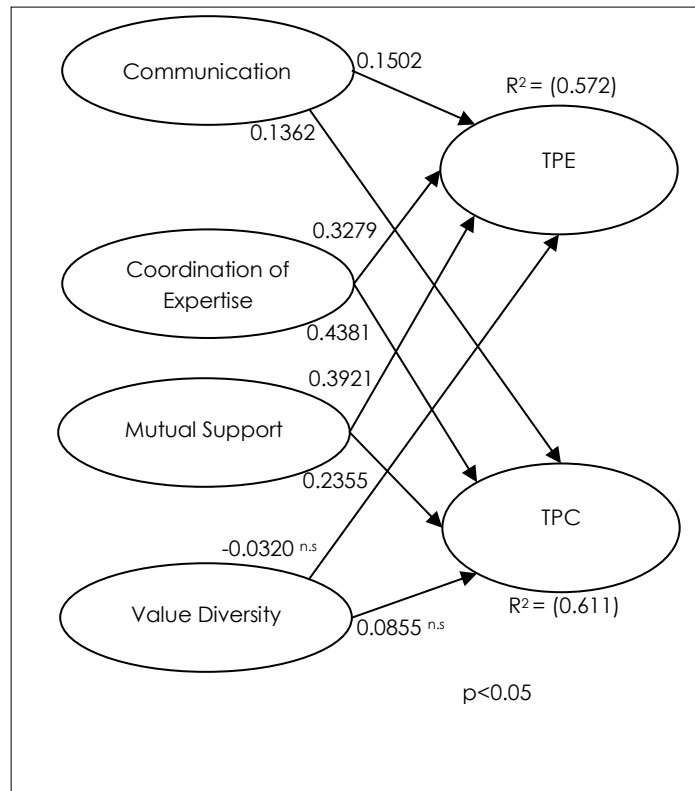
Figure 1: Structural model

Table 3
Intercorrelation matrix and AVE square root values

Variables	Communication	Coordination of Expertise	Mutual Support	Performance Efficiency	Performance Effectiveness
Communication	0.7576				
Coordination of Expertise	0.6960	0.8026			
Mutual Support	0.5994	0.6886	0.7795		
Performance Efficiency	0.6212	0.7437	0.6623	0.8351	
Performance Effectiveness	0.5989	0.6843	0.6917	0.7185	0.8654
Value Diversity	0.4547	0.5684	0.5082	0.5161	0.4219

V. DISCUSSION AND CONCLUSIONS

The main objective of this study is to examine the factors affecting the performance of software development team. In response to that, the findings reveal that the effectiveness and efficiency of the performance of software development team is influenced by communication, coordination of expertise and mutual support. On top of that, the findings reveal also that the performance of software development team is strongly influenced by coordination of expertise. This result is in line with Lewis [21] and Weimar [13]. Second, this study found that software development team performance is influenced by mutual support and communication, which agrees with Hoegl and Gemuenden [9] and Kozak [18]. However, it is not significantly influenced by value diversity. One plausible explanation for the insignificant result for value diversity is the context of this study. The software developers perhaps believe those teams members have similar believe regarding team's goal or mission or the principles that must be followed in seeking for goals or mission. Previous research has found that similarity in group members' goals and values enhance group

cohesiveness and commitment to the group [22].

According to Bell, Villado, Lukasik, Belau, and Briggs [23], it is believed that conflicts are increased by value diversity resulted in reduced tasks achievement. Since team members have diverse value viewpoints, the managers' software development projects must try to invoke value diversity in their team while preparing to manage probable related conflicts among them [14].

Theoretically, the main contribution of this paper lies in the examination of the factors affecting the performance of software development team. In the end, the results showcase new visions for researchers and organizations concerning the factors that affect the performance of software development teams. This paper explains that the teamwork factors that comprise of communication, coordination of expertise and mutual support positively affect the performance of software development team. This finding contributes to the field of Software Engineering particularly in telecommunication industries, in which they should consider the importance of those factors on the team performance of software development. Practically, this study has contributed to the

possible guidelines that can help the managers building-up an effective team to increase the performance of their organizations.

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