Impact of Individual and Task-related Characteristics on Perceived Team Effectiveness of Software Development Teams

Udayangi Perera
A.T. Fonseka

Abstract

This study investigated the reasons for the ineffective performance of software development teams in Sri Lankan organizations. It proposes a research model to examine team performance from an individual and task-related perspective. Data for the study was collected through the aid of a questionnaire based survey consisting of 177 participants in 9 Sri Lankan companies serving the Asia/Pacific and international market. The data was supplemented by 8 in-depth interviews. Analysis of the data was conducted using SPSS. The technique used was to first test correlations between each of the independent variables identified in the study with the dependent variable, perceived team effectiveness. Subsequently, a step-wise multiple regression analysis was used to test the impact that each category of variables has on perceived team effectiveness. Then a principal component analysis was conducted for the most significant predictors of perceived team effectiveness as revealed in the regression analysis. Findings from the analysis showed that nearly all the factors studied as positively affecting perceived team effectiveness, were indeed significantly correlated with team effectiveness. The findings of the factor analysis showed that the model tested by the researcher by grouping categories of variables together held true. It was also seen that of the two categories studied the task-related characteristics emerged to be the most significant determinants of perceived team effectiveness.

Key Words: Software Development Teams, Team Effectiveness, Person-Task Fit

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1. Introduction

Contemporary literature highlights the fact that a well-functioning team outperforms a group and outperforms all reasonable expectations given to its individual members, because a team has a synergistic effect. (Daft, 2003; Luthans, 2008; Robbins, 2004) The basic premise is that individual contributions cannot be as good as several individuals working together in a team.

In any organization, a key to the organizational success lies in its employees. The Information Technology (IT) industry is highly dependent on the knowledge, skills and competencies of its work force. Thus, skilled labour is an important and scarce resource in the aforesaid IT industry. The shortage of appropriately skilled labour will force employers to compete to attract, retain and effectively manage all available employees (Jackson, 1993). Similarly the success of the Information Technology (IT) and software development industry depends heavily on the commitment and performance of its employees.

Yet, despite investing heavily in teams many organizations appear far from satisfied with their decisions to become team-based. This is mainly due to the overall effectiveness of their teams. Outputs are not sometimes produced on time and in some instances, not at all. Further when outputs are delivered they can be of such poor quality, that the reputation of the organization is at risk. Teams can become confused about their goals, have members who do not accept their roles and leaders who do not always perform well. Teams at times have been shown to be very ineffective and this is the specific issue that engaged the researcher's attention.

The purpose of this study is to investigate and explain how the fundamental Individual characteristics such as job satisfaction, mutual trust, etc. and task associated characteristics such as presence of clear objectives and direction for team effort, etc can impact on the overall team effectiveness of IT teams.

The article is structured on the following lines. It begins with a description of the research problem and a review of the literature relevant to the problem. This is followed by the conceptual framework and the study design. The data gathered during the field study are presented next, followed by the study findings and a discussion of the findings. The final section contains the conclusions of the study and recommendations.

2. Research Problem

The Sri Lankan IT industry has witnessed a remarkable growth during the last ten years. The last five years, have seen the greatest development in the industry. There are more than thirty major software firms in Colombo that cater almost entirely to the global market. A salient feature differentiating the software industry from any other industry is its high dependence on skilled human capital. The success of any software firm is largely determined by the skills and the competence of its software programmers.
Hence, these skills and competencies must be managed effectively, in enabling the project teams to function and perform effectively.

In order to help organizations, efforts have been made by many researchers to understand team effectiveness (Staudinger, 2005). Whilst these efforts have facilitated a good understanding of the factors affecting team effectiveness, there are many areas that are yet to be fully understood. This is particularly true for teams in the IT industry, where the dominant work pattern is to work in teams.

Literature on factors determining team effectiveness in IT, and the success of software development teams, in particular, is limited. Another shortcoming seen in the existing literature on software development team effectiveness is that these studies are conducted using specific types of teams i.e. virtual teams (Piccoli & Ives, 2004), teams with 3 members (Cramton & Webber, 2006), teams of undergraduate students (Scott & Pollock, 2006) etc. Thus the generalizability of these findings is limited.

Frau (2009) attempts to provide an understanding of gender diversity in technical teams, and its impact on team effectiveness. A study conducted by Cramton & Webber (2006) examines the relationships among geographic dispersion, team processes, and effectiveness in teams carrying out software development work. Wang et al., (2005) have studied the impact of ISD (Information systems development) team members, self efficacy, team interaction and team trust on team effectiveness together with the mediating impact of knowledge sharing. In Stewart & Gosain (2006) a framework of the Open Source Software (OSS) community ideology is discussed. OSS is a subset of the software development community and the findings of this study support that OSS team members’ adherence to the tenets of the OSS community ideology impacts OSS team effectiveness.

Piccoli & Ives (2004) have investigated the effectiveness of virtual teams with the intent of identifying how management behaviour impacts effectiveness. Espinosa et al., (2001) employs qualitative, quantitative, and survey research methods to investigate the effect of shared mental models on coordination in large-scale software development to better understand how geographic distance affects coordination and team effectiveness.

Thus it can be seen that there is yet an opening for investigation in the area of determinants of software development team effectiveness. Similarly, the factors impacting team effectiveness are well established in the European context through various researches. Whether those factors can be generalized to the Asian context is not yet known.

Thus the researcher defines the problem statement of this study as:

What are the key factors that determine the effectiveness of software development teams in the Sri Lankan information technology industry?
In order to describe the nature and importance of the management problem created by ineffective performance of some work teams in the IT industry, the researcher conducted a pilot survey targeting managerial level employees in IT organizations, in order to ascertain their view of team effectiveness, establish how they measure effectiveness and also understand how they take actions based on the measures they adopt. The questionnaire filled by 29 respondents spanning across eleven (11) organizations provided evidence that management in organizations is well aware of the importance of team synergy, for the success of a software development effort. Yet more than 50% of the respondents believed their organizations did not emphasize maintaining or enhancing effectiveness of their work teams. Moreover only a small percentage utilized a measure to evaluate team effectiveness periodically.

It is interesting to note that, management places a high importance on the characteristics of the individual in determining whether the individual will perform well in a team. In comparison the importance placed on task-related factors such as the challenge present in work and organization specific factors such as management skills was relatively low.

The findings of this questionnaire were also supplemented through the use of personal interviews. Interviews were conducted with individuals in senior management positions in six (6) software development firms which are well-established in Sri Lanka.

From these interviews it was clear that in all companies the management recognized the importance of having a team which ‘clicks’ well in order to achieve success in its development projects. Yet, some of these companies did not have an established standard to measure the effectiveness/ineffectiveness of team work. Also, in most cases the management appeared to assume that it is individual characteristics such as the attitude of the individual which determines the effectiveness of the team he/she belongs to. In some other companies the management had procedures for the purpose of tracking effectiveness of their work teams even if no statistical methods were in use. Yet these appeared to exist at an informal level. In one of the six organizations the researcher found evidence of a formalized statistical process used for the measurement of team effectiveness. In this organization an internally developed tool, accessible via the corporate intranet was used to measure effectiveness at team level on a daily basis.

Through the previously described process of surveying and interviewing the researcher initiated a discussion about programming teams that culminated in the following informal observation, “Why is it that a team of very gifted individual programmers doesn’t necessarily make a great team?”

The conclusion that emerged from that discussion was that some programmers could not work well together, not due to lack of ability or sets of skills that the individual members might possess, but due to personality clashes or other issues. Such teams were sometimes composed of exceptional individual programmers having outstanding ability and potential, but still the team was unable to perform to their expected potential.
During the interviews the majority of interviewees agreed that for their companies’ effectiveness of a team and team performance is defined by the extent to which the teams meet allocated deadlines, is able to work together without conflict and produce high quality output on time. The managers/leaders were unable to indicate precisely the reason for the gap between expected and actual performance effectiveness.

Similarly the managers interviewed by the researcher, although reluctant to provide specific statistical information; agreed that in terms of expected performance approximately 53% of all projects were late, over budget and/or did not meet the project requirements.

Hence, the researcher was able to arrive at the conclusion that the ‘effectiveness of software engineering teams vary and that it is generally difficult to predict the reasons for this variance’. The Management was unable to comprehend all of the underlying factors which could impact the team effectiveness and thus address and manage them appropriately.

3. Objectives of the study

The objectives of the study are:

A. To recognize the impact that individual characteristics have on the effective performance of teams of software engineers in the IT industry

B. To describe the way in which individuals’ perceptions of task-related characteristics can impact the effective performance of teams of software developers.

C. To forward recommendations for formation of teams in a manner that will ensure their overall effectiveness.

D. To offer recommendations for enhancing the effectiveness of existing development teams.

4. Significance of the study

Since much of the existing research on team effectiveness in general, and specific research on effectiveness of software development teams has been conducted in the European context, this study will attempt to bridge the present inability to generalize the findings of previous researchers to the local context. Most of the existing research is centred on studying a subset of team effectiveness determinants which are mainly behavioural in nature. This study will attempt to broaden the understanding of other task-related determinants, which are equally important in formation of an effective team.
5. Literature Review

5.1 Team Effectiveness

In (Belbin, 2004) it is stated that the effectiveness of a team is determined by the extent to which it meets its goals, maintains the satisfaction of its members and survives. Cohen (1988) adds that effectiveness also encompasses the quality of the final product and the degree of enjoyment the members derived from the project experience. Therefore, it can be concluded that team effectiveness can be defined as the team's ability to perform with enhanced productivity as a result of the increased levels of interaction between team members arising from teamwork, and produce a final product of high quality, on time and within budget.

Whilst this is the variable which is of primary interest, during the preliminary investigation it was evident that organizations would not reveal specific statistical evidence pertaining to actual team effectiveness due to the sensitivity of this information. As stated in Hackman (2002) the perceived team effectiveness of individual team members has a significant positive impact on actual team effectiveness. As individual perception of team effectiveness can be measured accurately, the variable which will be of primary interest (the dependent variable) is ‘perceived team effectiveness’.

Many factors affect the perceived effectiveness of teams. Certo (1992) argues that the factors affecting team effectiveness, as commonly discussed in many models presented by various researchers, can be grouped under three broad headings pertaining to the individual, the organization and the task. These can be referred to as (1) Individual characteristics; (2) Organizational characteristics; and (3) Task characteristics; which determine the perceived effectiveness of teams.

For the purpose of this study the researcher considers the individual and task characteristics and each of these categories, together with the variables which are included in them will be discussed below.

5.2 Individual Characteristics Affecting Perceived Team Effectiveness

In literature person related variables or individual characteristics affecting team effectiveness are also referred to as factors affecting person-related fit or internal fit. Literature (Alimo-Metcalfe et al., 2008) specifies that person-related fit addresses the degree to which variables within the team (e.g., composition) are congruent with each other. Accordingly the component variables forming this broad concept can be listed as job satisfaction, mutual trust, cohesion/ team spirit, good interpersonal communication and level of unresolved conflict.

i. Job satisfaction

Job satisfaction is a judgment workers make about how favorable their work environment is (Motowildo, 1996) and can be reflected in their thoughts and feelings.
When people are generally satisfied and well treated at work, they seem more likely to be good organizational ‘citizens’, cooperating with people from other departments, taking on tasks outside their formal job descriptions and encouraging others to perform effectively. Job satisfaction is a key determinant of team effectiveness. (Ostroff, 1992; Patterson and West, 1998)

**ii. Mutual trust**

Mishra (1996) states that trust is one party's willingness to be vulnerable to another party based on the belief that the latter party is competent, open, concerned and reliable. For a team to operate effectively team members needs to be sure that everyone will fulfill their obligations and behave in a consistent and predictable manner. Thus there must be a high degree of mutual trust within the team. (Harris & Provis, 2000)

**iii. Cohesion/team spirit**

Cohesion is central to the study of teams and is largely influenced by the interpersonal relationships of group members (Pelled et al., 1999). Cohesiveness involves a feeling of solidarity with other group members. Highly cohesive teams tend to have less absenteeism, high involvement in team activities and high levels of member coordination during team tasks leading to overall effectiveness (Morgan & Lassiter, 1992; Bettenhausen, 1991)

**iv. Good interpersonal communication**

According to Luthans (2003) the establishment of an effective communication system is the only guarantee that everybody in a team will be working together to achieve organisational goals. Research has identified that good communication among team members is a positive behavior affecting team performance and overall team effectiveness. (Viveiros, 1999; Chong, 2007)

**v. Low levels of conflict/conflict management**

A conflict exists when two or more members of a group, or two or more groups, disagree. A conflict becomes harmful if tension within or between groups is such that it impedes members from thinking clearly or making sound decisions. Research has found evidence that effective conflict management improves team performance and functioning (Montoya-Weiss et al., 2001; Jehn & Chatman, 2000; Evans & Dion, 1991).

5.3 Task Characteristics Affecting Perceived Team Effectiveness

External fit refers to the alignment between certain team characteristics and the external environment. The external environment can be focused on Task characteristics which could impact the manner in which the team members perform within the team (Locke et al., 1981; Mento, Steel, & Karren, 1987; Gowen, 1986) The component variables as advocated in literature are Clear objectives, direction and project plans, Proper technical direction/leadership, Team task autonomy, professionally challenging work, Role clarity among team members and experienced and qualified project/team personnel.
i. Mission clarity / stable goals and objectives

Members of effective teams need clearly specified goals and continuous feedback in relation to progress. The positive relationship between specific, challenging goals and team task performance is well documented (Locke et al., 1981; Mento, Steel & Karren, 1987; Gowen 1986)

Teams with a clear charge and clear deadlines did much better than those without. A common recipe for failure was to burden a team with a vague purpose, squishy deadlines, and fuzzy success criteria, and to instruct the team to work out the specifics (Bolman & Deal, 1992).

ii. Autonomy

The concept of autonomy centres on the authority to make decisions about how to get the work done. In addition to the ability to make appropriate decisions, a key aspect of success for teams charged with a task or project is the authority to make the decisions that help them accomplish their goals. Autonomy provided in this manner can increase team effectiveness by increasing team members’ sense of responsibility and ownership of work. (Deci et al., 1990; Manz, 1993; Jasmine & Sameer, 2004)

iii. Challenging work

The job characteristic of professionally challenging work has been found to be the strongest single driver of team performance and project success. (Cleland & Ireland, 2006; Dodgson, 2000; DeShon et al., 2004)

iv. Experienced and qualified personnel

Knowledge and skills can have a tremendous impact on team processes and effectiveness. (Daft, 2003:616). A predominant factor in team effectiveness is the diversity of skills. Thus many researchers have stressed the importance of having experienced and qualified personnel who will contribute to the team’s total pool of task related skills, information and perspectives. The size of the pool represents the potential for more comprehensive or creative decision making and thereby its overall effectiveness. (Milliken & Martins, 1996)

v. Good leadership

Leaders are essential to highly effective teams since they set the vision and bring the team together in achieving this vision. (Lipman-Bluman & Leavitt, 1999; Heller, 2003)

vi. Role clarity

Each team member must have clear responsibilities assigned to him/her so that confusion is avoided and each can contribute freely towards increasing the effectiveness of the team. Rocine and Irwin (1994) suggest that team effectiveness is dependent upon the presence of balanced roles within the team.
6. Conceptual Framework

The conceptual framework depicts the causal relationships between the independent variables and the dependent variable (Figure 1).

**Figure: 1. Conceptual framework**

![Conceptual framework diagram]

Source: Conceptualization by researcher

7. Hypotheses

Based on the above conceptual framework, the following hypotheses are formulated.

**H₁:** Individual characteristics of job satisfaction, mutual trust, cohesion/team spirit, good interpersonal communication, and level of unresolved conflict are positively related to individuals perceived team effectiveness.

**H₂:** Task characteristics of clear objectives, direction and project plans, proper technical direction/leadership, task autonomy, professionally challenging work, role clarity and experienced and qualified project/team personnel are positively related to individuals perceived team effectiveness.

8. Study Design

Table 1 lists the indicators and measures formulated to understand each variable.
<table>
<thead>
<tr>
<th>Concept</th>
<th>Variable</th>
<th>Indicator</th>
<th>Source</th>
<th>No of Questions Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Team Effectiveness</td>
<td>Perceived level of effectiveness</td>
<td>Perceptions of the team members</td>
<td>Aladwani (2002); Xu &amp; He (2008)</td>
<td>7 Questions</td>
</tr>
<tr>
<td></td>
<td>Individual characteristics affecting perceived team effectiveness</td>
<td>Job satisfaction</td>
<td>Perceived level of job satisfaction of team members</td>
<td>6 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mutual trust</td>
<td>Perceived Level of mutual trust</td>
<td>8 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cohesion/ team spirit</td>
<td>Perceived team spirit</td>
<td>7 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good interpersonal communication</td>
<td>Perceived communication effectiveness of team members</td>
<td>6 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level of unresolved conflict</td>
<td>Team member perception of conflict resolution</td>
<td>4 Questions</td>
</tr>
<tr>
<td></td>
<td>Task characteristics affecting perceived team effectiveness</td>
<td>Clear objectives, direction and project plans</td>
<td>Availability of clear objectives and plans</td>
<td>7 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proper technical direction / leadership</td>
<td>Opinion of team members regarding effectiveness of leader</td>
<td>7 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Autonomy</td>
<td>Opinion of team members regarding autonomy</td>
<td>6 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>professionally challenging work</td>
<td>Extent to which work is perceived as professionally challenging</td>
<td>4 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Role clarity</td>
<td>Perception of role clarity within the team</td>
<td>4 Questions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experienced and qualified project / team personnel</td>
<td>a. Level of experience b. Level of qualification</td>
<td>5 Questions</td>
</tr>
</tbody>
</table>

Source: By Researcher
The approach adopted in this study is the deductive method. The main instrument for data collection was the questionnaire. The questionnaire consisted of two sections. The first section was designed to collect information about the respondents and the organizations to which they are attached. The second section consisted of 5-point Likert scale statements designed to gather information on perceived team effectiveness from team members. The questionnaire was pilot-tested to establish the clarity and appropriateness of the questions.

It was decided to host the survey online, making it convenient for respondents to answer the questionnaire. Where feasible, the survey was distributed via email as well as physically in hardcopy format.

In addition to the questionnaire, eight in-depth interviews were conducted to obtain qualitative data from a selected sample. These interviews helped to clarify the findings derived from the quantitative study. By this process, triangulation was ensured. The in-depth interviews were conducted with members of the top management of IT companies.

A random sampling technique was used to collect primary data from nine (9) companies registered under the Sri Lanka Companies Act. These were categorized as companies operating in the domestic market, export market or both based on their core business area. Initially 11 companies were selected, to which the questionnaire was sent, but only 9 responded.

From each company the researcher targeted 2 – 3 development teams for the survey. There were 94 respondents for the web based questionnaire survey. This was supplemented through hand delivery and collection of the questionnaire which resulted in a higher response rate. This resulted in a final sample of 177 respondents. The size of a development team varied between 5 – 11 members.

9. Data Presentation and Analysis

9.1 Validity and Reliability of Instruments

To measure each construct adequately, the researcher used the existent and validated items from previous research. Thus the validity of the statements together with their reliability was ensured.

However, in order to test the consistency of respondents’ answers, inter-item consistency analysis was performed using Cronbach’s coefficient alpha which indicates how well the items in a set are positively correlated to one another and is used in multipoint-scaled items such as in this research. The results generated are shown in Table 2.
Table 2: Reliability Analysis

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job satisfaction</td>
<td>0.735</td>
</tr>
<tr>
<td>Cognition based trust</td>
<td>0.842</td>
</tr>
<tr>
<td>Affect based trust</td>
<td>0.877</td>
</tr>
<tr>
<td>Cohesion/ team spirit</td>
<td>0.715</td>
</tr>
<tr>
<td>Good interpersonal communication</td>
<td>0.766</td>
</tr>
<tr>
<td>Good conflict resolution</td>
<td>0.801</td>
</tr>
<tr>
<td>Clear objectives for team work</td>
<td>0.831</td>
</tr>
<tr>
<td>Proper technical direction / leadership</td>
<td>0.653</td>
</tr>
<tr>
<td>Team task autonomy</td>
<td>0.734</td>
</tr>
<tr>
<td>Professionally challenging work</td>
<td>0.760</td>
</tr>
<tr>
<td>Role clarity</td>
<td>0.709</td>
</tr>
<tr>
<td>Perceived Team Effectiveness</td>
<td>0.731</td>
</tr>
</tbody>
</table>

Source: Survey data

As shown in Table 2, all variables indicate high Cronbach's coefficient alpha values.

The study set out to test two hypotheses. Results of these tests are presented below.

9.2 Tests of Hypotheses and Findings

i. Hypothesis 1 (H1): Individual characteristics of job satisfaction, mutual trust, cohesion/ team spirit, good interpersonal communication, and level of unresolved conflict are positively related to individuals perceived team effectiveness.

The null hypothesis for the above can be stated as:

H1o : There is no relationship between the individual characteristics of job satisfaction, mutual trust, cohesion/ team spirit, good interpersonal communication, and level of unresolved conflict and individuals perceived team effectiveness.

In order to test the first hypothesis as stated above correlation analysis was used, by establishing the correlations using Pearson Correlation among each dimension and dependent variable perceived team effectiveness. SPSS was the tool used for all statistical analysis.

The result of conducting this analysis is depicted in table 3 below. This indicates that significant yet weak positive correlations exist between job satisfaction, affect-based
trust, team spirit, good communication and good conflict resolution with perceived team effectiveness.

There was no visible positive correlation between cognition-based trust and perceived team effectiveness.

Although all of the correlations are weak, the strongest correlations in this set are to be seen between good conflict resolution and perceived team effectiveness.

Table 3: Correlation Matrix for Variables Considered As Individual Characteristics Affecting Perceived Team Effectiveness

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (N=177)</th>
<th>Standard Deviation</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Job satisfaction</td>
<td>3.79</td>
<td>0.6047</td>
<td></td>
</tr>
<tr>
<td>2. Cognition based trust</td>
<td>3.74</td>
<td>0.6295</td>
<td>.396**</td>
</tr>
<tr>
<td>3. Affect based trust</td>
<td>3.76</td>
<td>0.6423</td>
<td>.245**</td>
</tr>
<tr>
<td>4. Team spirit</td>
<td>3.94</td>
<td>0.5242</td>
<td>.377**</td>
</tr>
<tr>
<td>5. Good Communication</td>
<td>3.43</td>
<td>0.5594</td>
<td>.462**</td>
</tr>
<tr>
<td>6. Good conflict resolution</td>
<td>3.55</td>
<td>0.6996</td>
<td>.395**</td>
</tr>
<tr>
<td>7. Perceived team effectiveness</td>
<td>3.61</td>
<td>0.5896</td>
<td>.241**</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

ii. Related Qualitative Findings

It was interesting to note that all of the interview respondents considered team effectiveness to be a measure of how well the work teams in their companies were able to deliver a quality product, within time and budget.

The individual characteristics examined by the researcher were stated by all of the respondents as important personal characteristics which could affect how individuals behave in teams.

An interesting comment made by a Project Manager of an IT firm was that; “People working in teams must be able to relate well to each other simply as people on a social level. This helps them to share ideas and enjoy being together because they share the same values. The idea that they share the same value systems will enable them to count on and depend on each other”. This social intimacy which the respondent is referring to is the concept of affect-based trust among team members. This leads to the inference that affect-based trust then plays a major role in determining how
effectively a team works together. This impact could well be greater than the impact that cognition-based trust has on how effectively a team works together.

Cohen (1988) states that a correlation between 0.3 and 0.5 can be interpreted as one of moderate strength whilst correlations below 0.3 are considered to be weak. Thus it is seen that there is a positive but weak relationship between the dependent variable perceived team effectiveness and the category of independent variables, categorized as individual characteristics affecting perceived team effectiveness excluding cognition-based trust.

Therefore it is seen that the individual characteristics such as job satisfaction, mutual trust, cohesion/team spirit, good interpersonal communication, and level of unresolved conflict are indeed positively related to individuals perceived team effectiveness and the null hypothesis (H1o) is rejected for the above factors. There is no significant correlation between cognition-based trust and team effectiveness and the null hypothesis (H1o) is not rejected for that factor.

iii. Hypothesis 2 (H2): Task characteristics of clear objectives, direction and project plans, proper technical direction/leadership, task autonomy, professionally challenging work, role clarity and experienced and qualified project/team personnel are positively related to individuals perceived team effectiveness.

The null hypothesis for the above can be stated as:

H2o: There is no relationship between the task characteristics of clear objectives, direction and project plans, proper technical direction/leadership, task autonomy, professionally challenging work, role clarity and experienced and qualified project/team personnel and individuals perceived team effectiveness.

The Pearson Correlation results among each of the variables studied under hypothesis 2 and dependent variable perceived team effectiveness as depicted in table 4 below indicates that for clarity of objectives, role clarity, good leadership, challenging work and team task autonomy the correlation with team effectiveness is positive and moderately significant at the 0.01 level (2-tailed). There is no visible correlation between level of education of team members and level of experience of team members and team effectiveness.

Table 4 also shows that task autonomy is the variable that shows the strongest correlation with team effectiveness, from all variables studied.
### Table 4: Correlation Matrix for Variables Considered As Task Characteristics Affecting Perceived Team Effectiveness

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (N=177)</th>
<th>Standard Deviation</th>
<th>Correlation</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Clear objectives for team work</td>
<td>3.708</td>
<td>.59690</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Proper technical direction / leadership</td>
<td>3.263</td>
<td>.53515</td>
<td>470**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Team task autonomy</td>
<td>3.724</td>
<td>.55782</td>
<td>509** .332**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Professionally challenging work</td>
<td>3.694</td>
<td>.74200</td>
<td>481** .228**</td>
<td>453**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Role clarity</td>
<td>3.127</td>
<td>.76737</td>
<td>355** .495**</td>
<td>204**</td>
<td>.052</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Experienced team personnel</td>
<td>2.85</td>
<td>1.189</td>
<td>-.013 -.064</td>
<td>-.079</td>
<td>-.005</td>
<td>.024</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Qualified project team personnel</td>
<td>3.45</td>
<td>1.044</td>
<td>-.006 -.062</td>
<td>-.029</td>
<td>-.039</td>
<td>.008 .472**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Perceived team effectiveness</td>
<td>3.61</td>
<td>0.5896</td>
<td>360** .236**</td>
<td>476**</td>
<td>375**</td>
<td>364**</td>
<td>-.069</td>
<td>.076</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**. Correlation is significant at 0.01 level (2-tailed).
*. Correlation is significant at 0.05 level (2-tailed).

### iv. Related Qualitative Findings

Regarding the importance of task characteristics in ensuring team effectiveness some of the comments received were highly significant. According to the Director –Software Engineering of one company, “If you try to tell a software developer what to do and how to do it, you can be sure that what you want will not be done properly anyway. The better method is to tell them what you need and when and how you need it; this is what they call the spec (i.e. specification) and give them free rein to do it. If they get stuck they will come to you for help”. It is plainly seen that what this respondent is referring to the importance of autonomy and having clear objectives for the work, in ensuring that individuals work productively.

The following comment made by a project manager sheds light on the finding from quantitative data analysis that level of education and experience is of little importance in determining team effectiveness. The comment was that: “when we put a team together we make sure that the team members have the necessary knowledge of techniques and technologies needed to complete that particular project. Also we ensure that team members have regular sessions of brainstorming to discuss what ever problems they may be having in terms of what needs to be done to get things going on the project. This starts from the initial project kickoff meeting and is a part of daily routine. Also if there are any new people or people with little experience always the entire organizational team is ready to help them out in difficulty.” Thus it can be inferred that proper knowledge sharing among the team members will substitute for what
may be lacking at an individual level and therefore individual level of knowledge may be of little importance.

Another comment made by a team lead of an IS team in this respect was: “As the leader of the team I must be there as their facilitator, friend and guide. If I ever try to force my ideas on them then I can be sure to experience resentment within the team. I cannot walk before them or after them, but together with them, letting them all run at their own pace, just being their to make sure that no one is going to trip and fall. Also I have noticed that if I let them take on responsibilities, which perhaps should have been done by me, they all really like that because they like to be challenged. But at the same time there is the awareness among the team on whole that if I am not there things could go haywire. My greatest challenge is to fulfill this role adequately.” This comment clearly shows how leadership must be provided for a team to work well together and the importance of a good leader in maintaining an effective team.

Thus it can be seen that there is a positive relationship of moderate strength between the dependent variable perceived team effectiveness and the category of independent variables, categorized as task characteristics affecting team effectiveness. The variables level of experience and level of education are excluded in further analysis as it does not fall into the category of task characteristics according to the absence of correlation. Thus the null hypothesis (H2o) is not rejected for those two variables. As qualitative data gathered from interviews provide a plausible explanation for this lack of correlation as discussed previously with the exclusion of these two variables, the null hypothesis (H2o) is rejected for all the other variables studied under the category of task characteristics.

v. Multiple Regression Analysis for Conceptual Model

A multiple regression analysis was conducted by the researcher in attempting to further verify the impact of the two categories of independent variables on perceived team effectiveness of software development teams. The averages of the above mentioned categories were taken as independent variables and the dependent variable was taken as perceived team effectiveness. The R-square for this analysis was calculated to be 0.237, indicating that the percentage of variance in the dependent variable, explained by the collection of independent variables is approximately 23%. The regression output p-value received was 0.000. This p value refers to the entire collection of independent variables. Since this value is less than 0.05, it indicates that at least one of the independent variables is a significant predictor of the dependent variable team effectiveness. Therefore, the model holds true.

The coefficients table generated for the above output indicated that for individual characteristics the p-value was 0.207. This indicates that the p-value of individual characteristics is greater than 0.05, therefore the null hypothesis is not rejected for these factors and they cannot be considered as predictors of perceived team effectiveness. For the task characteristics the p-value is 0.000 and thus not greater than 0.05, thus the null hypothesis is rejected. Therefore task characteristics can be considered as predictors of perceived team effectiveness for this model.
To further reassess the model the researcher conducted a multiple regression analysis for the model again using a stepwise method. The R² square for this analysis was found to be 0.213. The p-value for the model was established at 0.000. Thus the model held true. The coefficients calculated from SPSS during this second analysis are shown in Table 5.

The description of variables excluded in this analysis is shown in Table 6 below.

<table>
<thead>
<tr>
<th>Table 5 : Adjusted Coefficients For Multiple Regression Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>Task -Related Factors</td>
</tr>
<tr>
<td>a. Dependent Variable: PER_TEAM_EFFECTIVENESS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 6 : Excluded Variables For Multiple Regression Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>a. Predictors in the Model: (Constant), Task characteristics</td>
</tr>
<tr>
<td>b. Dependent Variable: PER_TEAM_EFFECTIVENESS</td>
</tr>
</tbody>
</table>

This analysis indicates that the task characteristics can now be considered as the only significant predictor of perceived team effectiveness due to its p-value being less than 0.05. Therefore it can be seen that when considered independently of each other there are positive correlations between the two categories of variables and perceived team effectiveness. But when considered in relation to one another the strongest category affecting perceived team effectiveness is the task-related group which signifies the job characteristics of the tasks performed by software development team members.

**vi. Related Qualitative Findings**

When interviewees were asked if the team members will perform well together if the task related requirements are met regardless of person-based shortcomings the answer given by all respondents was in the negative. In explanation one Manager of a large software development company stated that "If the people we put together in a team don’t know how to be team players then we can expect a disaster, if the organization
doesn’t give them the necessary resources and support then again it is a disaster. But also if the people in the team are not happy with what they are doing and don’t know how to go about their tasks in the proper way again it is disaster. So you can’t really say that one is more important than the other”.

However, upon further questioning the same interviewee commented that “some times the people in a team may be getting along famously with each other, no conflict, good communication and all that but if expectations are not made clear at the beginning of the project, if they are not led properly ensuring that they don’t sidetrack from what they are supposed to do, if they are not given free rein to experiment with all their creativity then you may find that they cannot stick to time, and at the last moment we have to increase manpower which actually costs more.”. It can be inferred that this respondent is mentioning that role clarity, good leadership and autonomy are important in ensuring effective outcomes from a project and that it is not enough to have only the person-related factors such as good communication and low conflict within the team as studied by the researcher.

Another insightful comment made by a project leader who was interviewed was that “we may never be able to really rank saying that one is more important than the other, or that every thing will go well on a project if aspect A, B or C is fulfilled regardless of all other things. I think that is not practical. I can only tell you what I know from my own experience and that is for people in this industry to work well there must be the right level of challenge, where not too much is expected but just enough to keep their interest going, and a good leader must be there who is able to keep the team going even when things are not looking very rosy and everybody has just been working for 12 hours at a stretch.” This comment too suggests that a team must have good leadership and the right level of challenge for the work performed by the team members.

All of the above-mentioned characteristics are task-related characteristics. Therefore in light of the above comments it is logical to assume that the findings of the quantitative analysis that all factors studied have a positive impact on team effectiveness, but in particular task-related factors have the most significant impact is indeed correct.

vii. Factor Analysis

The researcher had stated the hypothesis for the study at a very broad level. Each hypothesis was stated in relation to a set of independent variables which were grouped together in to broad categories. Each hypothesis was concerned with investigating the affect of this category on the dependent variable perceived team effectiveness. Attempting to further verify the relationship that was visible through multiple regression analysis that task characteristics are the most significant predictors of perceived team effectiveness the researcher subsequently conducted a factor analysis by entering the individual set of indicators of the five variables “Clear objectives for team work, Role
clarity, Good leadership, Challenging work and Team task autonomy 'categorized as task characteristics. The variables, ‘Experienced team personnel and Qualified project team personnel' were excluded from analysis due to lack of positive impact on perceived team effectiveness as shown earlier.

Factor analysis is a collection of methods used to examine how underlying constructs influence the responses on a number of measured variables. (DeCoster, 1998) Factor analyses are performed by examining the pattern of correlations (or covariances) between the observed measures. Measures that are highly correlated (either positively or negatively) are likely influenced by the same factors, while those that are relatively uncorrelated are likely influenced by different factors.

Confirmatory factor analysis (CFA) tests whether a specified set of constructs is influencing responses in a predicted way. Thus CFA was a suitable technique to be used by the researcher because as advocated by DeCoster (1998) the primary objective of a CFA is to determine the ability of a predefined factor model to fit an observed set of data.

The researcher's main concern in applying factor analysis for this data was data reduction. Therefore the statistical method used for the factor analysis was principal component analysis (PCA). The purpose of PCA is to derive a relatively small number of components that can account for the variability found in a relatively large number of measures. This procedure, is typically performed when a researcher does not want to include all of the original measures in analyses but still wants to work with the information that they contain (DeCoster, 1998). Thus it is seen that factor analysis is an appropriate technique to be used for hypothesis testing for this study.

In running a factor analysis, the first thing to do is to look at the inter correlations between the variables as they should not correlate very highly (R > 0.8). According to Field (2005) although mild multicollinearity is not a problem for factor analysis, it is important to avoid extreme multicollinearity. The correlation coefficients for these variables were all less than 0.8 and, between 0.1 and 0.6. This indicates that extreme multicollinearity is not a problem for this data.

KMO and Bartlett's test of sphericity produces the Kaiser-Meyer-Olkin measure of sampling adequacy. According to Field (2005) the value of KMO should be greater than 0.5 if the sample is adequate. The KMO value for this sample was 0.854. Since this value is close to one, (Field, 2005) advocates that this indicates that patterns of correlations are relatively compact and the factor analysis should lead to distinct and compact factors.

Bartlett's measure tests the null hypothesis that the original correlation matrix is an identity matrix (Field, 2005). For factor analysis to be appropriate the researcher would require a significance value less than 0.05. For this data Bartlett's test was seen to be
highly significant at 0.000. Thus the correlation matrix is not an identity matrix and factor analysis is appropriate for this data.

For this analysis the researcher used varimax rotation, in order to maximize the loading of each variable on each of the extracted factors, while minimizing the loading on all other factors. The analysis was conducted by selecting Eigenvalues above 1 and identified five clusters. In comparison with the scree plot generated for the analysis as shown in Figure 2 it was established that these factors should be retained in the analysis, as the scree plot levels out after 5 components.

**Fig 2: Scree Plot of Factor Analysis**

The component matrix after rotation as depicted in table 7 indicated that five factors have loaded in correspondence to the five variables analyzed. It was seen that all loadings for a particular variable were greater than 0.49 and therefore all indicators could be retained in each analyzed component using a threshold of 0.49 for loading.

Thus the findings of the factor analysis confirmed that the indicators used by the researcher to measure each of the task characteristics, variables were indeed valid indicators for those variables. The analysis also confirmed that there are five clusters of task characteristics which must be paid special attention when organizations are concerned about the improvement of perceived team effectiveness among team members. These five clusters can be named as below in accordance with the variables studied.

1. Clear objectives for team work
2. Good leadership
3. Team task autonomy
4. Professionally challenging work
5. Role clarity among team members
Table 7: Rotated Component Matrix for Indicators of Task Characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Indicators</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Clear objectives for</td>
<td>I [1]***</td>
<td>.669</td>
</tr>
<tr>
<td></td>
<td>I [3]</td>
<td>.621</td>
</tr>
<tr>
<td></td>
<td>I [4]</td>
<td>.634</td>
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<td></td>
<td>I [7]</td>
<td>.506</td>
</tr>
<tr>
<td></td>
<td>I [8]</td>
<td>.498</td>
</tr>
<tr>
<td>Role clarity</td>
<td>J [1]</td>
<td>.215</td>
</tr>
<tr>
<td></td>
<td>J [2]</td>
<td>.322</td>
</tr>
<tr>
<td></td>
<td>J [4]</td>
<td>.426</td>
</tr>
<tr>
<td>Good leadership</td>
<td>K [1]</td>
<td>.231</td>
</tr>
<tr>
<td></td>
<td>K [2]</td>
<td>-.190</td>
</tr>
<tr>
<td></td>
<td>K [3]</td>
<td>-.172</td>
</tr>
<tr>
<td></td>
<td>K [4]</td>
<td>-.130</td>
</tr>
<tr>
<td></td>
<td>K [5]</td>
<td>.247</td>
</tr>
<tr>
<td></td>
<td>K [6]</td>
<td>.258</td>
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<tr>
<td>Challenging work</td>
<td>L [1]</td>
<td>.189</td>
</tr>
<tr>
<td></td>
<td>L [2]</td>
<td>.146</td>
</tr>
<tr>
<td></td>
<td>L [3]</td>
<td>.246</td>
</tr>
<tr>
<td></td>
<td>L [4]</td>
<td>.113</td>
</tr>
<tr>
<td>Team task autonomy</td>
<td>M [1]</td>
<td>.103</td>
</tr>
<tr>
<td></td>
<td>M [2]</td>
<td>.441</td>
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<td>.389</td>
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<td>M [5]</td>
<td>-.021</td>
</tr>
<tr>
<td></td>
<td>M [6]</td>
<td>.054</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

*** I 1, K1 etc are labels given to indicators of a specific variable when feeding to SPSS. The variable to which the indicators belong are shown in the first column.
10. Conclusions and Recommendations

10.1 Conclusions

Considering the outcome from both quantitative and qualitative analysis, several conclusions can be made in relation to the factors affecting team effectiveness of software development teams in the 9 companies in the sample.

Many of the interview participants were of the view that the personal characteristics of the team members had a significant impact on the manner in which they would perform in a team and thereby the final output of the team. In the study the researcher categorized several personal characteristics such as 1) personal job satisfaction, 2) cognition-based mutual trust, 3) affect-based mutual trust, 4) perception of team spirit, 5) good interpersonal communication, and 6) good conflict resolution among team members. These were categorized as individual characteristics affecting perceived team effectiveness. In hypothesis tests it was seen that these variables were positively correlated with perceived team effectiveness at a moderate level. This confirmed that there was indeed a relationship between the above personal characteristics of the team members and how effectively they would perform in a team.

The interview participants' comments and also the findings from the quantitative data analysis revealed that characteristics of the tasks which were performed by team members in software development teams had a significant impact on the effectiveness of the work teams. The researcher studied 1) clear objectives for team work, 2) proper technical direction/leadership for the team, 3) team task autonomy, 4) professionally challenging work, 5) role clarity, 6) having experienced and qualified team personnel in the team, categorized together as task characteristics affecting perceived team effectiveness. Hypothesis tests revealed that the level of experience and qualification level of the team members could not be treated together with the other task-related factors due to lack of correlation, but that the other factors were positively correlated with perceived team effectiveness at a moderate level. When tested independently it was seen that the level of experience and qualification level of the team members had no impact on team effectiveness. This confirmed that the characteristics of the task had a significant impact in determining how effectively team members would work together in a team.

Further analysis showed that of the two groups of characteristics, the most significant determinant of team effectiveness of software development teams was the task-related group of characteristics. Thus showing that whilst the individual characteristics of the team member were important in determining how well the team members performed in their teams the dominant role in determining team effectiveness was played by the characteristics of the task that the individual's in software development teams performed.

The above stated conclusions from the study reveal that the factors affecting team effectiveness are numerous and varied. Multiple independent factors, grouped under...
two broad categories were studied by the researcher in attempting to understand their impact on team effectiveness. All of them were derived from existing literature on team effectiveness in general and team effectiveness of teams in IT in particular. This study confirmed many of the findings of the previous researchers. Since much of the existing research on team effectiveness in general, and specific research on effectiveness of software development teams has been conducted in a European context, this study now provides the ability to bridge the findings of previous researchers to the local context. Most of the existing research was centered on studying a subset of team effectiveness determinants which are mainly behavioural in nature. This study has broadened the understanding of other task related determinants, which were proved to be equally important in the formation of an effective team.

10.2 Recommendations

The findings of this study are significant to the management of Sri Lankan software firms and human resource (HR) managers of those firms. The findings of this study showed that team members should possess certain personal characteristics such as ability to communicate openly with each other and resolve any conflicts quickly, trust each other and develop good cohesion among each other. These personal characteristics could be tested and evaluated through the use of in-depth interviews and psychometric tests in recruiting individuals for their organizations. Also when creating new teams or adding new members to existing teams these personal traits should be paid attention to, as such person-based factors play a significant role in determining how effectively these team members will perform together in a team. Specific training could also be given to team members in ensuring that personal strengths such as effective interpersonal communication are developed and enhanced.

The findings of the study also indicate that perceived job satisfaction of team members have an impact on whether they will perform well in a team. The management of organizations should place due emphasis on this and attempt to enhance the job satisfaction of their employees.

Another concern which is of great importance for management who wish to enhance the effectiveness of their existing teams is to ensure that team members are provided with proper guidelines and clear objectives for their tasks together with role clarity for individuals. As seen when analyzing the survey findings, role clarity appeared to be a dimension that many survey respondents had rated low or as undecided. This indicates that there isn’t enough role clarity presently in companies. Taking the necessary steps to address this issue will result in long term effectiveness within teams. As professionals in this industry appear to highly appreciate task autonomy and challenging work, these areas of the task should also be managed to the satisfaction of team members. These areas must be addressed by the management when they are designing jobs of software development team members.

Good leadership and proper technical guidance being available to the team is another factor which is vital in ensuring team effectiveness. Therefore management should
invest in adequate training programs for their employees. The focus of the training should be to enable employees to develop and enhance the skills needed to guide and lead a development team to greater effectiveness.

According to the findings of this research the above mentioned task-related dimensions are actually the chief determinant in team effectiveness. It appears to be a common mistake to assume that if a team is to function well, individuals must first be ‘team players’. But this research provides further insight that it is not simply enough for members of software development teams to be team players, but that the team players must also have proper objectives, good leadership, autonomy and challenge to produce effective results. It is the management’s task to provide this balance.

Implementing the above mentioned recommendations will enable management to improve performance of existing teams. The two factor model provided and tested by the researcher highlights areas which can be addressed a management’s effort to evaluate the performance of existing teams. Identification of gaps in expected and actual performance will facilitate improvement.

The significance of this improvement to teams is twofold: the evaluation of existing teams and the formation of new teams. When evaluating a team, if deficiencies within a team can be identified, then these problems can be resolved. The knowledge of the positive aspects which should be maximized in teams in order to enhance effectiveness can be used when forming new teams. Then the positive aspects for a team can be maximized and the negative aspects can be minimized from the outset.

The results reported here emerged from a single study, and the sample representation was 9 software development companies. Therefore it is for future researchers to investigate these findings further with a larger and diversified sample.

This study did not consider virtual teams or geographically-dispersed teams and the factors affecting the team effectiveness of such teams. Given the present trends in work patterns such virtual or dispersed teams are becoming increasingly popular in the IT industry. Therefore future researchers could investigate these areas further in order to identify any specific factors which may impact such teams.

References


Impact of Individual and Task-related Characteristics on Perceived Team Effectiveness

Psychology Conference, Sheffield, UK: University of Sheffield Institute of Work Psychology.


