

Measuring Team Effectiveness in Construction Projects: Team Members' Perceptions

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Abstract

Team effectiveness is the ability of a team of people to work together efficiently to achieve a desired goal. An effective team works together to undertake responsibilities, maintain good social relations while promoting personal and professional development. Effective teams are able to enrich the strengths of each team member. Although there are different ways to measure team effectiveness, individual team members' perceptions can portray their direct experiences. Higher team effectiveness ratings from team members indicate enhanced team collaboration, stronger resilience when facing setbacks, and high levels of team performance. After reviewing and assessing team effectiveness literature from different industries, this study identified factors vital to measure construction teams' perceptions. A pilot team effectiveness survey was developed, and a pilot analysis was conducted to understand the overlaps between these factors. Professionals from 36 construction projects participated in the pilot study. The team effectiveness survey was refined using reliability analysis on the collected data, correlations among the specific factors, and the participants' feedback. The final survey is composed of 12 factors that measure team effectiveness as well as control questions that capture team members' general views of their team. These factors include Goal Alignment, Decision Making, Team Communication, Conflict Management, Professional Relationships, Humor, GRIT, Risk Management, Innovation, Trust, Collaboration and Diversity-Equity-Inclusion (DEI). Measuring team effectiveness and its outcomes in construction projects can substantially benefit designing effective professional team development training programs. In addition, the efficiency of design and construction project teams may also be strengthened throughout this process.

Introduction

Teams are structured groups of people working on defined common goals that require coordinated interactions to accomplish specific tasks [1]. Each team member contributes knowledge, services, and proficiency to help the team attain its objective. The notion of teams has become the basic building block of present-day organizational designs [2]. Currently, most industries rely on teamwork more than ever to overcome daily challenges. The major goal is setting up teams and ensuring they successfully achieve their assigned project outcomes. Teams are usually composed of people with diverse backgrounds, experiences, and expertise to tackle complex goals and challenging problems [3], [4]. This assortment is essential as jobs are becoming increasingly complicated and interdependent.

The construction industry, being a project-based industry, is one of the areas where constant adjustments are compulsory. Construction projects are characterized by high uncertainty and inter-organizational task interdependence [5]. The work environment is variable with constantly changing teams, even with new phases of the same project. Each project requires different people from different companies with varying knowledge, personalities, background, and experience to harmonize and work with each other [6]. The industry's nature is mostly fluid in team formation, where team members seldom train together and come and go on a project-by-project basis [7]. Professionals brought together to form a construction team usually find it challenging to adjust to

this inconsistency. This consequently results in poor performance, lack of cohesion, failure to cooperate and conflict among team members [5]. The entire project life cycle might likely be disturbed following these gaps. However, the construction industry cannot survive without teams operating together. Therefore, for a construction project to be successful, there must be a way to ensure improved team effectiveness resulting in better team operations and enhanced project performance.

Team effectiveness is the ability of a team to work together to achieve its goals and objectives while enjoying shared experiences among team members. Team effectiveness mainly portrays the idea that a team of people working together efficiently, can achieve more than individual team members working alone [3]. Effective teams can have improved productivity, quality of work, performance, innovation, efficiency, and positive influences on team members [8], [9]. An effective team completes its task, maintains good social relations, and promotes its members' personal and professional development [10]. According to Essens et al. [11], "Effective teamwork will more likely arise with well-understood and selected conditions, well-directed performance, and well-defined outcomes, and timely adjustment of processes and conditions if necessary".

Research jointly done by the Construction Industry Institute (CII) and Charles Pankow Foundation [12] to examine and compare the performance of three project delivery systems in the U.S proved that higher team chemistry among the owner, designer, and builder, regardless of the delivery method, is essential for improved project performance. The best performing/most successful projects in this study had the attitudes and values of project participants aligned with concepts of cooperation and collaboration. There were clear expectations set where each team member understood what will or should be done to have a successful project. The worst-performing projects, on the other hand, had poor communication among the team members which was lacking in either frequency or quality, or both [12].

This study intended to develop a survey that measures team members' perceptions of how effective their team is. The literature review section presents different team effectiveness studies and what they said affects team success.

Literature Review

A literature review was conducted to analyze existing research on team effectiveness from the AEC and other industries. The search included peer-reviewed journal and conference articles. Keywords and phrases like "teams", "construction teams", "teamwork", "team effectiveness", "team success", and "team dynamics" were used in the literature search. The main criterion was to understand how studies from different industries explained team effectiveness and the factors that influence it. All searches were conducted electronically in English from databases including the University of Kansas library, Google Scholar, and ResearchGate. The search results showed that previous researchers tried to determine the characteristics that lead to the most effective team outcomes [13]. The importance of team effectiveness and the factors that affect it have been explored. A few of these studies from different fields and professions are presented below.

Mathieu et al. [2] provide factors that influence team effectiveness such as task scope and complexity, team interdependence, diversity, team process, information sharing, conflict, skills,

roles, team size, and shared cognition. After reviewing 685 articles, the study explains how teams are becoming progressively conceptualized as dynamic networks of activities that reside in a multilevel context and coevolve with environmental variables. These overlapping factors collectively combine to contribute to team effectiveness.

Azmy [7] reviewed and assessed several team effectiveness models from different industries and identified factors that are instrumental in enhancing team effectiveness. According to the study, some of the most salient factors that play a substantial role in developing effective teams in construction are team goals and objectives, problem-solving, decision-making, mutual trust and commitment, communication, team relationship, motivation, creativity and innovation, audit and monitoring, skills and knowledge, conflict solving, cohesiveness, roles and responsibility, team/task processes, among others.

Mathieu et al. [14] provided a new perspective whereby teams could be studied based on three overlapping coevolving facets that collectively combine to generate team effectiveness. These facets incorporate Structural Features, Compositional Features and Mediating Mechanisms. The study breaks down the features into elements including skill and authority, roles, adaptability, empowerment, task scope, technology, shared leadership, member ability, conflict, motivation, information sharing, creativity, decision-making, trust, cohesion, shared cognition, faultiness, as well as demographic, functional and personality diversities.

Seibert et al. [15], studying the effects of psychological and team empowerment, revealed their positive consequences on team effectiveness. According to the results, psychological empowerment elevated dominant employee attitudes including job satisfaction, organizational commitment and task and contextual performance. Team empowerment was similarly positively related to increased team performance. According to the study, the benefits of psychological and team empowerment had extended across a wide range of advantages in the studied industry.

Essens et al. [11], aiming to support military commanders in gaining and sustaining better insight into the effectiveness of their command teams, conducted a study that assessed critical factors of command team effectiveness. The study states how military commanders can benefit in guiding and controlling teams towards effective performance. According to the outcomes, effective teamwork is the result of a complex mix of condition factors (contextual, organizational, and personnel) and process factors (task-focused and team-focused), and outcome criteria. Task complexity, workload, clarity of goal, command structure precision, leadership skills, team members' knowledge, team size, decision-making, mutual trust, cohesion, mutual respect, and shared vision are some of the factors identified by the study.

Xiao et al. [16] studied the elicited components of task complexity in emergency medical care. The study explored how task complexity in the emergency medical field imposes challenges on team functions. The outcomes show team coordination and success elements critical to the specialty, including conflicts in goals, task clarity, and access to the patient. The study suggests training to increase explicit communications and improvements in the design of work procedures are necessary in order to meet the challenges of task complexity.

Levi and Askay [10], explaining team success, take action teams such as fire crews as an example. The study depicts that while completing the task or putting out the fire is a key criterion of success; it is also critical that the crews maintain a good working relationship. The crew members should also look out for each other and not get injured in the process. Similarly, Levi and Askay [10] state that interdependent sports like soccer, basketball and football require interpersonal skills. Communication, active listening, problem-solving, decision-making, and negotiating are vital to improving team effectiveness.

Looking at previous research in different areas of professions, the researchers of this study felt the need for a defined way to measure team success in the construction industry. The literature review revealed that there is insufficient information regarding a well-structured method of measuring team success in the construction industry. Therefore, the factors identified by previous researchers were taken into consideration Those that are specifically relevant to design and construction project teams were taken to develop a team success survey.

Table 1 Summary of Key Team Effectiveness Attributes/Factors from Literature

Factors	Literature
<i>Task Scope and Complexity</i>	[2], [4], [7], [11], [16]
<i>Team Interdependence</i>	[2], [4], [7], [11]
<i>Decision Making</i>	[4], [7], [10], [11]
<i>Conflict Management</i>	[2], [4], [7], [16]
<i>Problem Solving</i>	[7], [10]
<i>Diversity</i>	[2], [4]
<i>Creativity and Innovation</i>	[4], [7]
<i>Roles and Responsibility</i>	[2], [4], [7], [11]
<i>Empowerment</i>	[4], [15]
<i>Skills and Knowledge</i>	[2], [4], [7], [11]
<i>Communication</i>	[7], [10], [16]
<i>Trust</i>	[4], [7], [11]
<i>Information Sharing</i>	[2], [4], [7]
<i>Team Goals and Objectives</i>	[7], [11]
<i>Shared Leadership</i>	[4], [11]
<i>Shared Cognition</i>	[2], [4], [11]
<i>Team Size</i>	[2], [11]
<i>Adaptability</i>	[4]
<i>Team Process</i>	[2], [7]
<i>Monitoring</i>	[7]
<i>Technology</i>	[4]

Methods

After reviewing and assessing team effectiveness research from different industries, this study identified 17 team effectiveness factors vital to measure a construction team's perceptions. These factors are selected based on two main criteria. First, the most common factors shared among

studies from the different industries were singled out. Second, factors relevant to construction team setups were picked. The 17 factors include *goal alignment, decision-making, team communication, conflict management, professional relationships, humor, problem-solving, grit, risk management, innovation, collaboration, trust, transparency, accountability, flexibility, expertise, and diversity, equity and inclusion (DEI)*.

Following the selection, a team effectiveness survey was developed to evaluate the perceptions of design and construction project team members about their project teams. The survey consists of the 17 identified factors and control questions that collect additional information regarding the project teams. Each factor had a complementary question describing its meaning and asking the participants' perceptions. Table 2 summarizes these questions. Responses were recorded on a 10-point rating scale covering a range from "Among the best I ever participated in" to "Among the worst I ever Participated in". Table 3 presents the scale used to measure the factors. The participants were asked additional six open-ended control questions. The control questions try to assess if the specific team member completing the survey would want to work with the team again, rank the team relative to other teams overall, state how productive the team was and if they trust the team enough to work on a high-profile/risky project.

Table 2 Original Team Effectiveness Survey Factors

Factors	Question
<i>Goal Alignment</i>	Everyone prioritized a successful project outcome rather than focusing on their individual interests.
<i>Decision-Making</i>	There was a solid decision-making process within the team.
<i>Team Communication</i>	Everyone provided the right information, at the right times, to the right people, in the right way.
<i>Conflict Management</i>	There was a healthy and constructive approach to resolving disagreements among the team.
<i>Professional Relationships</i>	I looked forward to interacting with the other team members (we all got along in a friendly way, we cared about each other, all team members treated each other with respect and appreciation).
<i>Humor</i>	We laughed together, joked, poked fun good naturedly, and shared lighthearted moments.
<i>Grit</i>	The team exercised perseverance, resilience, didn't get down, mood didn't get down, kept trying, even keeled, drive, work ethic, avoided burnout.
<i>Problem Solving</i>	The team was effective at overcoming challenges.
<i>Risk Management</i>	The team had a solid approach to identifying, planning for, and minimizing risks to the project.
<i>Innovation/ Creativity</i>	The team used creativity and outside-the-box-thinking to improve the project.
<i>Collaboration</i>	Team worked together as a single team instead of separate units/groups
<i>Trust</i>	I believed others on the team had positive intentions, we trusted each other.

<i>Transparency</i>	Team members were honest with each other, they shared information openly even when it was difficult news.
<i>Accountability</i>	Team members recognized errors and lapses in other team members' performance, and were willing to hold others accountable, by providing appropriate feedback for self-correction.
<i>Flexibility</i>	Team members were able to adapt to changing conditions. (Ability to modify routine strategies or tasks) (Adaptability)
<i>Expertise</i>	The team had an impressive level of expertise/proper skillsets tailored to the project needs (right people, with the right knowledge/skills, in the right roles)
<i>DEI</i>	The team supported both project and organizational goals for DEI.

Table 3 Scale Description

Rating	Scale Description
10	<i>The single best project team experience I ever had</i>
9	Among the best I ever participated in (top 2 to 3)
8	Substantially above average (top 90%)
7	Above average
6	Slightly above average
5	<i>Average / Typical</i>
4	Slightly below average
3	Below average
2	Among the worst I ever participated in
1	<i>The single worst project team experience I ever had</i>

A pilot study was conducted mainly to get the insights of professionals in the construction business. Understanding the overlaps between the selected factors was another aim of the pilot study. Project managers, engineers, owner's representatives, and subcontractors from 36 construction projects participated in the pilot study. Participants were asked to give feedback regarding the survey factors, questions, and scale. The survey was sent and filled out electronically. The collected responses were carefully reviewed and incorporated into refining the team effectiveness survey. Descriptive statistics, reliability analysis and correlations among the different factors were used to study the collected data. SPSS was used as a statistical analysis tool to conduct all the analyses. Cronbach's alpha assessment was utilized to test how reliable the factors of the survey are in measuring team effectiveness. Principal component analysis was also conducted to see if a single factor representing the underlying construct could be extracted.

Results

A principal components analysis (PCA) was run on the 17 factors that measured team effectiveness. PCA requirements were tested and found to be suitable before conducting the analysis. According to the examination of the correlation matrix, all variables had correlation coefficients greater than 0.3. The overall Kaiser-Meyer-Olkin (KMO) measure was 0.814, a classification indicated as "meritorious" by Kaiser [17]. Bartlett's test of sphericity was

statistically significant ($p < 0.001$), showing the data was likely factorizable. One component was retained from the PCA analysis based on eigenvalues, scree plot testing and interpretability criterion. This component explained 56.6% of the total variance.

The test for internal consistency of the 17 factors resulted in a Cronbach’s alpha value of 0.939. Which is well above the acceptable value of 0.7 [18], showing the team effectiveness survey is reliable for subsequent practice. An additional view of the SPSS reliability assessment showed that if any of the factors were deleted, there would be no significant change in the internal consistency. Therefore, reducing the number of factors included in the survey would not affect their internal consistency. The researchers used aspects like feedback from professionals, high correlation among factors and overlaps recorded while analyzing the collected data to assess the factors.

Trust and *Transparency* were significantly correlated with a correlation coefficient of 0.78. Feedback from the participants showed that the two factors were redundant and should be merged. *Expertise* was picked as the least important by the pilot study participants. According to their responses, most team members they worked with on construction projects had the required professional knowledge and were experts in their fields. *Problem-Solving* similarly wasn’t considered essential by the professionals. They emphasized *Decision Making* and *Risk Management* as the most crucial factors regarding overcoming challenges faced by their teams. The *Accountability* factor was likewise voted out by the participants for its closeness to *Transparency*. *Flexibility* wasn’t considered practical because construction teams by their nature are constantly changing and adaptable to new environments. Taking all the feedback and correlation analysis results, *Trust* and *Transparency* were merged as a single factor while *Expertise*, *Problem-Solving*, *Accountability* and *Flexibility* were removed from the survey.

The finalized team effectiveness survey is composed of 12 questions, each characterizing the 12 factors to measure team effectiveness as well as six open-ended control questions. Table 4 summarizes the final 12 factors and their descriptive questions. The team effectiveness survey has 18 questions in total.

Table 4 Updated Team Effectiveness Survey Factors

Factors	Question
<i>Goal Alignment</i>	Everyone prioritized a successful project outcome rather than focusing on their individual interests.
<i>Decision-Making</i>	There was a solid decision-making process within the team.
<i>Team Communication</i>	Everyone provided the right information, at the right times, to the right people, in the right way.
<i>Conflict Management</i>	There was a healthy and constructive approach to resolving disagreements among the team.
<i>Professional Relationships</i>	I looked forward to interacting with the other team members (we all got along in a friendly way, we cared about each other, all team members treated each other with respect and appreciation).
<i>Humor</i>	We laughed together, joked, poked fun good naturedly, and shared lighthearted moments.

<i>Grit</i>	The team exercised perseverance, resilience, didn't get down, mood didn't get down, kept trying, even keeled, drive, work ethic, avoided burnout.
<i>Risk Management</i>	The team had a solid approach to identifying, planning for, and minimizing risks to the project.
<i>Innovation/ Creativity</i>	The team used creativity and outside-the-box-thinking to improve the project.
<i>Trust/ Transparency</i>	Team members were honest with each other, they shared information openly even when it was difficult news (had positive intentions).
<i>Collaboration</i>	Team worked together as a single team instead of separate units/groups
<i>DEI</i>	The team supported both project and organizational goals for DEI.

The control questions are presented as follows:

1. Would you want to work with this team again? (yes or no)
2. Rank this team relative to other teams you've worked with overall. (1 to 5)
3. Would you want this team to be on a high-profile, complex, and risky project? (yes or no)
4. Did the team use any innovative technology which improved the team's performance? (open response)
5. What was the working relationship amongst the team? What percentage of team meetings were conducted in a virtual/hybrid format/in person? (0 to 100%)
6. Out of the rest of the team, if you had to pick one person that you clicked with, who is the single person that you got along/worked best with the most? (must pick a person from a different company)

Discussion

This ongoing study mainly focused on developing a team effectiveness survey that measures the perception of design and construction project team members. As shown in the results, the initial survey that comprised 17 factors was narrowed down based on some statistical analysis judgements and feedback from the pilot study participants. The final survey measures the satisfaction of team members with being a member of their specific team. The survey helps understand the interdependent functioning of team members and their ability to work together to achieve project goals. Azmy [7] states that the team's ability to understand the project's common goals, roles and responsibilities while using effective communication strategies embraces the owner's expectations. Azmy [7] further explains how team effectiveness is perceived as the ability of the team members to work together flexibly, help each other, put in the effort, and function well as a team to overcome issues and complete the project within the given timeframe and cost. This goes hand in hand with the theoretical expressions and questions of the finalized team effectiveness survey developed by this study. The theoretical explanations of each of the 12 factors identified to be critical for team effectiveness are given below.

1. **Goal Alignment:** Clearly identifying project goals at the beginning of the project goes a long way towards achieving them. Based on these agreed set of goals, project team

members can prioritize a successful project outcome rather than focusing on their individual interests.

2. **Decision Making:** The decision-making process within the team must be based on mutual performance and understanding where all team members' interests are put into consideration.
3. **Team Communication:** Precise and useful information must be properly provided to each team member as this helps the team reach a common understanding
4. **Conflict Management:** Effective use of conflict management techniques, to overcome and resolve challenges/issues, guarantees healthy relationship amongst the team.
5. **Professional Relationships:** Developing a healthy work relationship helps the team stay united towards achieving its goals. With a good professional relationship, team members would value and respect each other.
6. **Humor:** The right amount of humor creates an enjoyable work environment
7. **Grit:** Preservice and resilience are essential for the team to persist towards achieving the project goal. It is a motivating drive that pushes the team forward when facing a setback.
8. **Risk Management:** Proper planning and preparation for possible risks that the project may face goes a long way. This saves the team a great deal of resources.
9. **Innovation/Creativity:** Collectively thinking and generating new ideas and methods to get the best project outcomes makes teams perform better. Using new technologies and techniques help teams effortlessly accomplish project goals.
10. **Trust/Transparency:** Developing trust among team members is critical in defining the general relationship of the team. If team members trust each other, they would not be afraid to talk about their weaknesses and ask for solutions/assistance. They would depend on each other without hesitation. Sharing information/mistakes openly without fear of reprisals/conflict improves confidence among team members.
11. **Collaboration:** Thinking of the team as a single entity where team members collaborating and working together as one is key.
12. **DEI:** With increasing globalization, teams are becoming more and more diverse. It is crucial to develop a team environment that accepts and appreciates Diversity, Equity, and Inclusion amongst team members where no discrimination is exercised.

Team-building efforts are interventions to change and improve team processes once they have developed and stabilized [19]. Measuring team effectiveness and its outcomes in design and construction projects can assist in designing effective professional team development training programs. This elevates the efficiency of construction project teams. Kozlowski and Ilgen [19] attest to the advantages of effective team training techniques. The study shows how the science of team training designs can be applied and adapted to improve team effectiveness across organizations. Construction teams could benefit from training interventions that magnify team effectiveness. The outcome of team effectiveness measurements clarifies where teams need improvements. Training strategies targeting the advancement of specific factors can be designed. Organizations are encouraged to customarily measure team effectiveness based on each member's perceptions and see how their teams are working together. Based on the responses they get; it is possible to design tailor-made training that strategically helps team members fill the gaps.

Conclusion and Recommendations

This study reviewed and assessed different team effectiveness literature from different industries and identified factors vital to measure construction project team effectiveness. A pilot team effectiveness survey was developed, and a pilot analysis was conducted to understand the overlaps between these factors. Project managers, engineers, owner's representatives, and subcontractors from 36 construction projects participated in the pilot study. From the responses collected, the team effectiveness survey was refined using participants' feedback, reliability analysis and correlations among different factors. The final survey consists of 12 factors that measure team effectiveness and six control questions to collect additional data about the team. The factors included in the narrowed-down survey instrument include *Goal Alignment, Decision Making, Team Communication, Conflict Management, Professional Relationships, Humor, GRIT, Risk Management, Innovation, Trust, Collaboration* and *Diversity-Equity-Inclusion (DEI)*. Measuring team effectiveness and its outcomes in construction projects can substantially benefit designing effective professional team development training programs. This enhances the efficiency of construction project teams. Training strategies that target the improvement of specific factors can be designed to enhance team effectiveness. Construction teams could benefit from training interventions that amplify team effectiveness.

Further research is required to assess if all the team effectiveness factors should be weighted the same or not. This study weighed all the factors the same. However, weighting methods may be necessary depending on the industry the teams are performing their projects in. Some factors may be more or less critical for team effectiveness.

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