

## Appraisal of Trust Degree among Innovation Team Members Based on Analytic Hierarchy Process\*

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**Abstract** To establish trust within innovation teams of scientists and technicians working on large-scale projects is considered an critical factor for the successful completion of the project when working in a virtual environment. To build trust among team members for any project requires a selection decision on which trust factors will best achieve the goals of the project. This paper presents application results of using two analytic methodologies used to evaluate trust survey information.

**Key words** Trust: Evaluation: Analytical hierarchy process: Project management

### 1 Introduction

A innovation team is defined as a self-managed knowledge worker team, with distributed expertise, that forms and disbands to address a specific organizational goal. The issue of building trust in a scientific virtual project team is important because of the unique opportunity and because the next generation of "big science" projects will require global virtual project teams. Trust in a co-located team is usually built on impersonal and interpersonal factors. Impersonal factors are linked to institutional norms and beliefs. Interpersonal factors relate to expectations of the working group. Both the impersonal and interpersonal factors of trust assume that the relationship between co-located team members has some longevity. Consequently, trust in co-located working groups is based on the expectations of members' behavior and also the collective norms of the working group's institution. Trust in a innovation team as described above, the traditional model of trust for a co-located team is built on long- term relationships that a innovation team does not have the luxury of time to establish. Building trust in a innovation team has been described as more a set of team leader (TL) and team member (TM) actions that fall into three categories: performance and competency; integrity; and concern for others.

Performance and competency pertain to the TLs' and TMs' track record of results. For example, does the TL bring projects in on time? Do the TLs or the TMs have the proper experience and technical expertise to make the project succeed? Do they honor their commitments? Commitment follow-through may be more important for innovation teams than for co-located teams because innovation teams have fewer events to judge whether a TL or a TM are really committed to the project's overall success. Integrity is described as a set of principles that makes a TL or TM dependable and reliable. Examples might include standing up for the team, speaking positively about the team's performance and maintaining consistent and balanced communications with the TMs. Once performance, competency and integrity are in place, the care and concern shown towards others by the TLs and TMs become important. Concern for others relates to the fact that we trust people who are consistently responsive to our needs and to the needs of others in the organization. Measures of this third category might include the TLs' actions related to effectively transitioning people on or off the project team or their understanding of the impact of team actions on people inside and outside the team.

### 2 Theoretical Research of Innovation Team Trust

Trust building on high performing temporary teams is focused on achieving mission success, on having clear goals and purpose and on meeting tight deadlines. There is no time to develop trust through more traditional means of impersonal or interpersonal trust factors. High levels of action rather than personal relationships are what establish trust in these temporary teams. The concept is referred to as swift trust, i.e. the ability to quickly get down to business, focus on the task, keep distractions to a minimum, and complete the job and then dissolve the team. The concept of swift trust was developed to explain how temporary teams can enjoy high levels of trust, even though members do not share any past

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affiliation and cannot necessarily expect to have any future association. A major premise of swift trust is that the time pressure of a team's project will hinder the ability of TMs to socialize and learn about one another's behavior, abilities and goals.

One of the ways to measure trust in teams is with trust surveys. Results from a trust survey can indicate policies and practices that should be maintained and identify areas for improvement. Trust surveys can also be used to identify which of the trust factors are important on a project. A survey of trust factors was developed based on the principles to manage a gauge of the trust climate within the project. The survey questions were selected to capture measures on three types of personnel, in three categories of co-located, virtual, and swift for trust, which are further broken down into seven different types of trust factors (representing the decision variables in this study), as presented in Table 1.

**Table 1 Trust Factors, Categories and Descriptions**

Trust factors	Trust categories	Description
x <sub>1</sub>	Co-located team trust	Organizational policies
x <sub>2</sub>	Co-located team trust	Management and team relationships
x <sub>3</sub>	Co-located team trust	Communications
x <sub>4</sub>	Innovation team trust	Performance and competency
x <sub>5</sub>	Innovation team trust	Integrity
x <sub>6</sub>	Innovation team trust	Concern for others
x <sub>7</sub>	Swift trust	Ability of business and form trusts quickly

Survey results were obtained from many managers, technical and support staffs from the six region laboratories involved in the certain project. A total of 105 completed survey forms were returned out of approximately 600 e-mail requests to employees. The scale used in the survey that measured trust on each question ranged from low trust score (a score of 1) to high trust score (a score of 5). Average scores for all participants by type of personnel and by trust factor are presented in Table 2.

**Table 2 Average Survey Preference Scores by Type of Personnel and Trust Factors**

Type of personnel	Co-located team trust			Innovation team trust			
	Organization policies	Management and team relationships	Communications	Performance and competency	integrity	Concern for others	Swift trust
Management	3.833	4.038	3.906	4.042	3.821	3.670	3.439
Technical	3.801	3.953	3.687	4.238	3.990	3.453	3.545
Support	3.828	4.120	3.900	4.344	4.104	3.524	3.583
Total	11.462	12.111	11.493	12.624	11.915	10.647	10.567

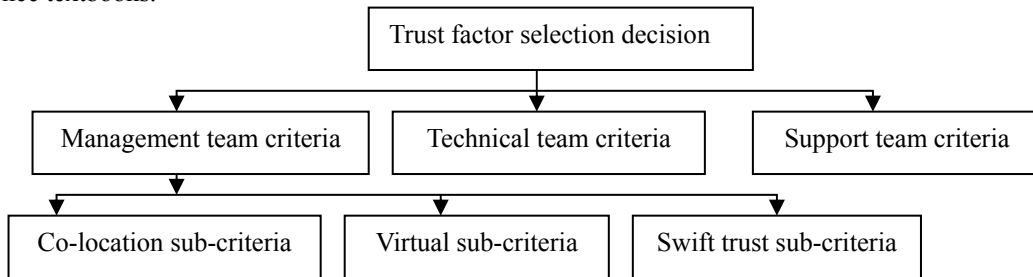
The final survey results indicated that employees gave the project an overall average score of 3.89 for all trust categories, with approximately 3.9 for co-locate trust, 4.3 for virtual trust, and 3.5 for swift trust. The overall survey results clearly indicated that trust factors associated with innovation teams were the most important. Overview of the managerial decision-making problem despite the strength of the survey scores for the virtual trust factors, project management knew the project was in transition. The partner labs were completing their project assignments and remaining project work would soon be performed only at the project home laboratory. Project management wanted to use the existing survey results to support their belief that the trust factors related to co-located trust should be emphasized over virtual and swift trust factors at the project's home site. However, management personnel did not feel their overall preference for trust factors were more important than the overall preferences of the technical and support personnel preferences.

Based on the above requirements, project management wanted to use one or more management decision-making methodologies to determine on which trust factors they should focus. Once the trust factors (which are the decision variables in this study) were identified, management planned to review associated survey questions and employee responses to identify to what specific emphasis and action areas they could best devote effort to improve trust for the project as a whole. Project management felt that by using more than one selection methodology they might better reveal solution patterns that would help to validate their final selection of trust factors.

### 3 Theoretical Research of Innovation Team Trust

One of the more popular methods that allows for the incorporation of judgmentally scaled opinions

into a ranking for selection decision purposes is the analytical hierarchy process (AHP). AHP can be used to determine the ranking of trust factors, and thereby provide prioritized focus of effort of managers to aid in trust building. AHP has also been combined with the multi-objective programming methodology of goal programming(GP) to permit individual preferences to be explored. Combining GP and AHP to determine which of the trust factors were most important in light of personal preferences represents a unique possibility in this case study. To that end, AHP is presented here first as a stand-alone methodology and then a combined AHP and GP model is presented as an extension to consider additional criteria in the decision-making process and to compare both solutions' results. AHP is a technique for considering data about a decision in a systematic manner and is a highly flexible decision methodology that is typically used in decision situations, which involve selecting alternatives from several candidate decision alternatives on the basis of multiple decision criteria of a competing or conflicting nature. Particularly important for the trust factor selection situation, the decision criteria may hold a different perceived degree of preference or level of importance to the decision in the eyes of the decision makers. AHP helps to bring consistency in selection problems whose decision criteria are expressed in subjective measures based on managerial experience. We compute the AHP weighting using the computer software application Decision Support Software. The procedure for computing the AHP preference vector used in this case to decide on trust factors can be found in most basic decision science textbooks.



**Figure1 AHP Criteria, Sub-criteria and Alternatives**

The use of AHP was investigated first as a means to establish a trust factor ranking. Utilizing the Decision Support software, preferences were established for criteria and sub-criteria. Survey average scores from Table II were used to build alternative preferences required in the process. Consistent with AHP, a decision hierarchy is established to map out how the final decision is related to the multiple criteria in the decision environment. This hierarchy is presented in Figure 1. Application issues used in the Expert Choice generated AHP solution of the trust factor problem is described below: .project management viewed each of the criteria as being equal. A preference value of 1/3 was consequently assigned to each. Sub-criteria preferences were based on management's weighting of 8,5 and 1 for the three trust categories; co-located team trust, innovation team trust, and swift trust. The AHP preferences for decision variables under each sub-criterion were assigned normalized values. These values were based on trust factor average preference scores from the project trust survey(Table 2).

Additional tests for AHP consistency were undertaken to ensure the computational accuracy of the application. This test evaluates the validity of the basic AHP pair-wise comparison process. A consistency index to random index ratio of less than 0.1 indicates a satisfactory degree of consistency. The Expert Choice software calculated the resulting ratio at less than 0.001, indicating near perfect consistency for this trust factor problem. Choice AHP solution and the resulting ranking of trust factors are shown in Table 3.

**Table 3 Ranking of Trust Factors Using AHP**

Trust factors	Trust categories	Resulting AHP weighting	Resulting AHP ranking
x <sub>1</sub>	Co-located team trust: organizational policies	0.192	1
x <sub>2</sub>	Co-located team trust: management relationships	0.193	1
x <sub>3</sub>	Co-located team trust: communications	0.188	1
x <sub>4</sub>	Innovation team trust: performance and competency	0.134	2
x <sub>5</sub>	Innovation team trust: integrity	0.116	3
x <sub>6</sub>	Innovation team trust: concern for others	0.107	4
x <sub>7</sub>	Swift trust: quick trust	0.071	5

Based on the AHP ranking results, project management should first place their efforts in building trust on co-located team trust and second on innovation team trust (just the performance and competency factor). If this decision based on the AHP ranking is true, then another methodology should reveal a similar result. To explore the validity of this AHP ranking and for comparison purposes, we next turn to AHP's use in a GP model. The GP model formulation consisted of seven decision variables, three priorities and 20 goal constraints, i.e. three management constraints and nine trust factor category constraints; one AHP weight constraint; and seven maximum preference score constraints.

**Table 4 Trust Factor Rankings Based on Combined AHP/GP Decision Methods**

Trust factors	Trust categories	Resulting GP weighting	Resulting GP Ranking*
$x_1$	Co-located team trust: organizational policies	5	3
$x_2$	Co-located team trust: management relationships	7.484	1
$x_3$	Co-located team trust: communications	5	3
$x_4$	Innovation team trust: performance and competency	6.220	2
$x_5$	Innovation team trust: integrity	5	3
$x_6$	Innovation team trust: concern for others	5	3
$x_7$	Swift trust: quick trust	5	3

Note: \*The larger the weight, the higher the rank

The GP objective function had to reflect the desire to permit the technical and support staff's goal constraints to be viewed as being as important as management's goal constraint. Management also wanted to assign weights of 8,5 and 1 to constraints associated with co-located team trust, innovation team trust and swift trust "categories". These weights corresponded to the sub-criteria preferences established using the AHP process. The computational results indicated that all of the goals as stated in the objective function have been fully achieved. The optimal GP weights of the trust factors and their corresponding ranking are presented in Table IV. Based on the GP ranking results, project management should first place their efforts in building trust on co-located team trust and second on innovation team trust. While these are the same two categories as chosen by the AHP method, the GP solution helped narrow the co-located team trust factors from three to just one.

#### 4 Conclusion

Most of management's emphasis should be placed on building trust via the co-located team trust and innovation team trust categories. The ranking of the individual trust factors of co-located team trust: management and team relationships and innovation team trust: performance and competency were first and second, respectively. They both identified swift trust with the lowest priority and should receive the least emphasis. On these points, the methodologies appear to help validate each other's answers. While it can be argued that the GP model was based on the outcome parameters of the AHP method, the GP model introduced additional decision-making criteria that could have made, but did not make, a substantial difference in the resulting solution for the highest ranked trust factors. The GP solution is different in that it adjusted the individual trust factor preferences from the AHP method to include project management's category weighting. This shifted the analytical process to favor better the co-located team and innovation team trust category factors, resulting in a different priority structure from using AHP alone. It is interesting to note in the bottom row of Table 2, the two trust factors with the largest summed average preference scores are the same as those GP model assigned the highest two ranks. In this regard, the GP model appears to have provided a solution that better reflects the trust survey findings than the AHP weightings. Project management expected co-located team trust factors to be important. The results of the combined AHP and GP decision methodologies have in this application reinforced their expectation. The application and information provided by the GP method have helped project management to initially focus their trust-building efforts more intensely on a fewer number of trust factors.

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