An Empirical Investigation of the Roles of Outcome Controls and Psychological Factors in Collaboration Technology Supported Virtual Teams

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Abstract

The purpose of this research is to examine whether outcome controls of group work (i.e. time pressure and reward) trigger psychological factors (i.e. distraction, motivation, and trust) and affect problem-solving virtual teams' ability to share information and develop high quality solutions. Results of a laboratory experiment on GSS-based virtual teams indicate that teams exhibited higher motivation and trust under time pressure, and both motivation and trust, in turn, have a positive relationship with information sharing and solution quality in ridge regressions. However, reward control has no significant impact on any psychological factors in both ordinary least squares regression and ridge regression.

1. Introduction

Since Ouchi [40] first formally proposed outcome control, valuable empirical research has attempted to identify various effects of outcome controls in the context of team work. The purpose of this study is to examine two outcome controls (time pressure and reward inspiration), which are expected to impact information sharing and the problem solution quality through a set of psychological factors. Effective sharing of information is an important aspect of group work. In situations where group members hold unique information to solve a problem, effective communication and information exchange are crucial to the timely completion of the task [2, 49]. The issue of information sharing is critical as well as challenging in the virtual team environment, in which individuals communicate using information technology (IT). Such challenges, according to Alavi and Tiwana [1], are attributed to dispersion of team members in space and time, indirect interaction, lack of collaborative history, shared work environments, uneven distribution of contextual knowledge, diversity in expertise and backgrounds of members, and weak organizational ties enabled by IT. Recent research has sought to use controls, such as face-to-face meeting and team role definition, to mitigate the difficulty of information sharing in virtual teams [14, 48, 52].

Time pressure and reward inspiration have been examined in prior research for either collocated teams [26, 29, 30] or virtual teams [32, 39, 51]. Exploratory studies on team performance have revealed that time pressure is a significant inhibitor to the creative performance [39] and information sharing [29]. Reward inspiration, in contrast, has been found to motivate and support cooperative behaviors in virtual teams when designed to evaluate collective performance [32]. But prior works have focused on the effect of controls on performance without considering the psychological factors that are triggered by the controls. The psychological factors may explain the collective perception of the virtual teams that shapes their problem solving processes and outcome. Our study is the first attempt to fill this gap in virtual team research. Trust, motivation and distraction are selected in that they are typical psychological factors related to virtual team research and outcome controls we used. The psychological factors, which are critical to the cooperative behavior leading to the success of all teams, are especially important in virtual teams. Different location and computer-mediated communication mode can create disparities in working contexts and lead to distrust, disappointment, and distraction. When team members are dispersed, it is more difficult to create the bonds of cohesion that can lead to trust, motivation and concentration based on assessments of ability, benevolence and perceived inclusiveness.

The results of our study indicate that teams under time pressure exhibit higher motivation and trust than those without the time control. However, reward inspiration has no significant influence on

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psychological factors. In addition, we do not find that psychological factors improve either the information shared or solution quality in the groups. The ridge regression results we referred to in our paper yielded improved point estimates of the parameters of the research model. We find that both motivation and trust have positive effect on information shared and solution quality while distraction has a small negative impact on them.

In the following Section, we discuss the research model and propositions linking the outcome controls to information sharing through psychological factors, and describe how information sharing together with psychological factors may affect the quality of solution and the process satisfaction. Next, we describe the research methodology and present the findings of the study. We conclude with the discussion of our findings and implications for future research.

2. Literature review and theory development

As shown in Figure 1, we anticipate that outcome controls including time pressure and reward inspiration should affect psychological factors (distraction, motivation, and trust) which in turn, influence information sharing. Problem-solving outcomes, in terms of the solution quality and satisfaction with process are influenced by information sharing in the group.

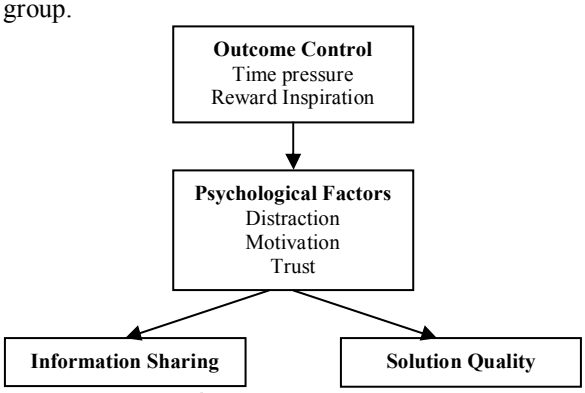

Figure 1. Proposed Research Model

2.1. Psychological factors

In this research, we focus on psychological factors such as, trust, motivation and distraction that are relevant for virtual team. Relationship building in a team involves interaction processes designed to increase feelings of belonging to the team [44]. Once team members have a sense that they belong to a team, they are desiring to be passionate about what they do and motivated to perform a better job [11, 12]. As a result, members who are made to feel responsible for the teamwork will be either intrinsically or extrinsically motivated to share information effectively and facilitate relationship building. In contrast, distraction inhibits reaction to members each other [6] and therefore makes the relationship building in virtual teams very slow. Trust involves interpersonal relationship building and plays a key role for effective information sharing in virtual settings. Trust occurs when a person is confident in and willing to act on the basis of the actions and decisions of others in the team [33]. Trust have been considered as critical in managing people who cannot meet face-to-face [21]; it facilitates effective interactions when members are willing to open themselves to each other and cooperate to solve a problem [27]. If team members distrust each other, they may refuse to cooperate or make contributions essential to team performance [13].

2.2. Outcome controls in virtual teams

Control is defined as a process of creating and monitoring rules through hierarchical authority and it restricts individuals' activities by regulating patterns of interaction [53]. Control theory classifies control mechanism into behavior, outcome, and clan controls [16]. Outcome controls, the focus of this study, are aimed at meeting pre-specified goals of a task that an individual or group performs, whereas behavior controls are designed to structure the transformation process of work [43]. Clan controls are operationalized through social norms and values [40]. In this research, we use time pressure and reward inspiration as outcome controls to improve the performance of virtual teams.

2.2.1. Time pressure. Time pressure has been commonly operationalized as the time available to perform a task [26] and can be applied either in objective or subjective manner. Time pressure can be operationalized objectively by imposing different levels to time constraint, such as low or high. Low-time-pressure groups have a time limit that is considered sufficient whereas high-time-pressure groups usually have 50 percent less time available to perform the tasks [5]. Subjective time pressure, on the other hand, is manipulated in some studies by emphasizing the importance of speed of decision process, or by using stopwatch to make time more salient [29, 30]. Comparing with actual time limits, subjective time pressure has been more widely researched for teamwork since finding that group members who believe they are working under time pressure are underperformed is more interesting than

finding that group members are underperformed when given less time to do the work [30]. Given that the manipulation of the amount of available time may significantly influence the amount of information exchanged in virtual teams and therefore make the information sharing among teams less comparable, we only focus on subjective time pressure.

Kelly et al. [29] note that subjective time pressure decreases the systematic processing of task information, and thus leads to faster decisions, thereby, implying that subjective time pressure is negatively related to information sharing. However, when time pressure is tied to psychological factors, some different conclusions may be drawn. For example, an absence of time pressure can lead to attention straying to activities outside the project, or lead to indifference [19]. Thus, we expect that the groups that experience time pressure focus more on the activities under and have less distraction than other groups. Also, since time pressure is likely to increase task difficulty [26], it can motivate individuals to cope with the threat to the goals. According to Hermann [22], when an individual detects a potentially threatening stimulus for his goal, he will be the most motivated to achieve the goal. The more negative impact the individual experiences, the greater the tendency to increase his motivation in the threatened goals. Moreover, group members working under time pressure have to trust each other without conditions in order to do the work efficiently. Unlike in face-to-face interactions, it is harder for virtual team members to establish trust in a new working relationship due to the difficulty in assessing teammates' trustworthiness without ever having met them [28, 34]. However, short-lived teams can develop high trust following a swift trust model [27]. The swift trust model suggests that team members assume others are trustworthy and begin working as if trust were already in place while seeking confirming or disconfirming evidence during group working [37]; however, team members under time control have no time to gather such evidence but follow their initial assumption in trust. Thus,

H1a: In virtual teams, members' perceived distraction will be lower in groups that are under time pressure than those that are not.

H1b: In virtual teams, members' perceived motivation will be higher in groups that are under time pressure than those that are not.

H1c: In virtual teams, members' perceived trust will be higher in groups that are under time pressure than those that are not.

2.2.2. Reward Inspiration. Organizations with explicit reward system can foster a culture of extensive information sharing [51]. Reward, either for individual work or collective work, has been found to be an effective stimulus in team settings. However, our study only focuses on collective work considering the negative effect of reward for individual work. According to Huber [25], if employees believe that knowledge sharing will restrain their personal efforts to distinguish themselves relative to their coworkers, some organizational incentive structures, such as pay-for-performance compensation schemes, may discourage knowledge sharing. By contrast, when the award is for collective work rather than for individual work, the reward inspiration system will generate among members a reciprocal association which can facilitate relationship building.

Under the condition of reward inspiration, extrinsic motivation emanates from external sources involved in supervisory control [7] and therefore group members are extrinsically motivated. Therefore, time inspiration used as outcome controls generate a compelling individual motivation because nonproducers receive no compensation and many mangers therefore believe outcome-based rewards are necessary to maintain motivation [3]. Individuals, who believe individual benefit is decided by group benefit, will be more intended to trust each other and share their information. Lawler [32] therefore recommends that pay-for-performance systems should focus more on collective than on individual performance in order to motivate and support cooperative behaviors. Moreover, the members motivated by the pay-for-performance mechanism are less likely to distract from the group work since the outcome control drives them to devote themselves fully and immerse into the work in order to find the best solution. Thus,

H1d: In virtual teams, members' perceived distraction will be lower in groups that have reward inspiration than those that do not have reward inspiration.

H1e: In virtual teams, members' perceived motivation will be higher in groups that have reward inspiration than those that do not have reward inspiration.

H1f: In virtual teams, members' perceived trust will be higher in groups that have reward inspiration than those that do not have reward inspiration.

2.3. Effectiveness of information sharing

Information sharing is an important condition for organizational knowledge management [47]. Gunawardena et al. [20] propose that the active construction of knowledge moves through five phases: 1) Sharing/comparing of information, 2) Discovering and exploring of dissonance or inconsistency among ideas, concepts, or statements advanced by different participants, 3) Negotiation of meaning and/or co-construction of knowledge, 4) Testing and modification of proposed synthesis or co-construction, and 5) Phrasing of agreement, statement, and applications of the newly constructed meaning. Embedded in these phases, information sharing can be viewed as a cycle process to create and disseminate knowledge: from information distribution (corresponding to the phase 1) to information explanation (including phase 2-4), and then to information application (corresponding to the phase 5). The messages communicated for information sharing therefore can be divided into three types: 1) task information distribution, 2) task information explanation, and 3) process information not for distribution and explanation but for context needed. In this study, all three types of messages are counted to measure information sharing. While motivation and trust are important psychological factors that facilitate information sharing, it is less likely that distracted members will have high volume of information in group work. Thus,

H2a: In virtual teams, the greater the perceived distraction of group members, the lower level of information will be shared in the group and vice versa.

H2b: In virtual teams, the greater the perceived motivation of group members, the higher level of information will be shared in the group and vice versa.

H2c: In virtual teams, the greater the perceived trust of group members, the higher level of information will be shared in the group and vice versa.

2.4. Problem-solving outcome measures

Prior research on virtual teams has focused on the performance variables, such as decision quality, number of ideas generated, decision time, member satisfaction, perceived decision quality, participation, and agreement [4, 7, 41, 42]. Since straightforward objective measures of results should be used to evaluate objects in an outcome-based control system [3], we exclude perceptual measures of the process satisfaction but only focus on an objective assessment of the solution quality. Prior virtual team research has widely reported the interrelated relationship between psychological factors and the solution quality. Since distraction not only reduces the efficacy of the process of message elaboration but also limits the possibility of an elaboration [6], it should be negatively related the solution quality. Motivation, as well as cohesion and satisfaction, contributes to virtual team effectiveness by promoting more efficient use of team resources while reducing implementation errors [46]. Motivation development investment is essential to increase the performance of a virtual team [54]. Like motivation, trust is also an important socio-organizational challenge inherent to the project-based nature of virtual team construction [45]. The literature on trust suggests that trust is important in determining the success and failure of virtual team. Trust impacting a virtual team's development can help managers and team leaders to facilitate and improve team success [19]. We therefore hypothesize

H3a: In virtual teams, the greater the perceived distraction of group members, the lower will be the quality of the final solution.

H3b: In virtual teams, the greater the perceived motivation of group members, the higher will be the quality of the final solution.

H3c: In virtual teams, the greater the perceived trust of group members, the higher will be the quality of the final solution.

3. Research methodology

3.1. Subjects

A total of 72 students (62.5% graduates, and 37.5% undergraduates) majored in business, computer and engineer from a large Midwestern university in the United States were involved in the research. On average, they were 24 years old and had 2 years of work experience. All subjects were volunteers and received extra credit for their participation. Subjects were randomly assigned to 24 teams, with 3 members in each. Teams were then randomly assigned to treatments.

3.2. Variable identification

All items were based on a 5-point Likert scale with values ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). A copy of all items used is available from the authors.

Psychological factors – Four items developed by McAllister [33] were used to measure trust. Both distraction and motivation were measured by 4 items respectively. The questionnaire items measuring constructs are listed in Table 1.

Table 1 Summary of Measurement Scales

Construct	Measure
Trust	We can freely share our ideas, feelings, and hopes.
	If I shared my problems with my members, I know they would respond constructively and caringly.
	My members approached their jobs with professionalism and dedication.
	I can rely on my members not to make my job more difficult by careless work.
Motivatio	I was motivated to perform better in the teamwork.
	I feel enthusiasm about the teamwork.
	As a team, we tried our best to do the work.
	The more effort we put into the project, the more we gained from the teamwork.
Distraction	It is difficult for us to focus on information sharing process.
	It is difficult for us to build a sharing and emotional relationship in the team.
	It is difficult for us to integrate the information provided by each member.
	The reaction for the information provided by other members is slow.

Information sharing – Information sharing was measured by using parsing rules adapted from Connolly et al. [8] (see Appendix I). Based on a review of parsing rules, a graduate student, blind to our conditions, counted each piece of information shared by members. The total number of process information, task information in distribution and explanation was served as our measure of information sharing.

Solution quality – The solution quality was evaluated by the points a team obtained in three information sharing stages: distribution, explanation, and application. Ten points were assigned for each stage. An algorithm (shown Appendix II) was used to evaluate ISE. The evaluation process started at the Application phase, which indicated the final solution of each group was checked first to see whether there was an error in the solution. If not, the group got full points in each of the three phases because it is impossible to make a 100 percent correct solution with missing value or errors in the information sharing process. Otherwise, the messages about task information distribution were then checked to see whether there was an information distribution missing or a false distribution regarding the error. If there was, one point was deducted from the Distribution phase. But if information was indeed distributed correctly, the messages about task information explanation were then checked to see whether there was an explanation missing or false explanation regarding the error. If there was, one point was deducted from the Explanation phase; otherwise, the group lost one point from the Application phase. Each decision loop checked only one error, and the loop did not end until all errors were identified. The solution quality was the average of the scores for information distribution, explanation, and application.

3.3. Task description

McGrath [35] differentiates between the problem-solving and decision making tasks. A problem-solving task has a demonstrable correct answer whereas a decision making task has a solution that is reflects the collective preference of group members. The task chosen for this study is a problem-solving task that has a demonstrable correct answer. Given that all participants have the learning experience of database management and application, the task chosen was to design a data model (Entity Relationship Diagram) for a database application. Each participant was provided with one page of introduction paper which listed four piece of unique information. The unique information provided the participants regarding the entities, attributes, cardinalities, and relationships that should be used for designing the database. The participants were asked to share information anonymously and synchronously and draw an entity relationship diagram (ERD) by using ER Assistant 2.10, a CASE tool. The ERD was the final solution provided by the group. Stasser [50] have used this kind of hidden profile tasks (i.e. where each group member has unique yet complimentary information) to examine information sharing. This type of task is important for group laboratory research because it simulates an important characteristic of "real-world" tasks where each member holds unique information [36].

3.4. Collaboration tool and training

The tool used in our experiments was Lotus Sametime, a type of software for group collaboration over the Internet. As a synchronous groupware application, Sametime facilitates communication among geographically dispersed coworkers. The tool provides support on text message exchange, screen sharing, program sharing, whiteboard, audio-conferencing, video-recording, and allows for voting on and ranking of the solution. Subjects were scheduled into four one-hour training sections to be orientated to the phases of the experiment and features of the software as well as the CASE tool used in the

experiment.

3.5. Experimental procedures

Subjects were randomly assigned to one of four conditions: (1) participants working under time pressure, (2) participants working under reward inspiration, (3) participants working under both time pressure and reward inspiration, and (4) control participants working under no special treatment. The outcome controls applied in this study was similar to those often used in collocated teams. The laboratory time pressure manipulation was carried out which referred to the elaborate procedure created by Kelly and Loving [30] to invoke realistic feelings of time pressure. The teams under time control were told to make decision quickly each 20 minutes: "Since it is very important to do the project efficiently, you need to come up with your solution quickly," and in order to make time more salient, after each 10 minutes they were informed of the remaining time. The teams under reward control were given a special offer emphasizing effectiveness of performance: "If your group can find the best solution for Henry Books, each of your members may get maximum 5 points beyond the 10 bonus points you obtain from the participation."

Members in each group were assigned to three different rooms and work on laptop workstations equipped with a mouse. One of the researchers acted as the facilitator from a separate room and monitors the group work. The activities experienced by groups included: (1) Group members participated in a discussion and distributed several pieces of information on hand. (2) Group members selected one from within the group to draw the ERD (refereed to as Drawer). The drawing process was observable by other members at same time. The other members could not directly modify the diagram but ask the drawer to do so. (3) Once the group finished the ERD, the group members completed a posttest questionnaire that collected demographic data and psychological factors. All teams were given 60 minutes to finish the process before being surveyed. According to the two pilot studies conducted on graduate students, 60 minutes were long enough to complete the first two activities associated with the study.

4. Results

4.1 Manipulation check

All groups were given the same amount of time to reach a solution, but groups in the time pressure condition believed that they had less time. We used two items to do the manipulation check (i.e. "I hope we have enough time to do the task" and "I can use the available time flexibly in order to accomplish the task goals"). The time pressure manipulation was successful and most participants in the condition believed they might not get out of study on time and therefore preferred using short, explicit sentences and even command-style sentences to discuss the issues. As for the reward inspiration control, participants' messages related to the reward served as a manipulation check. The groups in the condition generally sent a message (e.g. "Yes we really need it") to express their interests in the opportunity of getting more extra points and more proactively shared their information on hand.

4.2 Reliability and validity

In Table 1 we present the reliability statistics for the constructs used in the study. Nunnally [38] suggests that a reliability of a construct between 0.60 and 0.80 should be acceptable. Therefore, we consider an alpha value of 0.60 as the cut-off value. As shown in Table 1, after dropping two indicators items of trust and one indicator item of the process satisfaction, the reliabilities of all constructs are between 0.69 and 0.89, thus passing the test of construct reliability. Fornell and Larcker [17] propose that the average variance extracted from a construct should exceed 0.50. As Table 1 indicates, the average variance extracted from each construct exceeds 0.50.

Table 2. Convergent validity test

Constructs	Construct reliability [a]	Portion of variance extracted [b]
Distraction (with 4 indicator items)	0.747	59.21%
Motivation (with 4 indicator items)	0.860	71.82%
Trust (with 2 indicator items)	0.687	76.16%
Satisfaction on process (with 6 indicator items)	0.891	64.93%

[a]Construct reliability is estimated using Cronbach's α coefficients.
[b]Portion of variance extracted is estimated by computing, squared sum of factor loadings/number of factors of the underlying construct.

4.3 Hypothesis testing

The hypotheses were tested using Analysis of Variance (ANOVA) and regression analyses with a level of significance of 0.05. Any weak significance level in the range of .05 to .10 was treated as suggestive of the nature of relationship between the variables. SAS software was used for the statistical

analyses to develop General linear models (GLM) for ANOVA and regressions.

The outcome controls involved two categories for each of the treatments - time pressure and reward inspiration. The results of ANOVA demonstrate that groups having time pressure have higher motivation and trust. Reward inspiration does not change the psychological factors significantly. Although both treatment variables (time pressure and reward inspiration) are included in the same General linear model (GLM) for ANOVA, the results are presented separately in tables 2a and 2b.

Table 3a. Means and Standard Deviations of Dependent Variables and Results of ANOVA – [Treatment: Time Pressure]

Dependent Variable	Mean (Std Devn)		F-statistic	Prob. (F) Hypotheses Support
	Time Pressure	No Time Pressure		
Distraction	1.925 (0.552)	2.216 (0.756)	0.95	0.341 H1a: No
Motivation	4.781 (0.222)	4.514 (0.332)	4.49	0.048 H1b: Yes
Trust	4.635 (0.341)	4.347 (0.344)	3.68	0.070 H1c: Yes (Weak)

Table 3b. Means and Standard Deviations of Dependent Variables and Results of ANOVA – [Treatment: Reward Inspiration]

Dependent Variable	Mean (Std Devn)		F-statistic	Prob. (F) Hypotheses Support
	Reward	No Reward		
Distraction	2.084 (0.718)	2.068 (0.644)	0.00	0.949 H1d: No
Motivation	4.688 (0.237)	4.591 (0.380)	0.52	0.480 H1e: No
Trust	4.528 (0.382)	4.438 (0.360)	0.34	0.566 H1f: No

Next, we tested whether the psychological factors have relationship with information that is shared among the members in each group and the solution quality. We regressed the dependent variables (i.e. total number of information shared and solution quality) on distraction, motivation and trust. As shown in table 3, we did not find any support for hypotheses 2 and 3. In other words, neither the information shared nor solution quality was found to depend on distraction, motivation, and trust. We wanted to ensure that the regression results were not distorted because of multicollinearity among the independent variables. We found that the average variance inflation factor (VIF) across all predictors (distraction, motivation, and trust) in the regressions was 2.16, which indicates that multicollinearity may exist across the predictors.

Table 4. Results of regression analyses for problem-solving outcomes

Independent Variable	Solution Quality	Information Shared
Intercept	15.438*	-320.835*
Distraction	-0.791	13.77
Motivation	1.070	30.510
Trust	1.633	59.981
R-Square	0.329	0.312
F	3.11	2.88
Prob. (F)	0.051	0.063
N	23	23
Hypotheses Supported?	H3: No	H2: No
* p<0.10; ** p<0.05; *** p<0.01; **** p<0.001		

The existence of multicollinearity across the predictors (distraction, trust and motivation) makes the coefficients estimated through ordinary least squares fit imprecise. We, therefore, had to use ridge regression, which is more appropriate than ordinary least squares regression in estimating regression coefficients when predictors are multicollinear [15, 23, 24]. By allowing a small amount of bias in the estimates, ridge regression can combat the influence of "multicollinearity" and help to obtain more reasonable coefficients [23]. This technique involves the introduction a small biasing parameter k in the model used for estimation. Our results indicate that the use of ridge regression may be useful in obtaining improved point estimates of the parameters of the research model. As shown in figure 2, motivation and trust has positive impact on solution quality while distraction has negative effect on it. From figure 3, we find that both motivation and trust have positive effect on information shared while distraction has a small negative impact on it. While interpreting the results from each graph in figures 2 and 3, we focused on the portion of the graph in which the coefficient estimate seems to have stabilized.

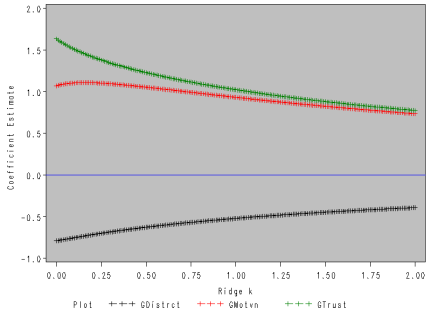

Figure 2. Ridge Plot for Solution Quality

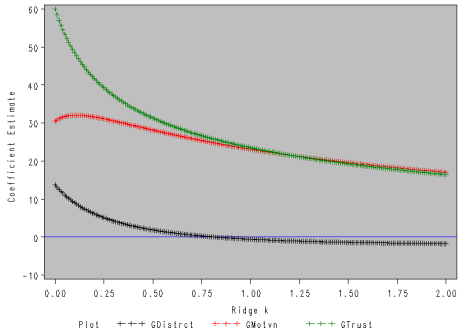

Figure 3. Ridge Plot for Information Shared

5. Discussion

Our research suggests that virtual teams working under specific outcome controls, such as time pressure and reward inspiration can effectively share information and improve group performance. Our findings find support in prior research on collocated and virtual teams [29, 30, 27, 39]. However, prior research did not consider the effect of outcome controls on psychological factors of virtual teams and tie the psychological factors to group performance. By including the psychological factors in our study we find that time pressure can increase motivation and trust. However, reward inspiration has not been found to significantly relate to any psychological factor. The reward control employed in our study was perhaps not sufficient to influence the psychological factors of the team members. Due the influence of multicollinearity, no psychological factor is found to improve information sharing and solution quality in virtual teams. We therefore conduct ridge regressions to improve the estimates. The findings reveal that motivation and trust have positive effect on information shared and solution quality. After examining the ridge plots, we find that distraction has the least predicting power. We also find that both motivation and trust are highly correlated (r=0.710). As such, we drop distraction and conducted factor analysis to determine whether the indicator items representing motivation and trust load on one factor. We find that all items when loaded on one factor have acceptable factor loadings; most of the loadings are above 0.75; only two items have relatively lower loadings, which are 0.50 and 0.58. The combined factor is considered as an independent variable and is referred as the psychological factor in this paper. Both information shared and solution quality are regressed on the psychological factor. We find that both information shared and solution quality have positive relationship with the psychological factor ($\beta_{\text{information shared}}$=37.443 and $p_{\text{information shared}}$=0.009; $\beta_{\text{solution quality}}$=1.908 and $p_{\text{solution quality}}$=0.008). These results together with the findings from the ridge regression analyses strongly imply that the psychological factors are related to information sharing and solution quality in virtual teams.

6. Research Implication

The empirical research has significant practical implications. The proposed model can be extended to justify or adjust the utilization of various outcome controls, mitigate the negative influence of psychological factors introduced by controls, and maximize their positive impact on information sharing and problem-solving outcomes. Some traditional thinking about outcome controls may be modified. For example, subjective time pressure, in fact, may facilitate effective information sharing and improve team performance in turn.

7. Conclusion

The psychological factors focusing on members, teams and tasks may be important in understanding the contradictory findings based on the study of problem-solving processes and outcomes in virtual teams. Through an examination of the psychological factors, we find some unexpected or unintended effect of outcome controls which contradicts the findings of prior research reported in the literature [29, 30, 27, 39]. Time control, emphasizing efficiency of team work, motivate members to put effort and trigger interpersonal trust which increases the level of information sharing and solution quality. The findings do not extend to reward control.

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Appendix I
A coding system for message classification
(Adapted from Connolly et al. [7])

Parsing rules for message coding:

1. Text continuing should be coded as one unit.
2. Assign text into first category which shows a good fit (i.e., first try to assign as PI; if this fails, try as TI-D; etc.)

Categories

PI	*Any text not covered in the introduction paper but related to the project is counted as process information, e.g., "You can write two labels on the line showing cardinality if you want".*
TI-D	*Any text covered in the introduction paper is counted as task information.* *Any new task information covered in the introduction paper is coded as distributed information, e.g., "I have information about authors, which will be an entity".*
TI-E	*Any old task information covered in the introduction paper is coded as explained information, e.g., "From book to publisher, I think the relationship is backward, the mandatory one should be on the other side".* *For any old information, supportive statement (e.g., "You are right. It's a weak entity"), confirmation (e.g., "That's an easy enough relationship"), critical argument (e.g., "Branch number shouldn't be added with book entity"), query statement (e.g., "sequence or sequence_no?") are coded as explained information.*
OTT	*Text that are not related to the project and do not fit into the existing categories, e.g., "I didn't have breakfast".*
UC	*Uncodable text.*

Appendix II
A flow chart used to evaluate the solution quality