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EXPLORATION OF EDUCATIONAL BACKGROUNDS, PERSONALITY TRAITS, AND GENDER ON TENDENCIES TO COLLABORATE AMONG OWNERS, ARCHITECTS, ENGINEERS, AND CONTRACTORS

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ABSTRACT

The construction industry is challenged by a lack of collaboration and trust, leading to an adversarial relationship among project stakeholders. With the introduction of Lean-Integrated Project Delivery (IPD) processes, collaboration has become a key strategy for increasing productivity. This research leveraged game theory and the Maroon-White simulation to explore whether there is any correlation between the educational background of owners, architects, engineers, and contractors and their tendencies to collaborate. It also explored whether there is a correlation between tendencies to collaborate based on various personality types as measured by Jung/Isabel Briggs Myers typology. Although results from this research are preliminary, university students studying to enter the OAEC stakeholder practices (Owner Architecture Engineering and Construction) showed similar rates of tendencies to collaborate. Correlation with personality types was inconclusive. However, multiple rounds of play often revealed long-term negative impacts when one team betrayed a collaborative agreement for its personal benefit. Also, although teams with females did not significantly modify the numerical results, facilitators noticed that women often openly voiced that a collaborative strategy would gain the most points, yet their suggestions tended to be dismissed by teammates. Further research is needed in this area.

KEYWORDS

Lean Construction, Maroon-White Game, simulation, integrated project delivery, IPD contract, collaboration, trust, betrayal, personality traits, gender.

INTRODUCTION

The construction industry is confronted by challenges such as a paucity of collaboration and trust, ineffective communications, and a lack of systems thinking. These attitudes are arguably partly responsible for adversarial relationships between Owner, Architecture, Engineering, and Construction (OAEC) [3] stakeholders (Elmarsafi 2008). Collaborative friction can lead to project delays, difficulty in resolving claims, cost overruns, litigation, and a win-lose climate

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[3] The acronym OAEC is used here instead of the more typical AECO to refer to Owner Architect Engineer and Contractor stakeholders. The (re)ordering is intentional to acknowledge the primary focus of the team in Lean-IPD is to align with the Owner's needs.

that affects all the project stakeholders. It is therefore worthwhile to explore tendencies toward collaboration or non-collaboration among students who are being educated to enter OAEC-related practices.

Research shows that with the evolution of construction projects from Design-Bid-Build[4] to the Design-Build[5] and Integrated-Project-Delivery[6] (IPD) methods, the need for collaboration is high. Shelbourn et al. (2007) argues that with advancing methods, it is time for the construction industry to embrace new ways to improve productivity, mitigate litigations, and to deliver at its best the demands of the Owner. Also, the construction industry's success depends on the collective efforts of players from different companies and backgrounds. To achieve this, collaboration and trust among key players in the industry are critical.

Research suggests that for the implementation of Lean-IPD, collaboration plays an important role (Smith 2013). With lean manufacturing principles giving rise to lean construction, IPD processes have helped to improve collaboration levels among different key players (Mesa et al. 2019). Yet even with the implementation of IPD, lack of trust and collaboration among stakeholders still exists. One possible reason for deficits in collaboration is the uniqueness of each construction project; repeating partnerships do not happen often. Also, natural competitive tendencies can often spur on sub-optimization and subsequent long-term losses (Smith and Rybkowski 2013).

The objective of this research was to investigate the potential influence of the educational background of owners, architects, engineers, and contractors on tendencies to collaborate in the construction industry. Also, based on the assumption that extroverts may tend to collaborate more than introverts, the research attempted to determine whether this is true in the case of OAEC disciplines. Finally, the research serendipitously explored whether, when in competitive teams, women tend to collaborate more than men.

SIGNIFICANCE OF THE STUDY

Collaboration plays an important role in the success or failure of Lean-IPD. An understanding of cultural and educational tendencies towards collaboration or non-collaboration of stakeholders offers a glimpse into factors that might facilitate or impede collaboration. For example, by understanding if there are disciplines that have lower tendencies to collaborate, a college curriculum can be structured to address the importance of collaboration. Optimization of the whole over the parts is one of the key tenets of lean, and stakeholder understanding of it facilitates implementation of IPD.

THE NEED FOR INTER ORGANIZATIONAL COLLABORATION

Collaboration has been defined as the process of shared decision-making among independent parties, involving joint ownership of decisions and collective responsibility for outcomes (Boyle and Kochinda 2004). Collaboration includes supporting sustained teamwork by creating a culture that values personal integrity, giving power and respect to each person's voice, integrating individual differences, resolving competing interests and safeguarding the essential contribution each must make to achieve optimal outcomes (Sterchi 2007). To become successful at a job it is necessary to coordinate with others (Johnson and Johnson 2004). Collaboration can be the key to overcoming work-related obstacles (Vygotsky 1978).

Basic essential characteristics of a group setting should include the following: cooperation, conversation, teamwork, confidence and coherence (Greenlee and Karanxha 2010).

[4] Design and construction are separate contracts; lowest construction cost is the criteria for final selection (Kenig 2011)

[5] Design and construction contracts are combined (Kenig 2011)

[6] Key parties are involved from the inception of the project and use a multi-party contract (Kenig 2011)

Constructive conversation tends to bond team members together. Sarker et al. (2011) concluded that better interactions lead to higher levels of achievement.

Inter-organizational collaboration has been shown to create a strategic advantage in most industries. According to Schifrin (2001), strategic alliances are a common business strategy in the US with 10,000 partnerships being created each year. In an industry such as construction, the conditions for the practice of inter-organizational collaboration are ripe. Opportunism by team players is readily available in most construction projects and generally comes at the expense of the other players or the project as a whole (John 1984). Research has also identified trust as one of the most effective ways to prevent opportunism (Walker 2003). When group members are familiar with one another, it can lead to an improved team environment, which shows tendencies to collaborate (Janssen et al. 2009; Stark and Bierly 2009). Inter-organizational collaboration has been studied across industries and has been shown to increase organizational capabilities and value generation through exchange of resources—thus contributing to an organization's competitive advantage (McEvily et al. 2003).

INTEGRATED PROJECT DELIVERY (IPD)-COLLABORATION

Integrated Project Delivery (IPD) is defined as a "project delivery approach that integrates people, systems, business structure and practices into a process that collaboratively harness the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste and maximize efficiency through all phases of design, fabrication, and construction" (AIA 2007). IPD, in contrast to the traditional method of delivery, integrates all key players from the project's inception. It leverages early contributions and expertise through utilization of new technologies, allowing all team members to add value and to realize their potential for contributing to the project. IPD seeks to improve project outcomes through a collaborative approach of aligning the incentives and goals of the project team through shared risk and reward, early involvement of all parties, and a multiparty agreement (Kent and Becerik-Gerber 2010).

Collaborative working is considered by many to be essential if design and construction teams are to consider the whole lifecycle of the construction process (Shelbourn et al. 2007). Inherent within this agenda of new ways of working is a move toward collaborative working and its associated fields: concurrent engineering and lean production (Anumba et al., 2004). Collaboration is essential if design and construction teams are to address the entire lifecycle of the construction product and take account of not only primary functionality but also productivity, buildability, serviceability, and even recyclability (Kusiak and Wang, 1993). Cooperative relationships among the supply chain actors (referred to as partnering) are an important element of lean construction (Naim and Barlow, 2003; Green and May, 2005; Jorgensen and Emmitt, 2008), facilitating the integration of different actors' competences and efforts toward joint problem-solving. At the core of IPD are collaborative, integrated and productive teams composed of key project participants (AIA 2007, Mesa et al. 2019). Guided by principles of trust, transparent processes, and effective collaboration, the IPD teams build upon early contributions of an individual's expertise.

New technologies when utilized in conjunction with collaborative processes are demonstrating substantial increases in productivity and decreases in requests for information, field conflicts, and other forms of waste (AIA 2007). AIA claims Integrated Project Delivery is built on collaboration, which in turn is built on trust. With better collaboration, the key players focus more on the success of the project rather than on individual goals. Without collaboration, IPD will falter, and participants will remain in the adverse and antagonistic relationships that plague the construction industry (AIA 2007). Kulkarni et al. (2012) discovered that collaborative project delivery systems produce more reliable cost outcomes for public owners. One of the factors that can undermine implementation of IPD is fear of loss of individual interest.

Huxom (1993) claims that the key disadvantages of collaboration are loss of control, flexibility, and glory. Despite these disadvantages, however, the benefits of collaboration override the disadvantages (Huxom 1993).

EDUCATIONAL INFLUENCE ON TENDENCY TO COLLABORATE

Collaboration has been studied substantially in a variety of fields. Borrego (2006) claims that engineers tend to view collaboration as an isolated division of labor and the views on collaborative relationships vary markedly between technical and social science fields. Also, Borrego et al. (2008) observed that the way an individual understands and appreciates the nature of knowledge affects the way he or she collaborates with colleagues in different academic disciplines. According to Lin and Darnall (2015), some organizations find it difficult to configure alliances for mutual benefit, resulting in the failure of half of strategic alliances.

With the advent of IPD, inter-organizational collaboration plays an important role. AIA claims that without collaboration IPD fails. In recent decades, collaborative working has focused on the delivery of technological solutions (Faniran et al. 2001; Karasu et al. 2022). There is a need for research on the human-related factors influencing the level of collaboration among the project stakeholders.

Borrego (2008) observed that the way an individual appreciates the nature of knowledge affects the way he or she collaborates with colleagues in different academic disciplines. Much of the research on the topic of influence of educational background on the level of collaboration has been conducted in the fields of health care, engineering, and social science. For example, Stacy (2007) claims that nurses have a better collaborative approach than physicians.

WOMEN AND TENDENCY TO COLLABORATE

According to research literature, women tend to be less competitive than men. Gneezy et al. (2003) found that women were less effective than men in competitive environments, despite the fact that their performance was similar to that of men in a non-competitive environment. Niederle and Vesterlund (2007) concluded that women tend to shy away from competition. In terms of group processes, Woolley et al. (2010), concluded that group collaboration is greatly improved by the presence of women in a group. In a study of group performances, Fenwick and Neal (2001) found that, on a management simulation task, groups with a greater number of women performed better than homogeneous groups.

In a meta-analysis comparing men and women in terms of task and interpersonal styles, Eagly and Johnson (1990) found that women were significantly more interpersonally oriented than men. The styles of males tend to be more autocratic than those of females (i.e., giving orders), whereas the styles of females tend to be more democratic than those of males (i.e. focus is on participation). In addition, when comparing all-female versus all-male groups, all-female groups demonstrate more egalitarian behaviors, such as equal amounts of communication among group members and shared leadership (Berdahl and Anderson 2005). While these findings may be undergirded by physiological and hormonal differences between males and females, results may also vary according to context and cultural practices.

GAME THEORY: PRISONER'S DILEMMA AND THE MAROON-WHITE GAME

The Prisoner's Dilemma has been defined as a paradox in decision analysis in which two individuals acting in their own best interest pursue a course of action that does not result in the ideal outcome. The typical prisoner's dilemma is set up in such a way that both parties choose to protect themselves at the expense of the other participant. As a result of following a purely logical thought process to help oneself, both participants find themselves in a worse state than if they had cooperated with each other in the decision-making process. The exercise explores the conflict between social incentives to compete versus those encouraging cooperation (Holt and Capra 2000). Research shows that when given the option to cooperate with another party

or look out for one's own best interests, barring additional incentives, the selection of a cooperative move is unlikely (Axelrod 1981; James Jr. 2002; Smale 1980).

The Maroon-White Game is an example of prisoner's dilemma. The Maroon-White Game is a three-group non-zero-sum game. A non-zero-sum game describes a situation where one team scoring points does not necessarily mean that fewer points are available for the other teams (Von Neumann and Morgenstern 2007). This type of game is commonly used in situations where cooperation between teams is a possibility.

This study used the simulation, the Maroon-White Game (Smith and Rybkowski 2013), to explore whether the educational backgrounds of four different stakeholders (owners, architects, engineers and contractors) influence their tendencies toward collaboration. The Maroon-White Game helps reveal whether individualism is favored over collectivism or vice versa in an organization and in the industry in general. This research also explored whether women have a higher tendency to collaborate when compared to men and whether specific personality types as defined by the by Jung/Isabel Briggs Myers Typology test are more or less likely to collaborate.

RESEARCH METHODOLOGY

INTRODUCTION

This research asked the following question: Is there a correlation between educational background and tendency to collaborate (TTC), specifically among those preparing to enter OAEC practices following graduation? Also: Does personality type, defined by the Jung/Isabel Briggs Myers Type Indicator, make a difference? Does gender? To address these research questions, researchers invited fourth year undergraduate students at Texas A&M University to participate in the Maroon-White Game (Smith and Rybkowski 2013).

DATA COLLECTION

Courses at Texas A&M University in the four disciplines of Business, Architecture, Engineers, and Construction Science representing the Owners, Architects, Engineers, and Contractors in the construction industry were selected for participation.

A recruitment email was sent to instructors of courses in these disciplines asking their permission to administer the game in one of their classes. Participants were asked to sign off on an informed consent form, required by the Institutional Review Board (IRB of Texas A&M University). The game was administered to two (2) senior-level business classes, one (1) graduate-level business class, three (3) senior-level architecture classes, two (2) senior-level construction science classes, and one (1) senior-level civil engineering class. Also, the game was played with members of one (1) construction company during a separate facilitation.

RESEARCH TOOL: THE MAROON- WHITE GAME

Simulation games are commonly used for research and teaching in the field of Lean-IPD (Bhatnagar et al. 2022). The Maroon-White game was used to address the stated research questions and played according to instructions in Smith and Rybkowski (2013). The Maroon-White Game was derived from the Red-Black Game outlined on the College of St. Benedict website (CSB-SJU n. d.) and was facilitated as follows: The facilitator divides participants into three teams: A, B, and C, and writes a score chart (Figure 1) on a chalkboard, flip chart, white board, etc. or projects the chart on a wall for everyone to see. Each team is given two cards written with "M" (maroon) and the other with "W" (white). Teams are instructed to discuss their decision to simultaneously hold high either the M or W card when instructed to do so. The facilitator repeats only one phase: "The object of the game is to gain the maximum number of points." Participants successively play seven (7) rounds and after each round the score is recorded. Teams are permitted to send an ambassador to negotiate with the other teams'

representatives starting from Round 3. If participants ask whether the maximum number of points is for the total group or individual teams, the facilitator simply states "both," and repeats: "The object of the game is to gain the maximum number of points."

If all teams declare "white" by the third round, the facilitator can invite each team to send an ambassador for a few minutes outside the room to negotiate on their behalf. The game is finished after seven rounds of play.

	A	B	C
MMM	50	50	50
WMM	100	0	0
WWM	0	0	0
WWW	0	0	0

Figure 1: Maroon-White Game Scoring Chart

Discussion following play included asking the following questions: What is the best way to maximize your points? What did you learn from this game? How did a betrayal (if any) affect your decision as a team? Once the trust is lost by selecting white, what effect did it have on you as a participant? How can this game be applied to construction? What factors affect one's ability to maximize points?

For this study, the number of female participants and personality types was collected. The researchers acknowledge that the Jung/Isabel Briggs Myers Typology Test is just one of several recognized personality tests; however, as it is widely known and used, the test was selected and virtually administered to participants before the game as one way to determine the personality type of the participants. The test defines 16 personality types made from the following combinations: E (Extraverted) vs. I (Introverted); N (Intuitive) vs. S (Sensing); F (Feeling) vs. T (Thinking); J (Judging) vs. P (Perceiving) (Human Metrics n. d.).

DATA COLLECTION & ANALYSIS

Data collected included:

- TTC (Tendency to Collaborate) = (Number of Maroon Responses ÷ Total Number of Responses) *100
- The percentage of women in each team
- The percentage of extroverts per team.

The left and right tallies in Figure 2 represent the worst and most-commonly observed scenarios, respectively. The middle tally shows the results if the teams pursued a collaborative approach. If the teams collaborate in each round, the maximum points that each team could gain is 350– and the total points would be 1050. A fully collaborative approach maximizes both the individual team points and total points. Teams play seven (7) rounds to mimic a potential real-world scenario where individuals elect to trust or not trust other individuals and teams, based on prior experience with those actors.

Table 1 lists the average TTC observed for Business Seniors, Business Graduates, Construction Science Seniors, Civil Engineering Seniors, Architecture Seniors, and the construction company. Figure 3 compares their TTC, showing similar rates of TTC per discipline. TTC is the lowest for the construction company when compared to the average TTC across Business Seniors, Business Graduates, Civil Engineering Seniors, Construction Science Seniors, and Architecture Seniors at Texas A&M University. Teams A and B consistently declared white, while team C frequently declared maroon. The low TTC among many members of the construction company may be attributed to the fact that teams A and B worked daily with subcontractors on low bid projects and so were unwilling to extend trust (according to teams A and B) while team C was composed entirely of estimators who stated they trusted one another.

The average TTC for all the academic disciplines was found to be 36.34% and the TTC for the construction company was lower than the than the average TTC among disciplines by 12.54%. Comparing only the disciplines across Texas A&M University, it can be observed from Figure 3 that the architecture senior students had the highest TTC with 39.15%. The business graduates and the civil engineering seniors had the second highest TTC with 38.09%. Construction Science seniors had the third highest TTC with 37.80%. The business seniors had the lowest TTC when compared to all the other disciplines with TTC of 28.56%, however this may simply reflect natural variation. Ultimately, there was no evidence that the level of collaboration is influenced by educational background. To verify whether gender plays any role in levels of collaboration, the percentage of females per team was calculated and their TTC was plotted in scatter plot. Figure 4 shows the scatter plot of percentage of women per team and their TTC.

Worst Case Scenario

Rnd		A	B	C	
1	WWW	0	0	0	0
2	WWW	0	0	0	0
3	WWW	0	0	0	0
4	WWW	0	0	0	0
5	WWW	0	0	0	0
6	WWW	0	0	0	0
7	WWW	0	0	0	0
		0	0	0	0

Best Case Scenario

Rnd		A	B	C	
1	MMM	50	50	50	150
2	MMM	50	50	50	150
3	MMM	50	50	50	150
4	MMM	50	50	50	150
5	MMM	50	50	50	150
6	MMM	50	50	50	150
7	MMM	50	50	50	150
		350	350	350	1050

Most Common Scenario

Rnd		A	B	C	
1	WWW	0	0	0	0
2	WWW	0	0	0	0
3	MMM	50	50	50	150
4	WMM	100	0	0	100
5	WWM	0	0	0	0
6	WWW	0	0	0	0
7	WWW	0	0	0	0
		150	50	50	250

TTC (left to right): (0/21) = 0% ; (21/21)*100 = 100% ; (6/21) = 28.5%

Figure 2: Possible Combinations and Commonly Observed Results.

Table 1: Disciplines and Their Average TTC (Tendency to Collaborate)

Group tested	No. of participants	TTC (mean %)
Business Seniors	44	28.57
Architecture Seniors	43	39.15
Construction Science Seniors	35	37.80
Business Graduates	16	38.09
Civil Engineering Seniors	14	38.09
Construction Company	13	23.80
	165	34.25

Note: The full set of results data for this research is available at Ramanath (2014). The mean TTC of student teams was 36.34%.

Because the percentage of female participants in each team was small (24% on average), it cannot be concluded that there is a difference in the level of collaboration based on the gender (Figure 4). However, if the women on the teams (the minority) had an intention to collaborate there is a possibility that the men on the teams (the majority) who did not wish to collaborate dominated. For example, it was observed that, in several instances, the individuals who suggested to collaborate while playing this game were females who were silenced, and their recommendation dismissed by teammates. We do not know whether the results would have been different had the teams been composed primarily of women. This needs to be further tested with larger sample sizes.

To verify whether the personality types play a role in the tendency to collaborate, the percentage of each personality type in each team was calculated and its TTC graphed in a scatter plot. From Figure 5 it can be seen that there is no significant statistical evidence to show that

extroverts, intuits, feelers, and the judgers have a better tendency to collaborate when compared to the introverts, sensors, thinkers and feelers respectively. However, it cannot be concluded that personality types does not influence the tendency to collaborate. To validate the results, more research needs to be done on the personality traits and their influence on tendency to collaborate.

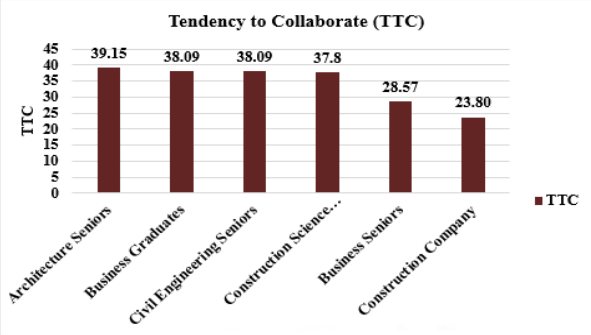

Figure 3: Disciplines and Their Average TTC

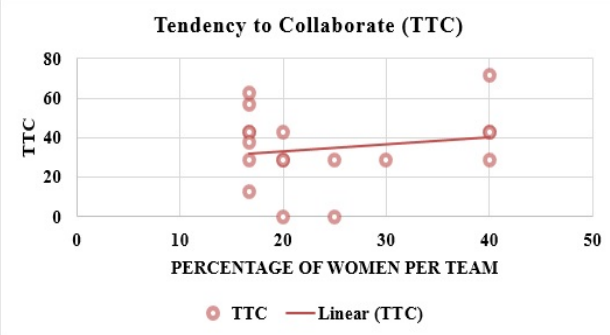

Figure 4: Percentage of Women per Team and Their TTC-Scatter Plot

DISCUSSION

A majority of the OAEC students from Texas A&M University appeared driven by competition during the initial rounds of the Maroon-White Game. It was observed they had an attitude of individualism over collectivism. It appears that natural competitive tendencies can often result in sub-optimization and long-term losses (Smith and Rybkowski 2013) and that these tendencies held true for the games administered. Researchers observed that an inability to collaborate with other teams prevented potential gains both in the short- and long-term. There seems to be a natural proclivity not to trust other teams in a competitive environment. The majority of participants chose "white" as their first choice during the game as they did not initially perceive the numerical benefit of collaborative thinking. Also, it was seen that the tendency to betray was often highest after gaining trust from other teams that agreed to declare "maroon." In other words, one team would often betray the other two teams even after all agreed that they would choose maroon. Subsequent to a betrayal, the other two teams would refuse to place themselves in a situation where they might be taken advantage of again, ultimately reaching the point where all three teams selected "white" during each round; teams even openly stated their intentions of doing so indefinitely. In fact, in only one (1) out of the ten (10) trials were teams able to regain collaboration following a betrayal. Because it is played in multiple rounds, the Maroon-White Game can be used to demonstrate to participants how natural tendencies to sub-optimize can substantially and negatively impact long-term gains, trust, and collaboration.

An unexpected outcome from observations of the M/W Game is that a formal, legally enforceable IPD contract is potentially preferable as it can help protect those who act with the expectation that others are trustworthy. This is because the "most common scenario" shown in Figure 2 illustrates how frequently one team chose to renege their verbal commitment to collaborate; most teams refused to collaborate during subsequent rounds following a betrayal. This recommendation differs from the partnering agreements popular in the 1990s where signed partnership agreements represented intentions to collaborate but did not hold legal standing.

Although this game is not an exact simulation of project delivery processes, it can arguably mimic the typical mindset of industry stakeholders and depict their typical decision-making processes. As discussed earlier, once the game was completed and outcomes discussed, a majority of participants agreed that collaborating maximized points and that they were sub-

optimizing by not collaborating. The initial lack of trust and the betrayal impacted future decisions. This outcome demonstrated the need to develop sustained long-term relationships in the industry, and an integrous reputation to undergird trust. This game demonstrates that the tendency to sub-optimize can damage the development of a long-term sustained relationship. Interestingly, when Gandhi (2014) used the M-W game to test TTC of architecture students, he found a slight drop in students between their first and fourth year, suggesting a possible erosion of trust over time. Similarly, in this study, those working for a general contractor showed a lower TTC than the university students; this may also represent a further decline of trust once stakeholders enter the industry. Also, with respect to the general contractor, two of the three teams that worked daily with subcontractors[7] in the field argued their work "taught them never to trust" which helped explain, they said, why they insisted on declaring "white" and never "maroon" throughout the game. The only team that showed any tendency to collaborate explained that they were all estimators for the same company, so were accustomed to extending a level of trust between themselves.

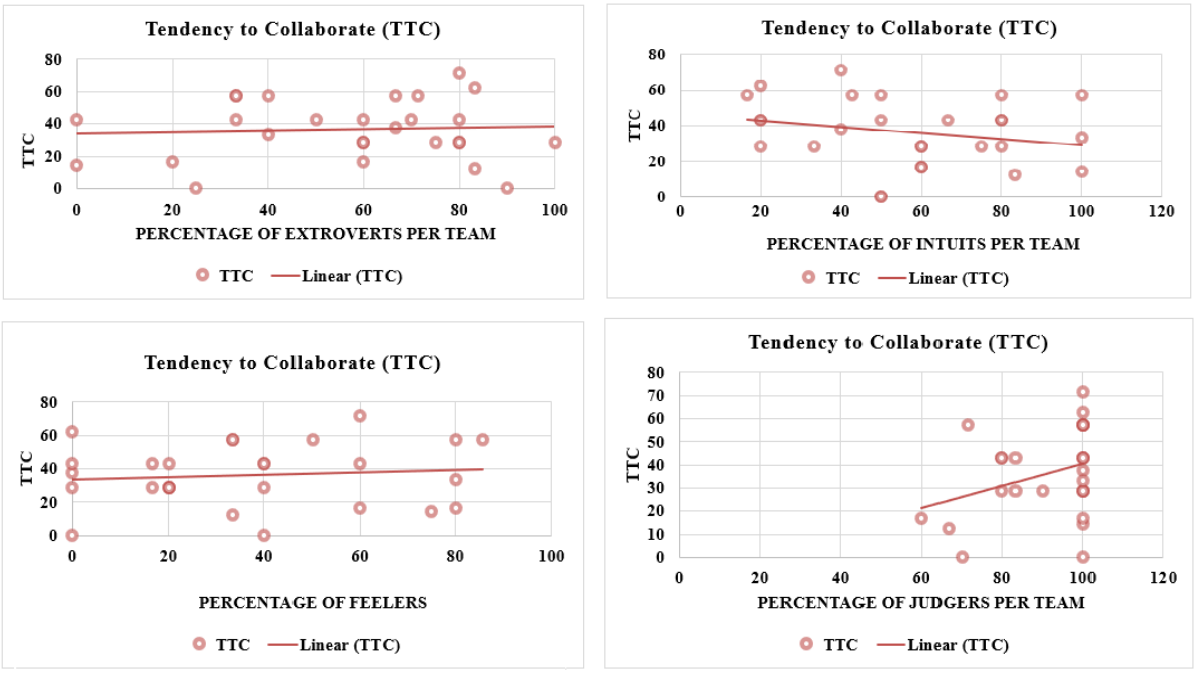

Figure 5: Percentage of Extroverts, Intuits, Feelers, & Judgers per Team and Their TTC

One important lesson from the game is that collaboration is important for sustaining long-term relationships. During the post-game discussion, participants stated the following factors that affected their tendency to collaborate: Absence of trust; lack of proper incentives; past experience; fear of betrayal; personality types; competitiveness; not seeing the long-term benefit; cultural differences; not knowing people enough or lack of a previous relationship; and favoring capitalism.

Recommended countermeasures to improve collaboration in the construction industry included: Change of mindset by playing games such as M-W; collaborative project delivery methods such as IPD; early negotiations; early and constant communication among stakeholders; setting expectations among stakeholders and informing them; mutual respect; and sustainment of long-term relationships to develop trust.

There were of course limitations with this exploratory research. For example, personality profiles of teams were collected in aggregate and individual correlations were not tracked per

[7] The term "subcontractor" is used here rather than the preferred term "trade partner" because the former was the term used by the general contracting company that did not practice Lean-IPD at the time of play.

se. Also, prior collaborative work experience of participants was not tracked. Finally, larger sample sizes are needed to achieve statistical significance.

CONCLUSION

This research investigated the tendency to collaborate among different disciplines. The average TTC's for business seniors, architecture seniors, engineering seniors and the construction science seniors were found to be 28.57%, 39.15%, 38.09%, and 37.80% respectively. The average TTC of business graduate students was found to be 38.09%. The architecture seniors had a higher TTC compared to all other disciplines. However, overall differences in TTC were not highly significant.

Of special interest is the observation that an actual construction company had a lower TTC than the average of student groups tested. It would be helpful to study this phenomenon further to determine whether the outcome is generalizable to include other general contractors and if so, why this might be so. Finally, how might contractors perform that are already accustomed to Lean?

This research also provided a platform to verify whether gender influences tendencies to collaborate. Based on numerical results, it appeared that gender did not appear to have an influence on tendency to collaborate. However, these final numerical outcomes were at odds with facilitators' observations that several females attempted to recommend collaboration during play, but their recommendations were often dismissed or ignored. Further research in this area is worth pursuing.

This research also explored whether personality types play a role in the tendency to collaborate. By comparing the percentage of extroverts, intuits, feelers, and judgers in each team to their TTC, there was no statistical evidence to conclude that personality types have an influence in the tendency to collaborate. However, further research is required to statistically validate the results.

Finally, the research revealed the corrosive effect of a single betrayal on the decision of the other teams to continue to collaborate. Recovering to a state of collaboration and trust seemed extremely difficult as only in one case out of ten were the teams able to collaborate fully once trust had been betrayed.

Opportunities for additional future research include exploring how the M/W game might be used to identify readiness of teams for IPD. It would be worth investigating if the game can help heighten awareness among project team members about the benefits of developing a more collaborative mindset before embarking together on an actual Lean-IPD project. It would also be valuable to systematically test to see if there may be generalizable differences in the tendency to collaborate between females versus males.

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