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Multi Actor Organizational Structure: The Effect of Interdependence on Performance in BIM Organizations

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MULTI ACTOR ORGANIZATIONAL STRUCTURE:
THE EFFECT OF INTERDEPENDENCE ON PERFORMANCE IN BIM ORGANIZATIONS

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ABSTRACT

The AECO industry has employed an organizational structure based on bringing firms and individuals together to accomplish the realization of a specific task. Traditionally this structure has been defined via contract. Organizational theorists have spent a great deal of effort trying to understand the dynamics that occur when individuals come together to accomplish a specific task.

In this paper we identify Multi-Actor Organizational Structures (MAOS) as defining the breadth of formal and informal characteristics that are observed in these temporary entities. Specifically we identify two types of MAOS a 'work group' and a 'real team' that have different sets of characteristics. These different characteristics are hypothesized to affect project performance. More specifically we suggest that there is a contingency relationship between the characteristics of the MAOS and the requirements of the task.

The analysis that is presented in the paper supports the contingency perspective and provides evidence that selecting the appropriate MAOS for a task will result in superior performance of that task.

KEY WORDS
Organizational behavior, Organizational structure, Contingency theory

INTRODUCTION

The use of multi actor organizational structures (MAOS) is seminal to the architectural, engineering, constructor, owner (AECO) industry. Firm level MAOS are institutionalized in the contractual traditions that define the production process for realizing the built environment. In other industries, individual level MAOS (this includes both groups and teams) have been recognized as critical parts of the organization since the Hawthorne studies (Mayo, 1933) of the 1920s and 30s. Leavitt (1975) observed that behavioral scientist viewed the small face to face group as one the most powerful tools that organizations could employ to increase the effectiveness of making and implementing decisions. He went so far as to suggest that groups not individuals might be the appropriate foundational elements for organizational design.

In the AECO industry, despite or potentially because of the emphasis on firm level MAOS, there has been less emphasis on individual level structures. Recently there has been recognition that understanding organizational dynamics holds significant promise for improving the performance of the industry (Chinowsky etal, 2010). The dramatic adoption of building information modeling (BIM) has also spurred increase industry interest in this area. While BIM has its roots in information technology, it has become clear to industry leaders that understanding the 'Human Side of BIM' (BIMForum, 2013) is critical to the realization of the potential of this technology. The importance of understanding individual level MAOS becomes evident when it is recognized that individuals enact the decisions made at the firm level. (Puddicombe, 2013)

The relatively late emphasis on individual MAOS may work to the industries advantage as there is mixed evidence related to their performance. While anecdotal evidence has supported the positive impact of groups and teams the empirical evidence is mixed. This paper begins to address this area with the AECO industry by examining the distinct individual level BIM MAOS, groups and teams, and their effect on project performance.

The first part of the paper presents a brief review of the voluminous research that has been conducted on individual level MAOS. It then introduces a normative model for structuring high performance teams. A subset of the model and resulting hypothesis, based on the concept of interdependence, is proposed. Lastly the results of an empirical study that tests the model are presented. The results suggest that careful structuring of the multi actor organization is critical to achieving high performance.

LITERATURE REVIEW

Overview

Groups and teams (MAOS) have been a major focus of organizational research since the Hawthorne studies. Firms have embraced teams as one of the foundational elements of organizational design. However the simple adoption of MAOS does not guarantee superior performance. In fact there are significant negative outcomes associated with the structure (Hackman, 1987). The resources required for the team to function may outweigh the benefits accrued. While the goal of the team is normally high performance norms of mediocrity may be established. The best decision may be sacrificed to that which is least objectionable to the group. Destructive conflict between group members can arise. A lack of synergy between individual and group rewards can result in a state of contested collaboration "…where team members maintain an outward stance of cooperation but work to further their own interests, at times sabotaging the collaborative effort." (Sonnenwald, 2000, p. 461).

Hackman (1987) has classified research in group behavior as descriptive and normative/action based. The descriptive tradition is the oldest and largest. It is based on the familiar 'input-process-output' framework. The focus of this research has been on describing the factors and empirically validating the associations between those factors. McGrath (1964) proposed a general model for organizing this work. (See Figure1)

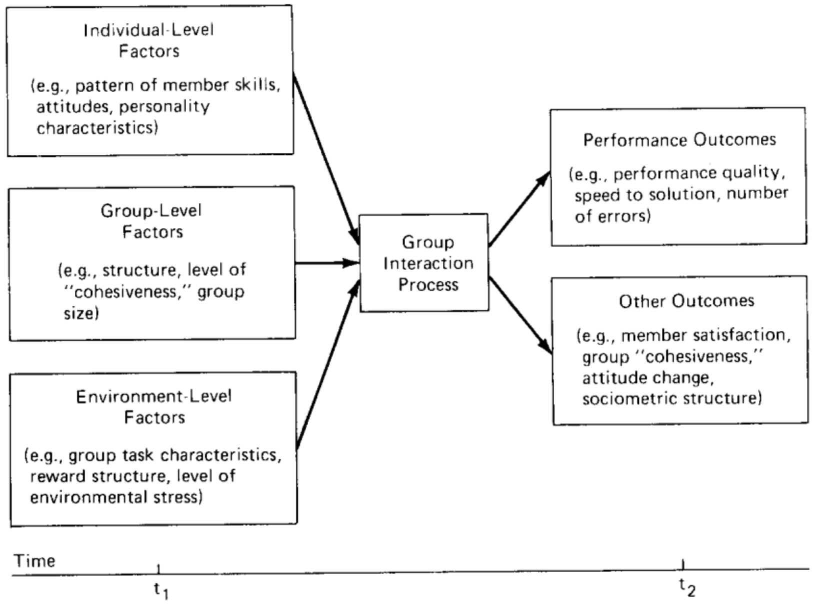

Figure 1: Input-Process-Output Model (McGrath, 1964)

The model posits three sets of inputs (individual, group and environmental) that interact in the group process to affect performance. Formally performance is described as a function of $\beta x_i+\beta x_g+ \beta x_e+ \beta x_i x_g+ \beta x_i x_e + \beta x_g x_e +\beta x_i x_g x_e$. A consist theme within this research has been the effect of the environmental factor 'task characteristics'. This suggests a contingency perspective where a match between the individual and group factors and the environmental factors is necessary in order to achieve superior performance.

Unfortunately there has not been significant consistency in the results of this research stream. As a result a number of additional models have been suggested. Figure 2 has been suggested as a possible alternative conceptualization. This model has come under criticism as it measures Process and Performance in the same time frame. While this observation may be appropriate in short lived teams, it is less significant in longer lived teams such as exist in the AECO industry. In these teams group performance can and should affect the interaction process (Puddicombe, 2006).

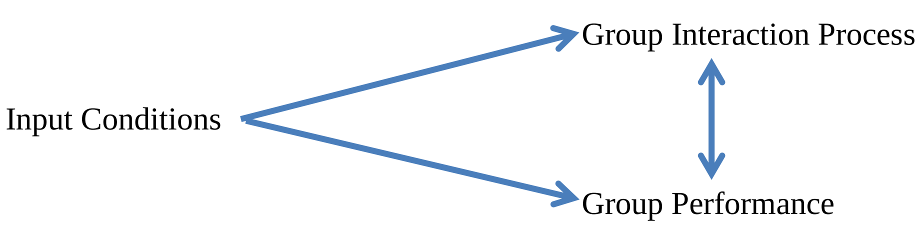

Figure 2: Alternative Model (adapted from Hackman, 1987)

Hackman's review consolidates the normative research on group effectiveness in the model in Figure 3. The first two areas are important as they describe managerial decisions related to the structure of the MAO. They also highlight opportunities and constraints that are unique to the AECO industry. The organizational context, while described as operating at a higher organizational level, could be more flexible in an AECO context. Due to the nature of the industry the systems could be adapted to the idiosyncratic requirements of the project. In the opposite manner the group design which could be determined by fiat in most industries will be subject to negotiation among the firms involved in the project.

Synergy is a variable that can work to amplify both the positive and negative effects of decisions related to the structure of the MAO. Synergy recognizes the process losses that are associated with group interaction. Positive synergy results when the interactions are positive and the 'whole is greater than the sum of the parts'. Negative synergy results when the friction associated with the group is greater than resulting benefits. Positive synergy can overcome weakness in the structure and amplify the strengths of the structure. Weak or negative synergy can weaken the effectiveness of a good structure and will amplify the negative effects of a weak structure. Synergy is then seen as resulting from the characteristics of the actors that constitute the group.

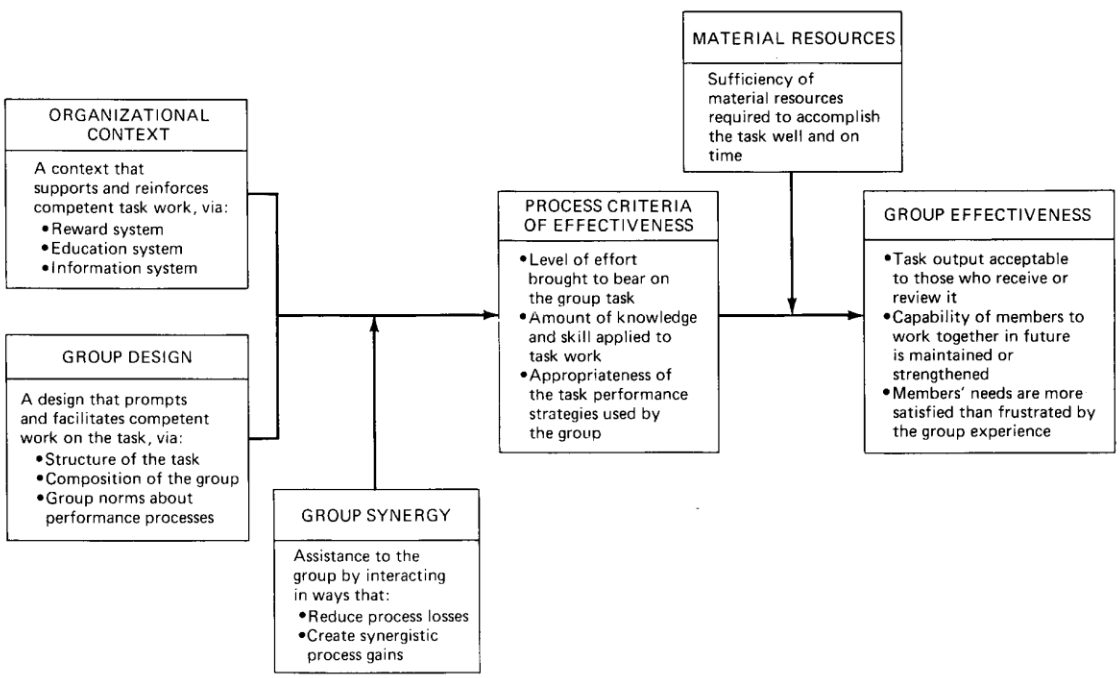

Figure 3: Normative model of group effectiveness (Hackman,1987)

The interaction of the structure and the people results in the day to day processes employed by MAO. While the structural and synergistic decisions can be described as the strategic plan the process criteria represents the tactical implementation. The plan is only as good as the implementation. The implementation will be constrained by the resources available suggesting that the resources will help determine the tactical implementation. The model suggests that group effectiveness will result following this normative approach.

Current Research

As described previously research into MAOS has produced a significant volume of work. However this has not produced a consensus, let alone a set widely accepted guidelines as to achieving high performance with groups and teams. Paulus (2004), a leading scholar in the area, argues that there are significant pitfalls associated with the use of teams and a lack of evidence related to their effectiveness. He suggests that part of the reason for this situation is methodological. Research has tended to distinguish between groups and teams and to approach each from a different direction. Research into groups has tended to be conducted via controlled experiments with students often being the actors who come together in a controlled situation for predetermined periods of time. This approach has allowed significant methodological rigor but at the expense of a 'real world' context. Work with teams focuses on field settings with groups that are ad hoc and that perform together over significant periods of time. The realism of team research is confounded by the multiple uncontrolled variables that emerge in a real world setting. This distinction between groups and teams has moved from the research arena and into the organizational realm where groups are often perceived negatively while teams are perceived positively.

Given the variety of variables described in the previous section the balance of the literature review will focus on select constructs that are suggested to effect project performance. Also given the volume of research produced in this area as well as the divisions between groups and teams we will focus on a number of meta-analyses, which will allow a condensed but comprehensive review of past research.

Researchers (Gully etal 2002; Stajkovic etal ,2009)) conducted comprehensive meta-analyses that focused on team efficacy, generalized potency and interdependence. Collective efficacy refers to the team's perception of their tasked based competency; generalized potency is similar but measures their overall perception of their competency. Both these measures are related to the synergy construct. Social cognition theory hypothesizes, and empirical research has shown, that team efficacy and potency are both associated with team performance.

Interdependence is posited to be a fundamental variable in understanding team performance (Koslowski and Bell, 2003). It is also a complex construct that has multiple dimensions. At its foundation interdependence refers to the degree to which team members must work together. The drivers of interdependence can be task based as well as structural. Task interdependence is technologically driven by the nature of activity that team is performing. Thompson's (1967) typology of pooled, sequential and reciprocal interdependence is the foundational example of task interdependence. Goal interdependence refers to the requirement that achievement of the collective goal is superior to the achievement of individual goals. Outcome interdependence refers to the existence of motivations (rewards and penalties) that are the consequence of team not individual performance. While the theoretical bases are distinct empirical evidence has suggested that the three dimensions of interdependence may represent a single underlying construct.

The results of the meta –analysis provided evidence that the both team efficacy and potency effected performance, with team efficacy demonstrating a larger effect. In addition it was found that the effect of team efficacy was moderated by the degree of interdependence. High interdependence interacted with high team efficacy to produce a larger effect on team performance.

In another study (Katz-Navon and Erez, 2005), interdependence was hypothesized to be a multi-dimensional construct. It was found to have a positive effect on the degree of collective efficacy. In addition it was also seen act as a moderator variable between collective efficacy and performance. This multi-level perspective of interdependence appears to have theoretical validity when one considers that task interdependence is an exogenous variable that is a given, while goal and outcome interdependence can be varied depending on managerial action. Stewart and Barrick (2000) recognized this distinction when they tested and found support for a model with interdependence as the main variable and its effect on performance moderated by task type.

Barrick etal, (2007) conceptually defined interdependence in terms of Katzenbach and Smith's (1993) work. They defined two types of MAOS a working group (low interdependence) and a real team (high independence). They tested the traditional concept of team processes effect on performance being moderated by interdependence. Their teams were unique in that they consisted of top management. Their results produced mixed results and suggested that increased interdependence did not necessarily translate to higher performance. Numerous other studies (Langfred, 2005; Somech etal, 2008) have also examined the relationship between interdependence and performance.

Current Study

Consolidating the research presented above the following model (Figure 4) is suggested as one that reflects both the traditions and the current trends in research into MAOS. The model suggests that managerial decisions as to the structure of the MAOS will drive the processes that the actors employ. The structure will interact with the synergy (collective efficacy, potency) of the actors. A defining characteristic of the processes employed will be the degree of goal and outcome interdependence. These processes will affect the performance of the group, but they will be moderated by the characteristics of the task to be accomplished. A defining characteristic of the task will be the degree of task interdependence required.

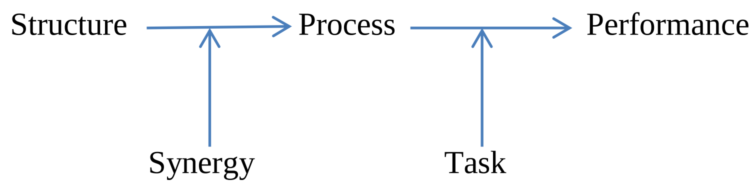

Figure 4: Revised Normative Model

This study examines the constructs process, task and performance. Specifically it addresses interdependence and performance. A contingency perspective is adopted that argues that there needs to be a match between goal and outcome interdependence and task interdependence in order to achieve superior performance.

Hypothesis: An MAOS that exhibits high goal and outcome interdependence will exhibit superior performance when matched with an activity that requires high task interdependence.

The study looked at processes that varied in their degree of goal and outcome interdependence and an activity that required high task interdependence. Drawing on Barrick etal (2007) we defined the degree of interdependence in the MAOS in terms of Katzenbach and Smith (1993) and the concept of a 'real team' vs. a 'work group'. A work group is a function of the individual members and those members take responsibility for their own results. A real team "…is a small number of people with complementary skills who are committed to a common purpose, set of performance goals and approach for which they hold themselves mutually accountable produces a collective product."

These are two different organizational forms with different characteristics that are listed below. The characteristics of a 'real team' are argued to indicate high interdependence, while the characteristics of a 'work group' indicate low interdependence. These characteristics are shown in Table 1.

The Characteristics of a Real Team	Characteristics of a Work Group
• Shared Leadership roles	• Strong, clearly focused leader solo leader
• Team discusses, decides, and does real work together	• The Leader discusses, decides and delegates
• Specific Team purpose that the team delivers itself	• The group's purpose is the same as the organizational mission
• Individual and mutual team accountability	• Individual Accountability
• Collective work products	• Individual work products
• Measures performance directly by assessing collective work products	• Measures effectiveness indirectly eg financial performance of the business
• Encourages open-ended discussion and active problem-solving meetings	• Runs efficient meetings with information sharing main activity

Table 1: MAOS characteristics (Katzenbach and Smith , 1993)

Research Methodology

A survey built on the dimensions Katzenbach and Smith proposed was developed. As part of a larger survey, members of the AECO industry who had participated in BIMForum (an industry group supported by both the AIA and the AGC) meetings were contacted by email and we received over 200 responses. Responses were received from both design and construction professionals. The respondents were asked to rate their last BIM project in terms of its performance, in terms of cost time and overall performance. They were also asked to rate the project's MAOS in terms of group and team characteristics. This was accomplished via a 7 point Likert like scale where the respondents were asked to indicate their agreement or disagreement with the team v group dimensions. The respondents rated their projects in terms of both team and group characteristics. This was important as a high rating on a team dimension does not necessarily indicate a low rating on a group dimension. For example 'Encourages open-ended discussion and active problem-solving meetings' does not necessarily preclude 'Runs efficient meetings with information sharing main activity'. Therefore for each BIM project we had three variables: a performance score, a work group score and a real team score. In this study the degree of task interdependence was held constant. A BIM project is considered an activity that requires a high level of interdependence.

Multivariate regression analysis employing STATA was employed to test the model. The analysis tested models of interdependence that included all the variables as well as one that tested the variables individually.

Results

The survey generated 272 responses. No all the surveys were complete and as a result the regression analysis includes a smaller group of cases. The breakdown of industry types is as follows: Owners-19, Architects-66 Engineers-14, CM/GC-97, Trade Contractors-23, BIM Consultant-23, Other-30. The majority of firms identified themselves as large. The majority of firms also indicated they had more than 5 years' experience with BIM.

The respondents were asked to consider there last completed BIM project. They were requested the rate their agreement with statements that indicated relative performance in terms of Cost, Time and Overall performance. They were also asked to rate their agreement with a set of statements that indicated high interdependence (team) and a set of statements that indicated low interdependence (group). As previously described the task of producing and using a BIM model is defined as having high task interdependence.

In Tables 2 and 3 the performance for the full set of high and low interdependence variables is shown. The constructs (which follow the order in Table 1) are identified as follows:

- Leadership = LEAD
- Delegation = DEL
- Purpose = PURP
- Accountability = ACC
- Work Product = PROD
- Performance measurement = PERF
- Process dynamics = DYN

As can be seen all the equations are statistically significant ($p<.00$). The pseudo R^2 for the performance variables TIME, COST, OVERALL when interdependence is high (Table 2) is .2079, .2092, .1996. The same values when interdependence is low (Table 3) are .1312, .1219, .1506. High interdependence has a greater effect size (as measure by the pseudo R^2) than low interdependence.

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	182	8	1.002742	0.2079	6.524659	0.0000
COST	182	8	1.0149	0.2092	6.576721	0.0000
OVERALL	182	8	1.024681	0.1996	6.19999	0.0000

		Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME							
	LEADT	.1673828	.065982	2.54	0.012	.0371547	.2976109
	DELT	.1596571	.0883049	1.81	0.072	-.0146295	.3339436
	PURPT	.0199407	.0554554	0.36	0.720	-.0895112	.1293925
	ACCT	.2194531	.0796613	2.75	0.006	.0622262	.3766799
	PRODT	.034095	.0885018	0.39	0.701	-.1405803	.2087704
	PERFT	.0844239	.0800022	1.06	0.293	-.0734758	.2423235
	DYNT	-.1554236	.0855912	-1.82	0.071	-.3243543	.0135071
	_cons	2.123908	.3860408	5.50	0.000	1.361982	2.885833
COST							
	LEADT	.1910266	.066782	2.86	0.005	.0592196	.3228336
	DELT	.10142	.0893755	1.13	0.258	-.0749796	.2778196
	PURPT	-.000538	.0561277	-0.01	0.992	-.1113168	.1102408
	ACCT	.2574016	.0806271	3.19	0.002	.0982685	.4165347
	PRODT	.057027	.0895748	0.64	0.525	-.1197661	.2338201
	PERFT	.047575	.0809722	0.59	0.558	-.1122391	.207389
	DYNT	-.1324112	.0866289	-1.53	0.128	-.30339	.0385676
	_cons	2.006896	.3907211	5.14	0.000	1.235733	2.778059
OVERALL		.2082117	.0674256	3.09	0.002	.0751343	.341289
	LEADT						
	DELT	.0969426	.0902369	1.07	0.284	-.0811572	.2750423
	PURPT	.001411	.0566687	0.02	0.980	-.1104355	.1132575
	ACCT	.0995064	.0814042	1.22	0.223	-.0611604	.2601732
	PRODT	.1812247	.0904382	2.00	0.047	.0027276	.3597217
	PERFT	.0068331	.0817526	0.08	0.933	-.1545212	.1681875
	DYNT	-.0344466	.0874639	-0.39	0.694	-.2070732	.1381801
	_cons	1.852592	.3944869	4.70	0.000	1.073996	2.631187

Table 2: High Interdependence - Team

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	182	8	1.058857	0.1312	3.754987	0.0008
COST	182	8	1.064742	0.1219	3.450631	0.0017
OVERALL	182	8	1.056609	0.1506	4.408388	0.0002

		Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME							
	LEADG	.004238	.0556655	0.08	0.939	-.1056285	.1141045
	DELG	.1225315	.0772517	1.59	0.115	-.0299395	.2750026
	PURPG	.0954538	.068036	1.40	0.162	-.0388283	.2297359
	ACCG	-.1100358	.0696608	-1.58	0.116	-.2475249	.0274532
	PRODG	-.0007144	.061291	-0.01	0.991	-.121684	.1202551
	PERFG	.1440848	.0655163	2.20	0.029	.0147758	.2733939
	DYNG	.111256	.0661801	1.68	0.095	-.0193631	.2418751
	_cons	2.833193	.4372082	6.48	0.000	1.970279	3.696107
COST							
	LEADG	.0797475	.0559749	1.42	0.156	-.0307296	.1902247
	DELG	.1092209	.0776811	1.41	0.162	-.0440976	.2625394
	PURPG	.0916426	.0684142	1.34	0.182	-.0433859	.2266711
	ACCG	-.1246198	.070048	-1.78	0.077	-.2628731	.0136334
	PRODG	-.0347042	.0616317	-0.56	0.574	-.1563461	.0869377
	PERFG	.123044	.0658805	1.87	0.063	-.0069838	.2530718
	DYNG	.0770667	.0665479	1.16	0.248	-.0542784	.2084118
	_cons	2.87745	.4396383	6.55	0.000	2.009739	3.74516
OVERALL		.077844	.0555473	1.40	0.163	-.0317892	.1874772
	LEADG						
	DELG	.1899081	.0770877	2.46	0.015	.0377607	.3420554
	PURPG	.1020239	.0678916	1.50	0.135	-.0319732	.2360209
	ACCG	-.0572244	.069513	-0.82	0.412	-.1944216	.0799727
	PRODG	-.0703393	.0611609	-1.15	0.252	-.191052	.0503734
	PERFG	.1007037	.0653773	1.54	0.125	-.0283308	.2297382
	DYNG	.0479752	.0660396	0.73	0.469	-.0823666	.1783169
	_cons	2.612473	.43628	5.99	0.000	1.751391	3.473555

Table 3: Low Interdependence - Group

In Tables 2 and 3 all the interdependence variables were entered together into the equation. As can be seen in the in the tables the significance of the individual variables varied across performance indices. In order to gain further insight we individually compared High and Low interdependence measures for each of the seven variables. High interdependence variables end in a ‘T’ (team) and low interdependence variables end in a ‘G’ (group). The results are shown in Tables 4-10.

In examining the tables it can be seen that all the high interdependence variables had a positive effect on all performance measures when entered into an equation with their low interdependence counterparts. This is a total of 21 (7*3) statistically significant positive responses. The low independence variables had a statistically significant positive effect on 10 responses.

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	188	3	1.081196	0.0712	7.095512	0.0011
COST	188	3	1.068869	0.1056	10.92372	0.0000
OVERALL	188	3	1.04607	0.1260	13.33248	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME						
LEADT	.2204578	.0612898	3.60	0.000	.099541	.3413746
LEADG	.0605112	.0529694	1.14	0.255	-.0439906	.1650129
_cons	3.163335	.3388348	9.34	0.000	2.494858	3.831812
COST						
LEADT	.2398211	.060591	3.96	0.000	.1202829	.3593593
LEADG	.1315229	.0523655	2.51	0.013	.0282126	.2348333
_cons	2.689347	.3349718	8.03	0.000	2.028491	3.350203
OVERALL	.2640864	.0592986	4.45	0.000	.1470979	.3810749
LEADT						
LEADG	.135411	.0512486	2.64	0.009	.0343042	.2365178
_cons	2.647376	.3278269	8.08	0.000	2.000616	3.294136

Table 4: Team V Group Leadership

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	188	3	1.053667	0.0987	10.1325	0.0001
COST	188	3	1.073142	0.0819	8.251936	0.0004
OVERALL	188	3	1.049986	0.1194	12.54462	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME						
DELT	.236633	.078062	3.03	0.003	.0826268	.3906393
DELG	.1020259	.0761962	1.34	0.182	-.0482992	.252351
_cons	2.830806	.348461	8.12	0.000	2.143338	3.518274
COST						
DELT	.2164491	.0795048	2.72	0.007	.0595964	.3733017
DELG	.0950886	.0776045	1.23	0.222	-.0580149	.2481921
_cons	2.834341	.3549014	7.99	0.000	2.134166	3.534515
OVERALL						
DELT	.1819952	.0777893	2.34	0.020	.0285271	.3354633
DELG	.2003449	.0759299	2.64	0.009	.050545	.3501447
_cons	2.584155	.3472434	7.44	0.000	1.899089	3.269221

Table 5: Team V Group Delegation

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	187	3	1.06207	0.0861	8.666225	0.0003
COST	187	3	1.073113	0.0718	7.115951	0.0011
OVERALL	187	3	1.070032	0.0883	8.915829	0.0002

		Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME							
	PURPT	.1269032	.0563401	2.25	0.025	.0157475	.2380589
	PURPG	.2438559	.0624967	3.90	0.000	.1205537	.3671582
	_cons	2.864829	.3651782	7.85	0.000	2.144354	3.585304
COST							
	PURPT	.1081717	.0569259	1.90	0.059	-.0041397	.2204831
	PURPG	.2266907	.0631465	3.59	0.000	.1021064	.351275
	_cons	2.877189	.368975	7.80	0.000	2.149223	3.605155
OVERALL		.1284568	.0567625	2.26	0.025	.0164678	.2404457
	PURPT						
	PURPG	.2497552	.0629652	3.97	0.000	.1255286	.3739818
	_cons	2.781028	.3679158	7.56	0.000	2.055152	3.506904

Table 6: Team V Group Purpose

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	187	3	1.02623	0.1480	15.9829	0.0000
COST	187	3	1.030722	0.1613	17.69125	0.0000
OVERALL	187	3	1.06333	0.1015	10.39063	0.0001

		Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME							
	ACCT	.3445037	.0611296	5.64	0.000	.2238987	.4651088
	ACCG	-.0574112	.0596548	-0.96	0.337	-.1751065	.0602841
	_cons	3.071418	.3097216	9.92	0.000	2.460356	3.68248
COST							
	ACCT	.3651842	.0613972	5.95	0.000	.2440512	.4863173
	ACCG	-.0927411	.0599159	-1.55	0.123	-.2109516	.0254694
	_cons	2.977449	.3110775	9.57	0.000	2.363712	3.591186
OVERALL							
	ACCT	.2815294	.0633395	4.44	0.000	.1565643	.4064946
	ACCG	-.0076981	.0618114	-0.12	0.901	-.1296483	.1142521
	_cons	3.099805	.3209186	9.66	0.000	2.466652	3.732959

Table 7: Team V Group Accountability

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	189	3	1.071799	0.0828	8.393548	0.0003
COST	189	3	1.074778	0.0808	8.180428	0.0004
OVERALL	189	3	1.050594	0.1139	11.95738	0.0000

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME						
PRODT	.2781455	.0679434	4.09	0.000	.1441067	.4121842
PRODG	.0378454	.0578035	0.65	0.513	-.0761893	.1518801
_cons	2.939929	.4028592	7.30	0.000	2.145169	3.73469
COST						
PRODT	.2705456	.0681322	3.97	0.000	.1361343	.4049569
PRODG	.0023068	.0579641	0.04	0.968	-.1120448	.1166585
_cons	2.973994	.4039788	7.36	0.000	2.177024	3.770963
OVERALL	.317233	.0665992	4.76	0.000	.1858461	.4486199
PRODT						
PRODG	-.0074771	.0566599	-0.13	0.895	-.1192557	.1043015
_cons	2.877376	.3948889	7.29	0.000	2.098339	3.656413

Table 8: Team V Group Product

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	186	3	1.058562	0.1172	12.14746	0.0000
COST	186	3	1.068646	0.0946	9.560218	0.0001
OVERALL	186	3	1.062975	0.0989	10.0395	0.0001

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME						
PERFT	.2092466	.0662299	3.16	0.002	.0785743	.3399189
PERFG	.1506178	.060176	2.50	0.013	.0318899	.2693457
_cons	2.942979	.2898376	10.15	0.000	2.371126	3.514833
COST						
PERFT	.196094	.0668608	2.93	0.004	.0641768	.3280112
PERFG	.1257718	.0607492	2.07	0.040	.0059128	.2456308
_cons	2.977146	.2925988	10.17	0.000	2.399845	3.554447
OVERALL	.1882086	.066506	2.83	0.005	.0569915	.3194258
PERFT						
PERFG	.1403402	.0604269	2.32	0.021	.0211173	.2595631
_cons	3.026011	.2910461	10.40	0.000	2.451773	3.600248

Table 9: Team V Group Performance

Equation	Obs	Parms	RMSE	"R-sq"	F	P
TIME	186	3	1.082521	0.0702	6.910521	0.0013
COST	186	3	1.094289	0.0564	5.469851	0.0049
OVERALL	186	3	1.075151	0.0781	7.752758	0.0006

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
TIME						
DYNT	.1310223	.0722024	1.81	0.071	-.0114339	.2734785
DYNG	.1434404	.0653351	2.20	0.029	.0145334	.2723474
_cons	3.166967	.3281427	9.65	0.000	2.519538	3.814397
COST						
DYNT	.1436587	.0729873	1.97	0.051	-.0003461	.2876634
DYNG	.1055502	.0660454	1.60	0.112	-.0247581	.2358585
_cons	3.144132	.3317098	9.48	0.000	2.489665	3.798599
OVERALL						
DYNT	.2051747	.0717108	2.86	0.005	.0636885	.346661
DYNG	.082389	.0648903	1.27	0.206	-.0456403	.2104184
_cons	3.038861	.3259086	9.32	0.000	2.39584	3.681883

Table 10: Team V Group Meeting Dynamic

DISCUSSION

The results show strong support for the hypothesis that there is a contingency relationship between process interdependence and task interdependence as it relates to project performance. As described, a BIM project requires high task interdependence. We examined processes that exhibited both low (group) and high (team) goal and outcome interdependence within the context of the BIM project. While low interdependence did have a statistically significant positive effect it was overshadow by the effect of high interdependence. For Time the effect size (Psuedo R^2) was 58% larger, for Cost it was 71% larger, and for Overall it was 32% larger.

When examining the individual variables there is overall support for the hypothesis, however there were inconsistencies with the individual variables. Given that the variables are all on the same scale we can compare the coefficients as well as the statistical significance. In terms of leadership, accountability, work product, performance measurement and process dynamics the coefficients for the team variables (T) were all higher than the group variables (G). In terms of delegation the team coefficient is higher for Time and Cost but the group coefficient is higher for Overall. The coefficients for the purpose construct were higher for group variables

All the constructs supported the hypothesis except for delegation which provided mixed support and purpose which did not support the hypothesis.

CONCLUSION
This study presents evidence that superior performance is achieved when a task with high interdependence requirements is matched with an MAOS that has higher goal and outcome interdependence. Specifically it suggests that a structure that exhibits the characteristics of a real team will outperform a structure that exhibits work group characteristics.

The study suggests that the BIM MAOS is an important variable that needs to be managed if superior project performance is to be achieved.

When compared individually (tables 4-10) all the variables were significant, however when examined together (tables 2-3) this was not the case. Future research will examine the dimensionality of the team and group variables via factor analysis. Additionally the contingency hypothesis implies an interaction effect: the nature of the effect (moderating, mediating) needs to be clearly defined.

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