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RESEARCH NOTES AND COMMENTARIES:

CONGRUENCE BETWEEN TECHNOLOGY AND COMPENSATION SYSTEMS: IMPLICATIONS FOR STRATEGY IMPLEMENTATION

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This paper examines the interactive relationship between the use of integrated manufacturing and compensation practices in predicting several aspects of plant performance in the concrete pipe industry. We predicted that compensation practices reinforcing collective effort, teamwork, and flexibility (team incentives and skill-based pay) enhance the effectiveness of integrated manufacturing systems (total quality management and advanced manufacturing technology), while practices inhibiting cooperation and teamwork among employees (individual incentives and seniority-based pay) impede it. Results provide moderate support for the congruence model across several measures of plant effectiveness (labor hours per ton, lost-time accidents, perceptual performance, and customer satisfaction). Implications of the research are addressed.

INTRODUCTION

Strategy implementation inevitably entails the decision to use organizational systems, whether they be technological, human resource (HR), financial, or other systems. These systems are not used in isolation, but in the context of one another, highlighting the need for consistency among them for effective strategy implementation. This study examines the strategic impact of fit between two critical managerial systems—integrated manufacturing and compensation systems—on measures of workforce effectiveness.

Integrated manufacturing is an approach intended to facilitate high-quality, error-free production, to avoid logistical impediments, and to focus particular attention on customer needs. It can create tacit knowledge not easily imitated by competitors and promote sustainable advantage (e.g., Dean and Snell, 1991, 1996; Powell, 1995; Snell and Dean, 1994) but is most likely to be effective when aligned with other organizational systems (Snell and Dean, 1992). Compensation systems likewise have clear strategic implications, but their effectiveness is enhanced when they are coupled with appropriate management systems (Lawler and Jenkins, 1992). Synthesizing these research streams, we examine the interaction of integrated manufacturing and compensation systems in predicting work force effectiveness.

Advanced manufacturing technology (AMT) and *total quality management* (TQM) are two

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prominent components of integrated manufacturing (Dean and Snell, 1991). AMT is the use of computer-aided technologies that facilitate design, engineering, and other processes through which products are made, with a particular focus on integration throughout the process. AMT blurs distinctions and increases shared information across phases of production (Dean and Sussman, 1989; Ettlie, 1988). TQM concerns the extent to which an organization focuses on customer satisfaction, stresses continuous improvement, and views the organization as a total system (Sitkin, Sutcliffe, and Schroeder, 1994). AMT is a specific aspect of integrated manufacturing, focusing on the production process only, whereas TQM offers a more comprehensive philosophy. Dean and Snell, 1996 (Dean and Snell, 1991; Snell and Dean, 1992, 1994) argue that the benefits of integrated manufacturing (including AMT and TQM) accrue only when it is coupled with appropriately designed jobs and suitable compensation practices.

Compensation practices can be categorized broadly as performance-based pay (merit systems, individual incentives, etc.), job content-based pay (hourly or salary pay), or person-based pay (seniority, skills, etc.). We focus on incentive pay and person-based pay since our data set was homogeneous with respect to job content-based pay.

Performance-based pay: individual incentives

Individual incentives are conceptually *incongruent* with many aspects of integrated manufacturing. AMT integrates previously distinct functions, permitting linkage of individuals previously being evaluated and rewarded separately (Dean and Snell, 1991). TQM also minimizes functional distinctions. AMT and TQM are inconsistent with individual incentives since (1) effective individual incentive plans hinge on the identification and accurate measurement of relevant individual performance dimensions (Gupta and Jenkins, 1996); and (2) individual incentives foster competition among employees. When individual incentives are used in conjunction with integrated manufacturing, employees pursue their own economic interests rather than directing effort to the success of the system as a whole. Intraorganizational competition provides 'powerful disincentives for cooperation' (Snell and Dean, 1994: 1114), something conceptually at diametrical odds with integrated manufacturing. Thus:

Hypothesis 1: Integrated manufacturing and individual incentives interact in predicting workforce effectiveness such that the combined use of these systems is associated with lower effectiveness.

Performance-based pay: team incentives

Team incentives are more effective when tasks are uncertain, tasks are interdependent, and goals are intertwined (Gomez-Mejia and Balkin, 1989). These are also the contingencies for the use of integrated manufacturing (Snell and Dean, 1994). AMT and TQM emphasize integrated goals (Dean and Snell, 1991), a factor promoting the effective use of team incentives. Moreover, since it is easier to measure team than individual performance, team incentives reduce problems of measurement (Jenkins and Gupta, 1982). Integrated manufacturing systems with integration, interdependence, and cooperation, supported by team incentives, should yield positive internal synergies as workers learn 'how various activities fit together and [make] process and quality improvements as a team' (Snell and Dean, 1994: 1115). Thus:

Hypothesis 2: Integrated manufacturing and team incentives interact in predicting workforce effectiveness such that the combined use of these systems is associated with higher effectiveness.

Person-based pay: seniority

The most common form of person-contingent pay in production facilities is seniority-based pay, where benefits accrue in terms of loyalty, retention, and stability. These outcomes are of marginal concern in firms using integrated manufacturing. Seniority adds value through learning curve effects that occur with experience and over long periods of time (Fisher and Govindarajan, 1992), but AMT and TQM entail the continual exploration of new technologies, adjustments, and search for flexible systems of production (Snell and Dean, 1992), factors that erode the subtle benefits of seniority. Thus:

Hypothesis 3: Integrated manufacturing and seniority-based pay interact in predicting workforce effectiveness such that the combined use of these systems is associated with lower effectiveness.

Person-based pay: skill-based pay

Integrated manufacturing increases the need for additional skills and flexibility (Snell and Dean, 1994). Increasingly, firms use skill-based pay, i.e., pay increases for acquiring new skills or demonstrating advanced knowledge levels as a means for encouraging (and rewarding) individuals for up-skilling and providing greater flexibility (Gupta and Shaw, 2000). The uncertain and fast-paced technological environment of integrated manufacturing requires workers to have greater technical, conceptual, and problem-solving skills than in traditional facilities (Snell and Dean, 1992). Technological advances can increase responsibility, interdependence among tasks, and the frequency of complex tasks, and reduce the amount of close supervision. These demands are well suited to skill-based pay. Thus:

Hypothesis 4: Integrated manufacturing and skill-based pay interact in predicting workforce effectiveness such that the combined use of these systems is associated with higher effectiveness.

Macro management literature focuses on financial performance as the ultimate outcome, but the immediate outcome of integrated manufacturing is *workforce* performance (Flynn, Sakakibara, and Schroeder, 1995), financial performance being a second-order outcome. Workforce performance is also the immediate outcome of interest for compensation practices (Lawler and Jenkins, 1992). In line with this, we include an array of mid-range performance outcomes including ‘hard’ measures (productivity and safety), perceptual workforce performance, and customer satisfaction (a primary goal of integrated manufacturing) in this study.

METHOD

The study population was all 202 member facilities of the American Concrete Pipe Association (ACPA) in the United States and Canada. Plant managers in 141 facilities (71% response rate) completed lengthy questionnaires (hereafter *plant survey*) dealing with management and compensation issues, among others. Eighty plant managers (60% cooperation rate) also provided lists of their major *purchasers* (companies to which the plant sold concrete pipe) and *specifiers*, (engineers who specify pipe in developments). In all, 767 purchasers (53.4% response rate) and 605 specifiers (58.6% response rate) completed short surveys focusing on plant and product satisfaction (*purchaser survey* and *specifier survey* respectively).

All independent variables were measured in the plant survey. *AMT* was a 3-item scale adapted from Dean and Snell (1991) concerning the extent to which technological advances and computer integration were used in concrete pipe production. *TQM* was a 14-item scale adapted from Flynn *et al*. (1995) focusing on how much continuous improvement, doing things right the first time, and devotion to fulfilling customer needs were promoted. *Individual incentives* was a 3-item scale concerning the extent of use of individual incentives tied to individual performance, merit pay, and individual pay increases based on individual quality performance or outcomes. *Team incentives* was a 4-item scale concerning the extent of use of team pay, pay based on group quality performance or outcomes, work team/group bonuses tied to work team/group performance, and pay based on team rather than individual effort. *Seniority-based pay* and *skill-based pay* were single items assessing the extent of use of seniority and skill-based pay.

Three dependent measures were developed from the plant survey, viz., *labor hours per ton* (number of labor hours worked by production employees in the focal year divided by the tons of concrete products produced in the same year), *lost time accidents* (natural log of the number of lost-time accidents in the plant in the last 5 years), and *perceptual performance* (a 9-item scale concerning controllable aspects of production worker performance (e.g., percent of pipe meeting technical specifications)). Two measures of *customer satisfaction* (satisfaction and complaints) were gleaned from purchaser *and* specifier surveys. *Satisfaction* was measured with a 4-item scale (e.g., All in all, I am very satisfied with this supplier’s products and services). *Com-*

plaints was a 5-item scale concerning issues such as pipe not meeting specifications. Purchaser and specifier surveys were aggregated for each focal facility. The average $r_{wg(j)}$ estimates (James, Demaree, and Wolf, 1984) exceeded 0.90 in all four cases, indicating excellent agreement.

Following previous research, we controlled for *organizational size* (the natural log of the number of production workers in the plant), *corporate dependence* (multi-plant corporations coded 1 and free-standing plants coded 0), and *unionization* (unionized plants coded 1 and non-unionized plants coded 0). We tested the hypotheses using hierarchical regressions, entering the controls in the first step, integrated manufacturing and compensation variables in the second step, and the interaction between the two independent variables in the third step.

RESULTS

Table 1 shows descriptive, psychometric, and pairwise correlational information (N's = 66–129) for all study variables. Table 2 includes the hierarchical regression analyses and shows that the interaction step provides a significant increment in R^2 in each equation, explaining between 8.7 percent and 28.8 percent of additional variance. While all significant interactions do conform to predicted form, the hypotheses were not uniformly supported. There was virtually no support for interactions including AMT, as 12 of the 13 significant interactions occurred between TQM and compensation. Hypothesis 1, interactions with individual incentives, was the most consistently supported, but only with TQM; i.e., the simultaneous use of individual incentives and TQM was associated with poorer performance in five equations. Hypothesis 4, interactions with skill-based pay, was supported in four equations (also only with TQM) such that the highest performance occurred when TQM and skill-based pay were used simultaneously; the lowest when either was used in isolation. Only very spotty support for Hypotheses 2 and 3 was found.

While interesting, the lack of uniform support may indicate that the predicted relationships fail to completely capture the dynamics of manufacturing system–HR system fit, that we lacked sufficient power to detect more consistent effects, and/or that measurement limitations diminished the sensitivity of our analyses. These limitations suggest that the hypotheses may not be fully tested in our study. These and other issues are discussed below.

DISCUSSION

We examined, and found moderate support for, the value of congruence between manufacturing systems and HR systems. In particular, the results: (1) provide more consistent support for TQM as a measure of integrated manufacturing than AMT; (2) suggest that skill-based pay may be the compensation system most consistent with TQM; and (3) highlight that individual incentives are incompatible with integrated manufacturing systems.

We examined two aspects of integrated manufacturing: AMT and TQM. Only one compensation interaction with AMT was significant compared to 12 significant interactions with TQM. Furthermore, TQM had significant main effects for four of seven outcomes; AMT had none. Several reasons may account for these differences. One, AMT focuses simply on technological aspects of manufacturing, whereas TQM is more systemic. The stronger impact of TQM may be the result of the more complicated system of inputs and processes associated with it, while the use of AMT (a more limited system) may have less broad-ranging impact. Two, TQM is more widely used, and hence perhaps more important in the concrete pipe industry. Since the process of manufacturing concrete pipe is not particularly complex, AMT may have more limited benefits in this context. Indeed, most other relevant research is conducted in technology-driven industries (e.g., Flynn *et al.*, 1995) or across industries where AMT may be more applicable. We cannot disentangle these alternative explanations within our data set, but we hope that future research will do so.

Among the most consistent results we obtained was the superiority of the combined use of skill-based pay and TQM. In essence, this result strongly suggests that the effectiveness of skill-based pay is enhanced when coupled with actions, policies, or programs that promote joint activities and interdependence (e.g., TQM). This result is interesting, especially when compared to the team pay results. TQM advocates usually espouse the

Table 1. Descriptive statistics, reliability estimates, and correlations among all variables[a,b]

	Mean	S.D.	α	$\bar{r}_{wg(j)}$	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.			
Control variables																				
1. Organizational size (log)	3.21	0.62	n/a	n/a	#															
2. Corporate dependence	0.87	0.33	n/a	n/a	−0.15	#														
3. Unionization	0.38	0.49	n/a	n/a	0.23**	−0.01	#													
Integrated manufacturing variables																				
4. AMT	1.73	1.17	0.78	n/a	0.07	0.05	0.13	#												
5. TQM	5.56	0.73	0.87	n/a	0.00	0.16	0.01	0.18*	#											
Compensation system variables																				
6. Individual incentives	2.43	1.27	0.72	n/a	−0.05	−0.12	−0.43**	−0.08	0.07	#										
7. Team incentives	2.00	1.35	0.74	n/a	0.01	0.06	−0.15	0.06	0.14	0.38**	#									
8. Seniority−based pay	2.21	1.38	n/a	n/a	−0.03	−0.05	0.27**	−0.08	−0.02	−0.11	−0.16	#								
9. Skill−based pay	2.29	1.28	n/a	n/a	0.13	0.04	−0.19*	0.09	0.13	0.49**	0.28**	−0.07	#							
Workforce effectiveness variables																				
10. Labor hours per ton	28.30	35.43	n/a	n/a	0.03	0.06	0.21**	−0.09	−0.15	−0.18*	−0.04	−0.02	−0.16	#						
11. Lost-time accidents	1.55	1.06	n/a	n/a	0.48**	−0.23**	0.29**	0.01	−0.10	−0.08	−0.14	0.08	−0.01	0.10	#					
12. Perceptual performance	5.57	0.91	0.84	n/a	0.03	−0.07	−0.21*	0.07	0.34**	0.20*	−0.03	−0.03	0.15	−0.16	0.07	#				
13. Satisfaction (purchasers)	5.82	0.51	0.75	0.96	0.03	0.07	0.04	−0.15	−0.09	0.03	0.08	−0.02	−0.06	−0.08	0.07	−0.05	#			
14. Complaints (purchasers)	1.72	0.29	0.79	0.92	−0.03	0.07	0.12	0.06	0.10	−0.03	−0.15	0.04	−0.09	0.01	0.02	0.04	−0.57**	#		
15. Satisfaction (specifiers)	5.81	0.38	0.87	0.93	0.07	−0.10	−0.10	−0.08	0.01	0.01	0.09	−0.06	0.10	−0.02	0.01	0.23*	0.36**	−0.30*	#	
16. Complaints (specifiers)	1.58	0.25	0.81	0.91	−0.03	0.12	−0.08	0.17	−0.02	−0.09	−0.05	−0.20	0.08	0.03	0.04	0.13	−0.29*	0.27*	−0.27*	#

[a] $^{**}p < 0.01$, $^{*}p < 0.05$. Pairwise deletion procedure was used to generate the table (*N*'s = 66–129).
[b] AMT = advanced manufacturing technology; TQM = total quality management; corporate dependence (1 = Multi-plant corporation, 0 = single-plant company); unionization (1 = union, 0 = no union).

Table 2. Hierarchical regression results[a]

							Customer satisfaction							
	Labor hours per ton		Lost-time accidents		Perceptual performance		Purchasers				Specifiers			
							Satisfaction		Complaints		Satisfaction		Complaints	
Block	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β	$\Delta R^2_{\text{Block}}$	β
Block 1: Control variables	0.033	†	0.327**	†	0.067*	†	0.194**	†	0.059	†	0.048	†	0.049	†
Block 2: Independent variables	0.046		0.060		0.189**		0.107		0.152*		0.042		0.092	
AMT		−0.06		−0.03		−0.01		−0.06		0.13		0.05		−0.09
TQM		−0.31**		−0.19*		0.38**		0.28*		0.04		0.23		−0.20
Individual incentives		−0.07		−0.12		0.04		0.06		0.17		−0.07		−0.08
Team incentives		0.20		−0.25**		−0.13		0.02		−0.41**		0.08		−0.20
Seniority-based pay		−0.08		0.03		0.13		0.14		−0.05		0.21		−0.15
Skill-based pay				0.18		−0.02		0.07		0.02		0.02		0.18
Block 3: Interactions	0.150*		0.087*		0.110*		0.159*		0.173*		0.288*		0.245*	
AMT × Individual incentives		0.07		−0.12		−0.09		0.17		−0.08		0.22		−0.21
AMT × Team incentives		−0.08		−0.18		0.23**		0.01		0.09		0.20		−0.11
AMT × Seniority-based pay		−0.01		−0.12		−0.02		−0.02		−0.07		−0.21		0.03
AMT × Skill-based pay		−0.03		0.16		−0.12		0.02		0.14		0.09		−0.19
TQM × Individual incentives		0.22**		0.29**		−0.20*		−0.30*		0.07		−0.03		0.44**
TQM × Team incentives		−0.45**		0.10		−0.12		−0.01		0.07		0.09		0.04
TQM × Seniority-based pay		0.02		0.05		−0.21**		0.04		−0.18		−0.54**		−0.24
TQM × Skill-based pay		0.16		−0.25**		0.03		0.44**		−0.47**		0.03		−0.33*
Total R^2		0.229*		0.474**		0.365**		0.450**		0.383**		0.378*		0.386*
Analysis N		120		120		120		79		79		66		66

[a] ** $p < 0.01$, * $p < 0.05$. The β column shows the standardized regression coefficient for each variable in the final equation. AMT = advanced manufacturing technology; TQM = total quality management; Dependence (1 = multi-plant corporation, 2 = single-plant company); Unionization (1 = union, 0 = no union).

utility of team rewards in TQM settings. Yet skill-based pay, essentially an *individual* compensation system, interacted significantly with TQM for four outcomes; team incentives interacted significantly with TQM for only one. Skill-based pay encourages employees to be multi-skilled, and promotes a systemic focus (Gupta and Shaw, 2000). Team incentives do not, in and of themselves, encourage behaviors other than cooperation among employees. Cooperation is certainly important in TQM systems, but skill development and a systemic perspective may be even more important. It may be useful to fashion compensation systems that combine skill development and cooperation, e.g., group-level skill-based pay plans.

Traditional incentive systems typically entail some form of monetary reward attached to personal characteristics such as merit or seniority. Manufacturing systems are often designed and implemented with an exclusive *manufacturing* focus. Snell and Dean (1994) discovered that organizational inertia precluded the development of compensation systems compatible with integrated manufacturing. They were 'compelled to dismiss the popular assumption that compensation contingencies derived directly from the technological imperatives of integrated manufacturing' (p. 1134). Our study shows that this is not just a theoretical premise but a practical reality, and that effective strategy implementation dictates consonance. When manufacturing systems are redesigned, it is prudent to rethink the compensation strategy from 'scratch,' i.e., to identify desirable employee behaviors and to tie compensation elements to these behaviors.

Our results have implications beyond the congruence of just *compensation* system and manufacturing systems for competitive advantage. The compensation system is only one, albeit arguably the most critical, HR system. Other HR management systems—selection systems, training systems, performance appraisal systems, safety systems, labor-management systems—are also essential. If fit between compensation systems and integrated manufacturing is important, most likely the fit of other HR systems with integrated manufacturing is also important. As such, this study should be viewed as a point of departure for more precise theory building and testing in these areas.

The limitations of the data set place boundaries around our results. To begin with, this was essentially a cross-sectional study. Second, we relied on one data source for much information. This concern is ameliorated by the consistent support for predictions across customer and plant data sources, by the support for predicted interaction patterns across data sources and outcomes, and by support for *opposing* higher-order interaction predictions. Third, the sample was small, with usable data from fewer than 150 plants, limiting statistical power. Despite this, we found *consistent* results across separate source dependent variables for higher-order interactions. Fourth, the study was limited to a single industry setting. In this, our study follows strategic HR research. Intra-industry studies have the advantage of controlling for extraneous inter-industry factors, but may limit generalizability. Thus, more research is needed within and across industries (Shaw *et al.*, 2000). Fifth, we examined a limited set of integrated manufacturing operationalizations and a limited number of compensation systems. Our study was limited by the constraints of our data set but it paves the way for more encompassing studies in the future.

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