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Implementing Computerized Technology: An Organizational Analysis

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Why do some organizations succeed and others fail in implementing the innovations they adopt? To begin to answer this question, the authors studied the implementation of manufacturing resource planning, an advanced computerized manufacturing technology, in 39 manufacturing plants (number of individual respondents = 1,219). The results of the plant-level analyses suggest that financial resource availability and management support for technology implementation engender high-quality implementation policies and practices and a strong climate for implementation, which in turn foster implementation effectiveness—that is, consistent and skilled technology use. Further research is needed to replicate and extend the findings.

During the past decade, analysts have admonished organizations to innovate their work practices, products, and services in order to survive and thrive in today's global marketplace (e.g., Barrett, 1995; Jick, 1995; Slocum, McGill, & Lei, 1995). And yet, many organizations adopt innovations—for example, total quality management, statistical process control, and manufacturing resource planning—with disappointing results. Recent analyses suggest that the reason is not innovation failure but implementation failure (Bushe, 1988; Pfeffer, 1994; Reger, Gustafson, DeMarie, & Mullane, 1994). That is, many organizations fail to fully implement the innovations they adopt; they fail to gain employees' skilled, consistent, and committed innovation use. In the absence of effective implementation, however, innovation adoption is more likely to yield waste and cynicism than performance improvement.

Unfortunately, research on innovation implementation is very limited (Beyer & Trice, 1978; Nord & Tucker, 1987; Tornatzky & Klein, 1982). Thus, relatively little is known about the organizational characteristics and practices that may explain between-organizational differences in implementation effectiveness: Why do some organizations succeed and others fail in implementing the innovations they adopt? To begin to answer this question, we studied the implementation of manufacturing resource planning (MRP II), a software system designed to streamline and integrate production, purchasing, scheduling, inventory control, and cost accounting, in a sample of manufacturing plants and companies. Below, we define key terms and present our hypotheses, method, and results.

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Innovation Stages, Implementation Effectiveness, and Innovation Effectiveness

Innovation scholars use stage models to describe the many steps of the innovation process. Source-based stage models trace the innovation process from the gestation of the idea to the marketing of the final product (e.g., research, development, testing, manufacturing, dissemination; Amabile, 1988; Tornatzky & Fleischer, 1990). Within these models, an *innovation* is a new product or service that an organization has created for market. Building on source-based stage models, researchers explore the correlates of the development of innovative products and services (see, e.g., Dougherty & Heller, 1994).

User-based stage models, in contrast, trace the stages of innovation from the user's awareness of a need or opportunity to change to the incorporation of the innovation in the user's behavioral repertoire (e.g., awareness, selection, adoption, implementation; Nord & Tucker, 1987; Tornatzky & Fleischer, 1990). Within these models and within our research, an *innovation* is a technology or practice that an organization is using for the first time, regardless of whether other organizations have previously used the technology or practice (Nord & Tucker, 1987). Innovation *adoption* refers to an organization's decision to install an innovation within the organization. Adoption is a decision point, a plan, or a purchase. *Implementation* follows adoption and is "the transition period during which targeted organizational members ideally become increasingly skillful, consistent, and committed in their use of an innovation" (Klein & Sorra, 1996, p. 1057).

Innovation adoption has been the focus of considerable research. Thus, for example, numerous studies have examined the innovation characteristics (e.g., innovation complexity, innovation trialability) that make an innovation particularly likely to be adopted by individual or organizational users (e.g., Tornatzky & Klein, 1982). Furthermore, many studies have examined the characteristics that distinguish innovative organizations (Damanpour, 1991).

Unfortunately, innovation implementation has been the focus of very little research. In this study, we examined manufacturing plants in the process of implementing the same technology. Innovation adoption was thus a constant in this study. All of the plants had formally adopted MRP II; they had bought the same software system. The plants differed, however, in their *implementation*

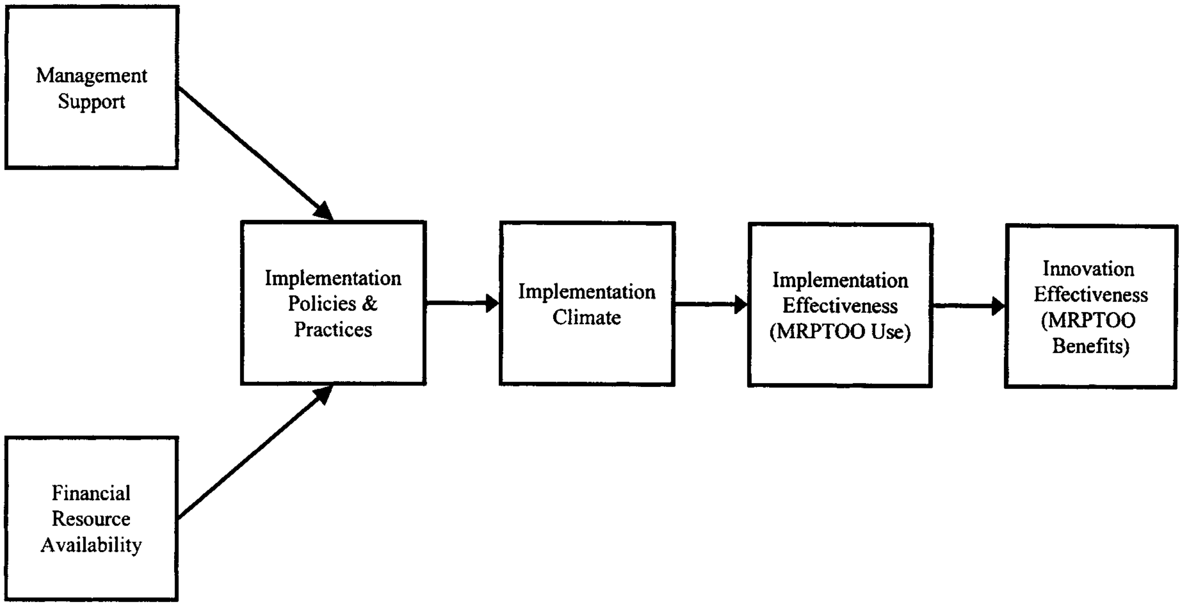

Figure 1. Hypothesized predictors of implementation effectiveness (innovation use) and innovation effectiveness (benefits of innovation implementation). MRPTOO = a pseudonym for a manufacturing resource-planning package.

effectiveness—that is, in "the consistency and quality of targeted organizational members' use of [the] specific innovation" (Klein & Sorra, 1996, p. 1058). Implementation effectiveness is an organization-level construct describing the pooled or aggregate consistency and quality of targeted organizational members' use of an innovative technology or practice.[1] Throughout this article, we thus interchangeably use the terms *implementation effectiveness* and *innovation use*.

Implementation effectiveness is a necessary, although not necessarily sufficient, condition for *innovation effectiveness*—an organization's realization of the intended benefits of a given innovation (e.g., improvements in productivity, customer service, and morale). (Accordingly, throughout this article, we interchangeably use the terms *innovation effectiveness* and *benefits of the innovation to the adopting organization.*) The effective implementation of a given innovation is no guarantee that the innovation will have its intended effect on the adopting organization. Just as a family may implement a new policy (e.g., no television on school nights) and yet fail to achieve its intended benefits (e.g., better school grades for the children), so an organization may implement a new strategy, policy, or technology and yet fail to achieve its intended benefits (Klein & Sorra, 1996). Suppose, for example, that a retail chain implements a new software system in an effort to reduce customer waiting time and increase customer satisfaction. The effective implementation of the software system may not result in a reduction in customer waiting time. Furthermore, even if it does, customer satisfaction may not increase. Perhaps customers seek more friendly and knowledgeable customer service, not shorter waiting times.

In this study, we examined possible antecedents and consequences of implementation effectiveness. Figure 1 depicts our conceptual model. The model suggests that two organizational characteristics (management support for implementation and financial resource availability) foster high-quality implementation policies and practices. These policies and practices engender a positive climate for innovation implementation, which leads in turn to implementation effectiveness (consistent, committed, and skilled innovation use). Innovation use, we posit, is positively related to innovation effectiveness (the organization's realization of the intended benefits of innovation implementation). We recognize, however, that a variety of factors, beyond the scope of this research, may moderate the relationship between implementation effectiveness and innovation effectiveness.

Below, we first describe the nature and hypothesized consequences of implementation policies and practices. We then step backward in the model to discuss the hypothesized antecedents of implementation policies and practices.

Implementation Policies and Practices, Implementation Climate, and Implementation Effectiveness

The empirical literature on the implementation of computerized technologies is dominated by single-site, qualitative studies (e.g., Leonard-Barton, 1988). (See Klein and Ralls [1995] for a review of the literature.) Quantitative studies of technology implementation are rare. Rarer still are quantitative studies examining between-organizational, not between-individual, differences in im-

[1] Manufacturing resource planning is an integrative management information system that requires the coordinated use of multiple organizational members. If any of the diverse organizational members who input information into an organization's MRP II system either enter incorrect information or fail to enter needed information, the MRP II system's reliability and effectiveness for the organization are compromised. Accordingly, our focus on the consistency and quality of organizational members' aggregate or pooled MRP II use is apt.

plementation effectiveness. Indeed, we know of only one study in which researchers gathered data from multiple users in each organization to assess the correlates of organizational effectiveness in implementing computerized technology; this study (Ettlie & Rubenstein, 1980) examined only four organizations.

Case studies of technology implementation offer a detailed description of organizational policies and practices that may influence an organization's implementation effectiveness (Klein & Ralls, 1995). These policies and practices include (a) the quality and quantity of an organization's efforts to train organizational members to use the new technology (e.g., Klein & Ralls, 1997); (b) user support—the provision of technical assistance to technology users on an as-needed basis (e.g., Rivard, 1987); (c) rewards, such as promotions, praise from supervisors, or improved working conditions, for technology use (Rousseau, 1989); (d) effective communication regarding the reasons for the implementation of the new technology; (e) the provision of time for users to experiment with the new technology (e.g., Zuboff, 1988); and (f) the quality, accessibility, and user-friendliness of the new technology itself (e.g., Beatty & Gordon, 1988).[2]

Because each study of technology implementation describes a different subset of one or more of these implementation policies and practices, the implementation literature as a whole paints a rich and varied, but somewhat jumbled, picture of the determinants of innovation implementation. Synthesizing this research, Klein and Sorra (1996, p. 1073) posited that the influence of implementation policies and practices is cumulative, compensatory, and equifinal. Thus, the presence of some high-quality implementation policies and practices may compensate for the absence or low quality of other implementation policies and practices. And yet, the influence of numerous implementation policies and practices is cumulative; more is better. Consider, for example, three organizations endeavoring to implement the same innovation—a new software system. One organization may achieve a fairly high level of implementation by offering targeted users high-quality software training, ongoing user support services, and rewards for use of the new system. A second organization may achieve the same level of implementation by offering employees a compelling explanation of the reasons for the software change, time to experiment with the new software, and easy access to high-speed computers on which the software runs particularly smoothly and efficiently. The third organization may achieve the highest level of implementation by establishing all of these policies and practices.

An organization's implementation policies and practices collectively influence innovation use, we posit, by shaping the organization's climate for implementation. Schneider and Bowen (1995) defined organizational climate as "the message employees get about what is important in the organization" (p. 239). Building on this and other conceptual and empirical analyses of climate (e.g., Hofmann & Stetzer, 1996; Kozlowski & Hults, 1987; Schneider, 1975; Schneider, White, & Paul, 1998), we defined *implementation climate* as employees' shared perceptions of the importance of innovation implementation within the organization. If employees perceive that innovation implementation is a major organizational priority—promoted, supported, and rewarded by the organization—then the organization's climate for implementation is strong. Climate emerges as employees "integrate hundreds, even thousands, of their [work] experiences into a theme" (Schneider & Bowen, 1995, p. 239). An organization's climate for the implementation results from employees' shared experiences and observations of, and their information and discussions about, their organization's implementation policies and practices (Klein & Sorra, 1996). If, for example, an organization offers targeted users extensive software training, rewards for software use, time to experiment with the new software, and ready access to up-to-date computers on which the software is installed, then the organization's climate for software implementation is likely to be relatively strong. If, on the contrary, the organization directs employees to use the new software but training and user support are minimal, rewards for software use are absent, and the new software is difficult and awkward to access, then the organization's climate for software implementation is likely to be weak.

This conceptualization both links and distinguishes between an organization's implementation policies and practices and its implementation climate: Implementation policies and practices influence implementation climate, but implementation policies and practices and implementation climate are not one in the same. Our conceptualization builds on prior theoretical analyses of climate. Hofmann and Stetzer (1996), for example, suggested that organizational climate develops "as individuals attach meanings to and interpret the environment within which they work. These meanings and perceptions then influence the way in which individuals behave within the organization through their attitudes, norms, and perceptions of behavior–outcome contingencies" (p. 314). Other theoretical analyses of climate are more ambiguous, however. Schneider and Gunnarson (1991) stated that (a) "climate refers to the visible practices, procedures, and rewarded behaviors that characterize an organization" (p. 542), suggesting that climate *is* organizational policies and practices, and (b) "climates are summary perceptions employees have about their organization that develop from the practices and procedures employees observe happening to them and around them" (p. 549), suggesting that climate *results from* organizational policies and practices. Furthermore, many measures of organizational climate (e.g., Kozlowski & Hults, 1987; Rouiller & Goldstein, 1993; Schneider & Bowen, 1985) appear to include items assessing organizational policies and practices as well as items assessing employees' summary perceptions of organizational priorities. In this study, we sought to shed additional light on the relationship between policies and practices and climate. Accordingly, we developed distinct measures of the

[2] The six implementation policies and practices presented here, and operationalized in our study, are mentioned frequently in the technology implementation literature. The last implementation policy or practice—the quality, accessibility, and user-friendliness of the new technology—may appear at first to differ in kind from the other implementation policies and practices. We included it as an implementation policy and practice for two reasons. First, like other implementation policies and practices, the quality, accessibility, and user-friendliness of a new technology may influence employee attitudes and skill in using the new technology. Just as it may be discouraging and annoying to try to use a new software system in the absence of adequate training or time to experiment with the new technology, so it may be discouraging and annoying to use a new software system if the system is slow, cumbersome, or unreliable. Second, the quality, accessibility, and user-friendliness of a new technology send employees a message regarding the extent to which technology implementation is an organizational priority. To put it colloquially, employees are quick to evaluate if the organization's "money" is where its "mouth" is.

two constructs, hypothesizing that implementation policies and practices would be significantly positively related to implementation climate.

Recent research suggests that an organization's positive climate for a specific outcome may influence employees' behaviors regarding that outcome. For example, climate for service predicts customer service (Schneider & Bowen, 1985; Schneider et al., 1998), climate for transfer of training predicts training transfer (Rouiller & Goldstein, 1993; Tracey, Tannenbaum, & Kavanaugh, 1995), and climate for technical updating predicts engineers' technical performance (Kozlowski & Hults, 1987). On the basis of climate theory and research, we hypothesized that organizational climate for implementation would be significantly positively related to implementation effectiveness. Finally, as we noted earlier, we hypothesized that implementation effectiveness would be positively related to innovation effectiveness—the benefits gained by the organization as a result of the new technology.

Antecedents of Implementation Policies and Practices

Within the research literature, organizational climate is most commonly conceptualized and operationalized as an independent variable. (For an exception, see Schneider et al.'s [1998] study of service climate.) Relatively few researchers have examined the antecedents of climate. We hypothesized that implementation policies and practices foster implementation climate. Although this formulation may help to resolve the issue of climate's immediate antecedents, it raises a new and clearly closely related question: What are the antecedents of an organization's implementation policies and practices? Having made the decision to adopt an innovation practice or technology, often at great expense, why do some organizations institute numerous high-quality implementation policies and practices, whereas other organizations' implementation policies and practices are poor and few? On the basis of prior research and theory regarding implementation and organizational change, we identified two possible predictors of the quality of an organization's implementation policies and practices: management support for implementation and financial resource availability. No prior research has, to our knowledge, assessed the relationship between these organizational characteristics and implementation policies and practices.

Management Support

The theoretical literatures on organizational change and on innovation suggest that the level of management support for innovation implementation may shape an organization's implementation policies and practices and its ensuing implementation climate. Kilmann and Covin (1988), for example, commented, "With top management behind the change effort, the necessary resources and commitment to conduct transformation will be available" (pp. 6–7). Qualitative case studies of technology implementation (e.g., Leonard-Barton & Krauss, 1985; McKersie & Walton, 1991) underscore the importance of management support for implementation in fostering high-quality implementation policies and practices. Furthermore, in a particularly rigorous multiple case study combining qualitative and quantitative methods, Nutt (1986) found that "implementation by intervention," in which leaders "became *protagonists by creating rationales* for action in the minds of key people" (p. 242), was a more effective implementation tactic than the other three tactics he studied (implementation by participation, by persuasion, and by edict). The more committed managers are to technology implementation, the more likely they are to invest in and to monitor the quality of implementation policies and practices (e.g., technology training, user support, hardware and software accessibility and effectiveness). Building on the theoretical and empirical literature, we thus hypothesized that organizational managers' support for innovation implementation would be significantly positively related to the quality of an organization's implementation policies and practices.

Financial Resource Availability

Organizations providing high-quality and readily accessible computer hardware and software, technology training, user support services, time to experiment with the new technology, and other implementation policies and practices incur substantial financial costs. Thus, in the absence of slack financial resources, an organization may have great difficulty in offering high-quality implementation policies and practices. Indeed, Bourgeois (1981) defined slack as

> that cushion of actual or potential resources which allows an organization to adapt successfully to internal pressures for adjustment or to external pressures for change in policy as well as to initiate changes in strategy with respect to the external environment. (p. 30)

Nord and Tucker's (1987) qualitative study of a banking innovation within 12 banks is the only study, to our knowledge, that has examined the relationship between financial resource availability and implementation. Nord and Tucker reported that innovation implementation was most successful in banks that had sufficient financial resources to offer training, to hire consultants, and to lower organizational performance standards during the implementation effort. We hypothesized that financial resource availability would be significantly positively related to the quality of an organization's implementation policies and practices.

Method

To test our model, we gathered survey data from more than 1,200 managers, technology implementation team members, and technology users in 39 manufacturing plants that were in the process of implementing manufacturing resource planning (MRP II). This design allowed us to hold the innovation constant while examining correlates of between-plant variability in implementation effectiveness.

Manufacturing Resource Planning

MRP II is a software system designed to enhance the efficiency, effectiveness, and coordination of production, purchasing, shipping, inventory control, and cost accounting within a manufacturing plant. Plants use MRP II systems to schedule and to maintain up-to-the-minute computerized records of their production, inventory consumption, use and purchasing of parts and supplies, and sales commitments. Implementation of an MRP II system affects numerous departments within a plant, including production, scheduling, purchasing, inventory control, and accounting. MRP II use is expected to improve a plant's productivity, inventory turns, lot tracking, and customer service. However, implementation of MRP II is difficult because it requires employees in diverse areas of a plant to take on new, highly interdependent computer-based tasks. Just as there are many makers of word-processing packages, so too there are many makers of MRP II packages. We studied the implementation of MRPTOO, a pseudonym for one company's manufacturing resource-planning package.

Level of Analysis

Our unit of analysis was the plant. Although many companies implement the same MRP II system across their plants, we chose the plant level of analysis because MRP II systems, such as MRPTOO, are customized to meet the planning and production requirements of a plant. Plants within a single company often differ greatly in their planning and production requirements (e.g., in their number of distinct products, customers, and parts). They may also differ greatly in their management support for implementation, climate for implementation, MRP II use, and so on. Our sample of 39 plants was drawn from 33 companies. We studied 1 plant per company in each of 27 companies. We studied 2 plants per company in each of 6 companies.

Sample of Plants

The makers of MRPTOO provided us with a list of manufacturing plants that had purchased their technology. Our goal was to study plants that were in the midst of implementation. Accordingly, plants were eligible to participate in our study if they had "gone live" with MRPTOO (i.e., begun to use MRPTOO) no more than 24 months before survey administration or if subject matter experts at the plant (e.g., the plant manager or the MRPTOO implementation team leader) indicated that the plant was still implementing MRPTOO; MRPTOO use was not yet routinized or status quo. We contacted 140 plants, 71 of which were eligible to participate and 42 of which agreed to participate (59% of eligible plants). Of these 42 plants, 39 provided usable data. Each of the 3 plants that we excluded was very small, had a poor survey response rate and thus had very few respondents, or both.

The plants were located across the United States. All of the plants were in process manufacturing industries, but the plants varied widely in their products. Products made in the plants included, for example, animal serum, dyes and chemicals, infant formula, paint stain and varnish, pet food, shampoo, tungsten carbide, and vitamins. The plants also varied in size. At the time of our initial data collection, the average plant size was 280 employees (range = 37–800, SD = 215.92). (However, not all employees were involved with MRPTOO.)

Survey Strategy and Sample of Individuals

In designing our data collection strategy, we sought to gather survey data from a diverse and representative array of individuals involved in the implementation of MRPTOO and to minimize single-source response bias in tests of hypothesized relationships. Accordingly, we developed a distinct survey instrument for (a) the plant manager, (b) other managers and supervisors directly or indirectly involved in the implementation of MRPTOO, (c) the implementation team leader (responsible for MRPTOO implementation training and support), (d) implementation team members, (e) Users A (a randomly selected group of half of the plant's MRPTOO users), and (f) Users B (the remaining half of MRPTOO users). Most survey scales appeared in only one or two of the six surveys. In deciding which scales to include in which surveys, we attempted to match the scales to respondents' experience and expertise. For example, the implementation team leader provided technical information about the use of MRPTOO in the plant, Users A completed our measure of implementation climate, Users B completed our measure of implementation policies and practices, and the plant manager and other managers and supervisors rated the benefits of MRPTOO to the plant.

A key informant at each plant (typically the plant manager or the implementation team leader) identified the plant member or members belonging to each of the six groups. We provided each plant with a survey packet, including a stamped, return-addressed envelope, labeled for each plant member identified by the key plant informant. The analyses reported here are based on the responses of 1,219 individuals, aggregated to the level of the plant. The average within-plant response rate for the 39 participating plants was 75% (range = 39.5%–100%). The number of respondents per plant varied as a function of the plant's size and the plant's response rate. The average number of respondents per plant was approximately 31 (SD = 20.28). The average number of manager and supervisor respondents per plant (i.e., the plant manager plus other managers and supervisors) was 6.95 (SD = 8.14). The average number of implementation team member respondents (i.e., the implementation team leader plus other implementation team members) was 4.49 (SD = 3.18). The average number of User A respondents per plant was 9.97 (SD = 6.18). The average number of User B respondents per plant was 9.85 (SD = 6.67).

Approximately 2 years after our initial wave of data collection, we collected brief follow-up data from the plant managers (n = 33; response rate: 85%) and implementation team leaders (n = 31; response rate: 84%). We obtained follow-up data from both the plant managers and the implementation team leaders of 28 plants.

Measures

Given the paucity of prior organizational-level quantitative research on technology implementation, we developed original measures of our constructs by building on our prior quantitative and qualitative studies of MRP II implementation. Except as noted, all measures had a 5-point response scale (1 = *not true*, 2 = *slightly true*, 3 = *somewhat true*, 4 = *mostly true*, and 5 = *true*). Because our level of analysis was the plant, we calculated Cronbach's alpha as the estimate of scale internal consistency reliability at the plant level of analysis (using item means for each plant). Because Cronbach's alpha is typically calculated at the individual level of analysis, we also provide this information for each scale. Scale means and standard deviations appear in Table 1. Items for all of the scales are available from Katherine J. Klein on request.

Management support for MRPTOO implementation. The plant manager and other managers and supervisors completed 6 items regarding management support for the implementation of MRPTOO. Sample items include "Plant managers and supervisors are strongly committed to the successful implementation of MRPTOO" and "Plant managers and supervisors take an active interest in MRPTOO's problems and successes." Alpha at the individual level of analysis was .87, and alpha at the plant level of analysis was .93.

Financial resource availability. This 7-item scale was completed by the plant manager, other managers and supervisors, the implementation team leader, and implementation team members. Sample items are "In this plant, money has been readily available to support activities related to the implementation of MRPTOO" and "We have had to implement MRPTOO on a tight budget" (reverse scored). At the individual level of analysis, alpha was .85. At the plant level of analysis, alpha was .93.

Implementation policies and practices. Users B (a randomly selected sample of half of the MRPTOO users in each plant) completed this 36-item measure of the extent to which organizational policies and practices supported the implementation of MRP II. The scale included (a) 7 items about MRPTOO training (e.g., "Training is readily available to employees who want to learn more about MRPTOO"), (b) 8 items about MRPTOO software and hardware quality and accessibility (e.g., "People can easily access computers to use MRPTOO"), (c) 5 items about rewards for MRPTOO use (e.g., "Supervisors praise employees for using MRPTOO properly"), (d) 5 items about the availability of user support regarding MRPTOO (e.g., "If employees have a problem when using MRPTOO, they can easily find someone to help them"), (e) 5 items about time to experiment with MRPTOO (e.g., "People at this plant feel that they have enough time to do their work *and* to learn new skills associated with the shift to

Table 1
Variables, Respondent Groups, Means, Standard Deviations, and Intercorrelations

Variable	Group	*M*	*SD*	1	2	3	4	5	6
1. Management support	M	3.59	0.63	—					
2. Financial resource availability	M, T	3.70	0.60	.52***	—				
3. Implementation policies and practices	B	2.79	0.42	.31*	.42**	—			
4. MRPTOO communications	B	2.81	0.53	.38*	.38*	.87***	—		
5. Time to experiment with MRPTOO	B	2.64	0.61	.29	.39*	.87***	.71***	—	
6. MRPTOO training	B	2.88	0.53	.26	.30	.78***	.57***	.63***	—
7. MRPTOO software–hardware	B	3.05	0.45	.27	.23	.81***	.66***	.64***	.52***
8. Rewards for MRPTOO use	B	2.09	0.46	.11	.20	.69***	.51***	.63***	.40**
9. MRPTOO user support	B	3.07	0.55	.23	.50**	.88***	.79***	.66***	.71***
10. Implementation climate	A	3.95	0.48	.55***	.39*	.40**	.37*	.22	.32*
11. MRPTOO use (T1)	TL, A, B	0.00	0.89	.41*	.26	.51***	.42**	.38*	.37*
12. Avoid MRPTOO (T1)	A	1.53	0.35	−.34*	−.23	−.27	−.14	−.17	−.20
13. Endorse MRPTOO (T1)	B	3.76	0.66	.35*	.12	.59***	.45**	.53***	.50**
14. Quality of MRPTOO use (T1)	TL	0.00	1.00	.34*	.29	.39*	.39*	.25	.22
15. Benefits of MRPTOO (T1)	M	3.20	0.33	.52***	.35*	.26	.27	.38*	.19
16. Quality of MRPTOO use (T2)	TL	0.00	1.00	.15	−.07	.30	.28	.31	.20
17. Benefits of MRPTOO use (T2)	PM	3.41	0.29	.41*	.04	.32	.35*	.37*	.21
18. Months live (T1)	TL	21.00	13.58	.02	−.01	.07	−.03	.13	−.07
19. Months live (T2)	TL	47.95	16.62	−.04	.06	.25	.21	.15	.05
20. Plant size	PM	280.30	215.90	−.17	.12	−.04	.03	−.13	.10

Note. All measures were collected at Time 1 (T1) except as noted otherwise. The sample size for all correlations was 39 plants, with the following exceptions. The sample size for the correlation between quality of MRPTOO (a pseudonym for a manufacturing resource-planning package) use (Time 2 [T2]) and months live (T1) and for the correlation between quality of MRPTOO use (T2) and months live (T2) was 31. The sample size for the correlation between perceived benefits (T2) and months live (T1) was 33. The sample size for the correlation between perceived benefits (T2) and months live (T2) was 31. The sample size for the correlation of quality of MRPTOO use (T2) and perceived benefits (T2) was 28. The sample size for all other correlations with months live (T2) was 38. The sample size for all other correlations with quality of MRPTOO use (T2) was 31. The sample size for all other correlations with perceived benefits (T2) was 33. Given a sample size of 39, the *p* value for a correlation of .31 = .0540. We considered this value to be statistically significant (i.e., $p \leq .05$). Group = respondent group; M = management; T = implementation team; B = Users B; A = Users A; TL = implementation team leader; PM = plant manager.
* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

MRPTOO"), and (f) 6 items about communications to employees about MRPTOO (e.g., "Employees here often feel like they are being kept in the dark about MRPTOO"; reverse scored). At the individual level of analysis, alpha for the 36-item overall implementation climate scale was .94. At the plant level of analysis, alpha for the overall scale was .96.

We combined the six subscales to form a composite measure of implementation policies and practices for four reasons. First, we conceptualized implementation policies and practices as a cumulative summary of specific policies and practices. Our goal was not to compare and contrast the correlates of specific implementation policies and practices. Second, as shown in Table 1, the six subscales were highly positively intercorrelated. Third, an exploratory, second-order plant-level factor analysis using principal-axis extraction (with the minimum eigenvalue for retention of a factor set at 1.00) found only one factor. Factor loadings ranged from .63 to .87, and the factor accounted for 61% of the variance. Fourth, given our sample size, we sought to limit the number of variables in our analyses. We lacked the power to conduct analyses in which we simultaneously examined the six implementation policies and practices subscales and other measures from the model.

Implementation climate. Users A completed our 7-item scale designed to assess MRPTOO users' global summary perceptions of the extent to which their plant supported the implementation of MRPTOO. Sample items include "MRPTOO is a top priority at this plant"; "In this plant, there is a big push for people to make the most of MRPTOO"; and "People here really don't care about the success of MRPTOO" (reverse scored). At the individual level of analysis, alpha was .83. At the plant level of analysis, alpha was .93.

Implementation effectiveness: MRPTOO use. In preparing our measures of implementation effectiveness, we asked MRP II experts what criteria they used to assess effective MRP II use within a plant. They emphasized that a plant's use of MRP II was exemplary if (a) employees actually used the MRP II system (employees had not fashioned "work around" systems so as to use other techniques—e.g., the plant's prior software—to accomplish tasks designed to be performed with the new MRP II system); (b) plant members were genuinely enthusiastic about the new MRP II system; and (c) the MRP II system was current—that is, information was continually entered into the MRP II system in real time, not in batch mode.

We developed measures of each of these three criteria, combining the measures to form a composite measure of MRPTOO use. Users A completed the first scale, a 4-item self-report scale assessing avoidance of MRPTOO. A sample item is "When I can do a task either using MRPTOO or not using MRPTOO, I usually choose not to use MRPTOO." At the individual level of analysis, alpha was .68. At the plant level of analysis, alpha was also .68.

Users B completed the second scale, a 5-item self-report measure tapping user endorsement of MRPTOO. A sample item is "I think MRPTOO is a waste of time and money for this plant" (reverse scored). At the individual level of analysis, alpha was .81. At the plant level of analysis, alpha was .85. This measure constituted a self-report attitude measure.

Finally, the implementation team leader completed the third measure, a 7-item scale assessing the team leader's expert description of the extent and quality of the plant's use of MRPTOO. A sample item is "What is the average time delay between purchase order receiving and transaction entry into MRPTOO?" The more quickly such information is recorded within MRPTOO, the more current and accurate the MRPTOO database. A second sample item is "Approximately what percentage of the employees who report data that is ultimately entered into the MRPTOO computer system actually enter the information directly into the computer them-

7	8	9	10	11	12	13	14	15	16	17	18	19	20
—													
.50**	—												
.66***	.49**	—											
.40*	.25	.39*	—										
.55***	.30	.50**	.64***	—									
−.35*	−.16	−.22	−.65***	−.70***	—								
.64***	.27	.54***	.51***	.86***	−.57***	—							
.40**	.28	.43**	.52***	.89***	−.44**	.59***	—						
.30	−.16	.25	.18	.37*	−.22	.45**	.24	—					
.24	.25	.31	.08	.55**	−.19	.46**	.60***	.32	—				
.50**	−.04	.15	.27	.34	−.23	.30	.31	.43*	.38*	—			
.19	−.04	.14	−.04	.25	−.06	.36*	.18	.45**	.08	.15	—		
.26	.05	.41*	−.01	.18	.05	.34*	.11	.15	−.04	−.19	.67***	—	
−.29	.04	.08	.04	−.08	.08	−.07	−.06	−.31*	−.11	−.40*	−.14	.08	—

selves?" The higher the percentage of MRPTOO users who do enter data themselves, the more timely and effective the plant's MRPTOO use. Cronbach's alpha for the 7-item scale was .75. (Because only 1 respondent per plant completed this measure, the individual level of analysis and the plant level of analysis for this scale were identical.)

To combine the three scales, we first reverse scored items as necessary, so that higher numbers were indicative of better MRPTOO use. We then aggregated the items of the first two scales to the plant level of analysis and calculated the average of the 9 items, forming a plant-level measure of users' acceptance of MRPTOO. (Cronbach's alpha, at the plant level of analysis, for the combined scale of 9 items was .85.) Next, we calculated the average of the 7 items completed by the implementation team leader (after standardizing these 7 items because the response scales for the items differed greatly). Finally, we standardized and averaged the two scales: user acceptance of MRPTOO score (as rated by Users A and B) and quality of MRPTOO use (as rated by the implementation team leader). The internal consistency reliability of the composite measure (the linear combination of the two scales), based on Nunnally and Bernstein's (1994, pp. 266–268) formula, was .87. As shown in Table 1, the three subscales measuring implementation effectiveness were significantly positively intercorrelated (average intercorrelation = .53). Our use of a composite measure based on three different sources minimized the extent to which single-source bias may have inflated particular relationships in the model.

Innovation effectiveness: Perceived benefits of MRPTOO implementation. The plant manager and other managers and supervisors completed this 16-item measure describing the effects of MRPTOO use on the plant as a whole. Using a 5-item response scale, respondents rated the extent to which various measures of plant performance (e.g., product quality, inventory accuracy, customer service, on-time deliveries, obsolete inventories, and manufacturing cycle time) had improved, not changed, or worsened "because of MRPTOO." At the individual level of analysis, alpha was .85. At the plant level of analysis, alpha was .91. (Unfortunately, because our sample of plants was drawn from diverse industries, we were unable to collect objective indicators of MRPTOO benefits to the plants. We could not, for example, compare a paint manufacturer's and a candy manufacturer's improvements in inventory turns and in customer service. Nor do all plants collect objective indicators of such dimensions of plant performance. Finally, as noted below, it may be difficult to attribute changes in objective plant performance over a period of months or years to one specific cause.)

Quality of MRPTOO use (Time 2). Approximately 2 years after our initial wave of data collection in the plants, we asked the implementation team leader at each plant to complete our 7-item measure of the extent and quality of the plant's MRPTOO use (described above). Alpha for this scale was low: .54. (Because there was only 1 respondent per plant, the plant-level alpha equaled the individual-level alpha.)

Perceived benefits of MRPTOO implementation (Time 2). Approximately 2 years after our initial wave of data collection, we asked plant managers to complete our 16-item scale, described above, assessing the effects of MRPTOO on plant performance. Alpha was .82.

Control variables. At both Time 1 and Time 2, we asked the implementation team leader to report how many months ago the plant had gone "live" with (i.e., begun to implement) MRPTOO. Both variables (months live at Time 1 and months live at Time 2) appear in Table 1. Note, however, that correlations between months live at Time 2 and variables measured at Time 1 are meaningless, because the value of the measures we collected at Time 1 had no bearing on when we collected our second wave of data in the plants. We also included plant size (number of employees) as a control variable in Table 1 and in selected other analyses.

Data Aggregation

A number of statistical tests are available to assess the extent to which individual-level data show within-unit agreement and may, accordingly, be aggregated to the higher unit level (Bliese, 2000; Klein et al., 2000). Table 2 summarizes the results of these tests for the six scales that we aggregated to the plant level. The results reported in Table 2 support the aggregation of the scales to the plant level of analysis.

In column 2 of Table 2, we show the results of one-way analyses of variance. Each one-way analysis of variance yielded an eta squared for the scale. The eta-squared value was equivalent to the multiple correlation squared from a regression model in which the dependent variable was the individual-level scale (e.g., financial resource availability) and plant membership was coded into $N - 1$ (here, 38) categories (Bliese, 2000). The resulting values for eta squared provide one indication of the extent to which individual responses to our scales varied as a function of plant membership. The resulting eta-squared values ranged in size from .23 to .40. All were statistically significant.

Bliese and Halverson (1998) have shown that the magnitude of eta-squared values is influenced by the extent of within-unit and between-unit variability in the data and by the number of individuals within each unit. The intraclass correlation, or ICC(1) (Bartko, 1976; James, 1982), provides an estimate of between-unit variability that is not biased by either unit size or the number of units in the sample. We calculated ICC(1) by using Blalock's (1972) formula for ICC(1) when unit sizes are unequal. The resulting values appear in column 3 of Table 2. ICC(1) varied from .15 to .23, with an average of .20. Thus, on average, 20% of the variance in individual-level responses to our scales was explained by plant membership. The F test for ICC(1) is equivalent to the F test for eta squared. Accordingly, all of our ICC(1) values were statistically significant. Furthermore, our ICC(1) values compared favorably with values reported in other studies (e.g., James, 1982; Ostroff, 1992; Schneider et al., 1998) using individual-level data aggregated to the organizational level.

In column 4 of Table 2, we show values for ICC(2), also referred to as ICC(1,k). ICC(2) values indicate the reliability of the aggregated plant means (Bliese, 2000). ICC(2) values are a function of ICC(1) and average group size (Bliese, 2000). Thus, the greater the ICC(1) and the larger the number of individuals sampled per unit, the more reliable the unit means. The ICC(2) values for our scales ranged from .60 to .75, averaging .67. All were statistically significant. Glick (1985) recommended a cutoff of .60 for ICC(2).

Finally, in column 5 of Table 2, we show the average $r_{wg(j)}$ values for each scale by plant. The average $r_{wg(j)}$ values for our scales ranged from .65 to .98, with an overall average value for the six scales of .81.

Table 2
Aggregation Checks: Conformity of Data to the Plant Level of Theory

Scale	η^2	ICC(1)	ICC(2)	$r_{wg(j)}$
Financial resource availability	.28***	.21	.75	.65
Management support	.31***	.19	.61	.78
Upward communication	.40***	.23	.60	.88
Implementation policies and practices	.33***	.22	.74	.79
Implementation climate	.23***	.15	.64	.81
Perceived benefits	.33***	.22	.65	.98

Note. The $r_{wg(j)}$ values are averages for each measure. The plant $r_{wg(j)}$ values for the six measures ranged from .15 to 1.00, excluding out-of-range values (values < 0) for a few (0 to 4) plants per measure. ICC = intraclass correlation.
*** $p \leq .001$.

Analyses

To test the hypotheses, we first examined the bivariate correlations among the variables and then conducted a series of regression analyses to test successive segments of the model. According to Kenny, Kashy, and Bolger (1998), a variable (M) mediates the relationship between an antecedent variable (X) and an outcome variable (Y) if (a) X is significantly related to Y; (b) X is significantly related to M; (c) after X is controlled for, M remains significantly related to Y; and (d) after M is controlled for, the X–Y relationship is zero. Kenny et al. (1998) described the second and third of these steps as "the essential steps in establishing mediation" (p. 260). The first step, they commented, "is not required, but a path from the initial variable to the outcome is implied if [the two middle steps] are met" (Kenny et al., 1998, p. 260). Furthermore, the last step is necessary only to prove a complete mediation effect. Accordingly, we tested successive segments of our model by focusing on whether the second and third steps of Kenny et al.'s four-step procedure supported the mediated relationships hypothesized in our model. This analysis strategy required several regressions, as reported in the Results section.

We used structural equation modeling to provide an omnibus test of the entire model. In these analyses, we fixed the measurement model, using the manifest variables at the plant level of analysis. Because our sample of plants was very small for structural equation modeling, we used bootstrapping to assess the likelihood that our findings were due to chance. As Mooney and Duval (1993) explained,

> The basic bootstrap approach is to treat the sample as if it is the population, and apply Monte Carlo sampling to generate an empirical estimate of the statistic's sampling distribution. . . . This is done by drawing a large number of "resamples" of size n from this original sample randomly *with replacement.* (pp. 9–10)

Bootstrap methods are useful in structural equation modeling cases in which "we do not know whether the sample is sufficiently large to rely on the asymptotic chi-square distribution for the test" (Bollen & Stine, 1992, p. 218). We used Bollen and Stine's modified bootstrapping procedure, with 1,000 bootstrap samples, to obtain an estimate of the probability that the bootstrapped samples did or did not significantly depart from the model; a higher probability suggests they did not. Nevertheless, given our small sample size, the fit indices must be interpreted very cautiously.

Results

Preliminary Findings: Bivariate Correlations

The correlations among the variables are shown in Table 1. As we hypothesized, both financial resource availability ($r = .42, p < .01$) and management support ($r = .31, p < .05$) were significantly positively related to implementation policies and practices. Furthermore, implementation policies and practices was significantly positively related to implementation climate ($r = .40, p < .01$), which in turn was significantly related to MRPTOO use at Time 1 ($r = .64, p < .001$). In addition, as we hypothesized, MRPTOO use at Time 1 was significantly positively related to the perceived benefits of MRPTOO implementation at Time 1 ($r = .37, p < .05$). Our Time 2 data extended these findings over time. MRPTOO use at Time 1 was significantly positively related to quality of MRPTOO use at Time 2 ($r = .55, p < .01$). Furthermore, quality of MRPTOO use at Time 2 was significantly positively related to perceived benefits of MRPTOO implementation at Time 2 ($r = .38, p < .05$). Other statistically significant and potentially important relationships—for example, between management support and implementation climate—appear in Table 1 as well. We used regression to explore these and other relationships, as described below.

The three control variables—months live at Time 1, months live at Time 2, and plant size—showed few significant relationships with the variables in the model. However, perceived benefits of MRPTOO implementation (Time 1) was significantly positively related to months live (Time 1; $r = .45$, $p < .01$) and was significantly negatively related to plant size ($r = -.31$, $p < .05$). In addition, perceived benefits of MRPTOO implementation (Time 2) was also significantly negatively related to plant size ($r = -.40$, $p < .05$). Given our small sample size and the limited number of significant relationships between the control variables and the variables in the model, we included the control variables (specifically, months live at Time 1 and plant size) only in analyses involving perceived benefits of MRPTOO implementation.

Predicted Antecedents of Implementation Climate: Financial Resource Availability, Management Support, and Implementation Policies and Practices

We began our regression analyses by regressing implementation policies and practices on management support and financial resource availability. Together, management support and financial resource availability explained 19%, $F(2, 36) = 4.20$, $p < .05$, of the variance in implementation policies and practices. As we predicted, financial resource availability was significantly related to implementation policies and practices ($\beta = .36$, $p < .05$). Contrary to our model, however, management support was not significantly related, within the simultaneous regression, to implementation policies and practices. These results and the results of other simultaneous regressions discussed below are presented in Table 3.

We next tested whether, as predicted, implementation policies and practices mediated the relationship between financial resource availability and implementation climate. Given the nonsignificant relationship between management support and implementation policies and practices, implementation policies and practices could not mediate the relationship between management support and implementation climate. Nevertheless, we included management support within the simultaneous regression so that we could simultaneously examine (a) whether implementation policies and practices mediated the relationship of financial resource availability and implementation climate and (b) whether management support was significantly related to implementation climate, after we controlled for financial resource availability and implementation policies and practices. Together, financial resource availability, management support, and implementation policies and practices explained 37%, $F(3, 35) = 6.83$, $p < .001$, of the variance in implementation climate, but only management support was significantly related to implementation climate ($\beta = .45$, $p < .01$). Thus, contradicting our model, implementation policies and practices did not mediate the relationship of the antecedent variables to implementation climate. Rather, the results suggest that management support had a direct, nonmediated effect on implementation climate.

A Recap and Reconceptualization: Examining the Dual Influence and Mediating Roles of Implementation Policies and Implementation Climate

The correlation and regression results that we have presented thus far support several elements of the model but call into question (a) our prediction that implementation policies and practices mediated the influence of financial resource availability and management support on implementation climate and thus, by extension, (b) our prediction that implementation climate mediated the influence of implementation policies and practices on MRPTOO use. In developing these hypotheses, we were influenced by theoretical research suggesting that climate results from employees' shared perceptions of organizational policies and practices. However, as we noted earlier, the theoretical literature regarding the relationship of organizational policies and practices to organizational climate is ambiguous. Furthermore, the relationship between

Table 3
Results of Simultaneous Regressions Testing Components of the Model

Variable	β	F	df	R^2
DV: Implementation policies and practices		4.20*	2, 36	.19
Financial resource availability	.13			
Management support	.36*			
DV: Climate		6.83***	3, 35	.37
Implementation policies and practices	.24			
Financial resource availability	.06			
Management support	.45**			
DV: MRPTOO use at Time 1		8.39***	4, 34	.50
Implementation climate	.51**			
Implementation policies and practices	.33*			
Financial resource availability	.08			
Management support	−.12			
DV: MRPTOO use at Time 2		6.66**	3, 27	.43
MRPTOO use at Time 1	.79***			
Implementation climate	−.44*			
Implementation policies and practices	.08			

Note. DV = dependent variable; MRPTOO = a pseudonym for a manufacturing resource-planning package.
* $p \leq .05$. ** $p \leq .01$. *** $p \leq .001$.

climate and policies and practices has not, to our knowledge, been examined in prior empirical research.

In light of the findings we have presented thus far, the ambiguous theoretical literature regarding the relationship of policies and practices to climate, and the dearth of prior research on the topic, we speculated—in a modification of our original model—that implementation policies and practices and implementation climate might simultaneously, rather than sequentially, influence MRPTOO use. Perhaps implementation policies and practices mediate the relationship between financial resource availability and MRPTOO use, and implementation climate mediates the relationship between management support and MRPTOO use. As shown in Table 3, the results of our post hoc analysis supported this interpretation. Implementation climate, implementation policies and practices, management support, and financial resource availability together explained 50%, $F(4, 34) = 8.39, p < .001$, of the variance in MRPTOO use. Both implementation climate ($\beta = .51, p < .01$) and implementation policies and practices ($\beta = .33, p < .05$) were significantly positively related to MRPTOO use, but neither financial resource availability nor management support was.

Relationships Among MRPTOO Use at Time 1, MRPTOO Use at Time 2, Perceived Implementation Benefits at Time 1, and Perceived Implementation Benefits at Time 2

Time 1 relationships. In testing the final segments of the model, we first conducted a hierarchical regression that examined the relationship between MRPTOO use and perceived benefits of MRPTOO implementation at Time 1, after we controlled for months live at Time 1 and plant size. (As we noted earlier, both of these control variables were significantly correlated with the perceived benefits of MRPTOO implementation.) As shown in Table 4, the three variables explained 33%, $F(3, 35) = 5.76, p < .01$, of the variance in perceived benefits of MRPTOO implementation, but only months live was significantly related to perceived benefits ($\beta = .35, p < .01$). Thus, the longer a plant had used MRPTOO, the greater were the perceived benefits of MRPTOO implementation. Both plant size ($\beta = -.24, p = .09$) and MRPTOO use ($\beta = .26, p = .08$) were positively and nearly significantly related to perceived benefits of MRPTOO implementation. In a separate regression (not shown), we tested whether, after we controlled for months live and plant size, MRPTOO use mediated the relationships between the two antecedent variables—implementation climate and implementation policies and practices—and perceived benefits of MRPTOO implementation. Not surprisingly, given the results just described, MRPTOO use at Time 1 was not significantly related to perceived benefits in this analysis. (The only significant predictor was months live.) In sum, the results did not support our prediction that MRPTOO use would mediate the relationship between the antecedent variables and the perceived benefits of MRPTOO implementation.

Time 2 relationships. As shown in Table 1, MRPTOO use at Time 1 was significantly positively related to MRPTOO use at Time 2. To test the final segments of the model, we tested whether MRPTOO use at Time 1 mediated the relationship of implementation climate and implementation policies and practices on MRPTOO use at Time 2. As shown in Table 3, the results of the simultaneous regression suggest that MRPTOO use at Time 1 mediated the effects of implementation policies and practices on MRPTOO use at Time 2. MRPTOO use at Time 1 was significantly positively related to MRPTOO use at Time 2 ($\beta = .79, p < .001$); implementation policies and practices were not ($\beta = .08, p > .05$). Unexpectedly, implementation climate was significantly negatively related to MRPTOO use at Time 2 ($\beta = -.44, p < .05$). Given that the correlation between climate and MRPTOO use at Time 1 was positive and significant ($r = .64, p < .001$), as was the correlation between MRPTOO use at Time 1 and MRPTOO use at Time 2 ($r = .55, p < .01$), the results appear to be artifactual—attributable to multicollinearity among the measures.

Table 4
Results of Hierarchical Regressions Testing Components of the Model

Variable	β	*df*	ΔR^2	R^2
DV: Perceived benefits of MRPTOO implementation at Time 1				
Step 1		2, 36	.27**	.27**
Months live at Time 1	.42**			
Plant size	−.25			
Step 2		3, 35	.06	.33**
Months live at Time 1	.35**			
Plant size	−.24			
MRPTOO use at Time 1	.26			
DV: Perceived benefits of MRPTOO implementation at Time 2				
Step 1		2, 25	.19	.19
Months live at Time 1	.13			
Plant size	−.40*			
Step 2		3, 24	.09	.28
Months live at Time 1	.09			
Plant size	−.35			
MRPTOO use at Time 2	.31			

Note. DV = dependent variable; MRPTOO = a pseudonym for a manufacturing resource-planning package.
* $p \leq .05$. ** $p \leq .01$.

Finally, we regressed perceived implementation benefits at Time 2 on MRPTOO use at Time 2, after we controlled for plant size and, to be consistent with our prior analyses of perceived implementation benefits at Time 1, months live at Time 1. As shown in Table 4, after we controlled for plant size and months live at Time 1, MRPTOO use at Time 2 explained 9% of the variance in perceived implementation benefits at Time 2, a nearly significant increment in explained variance ($p < .10$). (Note that, because of missing data, our *n* for these analyses was only 28.) We also tested whether, after we controlled for months live at Time 1 and plant size, MRPTOO use at Time 2 mediated the relationship between MRPTOO use at Time 1 and perceived implementation benefits at Time 2. Not surprisingly, given the preceding results and our sample size, none of the variables in this simultaneous regression (not shown) were significantly related to the outcome measure.

Putting It All Together

In sum, in testing the model and conducting post hoc analyses, we found that (a) management support was significantly positively related to implementation climate, (b) financial resource availability was significantly related to implementation policies and prac-

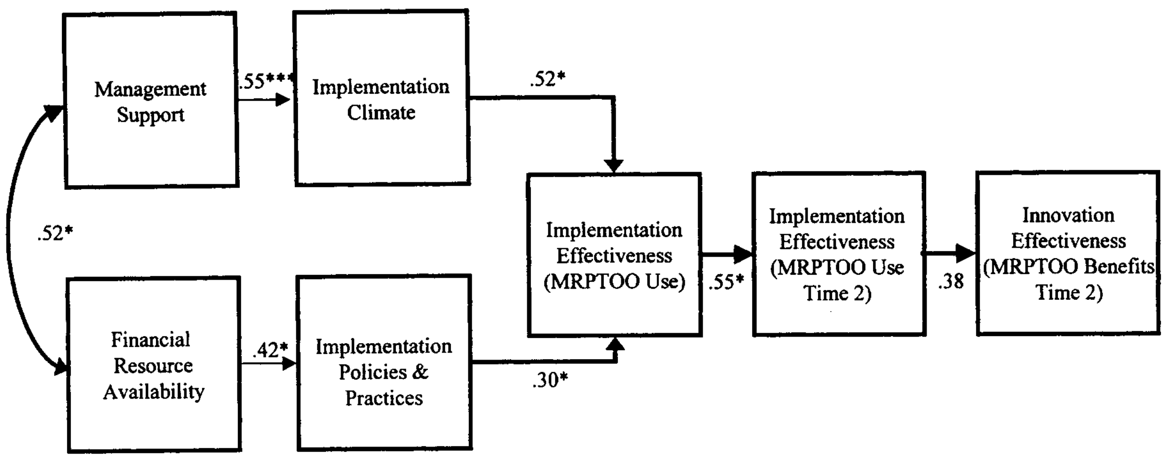

Figure 2. Path model and path coefficients for the revised model. MRPTOO = a pseudonym for a manufacturing resource-planning package. $^*p < .05$. $^{***}p < .001$.

tices, (c) both implementation climate and implementation policies and practices were significantly related to MRPTOO use at Time 1, and (d) MRPTOO use at Time 1 was significantly related to MRPTOO use at Time 2. Although MRPTOO use at Time 1 was significantly positively correlated with the perceived benefits of MRPTOO implementation at Time 1 and MRPTOO use at Time 2 was significantly positively correlated with the perceived benefits of MRPTOO implementation at Time 2, our regression analyses—in which we included the control variables of months live and plant size—did not reveal significant relationships between MRPTOO use and perceived benefits.

The path model shown in Figure 2 summarizes our revised model. We obtained the path coefficients shown in Figure 2 by regressing each variable in the model on its immediate antecedent or antecedents (e.g., regressing implementation policies and practices on financial resource availability). With minor exceptions, the path coefficients in Figure 2 are identical to those found in testing the model using structural equation modeling.[3]

We used structural equation modeling to provide an overall test of our original model, shown in Figure 1, and of the revised model, shown in Figure 2.[4] The fit of the original model was poor. The overall chi-square for the model was 16.75 with 5 degrees of freedom (p = .005), the comparative fit index was .78, the incremental fit index (Bollen, 1989) was .80, and the goodness-of-fit index was .86. The Bollen–Stine bootstrapped probability of the model was .06, indicating that the bootstrapped samples departed from the model at a nearly statistically significant level (see Arbuckle, 1997). In contrast, the fit of the revised model was good and significantly better than that of the original model: The overall chi-square for the model was 4.86 with 5 degrees of freedom (p = .43), the comparative fit index was 1.00, the incremental fit index was 1.00, and the goodness-of-fit index was .95. The Bollen–Stine bootstrapped probability of the revised model was .56, indicating that the bootstrapped samples did not depart from the model at any conventional significance level (see Arbuckle, 1997).

Discussion

The results of this study are important but preliminary. The results are important because an organization's success or failure in implementing innovations may have a profound influence on the organization's survival. Nevertheless, innovation implementation has been the object of little research. Indeed, we know of no other quantitative, multilevel assessment of the correlates of organizational implementation effectiveness. This study documents, for the first time, that organizational differences in implementation effectiveness (innovation use) are significantly related to management support, financial resource availability, policies and practices, and climate. Our efforts to gather data from multiple respondents within each plant and to minimize the potential influence of response–response bias strengthen the credibility and importance of our results.

And yet, for several reasons, the results must be considered preliminary. First, although we collected data from more than 1,000 individuals, our sample of plants was small. Thus, the stability of our findings is uncertain. Furthermore, because we relied on traditional tests of significance in interpreting our findings, we may have downplayed substantively meaningful relationships—relationships that might, in a larger sample, have proved statistically significant.

Clearly, the study should be replicated in a larger sample of organizations. Second, we studied the implementation of only one innovation. We chose this innovation with care, focusing on manufacturing resource planning because of its prevalence and organizational complexity and focusing more specifically on MRPTOO so as to eliminate any confounding effects attributable

[3] The path coefficients in the structural equation model were as follows: management support to implementation climate, .55; financial resource availability to implementation policies and practices, .42; implementation climate to MRPTOO use at Time 1, .54; and implementation policies and practices to MRPTOO use at Time 1, .32.

[4] We excluded MRPTOO use at Time 2 and perceived benefits of MRPTOO implementation at Times 1 and 2 from both structural equation models because the inclusion of MRPTOO use at Time 2 shrank our sample size to 31 plants, the inclusion of perceived benefits of MRPTOO implementation at Time 2 shrank our sample size still further, and both measures of perceived benefits were significantly correlated with the control variables.

to variability in the manufacturing resource-planning vendor. Still, our results may not generalize to other innovations and to other organizations. Third, because the plants came from diverse industries, we were unable to collect objective measures of the benefits that the plants accrued in implementing MRPTOO. Had all the plants come from a common industry, objective measures of the benefits of MRPTOO implementation might still have been unavailable. Plants often assess only a small number of objective indicators of plant performance. Furthermore, plants undergo so many simultaneous changes—in products produced, management, technology, strategy, competitors, and so on—that it is very difficult to attribute objective changes in performance to a single cause. Fourth, we collected only minimal longitudinal data. Thus, causal inferences based on the findings are necessarily speculative. Finally, we have surely omitted from our study potentially important determinants of innovation implementation. Additional study is needed of other possible predictors (see, e.g., Klein & Sorra, 1996; Reger et al., 1994). Below, we explore the implications of the results in more detail.

Financial Resource Availability, Management Support, Implementation Policies and Practices, and Implementation Climate

As we hypothesized, financial resource availability was significantly positively related to implementation policies and practices. The significant relationship between financial resource availability and implementation policies and practices underscores the fundamental point that the provision of high-quality implementation policies and practices, such as training, user support, rewards for technology use, and high-quality hardware, is expensive. Contradicting our model, management support for MRPTOO implementation was not significantly related, within our regression analyses, to implementation policies and practices. In many plants, technology implementation specialists (e.g., computer technicians) may assume a primary role in developing and maintaining implementation policies and practices such as technology training, user support, and software and hardware quality and accessibility. When provided with ample financial resources, these individuals may be of more direct consequence in shaping the quality of a plant's implementation policies and practices than are plant managers.

And yet, the influence of plant managers should not be underestimated. Management support for MRPTOO implementation, we found, was directly and significantly positively related to implementation climate. This result suggests that managers' personal statements and behaviors send employees a message about the merits of technology implementation: Is technology implementation a priority to be embraced or a nuisance best avoided? To our knowledge, the relationship of management views and organizational climate has not been documented in prior quantitative, multiorganizational research.

In our post hoc analyses, we found that implementation policies and practices and implementation climate were both significantly and simultaneously positively related to MRPTOO use. Perhaps implementation policies and practices influence innovation use by shaping employees' skill and comfort in innovation use, whereas a strong implementation climate facilitates innovation use by building employees' recognition and acceptance of the importance of innovation implementation. Although this interpretation has, with hindsight, intuitive appeal, we were surprised that implementation policies and practices and implementation climate were not more strongly correlated. The theoretical literature, as we have noted, suggests that the two constructs are hand in glove—either cause and effect or one in the same. Our findings regarding the relationship of implementation policies and practices and implementation climate are difficult to interpret, however, because no other researchers have, to our knowledge, collected separate unit-level measures, from different groups of respondents, of the two constructs.

Innovation Use and Perceived Benefits of MRPTOO Implementation

We found that MRPTOO use at Time 1 was significantly positively related to MRPTOO use at Time 2. Furthermore, at both Time 1 and Time 2, MRPTOO use was significantly positively correlated with the perceived benefits of MRPTOO implementation. Our findings regarding the perceived benefits of MRPTOO implementation must, however, be interpreted with caution. First, our Time 1 and Time 2 measures of the gains in plant performance attributable to MRPTOO were confounded with the control variables. In analyses controlling for plant size and the length of the implementation process in each plant (months live), the relationship of MRPTOO use to perceived benefits was not significant. Second, the direct effects of an organization's use of a new technology are difficult to discern and thus difficult to measure:

> Calculating a level of return for most AMT [advanced manufacturing technology] projects is an extremely difficult undertaking. . . . It is virtually impossible to tell if the expected level of return has, in fact, been achieved, due to changes in demand and production rates, responses of competitors, and so on. (Dean, 1987, pp. 42–43)

Third, in rating the benefits of technology implementation, managers may have been influenced by their observations of employees using the new technology. In the absence of clear-cut evidence of the direct benefits of MRPTOO implementation, managers may have reasoned: "Employees use the technology eagerly and well, so it must be beneficial" or "We've been at this process for so long that, by now, MRPTOO must be giving us some real gains." Fourth, as we noted in the introduction, a variety of factors that we did not measure may moderate the relationship between implementation effectiveness and the benefits of innovation implementation to the adopting organization.

Implications and Directions for Future Research

Research on innovation adoption dominates the innovation literature. As a result, the innovation and organizational characteristics associated with innovation adoption are well documented. However, innovation implementation is by no means the inevitable consequence of innovation adoption; "adopted policies may never be put into action and adopted technologies may sit in unopened crates on the factory floor" (Klein & Ralls, 1995, pp. 32–33).

In this study, we collected data from users, technology specialists, and managers—a real strength of our research effort—to assess the correlates of the implementation of a complex advanced computerized manufacturing technology across a sample of manufacturing plants and companies. The results supplement the conclusions of prior largely qualitative studies of implementation and highlight the challenges of innovation implementation. Many plants failed to gain employees' full acceptance and skilled use of the new technology. Furthermore, many plants reported few benefits as a result of their adoption and implementation of MRP II. Our findings underscore the importance of both financial resource availability and management support for implementation. Plants characterized by strong management support for implementation and the availability of financial resources were most likely to exhibit high-quality implementation policies and practices and a strong climate for implementation. A strong implementation climate, our results indicate, is not synonymous with high-quality implementation policies and practices but complementary to them. Policies and practices are concrete and tangible. Climate, as we operationalized the term, is more ephemeral—a plant's esprit de corps, its members' shared perception that technological change is an organizational priority.

Although our study contributes important information on a topic long neglected in the organizational literature, our study has a number of limitations, as we have noted. Although we studied, to the best of our knowledge, a substantial percentage of the population of plants actively implementing MRPTOO at the time of our study, our sample size of plants was small. Furthermore, in examining the implementation of a single technology, we controlled for the effects of innovation characteristics on implementation effectiveness but thereby limited the generalizability of our findings. Finally, implementation should ideally be studied over time. Additional research is needed to overcome these weaknesses, to replicate—or challenge—our findings, and to further explore the determinants and dynamics of innovation implementation. Our study provides a starting point for such research—a set of core constructs and measures that researchers may adopt and enhance as well as crucial evidence that interorganizational variability in implementation effectiveness can be quantified and explained.

Many important questions remain. Is the implementation of nontechnological innovations—such as self-managing teams or open-book management—more or less difficult than the implementation of technological innovations? What explains the variability among plant managers' support for innovation implementation? How does the process of implementation unfold over time? For example, if innovation implementation is initially unsuccessful, can an organization subsequently turn the tide and successfully implement the innovation? What factors moderate the relationship between implementation effectiveness and the benefits of the innovation to the adopting organization?

To survive and thrive in the 21st century, organizations must innovate their production processes, products, and services with increasing frequency. Our study offers a preliminary assessment of the challenges of innovation implementation and the ways in which organizations may overcome these challenges. The time is right for further research on the antecedents and consequences of innovation implementation. We hope that our study helps pave the way.

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