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Abstract:

Systems implementation is an important topic, and numerous studies have been conducted to identify determinants of success. Among organizational factors that can have an impact on success, top management support and training are two of the most extensively studied variables. While the positive influence of both of these organizational factors is generally recognized, not all empirical evidence is supportive. Some researchers attribute the inconsistent findings to moderators such as task interdependence. Other researchers contend that the wide-ranging correlations observed in different studies are caused by nothing but statistical artifacts. Still another reason for the inconsistent results could be how the two variables are modeled. I meta-analyzed thirty prior studies that examine the effect of both top management support and training. The results support both independent variables having a moderate positive effect on implementation success. Additionally, they suggest that the most plausible model is one where training partially mediates the effect of top management support. Finally, the preponderance of evidence indicates that task interdependence does not moderate the effect of either top management support or training. Instead, the role of task interdependence is similar to that of top management support and training: as an independent variable with a direct effect on implementation success.

Keywords: Management Support, Training, IS Implementation, Systems Success, Task Interdependence, Meta-Analysis.

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I. INTRODUCTION

Implementing information systems is usually resource intensive, but the results are often less than satisfactory. The industry is full of horror stories where, after spending millions of dollars and enduring protracted delay, organizations are forced to abandon an IS project (Wright & Capps, 2010). Even if a system is delivered on time and in budget, it is not guaranteed that its intended users will use or enjoy it, nor that it will achieve its expected business benefits. Consequently, numerous studies have been devoted to finding factors that contribute to the success of implementing information systems. Among the factors that have been most extensively investigated, top management support has usually been found to play a critical role in the project outcomes (Ifinedo, 2008). Some researchers even claim that top management support is the most critical factor to the success of implementing information systems (Young & Jordan, 2008).

However, not all empirical evidence backs the critical role of top management support (Kamhawi, 2007; Thong, Yap, & Raman, 1996; White & Leifer, 1986). In an effort to reconcile the inconsistent findings, Sharma and Yetton (2003) developed a contingency model. The results of their meta-analysis suggest that the effect of top management support is moderated by task interdependence and that top management support is critical when task interdependence is high, but "a relatively weak and probably not critical component when task interdependence is low" (Sharma & Yetton, 2003, p. 545). A more recent meta-analysis, however, found top management support equally effective in both high and low task interdependence groups (Hwang & Schmidt, 2011). Is the effect of top management support universal as Young and Jordan (2008) and Hwang and Schmidt (2011) report or situational as Sharma and Yetton (2003, 2011) assert? The answer has important implications for both IS implementation practice and research.

Another organizational support variable that has received a lot of attention is training. Similar to top management support, the positive effect of training has been widely recognized. Also similar to top management support, the effectiveness of training has been challenged. In another meta-analysis, Sharma and Yetton (2007) conclude that the effect of training is contingent on technical complexity and task interdependence. The motivation for Sharma and Yetton's (2003, 2007) two meta-analyses is that empirical evidence on the effect of top management support and training is inconsistent. Consequently, a moderator such as task interdependence or technical complexity is tested in a contingency model to reconcile the inconsistent results found in the literature. Hwang and Schmidt's (2011) opposing view is that discrepancy in research findings on top management support is, for the most part, caused by statistical artifacts rather than task interdependence. In this paper, I shed light on this debate by analyzing results from prior studies that examine both top management support and training. From this, I investigate the interaction between top management support and training in different models of IS implementation success. I:

1. Determine the effect of top management support on implementation success
2. Determine the effect of training on implementation success
3. Model the relationship between top management support and training as they affect implementation success, and
4. Test the moderating effect of task interdependence on top management support and training.

II. LITERATURE REVIEW

In a meta-analysis of organizational and individual determinants of IS success, Sabherwal, Jeyaraj, and Chowa (2006) reviewed 121 studies published from 1980 to 2004. Table 1 summarizes their findings. As Table 1 shows, all the determinants are relatively well studied. Because a given study can include multiple independent variables, some of the studies in column two overlap. The remaining columns display the mean true score correlation of four common systems success measures. The positive effect of these factors on systems success is consistent with most of the IS literature. However, the correlation found in any given study can differ from the mean correlation. Are those differences due to statistical artifacts (Hwang & Schmidt, 2011) or the result of moderator variables (Sharma & Yetton, 2003, 2007)?

Another potential reason for varied results found across studies is how the variables are modeled. In a study where two or more independent variables are investigated (e.g., top management support and training), their effects can be modeled in at least three different ways as Figures 1-3 illustrate.

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Table 1: Organizational and Individual Determinants Of Systems Success					
Determinant	**Number of studies**	**System quality**	**Perceived usefulness**	**User satisfaction**	**System use**
Management support	37	0.18	0.34	0.34	0.24
Facilitating conditions	35	0.20	0.20	0.30	0.18
User experience	32	0.31	0.29	0.17	0.35
User training	31	0.25	0.23	0.19	0.24
User attitude	38	0.43	0.50	0.37	0.32
User participation	36	0.24	0.34	0.37	0.24

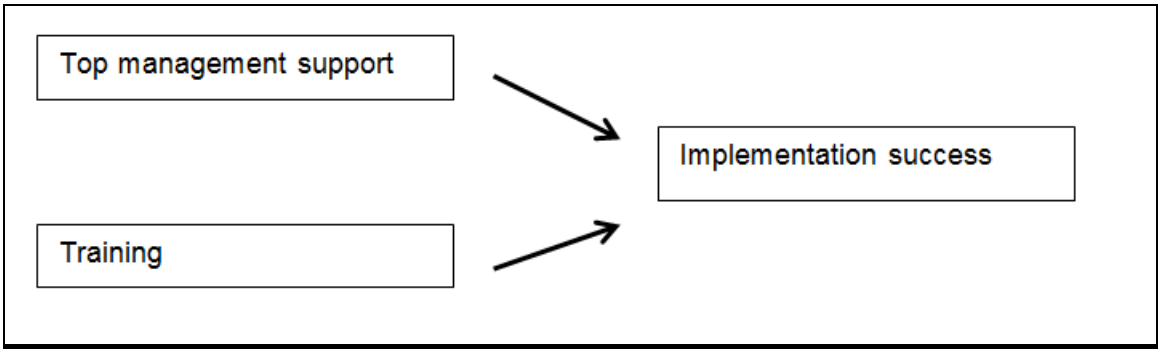

Figure 1. Direct Effects Model

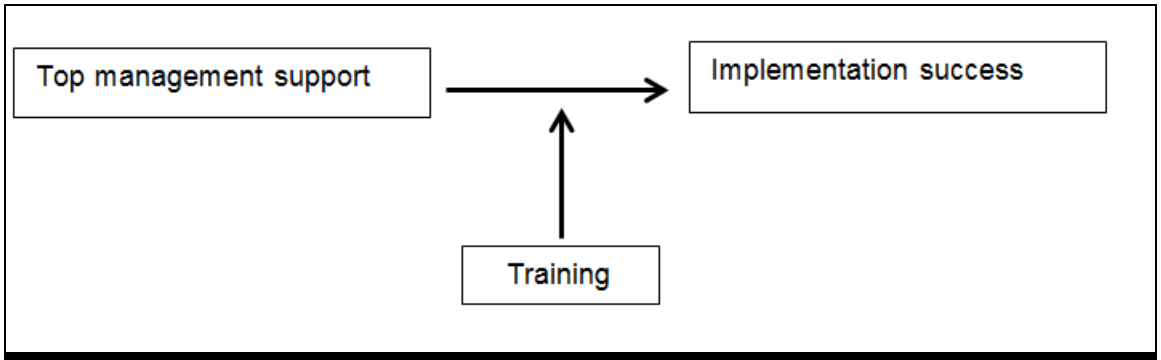

Figure 2. Moderator Effects Model

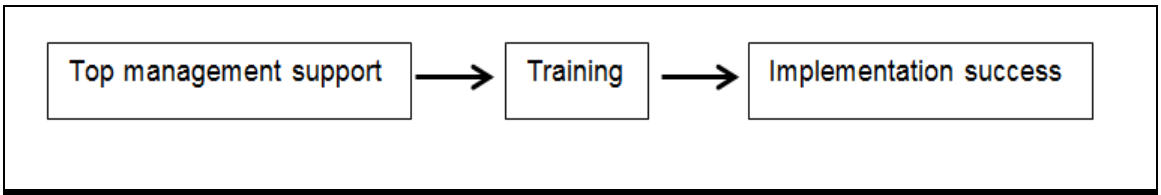

Figure 3. Mediational Model

Figure 1 illustrates a direct effects model where the two independent variables exert a direct and non-overlapping effect on the dependent variable. This straightforward model has been the dominant choice in prior studies (e.g., see Sanders & Courtney, 1985; Santhanam, Guimaraes, & George, 2000). Unlike the direct effects model, where the two independent variables are assumed to be orthogonal, the moderator effects model assumes that the two independent variables interact in a way that one variable moderates the effect of the other variable. Figure 2 illustrates that training can moderate the effect of top management support. It is also possible that top management support can moderate the effect of training, hence switching their respective roles in Figure 2. Finally, a mediational model, as Figure 3 illustrates, suggests that the effect of top management support is mediated by that of training. Figure 3 shows that the direct effect of top management support is only observable on training. In other words, the effect of top management support on implementation success is totally mediated by training. This is known as a full mediational model. It is also possible that some direct effect from top management support on implementation success can still be

observed, resulting a partial mediational model. Another variation of Figure 3 is switching the roles of top management support and training, whereby the former mediates the effect of the latter.

The Role of Task Interdependence

Task interdependence is an important characteristic of the task that can play a role in systems implementation. Thompson (1967) distinguishes three types of task interdependence: pooled, sequential, and reciprocal, with pooled being the most independent and reciprocal the most interdependent. In prior IS studies, low interdependent or independent tasks have been conceptualized as those that do not require the assistance of others for completion whereas interdependent tasks are those that require others' assistance for completion (Sanders & Courtney, 1985). On the other hand, Sharma and Yetton (2003) characterize low interdependent tasks as those supported by personal productivity applications, and high interdependent tasks as those supported by enterprise systems. While both conceptualizations capture some aspect of task interdependence, the lack of generally accepted definition and measurement may have contributed to the inconsistent findings on the effect of task interdependence that Sharma and Yetton (2003) discuss.

For this paper's purpose, the question is whether task interdependence moderates the effects of top management support and training. Sanders and Courtney (1985) conducted one of the first empirical tests of the effect of task interdependence on implementation success. Their results show that task interdependence affected three of their six success measures. Guimaraes, Igbaria, and Lu (1992) similarly found that task interdependence affected two of their three success measures. Both studies use a direct effects model to test the effects of a number of independent variables including task interdependence, top management support, and training. In other words, neither study models task interdependence as a moderator. Support for this position can be evaluated by examining the correlation between task interdependence and the other two independent variables. As I discuss in the result section, if the correlations are low, a direct effects model is more plausible than a moderator effects model. While Sanders and Courtney (1985) do not provide that information, Guimaraes et al. (1992) report a non-significant correlation both between task interdependence and top management support ($r = 0.03$) and between task interdependence and training ($r = 0.03$). Sharma and Yetton (2003, 2007), on the other hand, used a regression model to show the moderating effect of task interdependence on both top management support and training. I examine both correlation data and regression analysis to analyze the moderating effect.

III. METHODOLOGY

I use a meta-analysis to test the various models identified in the previous section. The sample consists of prior implementation success studies that include both top management support and training as independent variables. As is common in meta-analysis, I conducted a comprehensive literature search using popular databases including ABI/INFORM, Science Direct, Sociological Abstracts, and Dissertation Abstracts. Using keywords such as systems implementation, systems success, top management support, and training, I identified potential studies. I examined abstracts of these studies and located full-text articles for those that were suitable for meta-analysis. I also examined the above studies' references and I inspected reviews and theoretical studies for further potential studies. In the end, I included a total of 30 studies reported in 27 publications in the final meta-analysis sample. The number of studies is comparable to the 22 studies of top management support that Sharma and Yetton (2003) review and the 27 studies of training that Sharma and Yetton (2007) analyze.

For each study included in the sample, I coded correlations between the independent variables (i.e., top management support and training) and the dependent variable (i.e., implementation success). Based on the DeLone and McLean's (2003) updated IS success model, I measured implementation success via three distinct indicators: use, satisfaction, and net benefits. Other studies have used other success measures, but they are not as popular as those three. Note that Sharma and Yetton (2003, 2007) also adopt use and satisfaction as measures of implementation success. However, they combine the two indicators into a single measure, which may have confounded their results. I examine this issue in more detail in the result section.

I also coded correlations between top management support and training where available. I used these values for testing the direct effects and mediational models. In addition, I coded the scales used for these two variables and the mean scores where available. Many studies used a Likert-type scale to measure the two variables. For instance, a mean of 3.5 on a 7-point scale gives a score of 0.5, which provides a measure of the degree of top management support or training. I used these values in testing the moderator effects model.

I also coded task interdependence for each study. Following Sharma and Yetton's (2003) methodology, the value can range from 5 (low) to 30 (high). I used these values in testing the moderating effect of task interdependence on top management support and training.

I corrected reported correlations for measurement errors using available reliability data (Hunter & Schmidt, 2004). I then used these corrected correlations for model testing purposes, as I detail next. Appendix A contains statistics of the sample I used in this meta-analysis.

Direct Effects Model

A direct effects model assumes that top management support and training act independently of one another on implementation success. Based on theories and most existing studies, we could expect a positive correlation between top management support and implementation success and a positive correlation between training and implementation success, which lends support to the direct effects model. On the other hand, the correlation between top management support and training should be non-significant if the two variables exert a truly independent effect on implementation success. A non-trivial correlation (positive or negative) between top management support and training would suggest that other models (moderator effects or mediational) are more appropriate.

Moderator Effects Model

In a moderator effects model, an independent variable interacts with a second independent variable to affect the relationship between the latter and the dependent variable. As Figure 2 illustrates, if training is a true moderator, the effect of top management support on implementation success will vary depending on the level of training. A strong effect of top management support on implementation success may be associated with a high (or low) level of training.

Testing moderator variables has become increasingly popular in meta-analyses conducted by IS researchers (Hwang & Schmidt, 2011; Petter & McLean, 2009). One common approach is regressing the potential moderator (e.g., training) on the correlation between the independent variable (e.g., top management support) and the dependent variable (e.g., implementation success). If the regression model is significant, it is inferred that the moderator is operating. Even though this approach is intuitive and popularly used in many IS meta-analyses (e.g., Sharma & Yetton, 2003, 2007; Wu & Lederer, 2009), it has severe limitations (Hwang & Schmidt, 2011). As a result, Hwang and Schmidt (2011) recommend comparing credibility intervals of subgroups based on the moderator variables. In this research, I use both the regression analysis and the subgroup analysis to test the moderating effect.

Mediational Model

I use the procedure Viswesvaran, Sanchez, and Fisher (1999) describe to test for mediational effects. In this procedure, pairwise correlations between the three variables (i.e., top management support, training, and implementation success) are calculated first. Support for a full mediational mode as Figure 3 illustrates is obtained if the partial correlation between top management support and implementation success drops to zero after partialing out the effect of training. If the partial correlation between top management support and implementation success decreases to a nonzero amount after partialing out the effect of training, support for a partial mediational model is found. Finally, if the partial correlation between top management support and implementation success does not drop after partialing out the effect of training, the mediational model is not supported. In sum, in this meta-analysis I accumulate pairwise correlations between the three variables. Then, I conduct partial correlation analysis to determine if a full or partial mediational model is supported.

IV. RESULT

Table 2 displays the effect of top management support on implementation success as measured by use, satisfaction, and net benefits, respectively. As Table 2 shows, the mean true score correlation for all success measures range from 0.22 to 0.34, a correlation considered to be medium (Cohen & Cohen, 1983). The 90 percent confidence intervals for the mean true score correlation and the 80 percent credibility intervals for the distribution of true score correlations are all positive, which further confirms the effect of top management support. These results are comparable with the findings of Sabherwal et al.'s (2006) meta-analysis, which reported a mean true score correlation of 0.24 for use and 0.34 for satisfaction.

Table 2: Top Management Support on Implementation Success

Success measure					80% CV		90% CI	
	k	*N*	ρ	SD_ρ	Lower	Upper	Lower	Upper
Use	24	4546	0.22	0.10	0.08	0.35	0.17	0.26
Satisfaction	9	1539	0.29	0.10	0.16	0.43	0.22	0.37
Net benefits	16	2854	0.34	0.15	0.15	0.52	0.27	0.40

Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_ρ = standard deviation of true score correlations; CV = credibility interval; CI = confidence interval.

Table 3 displays the effect of training on implementation success again as measured by use, satisfaction, and net benefits, respectively. Similar to top management support, training has a medium mean true score correlation. The positive confidence intervals and credibility intervals further reaffirm the effect of training. These results are also comparable with the findings of Sabherwal et al.'s (2006) meta-analysis, which reported a mean true score correlation of 0.24 for use and 0.19 for satisfaction. In sum, consistent with most of the literature, Sabherwal et al.'s (2006) meta-analysis, and Hwang and Schmidt (2011), my sample shows a medium positive effect of top management support on implementation success. Also consistent with most of the literature and Sabherwal et al.'s (2006) meta-analysis, my sample shows a medium positive effect of training on implementation success. Nevertheless, the credibility intervals indicate that an actual correlation found in a single study can range widely (e.g., from 0.08 to 0.35 for the correlation between management support and use). Are the differences the results of statistical artifacts (Hwang & Schmidt, 2011) or moderators (Sharma & Yetton, 2003, 2007)? The moderator effects model section provides an answer.

Table 3: Training on Implementation Success

Success Measure					80% CV		90% CI	
	k	*N*	ρ	SD_ρ	Lower	Upper	Lower	Upper
Use	24	4546	0.25	0.16	0.04	0.45	0.18	0.30
Satisfaction	9	1539	0.21	0.12	0.06	0.37	0.13	0.30
Net benefits	16	2854	0.22	0.08	0.12	0.33	0.18	0.27

Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_ρ = standard deviation of true score correlations; CV = credibility interval; CI = confidence interval.

Direct Effects Model

Only 19 of the 30 studies reported correlations between top management support and training. Those correlations were accumulated using the same procedure for implementation success measures. Results shown in Table 4 indicate that the mean true score correlation is also of medium size and that the positive effect is confirmed by both the confidence and credibility intervals. Since top management support and training are positively correlated, the direct effects model is concluded to be inappropriate when studying their joint effects on implementation success.

Table 4: Top Management Support and Training

				80% CV		90% CI	
k	*N*	ρ	SD_ρ	Lower	Upper	Lower	Upper
19	3865	0.25	0.19	0.01	0.49	0.17	0.33

Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_ρ = standard deviation of true score correlation; CV = credibility interval; CI = confidence interval.

Moderator Effects Model

Testing a moderator effects model using regression entails regressing a moderator on the correlations. Most studies I analyzed measured both top management support and training with a Likert-type scale. The mean score provides a measure of a particular variable (i.e., the degree of top management support or training). However, not all studies reported the mean scores; only three studies that measured satisfaction reported the mean for both top management support and training. Similarly, only six studies that examined net benefits and 11 that measured use did so. Given the small samples, I include only the 11 studies that explored use in the moderator analysis.

Table 5 shows the regression results based on a model in which training moderates the effect of top management support on use. I used the meta-analysis program that Borenstein, Hedges, Higgins, Rothstein (2009) developed and Sharma and Yetton (2011) recommend. The program provides two algorithms for estimating a mixed effects regression model, which both Sharma and Yetton (2011) and Hwang and Schmidt (2011) recommend. As Table 5 shows, the slop represents the moderator (i.e., training), whose effect can be determined by the Z-value and P-value. As the Z-values and P-values indicate, the moderating effect of training is non-significant.

Table 5: Training Moderates Management Support on Use (Regression Model)				
Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.14	0.11	1.30	0.19
Slop	0.15	0.22	0.70	0.48
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.14	0.10	1.34	0.18
Slop	0.16	0.21	0.78	0.44

-The moderating effect of a variable can also be examined in a subgroup analysis (Hwang & Schmidt, 2011). In a subgroup analysis, the sample is broken into subgroups based on the coding of a moderator. Using training scores obtained from the 11 studies, I calculated a mean and used it to classify these studies into high or low training group. I then calculated the mean and standard deviation of each group and used them to construct the 90 percent confidence intervals. A Q-value can be calculated to determine the heterogeneity of the two groups. A significant Q-value suggests that the two groups differ substantially and hence supports the moderating effect.

As Table 6 shows, the high training group has a mean correlation of 0.24, whereas the low training group has a mean correlation of 0.15. This seems to indicate that the effect of top management support is more pronounced when ample training is also provided. While this interpretation makes intuitive sense, the difference is non-significant. Hwang and Schmidt (2011) advocate comparing the credibility or confidence intervals rather than using a significance test. A moderator variable is confirmed when the intervals are orthogonal. Since the confidence intervals in Table 6 overlap, training appears not to have a moderating effect.

Table 6: Training Moderates Management Support on Use (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High Training	6	1432	0.24	0.06	0.14	0.34	1.84	0.18
Low Training	5	1061	0.15	0.02	0.10	0.19	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

Next, I examined the potential moderating effect of top management support. Table 7 shows the regression results, which indicate that the moderating effect is non-significant. Table 8 shows the subgroup analysis. Based on the Q-value and the overlapping confidence intervals, top management support appears not to be a moderator either.

Table 7: Management Support Moderates Training on Use (Regression Model)				
Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.38	0.34	1.10	0.27
Slop	-0.17	0.54	-0.31	0.76
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.35	0.27	1.31	0.19
Slop	-0.12	0.43	-0.29	0.77

Table 8: Management Support Moderates Training on Use (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High Support	5	739	0.28	0.03	0.22	0.33	0.00	0.97
Low Support	6	1754	0.28	0.09	0.12	0.43	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

Mediational Model

As Table 4 shows, based on the 19 studies that reported correlations between top management support and training, the two variables have a mean true score correlation of 0.25. Since both variables also have a mean true score positive correlation with implementation success, a mediational model likely exists. Table 9 shows that the zero-order correlation between management support and implementation success is reduced from 0.22 to 0.17 after

controlling for the effect of training. Similarly, the zero-order correlation between training and implementation success is reduced from 0.24 to 0.20 after controlling for the effect of management support. Moreover, since both partial correlations are non-zero, the results support a partial rather than a full mediational model. Statistically, it means that both top management support and training can partially mediate each other's effect on implementation success.

Table 9: Correlations of Implementation Success and Management Support and Training

	Correlation	Partial correlation
Management support	0.22	0.17
Training	0.24	0.20

The Role of Task Interdependence

As reviewed earlier, task interdependence has been shown to have a significant effect on implementation success (Guimaraes et al., 1992; Sanders & Courtney, 1985). Moreover, task interdependence is not correlated with either top management support or training (Guimaraes et al., 1992). If these findings can be generalized and applied to the mediational model discussed previously, task interdependence should exert a direct effect on implementation success that is independent of top management support or training as Figure 4 illustrates.

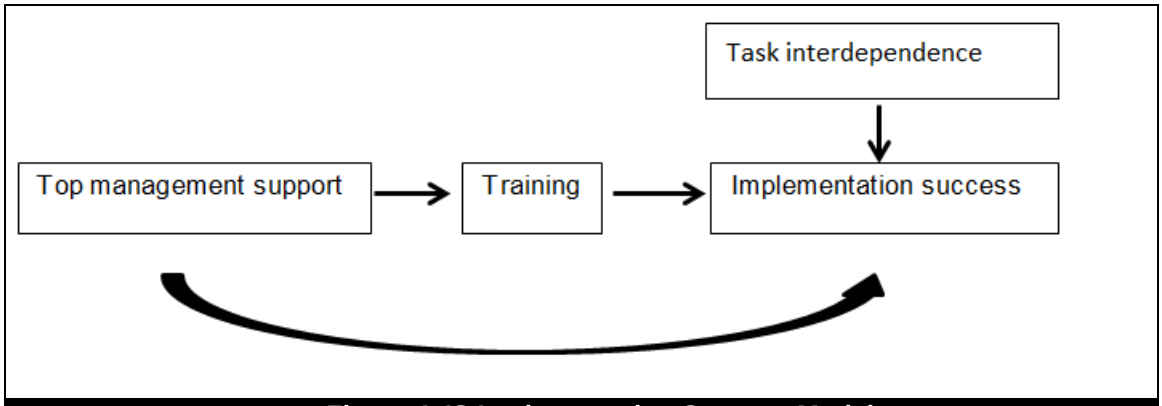

Figure 4. IS Implementation Success Model

The model depicted in Figure 4, if supported, would mean that task interdependence does not moderate the effect of either top management support or training on implementation success as Sharma and Yetton (2003, 2007) suggest.

In sum, support for the model depicted in Figure 4 requires the satisfaction of two conditions: a significant relationship between task interdependence and implementation success, and a non-significant relationship between task interdependence and top management support and training. In this study, 11 of the 30 studies reported the means and scales that they used for top management support and training and thus provided a measure for both variables. I correlated these measures with the task interdependence scores that I coded for this meta-analysis, and the correlations were all non-significant. Correlation between task interdependence and top management support is 0.36 (p=0.28), and correlation between task interdependence and training is 0.26 (p=0.44). This provides evidence that supports the second condition.

Nevertheless, Sharma and Yetton (2003, 2007) have shown that task interdependence moderates both top management support and training. However, Hwang and Schmidt (2011) challenge the moderating effect of task interdependence on top management support, but Sharma and Yetton (2011) reaffirm it. One possible reason for the discrepancy is that these studies are measuring implementation success differently. Specifically, rather than treating implementation success as a multi-faceted construct, Sharma and Yetton (2003, 2007) lumped use and satisfaction into a single success measure. For this research, I tested the moderating effect of task interdependence separately on use, satisfaction, and net benefits. Tables 10-21 display the results.

Results shown in Tables 10 and 11 do not support the moderating effect of task interdependence on top management support when success is measured by use. Similarly, results shown in Tables 12 and 13 do not support the moderating effect when success is measured by satisfaction, and the results shown in Tables 14 and 15 do not support the moderating effect when success is measured by net benefits. Tables 16-21 show the moderating effect on training. The moderating effect is supported only when success is measured by satisfaction; the effect is non-significant when success is measured by either use or net benefits.

To summarize, the role played by task interdependence in systems implementation is probably similar to that of top management support and training in that they all have a direct effect on systems success. The moderating effect of task interdependence on top management support and training is probably spurious because the three variables are not correlated. Moreover, in the current meta-analysis, the moderating effect is found significant only when tested against the relationship between training and satisfaction; in the other five relationships, the result is non-significant, which casts doubt on its true effect.

Table 10: Task Interdependence Moderates Management Support on Use (Regression Model)

Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.17	0.10	1.74	0.08
Slop	0.01	0.01	0.75	0.46
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.17	0.10	1.75	0.08
Slop	0.01	0.01	0.75	0.45

Table 11: Task Interdependence Moderates Management Support on Use (Subgroup Analysis)

	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	3	948	0.28	0.10	0.07	0.46	0.30	0.59
Low TI	21	3598	0.22	0.03	0.15	0.29	-	-

Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.

Table 12: Task Interdependence Moderates Management Support on Satisfaction (Regression Model)

Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.08	0.16	0.47	0.64
Slop	0.02	0.01	1.56	0.12
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.08	0.14	0.53	0.60
Slop	0.02	0.01	1.76	0.08

Table 13: Task Interdependence Moderates Management Support on Satisfaction (Subgroup Analysis)

	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	5	643	0.37	0.07	0.24	0.49	0.29	0.13
Low TI	4	896	0.23	0.05	0.14	0.31	-	-

Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.

Table 14: Task Interdependence Moderates Management Support on Net Benefits (Regression Model)

Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.20	0.16	1.23	0.22
Slop	0.01	0.01	0.74	0.46
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.20	0.15	1.37	0.17
Slop	0.01	0.01	0.80	0.42

Table 15: Task Interdependence Moderates Management Support on Net Benefits (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	7	1197	0.32	0.09	0.16	0.46	0.07	0.79
Low TI	9	1657	0.29	0.05	0.21	0.37	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

Table 16: Task Interdependence Moderates Training on Use (Regression Model)				
Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.16	0.12	1.42	0.15
Slop	0.01	0.01	0.98	0.33
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.17	0.12	1.38	0.17
Slop	0.01	0.01	0.90	0.37

Table 17: Task Interdependence Moderates Training on Use (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	3	948	0.39	0.11	0.17	0.57	1.12	0.29
Low TI	21	3598	0.24	0.04	0.17	0.31	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

Table 18: Task Interdependence Moderates Training on Satisfaction (Regression Model)				
Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	-0.19	0.13	-1.38	0.17
Slop	0.03	0.01	3.48	0.00
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	-0.18	0.12	-1.56	0.12
Slop	0.03	0.01	3.96	0.00

Table 19: Task Interdependence Moderates Training on Satisfaction (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	5	643	0.38	0.07	0.26	0.50	9.77	0.00
Low TI	4	896	0.11	0.04	0.06	0.17	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

Table 20: Task Interdependence Moderates Training on Net Benefits (Regression Model)				
Mixed effects regression (methods of moment)				
	Point estimate	Standard error	Z-value	P-value
Intercept	0.06	0.10	0.58	0.56
Slop	0.01	0.01	1.80	0.07
Mixed effects regression (unrestricted maximum likelihood)				
Intercept	0.06	0.10	0.60	0.55
Slop	0.01	0.01	1.86	0.06

Table 21: Task Interdependence Moderates Training on Net Benefits (Subgroup Analysis)								
	k	***N***	ρ	SD_r	**90% CI Lower limit**	**90% CI Upper limit**	**Q-value**	**P-value**
High TI	7	1197	0.28	0.03	0.22	0.33	1.48	0.22
Low TI	9	1657	0.20	0.05	0.11	0.29	-	-
Note: *k* = number of studies; *N* = total sample size; ρ = mean true score correlation; SD_r = standard deviation of sample correlations; CI = confidence interval.								

V. DISCUSSION

Various determinants of implementation success, including top management support and training, have been investigated in the past. While the literature in general supports the positive effect of both top management support and training, contradictory evidence has been reported in both individual studies (Kamhawi, 2007; Thong et al., 1996; White & Leifer, 1986) and meta-analyses (Sharma & Yetton, 2003, 2007). In order to shed additional light on the debate, I meta-analyzed individual studies that included both independent variables. My results indicate a moderate positive effect of both variables on implementation success, consistent with the literature and other meta-analyses (Hwang & Schmidt, 2011; Sabherwal et al., 2006).

To determine whether there were methodological reasons that contributed to the literature's inconsistent findings, I explored different ways that the two independent variables can be modeled and, as a result, how they can affect the outcome. I tested three potential models: direct effects, moderator effects, and mediational model.

My results indicate that the direct effects model can be ruled out as there is a clear, positive correlation between top management support and training. This makes sense since both are part of the support mechanism for effectively implementing information systems. If an organization's top management is committed to an information system, it is less likely to skim on training that has been shown critical to the success of implementation. The reverse is probably also true. It is unfortunate that none of the prior studies considered the relationship between top management support and training. This is true of both early studies that used correlational models (e.g., Maish, 1979; Sanders & Courtney, 1985) and later studies that used more sophisticated models such as PLS (e.g., Thompson et al., 1991) or LISREL (Manson, 1997) to analyze their data. Improper use of the direct effects model may have led some researchers to report inconsistent findings of the effects of top management support and training (e.g., Kamhawi, 2007). It is advisable, therefore, to move away from a direct effects model in future research.

If top management support and training are positively related, they can potentially moderate or mediate each other's effect. I examined the moderating effect of each variable first in a regression analysis and then in a subgroup analysis. I found that neither variable had a moderating effect in either regression or subgroup analysis. The overall evidence suggests that the moderator effects model is probably not proper either.

For the mediational model, I examined the partial correlation between one independent variable and implementation success after controlling for the effect of another independent variable. My results indicate that both top management support and training are plausible mediators. The question then becomes which should be modeled as the mediator in future research. Logically, training should be the mediator, and some empirical evidence exists that supports this relationship. In an early study of EIS implementation, Poon and Wagner (2001) suggest companies focus on a small set of critical success factors (CSFs) that include top management support, adequate resources, and linkage to business objectives. Their study shows that companies that managed these three CSFs well also scored well on other CSFs and vice versa. Young and Jordan (2008) echo this view, who confirmed through their case study that top management support is a meta-factor that encompasses other CSFs. In another study, Knapp, Marshall, Rainer, and Ford (2007) validated a model in which the effect of top management support on information security success is mediated by four variables, one of them being training. Finally, the theoretical model used in Sabherwal et al.'s (2006) meta-analysis also includes training as a mediator of the effect of top management support, a relationship further supported by two recent studies (Dong, Neufeld, & Higgins, 2009; Waal, Batenburg, & Fruytier, 2012). It seems, therefore, prudent that future research follows a similar mediational model.

I also tested the moderating effect of task interdependence. My results show that task interdependence is not correlated with either top management support or training, which indicates that it is not likely to moderate either variable's effect. Additionally, in six of the relationships between top management support, training and implementation success tested, the moderating effect was significant only on training when success was measured by satisfaction. This is contrary to Sharma and Yetton's (2003, 2007) findings. The differences could be due to the fact that Sharma and Yetton lumped all success measures into one indicator. Another difference is that Sharma and Yetton analyzed studies of top management support and training separately, whereas I examined studies that included both variables.

Implications for Research

This study's main research implication is that future research of IS implementation should adopt a mediational model. As mentioned earlier, even though some of the later studies used sophisticated modeling tools such as PLS (Thompson, Higgins, & Howell, 1991) or LISREL (Manson, 1997), the relationship between top management support and training was never modeled. Given the positive relationship between the two variables, this omission will likely cause an overestimation of the effect of both variables as demonstrated by the drop in magnitude from correlations to partial correlations. Moving from a direct effects model to a mediational model will likely yield a smaller correlation for both independent variables, but it reflects more accurately the true relationships.

A similar mediational model should probably be extended to the study of other support variables such as user participation. Many studies have investigated the effect of user participation on implementation success, and, in general, a positive relationship has been established despite some contradictory evidence (Hwang & Thorn, 1999). Less research efforts have explored the link between top management support and user participation. Sabherwal et al.'s (2006) meta-analysis shows that user participation mediated the effect of top management support on some but not all implementation success variables. More empirical research that tests the interactions of top management support, training, and user participation will contribute to a better understanding of the process that results in implementation success.

Another key finding is that task interdependence plays the same role as top management support and training in systems implementation: as an independent variable rather than a moderator variable. The model depicted in Figure 4 suggests that task interdependence has a direct effect on implementation success; a relationship consistent with the prescription of the task-technology fit theory (Goodhue & Thompson, 1995). For instance, if the task is highly interdependent, an integrated enterprise system as opposed to departmental silos should be developed. Of course, success is not guaranteed by the task-technology fit; it also depends on organizational and user characteristics such as top management support and training. For an enterprise system, for example, the training program needs to focus on integration aspects of business processes, which are not necessary for a personal application. Similarly, the type of top management support needed for different tasks/systems is probably different too (Elbanna, 2013). The point is that task interdependence, along with other task characteristics, should determine the technology or the type of system to be developed. Once that decision is made, the proper type and level of CSFs such as top management support or training can then be determined. The effectiveness of any CSF ultimately depends on how well it fits with the task/technology rather than on the task itself.

Nevertheless, variance exists in findings reported in prior studies. If task interdependence is not a moderator variable, could there be other variables that caused inconsistent results? More research is encouraged but several precautions are in order. In light of the different results between this meta-analysis and those of Sharma and Yetton (2003, 2007) regarding the effect of task interdependence, it is advisable to accumulate results separately for different success measures in future research. In addition, IS studies are inherently heterogeneous (Hunter, 2010); therefore, a high heterogeneous statistic such as a large Q-value can be the result of statistical or unobserved artifacts rather than a true moderator. Consequently, any search for moderators should be theory based rather than statistics driven. Another hurdle that needs to be surmounted is controlling for the effect of common method variance, which can be substantial in IS studies (Sharma et al., 2009). In other words, the meta-analyst needs to demonstrate that a large Q-statistic, for instance, is caused by a moderator variable rather than common method variance. Finally, moderators identified in a meta-analysis can be substantive or due entirely to chance (Viechtbauer, 2007). Follow-up empirical studies are needed to verify any moderators uncovered in a meta-analysis.

Implications for Practice

The most important finding for practice is the reaffirmation of top management support's criticality. The mediational model confirms the direct effect of top management support on implementation success and its indirect effect exerted through other success factors such as training. Previously, even though some studies reported a non-significant main effect, the indirect effect was still observable (e.g., Bajwa, Rai, & Brennan, 1998). In addition, while Sharma and Yetton (2003) question the effectiveness of top management support in low task interdependence contexts, they actually acknowledge the indirect effect of top management support. Following the work of Orlikowski, Yates, Okamura, and Fujimoto (1995), Sharma and Yetton (2003) propose that top management promote institutional structure changes that are needed for implementation success by engaging in various metastructuration actions. One of the metastructuration actions that they advise is instituting new structures to overcome perceived learning barriers of end users. As they state: "Managerial interventions, such as authorizing end-user training and the development of end-user resource materials can promote end-user learning and overcome such barriers" (p. 536).

This seems like an endorsement for the (indirect) effect of top management support, even when task interdependence is low. Other researchers have provided qualitative evidence of the effect of similar

metastructuration actions. Dong et al. (2009) demonstrate the effect of top management support on training in a case study of ERP implementation at two universities. Similarly, Waal et al. (2012) show that the effect of top management support can be observed via its impact on training and user participation in a case study of the implementation of a healthcare information system. Furthermore, as this research shows, the effect of top management support is not moderated by task interdependence. Combined with the qualitative evidence presented by Dong et al. (2009) and Waal et al. (2012), it seems that companies would be well-advised not to forgo management support for even low interdependence tasks.

For practice, the findings from this meta-analysis also support the importance of training, whose direct effect on implementation success is demonstrated by the findings accumulated in this meta-analysis. Moreover, the preponderance of evidence presented in this research indicates that the effect of training is not moderated by task interdependence. This does not mean that task interdependence is not important; on the contrary, a training program should be designed to fit the type of task involved. Most, if not all, business users require extensive training whether the system is designed to support a task of high interdependence. An example is call center workers whose jobs have low interdependence because each employee more or less works independently to service their customers. Training has been considered a win-win investment with potential return that includes job satisfaction, self-confidence, and reduced turnover (Gherardi, 1999). Factors such as task interdependence and task complexity ought to be incorporated into the design of the training program (Wexley & Latham, 2002). The effectiveness of the training program is then a function of the fit with the task rather than a characteristic of the task such as task interdependence. In short, consider task interdependence in the design of a training program, but do not use it as a determinant of the necessity for training.

VI. CONCLUSION

Systems implementation is an important topic and numerous studies have been conducted to investigate the effects of various determinants of success. Although top management support and training have generally been recognized as critical success factors, their positive effects are not always born out in empirical data. One of the reasons for the inconsistent results could be the way that the two variables are modeled. In this research, I examined different models of top management support and training using meta-analytical procedures. My results indicate that a mediational model whereby training mediates the effect of top management support is the most plausible model. This model reaffirms the critical role played by top management support because it affects implementation success both directly and indirectly through training. Moreover, the effect of top management support is not moderated by task interdependence as Sharma and Yetton (2003, 2011) suggest. This research also confirms the importance of training. The preponderance of evidence suggests that the effect of training is not moderated by task interdependence either, contrary to Sharma and Yetton's (2007) assertion. This does not imply that task interdependence is not important; rather, it means that task interdependence should be designed into a training program instead of being used as a determinant of the necessity for such a program.

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APPENDIX A: CODING OF META-ANALYSIS SAMPLE

Table A1: Management Support and Implementation Success Data

Study	Use	Satisfaction	Net impact	Reliability management support	Reliability implementation success	Corrected correlation	Sample size
Adekoya93	0.17	0.16	0.19	0.72	0.80/0.80/0.80	0.22/0.21/0.25	105
Dahmer94	0.18	na	na	0.85	0.82	0.22	344
Feder96	0.07	na	na	0.82	0.89	0.08	99
Guimaraes92	na	0.08	-0.06	0.85	0.85/0.79	0.09/-0.07	118
Habelow00	0.42	na	na	0.79	0.82	0.52	106
Howard91	0.12	na	na	0.79	0.82	0.15	422
Igbaria90	0.24	0.21	0.22	0.76	0.78/0.91/0.87	0.31/0.25/0.27	187
Igbaria93	0.13	0.09	0.09	0.81	0.92/0.89/0.85	0.15/0.11/0.11	225
Igbaria951	0.09	na	0.23	0.89	0.91/0.86	0.10/0.26	107
Igbaria952	0.08	na	0.11	0.83	0.80/0.82	0.10/0.13	105
Igbaria96	0.24	0.27	0.35	0.78	0.82/0.93/0.83	0.30/0.32/0.43	379
Igbaria97	0.20	na	0.30	0.92	0.81/0.94	0.23/0.32	358
Kamhawi07	na	na	0.44	0.88	0.71	0.56	70
Kleintop93	-0.09	na	na	0.85	0.82	-0.11	108
Leonard-Barton88	0.20	na	na	0.56	0.82	0.30	88
Maish79	0.19	na	na	0.79	0.82	0.24	58
Manson97	0.30	na	na	0.76	0.82	0.38	484
Olson99	0.01	na	na	0.90	0.82	0.01	163
Purvis94	0.28	na	na	0.79	0.82	0.81	59
Rai90	0.10	na	na	0.84	0.82	0.12	405
Ruppel95	0.39	na	na	0.66	0.82	0.53	120
Russo93	0.28	na	na	0.79	0.82	0.35	30
Sanders851	na	0.45	0.29	0.79	0.89/0.83	0.54/0.35	156
Sanders852	na	0.33	0.09	0.79	0.89/0.83	0.39/0.11	90
Sanders853	na	0.39	0.29	0.79	0.89/0.83	0.47/0.35	132
Santhanam00	na	0.27	0.21	0.83	0.93/0.90	0.31/0.24	147
Schiffman92	0.11	na	na	0.79	0.82	0.14	209
Thompson91	0.31	na	na	0.65	0.64	0.48	212
Whang92	0.11	na	na	0.81	0.82	0.14	106
Yetton99	0.03	na	na	0.86	0.85	0.04	67

Note: Reliability measures for implementation success are for use, satisfaction, and net benefit, respectively.

Table A2: Training and Implementation Success Data							
Study	**Use**	**Satisfaction**	**Net impact**	**Reliability training**	**Reliability implementation success**	**Corrected correlation**	**Sample size**
Adekoya93	0.19	0.08	0.13	0.72	0.80/0.80/0.80	0.25/0.11/0.17	105
Dahmer94	0.01	na	na	0.87	0.82	0.01	344
Feder96	0.32	na	na	0.73	0.89	0.40	99
Guimaraes92	na	0.17	0.15	0.71	0.85/0.79	0.22/0.19	118
Habelow00	0.59	na	na	0.81	0.82	0.72	106
Howard91	0.12	na	na	0.81	0.82	0.15	422
Igbaria90	0.40	0.07	0.01	0.71	0.78/0.91/0.87	0.54/0.09/0.01	187
Igbaria93	0.12	0.06	0.14	0.80	0.92/0.89/0.85	0.14/0.07/0.17	225
Igbaria951	0.09	na	0.09	0.73	0.91/0.86	0.11/0.11	107
Igbaria952	0.43	na	0.28	0.89	0.80/0.82	0.51/0.33	105
Igbaria96	0.20	0.13	0.12	0.76	0.82/0.93/0.83	0.25/0.15/0.15	379
Igbaria97	0.14	na	0.14	0.86	0.81/0.94	0.17/0.16	358
Kamhawi07	na	na	0.29	0.77	0.71	0.39	70
Kleintop93	0.20	na	na	0.97	0.82	0.22	108
Leonard-Barton88	0.23	na	na	0.81	0.82	0.28	88
Maish79	0.31	na	na	0.81	0.82	0.38	58
Manson97	0.24	na	na	0.81	0.82	0.29	484
Olson99	0.02	na	na	0.89	0.82	0.02	163
Purvis94	0.18	na	na	0.81	0.82	0.22	59
Rai90	0.48	na	na	0.84	0.82	0.58	405
Ruppel95	0.13	na	na	0.81	0.82	0.16	120
Russo93	0.05	na	na	0.81	0.82	0.06	30
Sanders851	na	0.27	0.23	0.81	0.89/0.83	0.34/0.29	156
Sanders852	na	0.48	0.29	0.81	0.89/0.83	0.61/0.36	90
Sanders853	na	0.39	0.16	0.81	0.89/0.83	0.49/0.20	132
Santhanam00	na	0.16	0.11	0.54	0.93/0.90	0.23/0.16	147
Schiffman92	0.12	na	na	0.81	0.82	0.15	209
Thompson91	0.11	na	na	0.86	0.64	0.15	212
Whang92	0.15	na	na	0.80	0.82	0.19	106
Yetton99	0.01	na	na	0.91	0.85	0.01	67
Note: Reliability measures for implementation success are for use, satisfaction, and net benefit, respectively.							

Table A3: Management Support, Training, and Task Interdependence Data				
Study	**Management support**	**Training**	**Correlation (management support and training)**	**Task interdependence**
Adekoya93	0.61	0.04	na	10.0
Dahmer94	0.61	0.63	0.46	7.7
Feder96	0.56	0.10	0.28	7.7
Guimaraes92	0.77	0.69	0.33	7.7
Habelow00	na	na	0.28	11.0
Howard91	0.32	0.43	0.27	7.7
Igbaria90	na	na	0.01	10.0
Igbaria93	na	na	0.01	10.0
Igbaria951	na	na	na	10.0
Igbaria952	na	na	na	10.0
Igbaria96	0.64	0.51	0.13	10.0
Igbaria97	na	na	0.13	10.0
Kamhawi07	0.83	0.79	0.34	25.0
Kleintop93	0.66	0.58	0.42	8.7
Leonard-Barton88	na	na	-0.11	13.2
Maish79	0.66	0.70	na	13.7
Manson97	0.68	0.64	0.11	20.0
Olson99	na	na	0.42	14.0
Purvis94	0.81	0.55	na	24.7
Rai90	0.55	0.41	na	25.0
Ruppel95	na	na	0.07	17.2
Russo93	0.87	0.28	na	12.6
Sanders851	na	na	na	20.7
Sanders852	na	na	na	20.7
Sanders853	na	na	na	20.7
Santhanam00	na	na	na	19.0
Schiffman92	0.74	na	-0.12	10.0
Thompson91	na	na	0.43	8.7
Whang92	na	0.55	0.41	14.4
Yetton99	na	na	0.08	16.0
Note: 1) For top management support and training the rating = mean/max scale. For example, a mean of 2.5 on a 5 point scale gives a rating of 0.5. 2) Task interdependence is coded following Sharma and Yetton (2003), with a range from 5 to 30.				

ABOUT THE AUTHOR

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