24. Are the conclusions justified?

25. What might account for the low correlation coefficients that were obtained?

26. What factors, other than the projects, might have resulted in positive attitudes?

For answers to these questions, see page 358.

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Chapter 6

Regression Analysis Studies

When two variables are found to be correlated, one may be used to predict the other. If extroversion is shown to be correlated with salesmanship (both measured at the same time), extroversion now may be used to predict salesmanship (which will be measured at a later time) of prospective salespersons. **Regression analysis** deals with predicting certain continuous, behavioral variables on the basis of knowledge about other, independent variables, some of which may be **dummy coded** categorical variables. Or it describes the role played by certain independent variables in a particular dependent variable. Thus, it may describe how well graduate record exam (GRE) scores predict performance in graduate school, or it may describe the average amount of change in blood glucose (BG) for each unit change in stress. The variable that is being predicted (Ŷ: salesmanship, graduate school success, BG) is called the **criterion variable**. The variable from which the prediction is made (X: extroversion, GRE, stress) is called the **predictor variable**. When we are concerned with a single dependent variable but more than one independent (or predictor) variable, the problem is called **multiple regression analysis (MRA)**. In this instance, the regression equation is

$$\hat{Y}=b_0+b_1X_1+b_2X_2+\ldots+b_pX_p$$

Here, the *predicted* criterion variable is designated Ŷ. Assuming a straight line relationship between Y (the *actual* criterion variable) and Xs, b_0 is the Y intercept, the average value of Y when each X equals 0, and the remaining *b*s are regression coefficients or, more accurately, partial regression coefficients. Each reflects the average amount of change predicted in Y for each unit change in the corresponding X when all other independent variables are held constant. That is, each *b* is a partial

regression coefficient. For example, b_2 is the coefficient for the regression of Y on X_2 with the effects of $X_1, \ldots, X_p$ partialed out, removed, or statistically controlled.

Because we often want to directly compare the contributions of each variable in predicting Y, βs (**beta weights**) or standardized regression coefficients, based on Z scores, are computed instead of *b*s, based on raw scores. Because beta weights are based on Z scores rather than units of measurements that may differ, they can be compared directly. Now we can say that a predictor variable with a larger β is associated with a larger unit change in the criterion than one with a smaller β. Each β reflects the average amount of change predicted in Y in terms of standard deviation (SD) units for each unit change in X. Each of the βs is tested for significance. If one is not significant, then its corresponding independent variable does not significantly contribute to the predicted $\hat{Y}$, once the other variables are included, even though it may correlate highly with the criterion variable. If βs are tested for significance, *df* for an *F* test (analysis of variance [ANOVA] test, covered in Chapter 11) are 1 and *N* (number of sets of scores) − *p* (number of predictor variables) − 1.

Another bit of information that emerges from MRA is **multiple *R***: the correlation between the dependent variable and the predictor variables. Its square is interpreted as any r^2 as percentage variance in the dependent variable that is associated with the predictor variables. This is so because *R* actually is the correlation between Y and $\hat{Y}$. It is calculated by $R = \sqrt{\beta_1 r_{1y} + \beta_2 r_{2y} + \ldots + \beta_p r_{py}}$ (or by $r = \sqrt{r^2_{y1} + r^2_{y(2.1)} + \ldots + r^2_{y(p.12\ldots p-1)}}$, where each r^2 is the squared semipartial correlation between each variable and the criterion with the effects of remaining variables removed only from the variable). Its significance is tested by an *F* test with *p* (number of predictor variables) and $N - p - 1 df$. This is an important test. If *R* is not significantly greater than zero, $\hat{Y}$ cannot be predicted from the predictor variables taken together.

If the intent of the analysis is to determine whether certain predictor variables *explain or account* for an outcome measure, all variables are entered into the equation simultaneously. However, if the intent is to *predict* the outcome (criterion) variable, alternate multiple regression procedures are available. In **hierarchical analysis**, the investigator decides ahead of time on the order in which each variable will be added. As each one is added, it is followed by an MRA. Therefore, the unique effect of each independent variable can be determined (the effects of earlier variables are partialled out). But the predetermined order (usually based on "causal" priority to the criterion) is important, because partial regression coefficients—and, consequently, any increment in R^2—will change when effects of different variables are partialled out. The best-known procedure, which is used when investigators have no a priori basis for ordering the variables in terms of their probable "causal" priority to the criterion variable, is **stepwise multiple regression**. After the significance of all predictor variables has been determined, the most significant predictor, in terms of having the highest correlation with the dependent variable, is entered into the equation, and R^2 is determined. Then, semipartial correlations (with the effect of the first variable removed) are determined between remaining independent variables and the criterion variable. The second most significant predictor, the one with next highest semipartial correlation (i.e., the effect of the first variable is partialled out from the effects of the second variable) with the dependent variable, is added, Y is regressed on these two variables, and R^2 is redetermined. This represents the percentage variability in Y that is attributed to the first variable and to the second variable that is over and above that attributed to the first. If the change in R^2 from the first to this second one is significant, the effect of the first variable (originally chosen only because of its correlation with the criterion) is reexamined to see whether it still makes a significant contribution. If it is still significant (i.e., still accounts for a reasonable amount of variance), the next variable, based on the same criterion, is entered and the process is repeated until the change in R^2 no longer is significant. That last variable is removed. In this instance, we are moving in a forward direction. (In **forward selection**, the reevaluation steps are eliminated.) In **backward elimination**, all predictor variables first are added to the equation. Those predictors with nonsignificant partial regression coefficients or nonsignificant semipartial correlations (again, between the criterion and variable, with the effect of remaining variables removed only from the predictor) are eliminated, and the analysis is repeated with the remaining predictors, which will now yield new semipartial correlation coefficients because of the removal of one (or some) independent variable from the equation. Again, predictors with nonsignificant partial regression coefficients or semipartial correlation are eliminated, and the process is repeated until the equation includes only those predictors whose partial regression coefficients are significant. This difference in procedure also means that variables that might be considered important when analysis in a forward direction is conducted might not correspond to variables that are considered important when a backward elimination analysis is performed.

Use of MRA is not without cautions. The data must fit the assumption of the model employed. In addition, if extreme scores (outliers) are included, these can distort results. Any serious analysis should be preceded by diagnostic tests. *Stem and leaf plots* (a form of frequency distribution) of each predictor variable should reveal relatively symmetrical distributions with few, if any, outliers. A preliminary regression analysis will yield measures of *distance* (the deviations of Y scores from the regression line), *leverage* (the deviation of X scores from their means), and *influence* (outliers that deviate on both variables). Outliers may or may not affect predictability. Preliminary analysis compares

errors in predictions (called *residuals*) with and without these potentially influential cases. If there is a difference, these cases are examined to determine whether there is justification for eliminating them from the final analysis. Otherwise, both regression equations could be presented, the data can be transformed (e.g., log transformation) to reduce variability, or more data might be gathered. If no mention is made about tests for outliers, an examination of means and SDs can give you some idea about the shape of the distribution of scores.

Other problems can occur with stepwise regression analysis. Some variables declared to be significant predictors may be significant by chance because so many tests are conducted (especially with a large number of predictors). No adjustments are made in the successive alpha levels when each new R^2 is generated, nor is it considered when the variable is selected from the pool on the basis of intercorrelations between the criterion and independent (predictor) variables. Variables that are significant when one sample is measured may not be so for another sample and vice versa. This would be evident in a cross-validation study in which the regression equation is tested on an independent sample of data. For these and other reasons, the results of stepwise regression analyses should be interpreted cautiously.

Another problem can arise if one independent variable is highly correlated with another independent variable or with a linear combination of some or all of the remaining independent variables. The phenomenon is called **multicollinearity**. It might be suspected if R^2 is high, an outcome of high correlations between independent variables, but the partial regression coefficients are not (or one may be unusually larger or smaller than anticipated). Therefore, the net effect is to increase the degree of error in estimating each partial regression coefficient. The estimations of partial regression coefficients for the population will be very unstable (i.e., change from one sample to the next) and will not provide reliable predictions. An examination of intercorrelations between independent variables will be of little help in detecting multicollinearity, because it misses possible correlations between one and some combination of other variables. One procedure that is favorable is to regress each variable on the remaining ones. If the resulting R^2s are low, there is no problem. If one or more is high, then the problem exists. If an investigator recognizes the problem, he or she can combine the correlated variables if they can be logically combined. Here, the researcher may first conduct a factor analysis (see Chapter 7), which results in uncorrelated sets of variables, and then select representative variables from each set as the predictors. Or, if the variables are of interest, they can be entered first in a hierarchical analysis, before the critical variables are entered. Of course, a reader is not likely to be able to carry out the procedure but can at least suspect that high multicollinearity is a possibility when expected partial regression coefficients are not significant.

Regarding design issues, multiple regression studies should be as rigorously conducted as an experiment. Given that some of the predictors are scores on psychological tests, the tests should be reliable and valid and be administered in counterbalanced order—that is, each test should appear in each position an equal number of times. Moreover, the individuals administering the tests should be naive with respect to crucial bits of information so as not to influence those who are tested. Finally, testing conditions should be uniform to reduce variability, and volunteer participants should not differ radically from those who refused to take part in the study—that is, there should be no selective loss of participants. In addition to these factors, which can affect accuracy of the prediction, two others should be mentioned. The time intervening between measurement of the criterion and predictor variables is important. The longer the interval, the greater the opportunity for other variables to affect the criterion variable besides the predictors. Finally, some criterion variables are more difficult to predict than others, because they are affected by so many variables—all of which may not be included in the multiple regression equation. Caution factors associated with multiple regression analyses are presented in Box 6.1.

Box 6.1 Caution Factors Associated With Multiple Regression

- Tests used are reliable and valid.
- Sample is not biased (no undue number of nonresponders).
- Multiple tests were presented in counterbalanced order.
- The test administrator was naive with respect to study's purpose.
- Testing conditions were uniform.
- Time between tests and criterion measurement is reasonable.
- Intercorrelarions between independent and criterion variables are significant at adjusted alpha level.
- Hierarchical analysis is performed if a priori basis exists for ordering variables.
- Stepwise procedure is used in absence of a rationale for ordering variables.
- Data were examined for outliers and multicollinearity.

Now we are prepared to review two articles that involved multiple regression. We'll evaluate the first one together, and you'll evaluate the second one alone.

STUDY EXAMPLE 6.1: "EMPLOYEE PARTICIPATION AND ASSESSMENT OF AN ORGANIZATIONAL CHANGE INTERVENTION: THREE-WAVE STUDY OF TOTAL QUALITY MANAGEMENT"

This study evaluates the impact of a total quality management program introduced into an organization that supplies engineering and electrical components multinationally. Total quality management is a concept and process that has been used in the United States for at least 20 years. The goal is to view production as a process that involves participants at all levels of an organization, from management to workers, to improve quality of a product so that it meets customer requirements. In this study, employees were surveyed before and after the program was introduced to determine the extent to which participation in the program affected their perception of its benefits and commitment to the organization.

The Study

Coyle-Shapiro, J. A.-M. (1999). Employee participation and assessment of an organizational change intervention: Three-wave study of total quality management. *Journal of Applied Behavioral Science*, *35*(4), 439–456. Copyright © 1999 by Sage.

As a management innovation, total quality management (TQM) has come under scrutiny from a number of fronts. First, the diversity of practices being implemented under the rubric of TQM has created ambiguity as to what TQM is and what it is not. . . . TQM, as set out by its founders, is a coherent philosophy with a distinctive set of interventions, but the reality of organizational practices does not mirror that philosophy.

. . . The conceptual mapping of the impediments to achieving successful TQM change is not matched by empirical studies investigating the introduction and development of the TQM process. Toward this latter end, this article examines the process of change involved in implementing TQM, as well as employees' experiences of participation, and evaluates the impact of employee participation in TQM on their commitment to the organization using a longitudinal research design.

Process of Change

The type of change associated with TQM is subject to debate, with some commentators viewing TQM as a distinct management paradigm associated with transformational change. . . . Others challenge this view, adopting a more cautious interpretation of TQM as tectonic change. . . . In contrast, there is broad consensus

regarding the process by which TQM is implemented. An underlying assumption of TQM is that . . . top management commitment and support is a precondition for the success of TQM. . . . Change is assumed to occur in a straightforward manner throughout the managerial hierarchy, culminating with first-line supervisors involving employees in TQM. Second, the primary levers for change include training, education, and recognition. . . . The underlying assumption is that change occurs as a consequence of education and training, not only in terms of individual attitudes and behaviors but also as a stimulus for changes in organizational practices to support a TQM philosophy. . . .

. . . . The support of first-line supervisors is crucial to effecting change at the level of employees. As TQM requires greater involvement from employees regarding quality and improvement issues, supervisors who operate along participative lines may be more likely to involve employees in a TQM intervention. . . .

Participation in Total Quality Management

. . . Although the consequences of TQM for employees are keenly debated, what is clearly absent is a more dispassionate empirical test of employees' assessments of their participation in TQM. Therefore, it is important to empirically test the link between participation in TQM and evaluation of the benefits accruing from that participation.

Outcomes of Total Quality Management

. . . Although TQM does not set out to enhance organizational commitment directly, the implementation of TQM elicits greater involvement in organizational activities. . . . Therefore, through increased communication and consultation, employees may feel a greater identification with, involvement in, and loyalty to the organization. Based on the [previous] discussion, the following hypotheses are proposed:

Hypothesis 1: There will be a positive relationship between employees' perceptions of the participative style of their supervisors prior to TQM and their participation in TQM.

Hypothesis 2a: There will be a positive relationship between employees' participation in TQM and their assessments of the benefits of TQM.

Hypothesis 2b: Employee assessment of the benefits of TQM will be more important in predicting subsequent participation in TQM than is employees' initial participation.

Hypothesis 3: There will be a positive relationship between employees' participation in TQM and their commitment to the organization.

▶ *(Note that all hypotheses involve concepts that will have to be measured: employee perception of supervisor's style of participation, assessment of benefits, importance of assessment of benefits, participation, and commitment.)*

1. What was the rationale for the study?

Because of diverse practices in implementing TQM, there is controversy about what it is and is not. Although obstacles to achieving successful TQM have been studied, few have looked at its introduction and development. The present study examines the introduction and development of the process, employees' experiences of participating in it, and the impact of their participation on their commitment to the organization.

There is debate about the type of change involved in TQM, managerial or constructive. There is more agreement about its implementation, which requires support and commitment by top managers. Change is assumed to occur in a downward fashion from managers to supervisors to employees through education and training. Supervisor attitude seems to be more important in the effect of TQM on employees because supervisors come into direct contact with them. But little is known about employee participation in TQM and their benefits gained from participation. And an outcome of TQM could be greater commitment of participators to their organization.

2. What was the purpose of the study?

The study tested the following hypotheses: Employees' perception of supervisor's style of participating in the organization before TQM and employees' participation in it will be positively correlated; employees' participation in TQM will be positively related to their perceived benefits of TQM; subsequent participation in TQM will be better predicted by perceived benefits than by initial participation; [and] employees' participation in TQM will be positively correlated with their commitment to the organization.

Method

Institutional Setting

This study was conducted at one site of a UK-based multinational supplier of engineering and electrical components that employs approximately 600 people. . . . In the late 1980s . . . changes were introduced to the terms and conditions of employment, the pay-grading structure was amplified, and harmonization of methods of the payment and pension scheme occurred. . . . In 1990 the site launched continuous improvement groups . . . for employees to contribute to . . . on a voluntary basis. Overall, employee participation in these groups was sporadic, with some groups disbanding while others started. Against what was perceived by management as the failure of the grassroots approach to improvements, the site embarked upon TQM. . . .

The Total Quality Management Intervention

. . . The objective was to change the culture of the site toward continuous improvement, and this was to be achieved by the "participative involvement" of everyone.

With the assistance of a TQM proponent from within the organization and a group of outside consultants, a change program focusing on education and training was designed. . . . The initial targets for change were those in the management hierarchy. . . . It was assumed that as a consequence of the training and education program, a series of changes would occur throughout the site. . . .

The starting point was the training and education program, which the outside consultants ran off-site for the executive team. Subsequently, a group of internally selected facilitators were taken off-site and undertook the program as well as a facilitation workshop. . . . Supervisors and managers, having completed the program, were held responsible for training their subordinates. It was assumed that after completing the program, managers and supervisors would actively cascade the training to their employees and set up improvement teams. In practice, this approach to change led to an uneven involvement of employees in TQM activities as a consequence of the recalcitrance of some supervisors.

. . . In autumn of 1993, in view of the pockets of continued resistance, it was decided that progress in the intervention was to become an integral part of each manager's annual performance objectives and thus part of their performance appraisals. . . . After some debate, the steering committee decided against compulsory participation at employee levels. However, all new employees would be required as part of their jobs to participate in the intervention. During 1994, the site took over the manufacturing of a new product from a different site and consequently hired a new group of employees who were informed that their participation in TQM was integral to their employment at the site.

3. What is the general background of the testing site?

The site employed 600 people in distributing engineering and electrical components. Changes, which began in the late 1980s and included continuous

improvement groups, were not successful and led to the introduction of TQM. Attempted gains in improvement were implemented by education and training, starting at the managerial level. Some supervisors, however, resisted change, and this resulted in uneven involvement of employees. Participation was not compulsory, except for new employees.

Research Design

The research method employed consisted of a before-and-after study of the TQM intervention with three measurement occasions: 6 months prior to the commencement of the intervention and 9 months and 32 months after the start of the intervention.... Prior to the administration of the first-round questionnaire, trade union representatives were informed of the research, given the opportunity to raise questions and/or concerns, and asked to support the research. Subsequently, as part of a quarterly communications day whereby all employees in groups are given a 40-minute presentation on relevant issues for the site, I introduced myself to the entire workforce and stated my independence from management at the site and the overall organization. In addition, employees were informed that the results of the survey would be communicated to them. All these steps were taken to facilitate continued cooperation.

▶ *(Note that the author [far from being uninvolved] introduced herself to the entire workforce and informed them that they were taking part in the study. This might open the door for the Hawthorne effect.)*

A random sample of 40% of employees stratified by work area was asked to participate in the research. Participants were informed that they would be allocated a code number so that they could be identified and tracked over time. Most of the employees completed the questionnaire on a one-to-one basis away from their work areas during work time. The first phase of data collection took place... 6 months prior to the commencement of the TQM intervention, at which stage none of the respondents were aware of the pending initiative. Therefore, the baseline questionnaire was not influenced by individuals' knowledge of the forthcoming intervention. The same administration procedure was adopted for the postintervention measurements.

▶ *(Note that the 40% who were selected might have felt "special" even though they didn't know about the forthcoming intervention. But the author presumably knew, and most questionnaires were filled out on a one-to-one basis. Moreover, they were completed while employees were on the job but away from their work areas.)*

At Time 1, 186 of the 200 employees asked to complete the questionnaire did so, yielding a response rate of 93%. The employee participant sample was reduced to 166 at Time 2 and 118 at Time 3, due primarily to employees leaving the site in the intervening period. Consequently, the sample used in the analysis was confined to employees who completed questionnaires on all three measurement occasions. At Time 3, the participant group was 95% male, with a mean age of 48.0 years, a mean organizational tenure of 18.0 years, and a mean job tenure of 8.85 years. The sample consisted of machine operators (33.3%), craftsmen (26.4%), engineers (14.5%), and material/purchase controllers (7.9%), with the remainder of the sample in administrative positions.

▶ *(Note that there were virtually no nonresponders in the pre-TQM phase, but by Time 3 [32 months after the introduction of TQM], there was a loss of 36.6% [186–118/186] of the employees. Because these were people who had left the organization, we have to consider that they may have been dissatisfied with the program. Moreover, even though information was available, there is no mention of a comparison made between those who left and those who remained.)*

4. What was the general design of the study?

This was a before-and-after study, with questionnaires filled out (mainly on a one-to-one basis with the experimenter) 6 months before and 9 and 32 months after TQM was introduced.

5. What were the initial and final samples?

A random sample of 40% of the workforce (200) was approached, and 186 consented to take part in the survey. Six months later, the sample size was reduced to 166 employees, and 32 months later, it was reduced to 118. Most were males and about 48 years old; they had been with the organization for about 18 years and at their present job for almost 9 years. The majority were machine operators and craftsmen. The remainder were engineers, machine/purchase controllers, and administrators (almost 18%).

6. What are some weak spots in the design?

First, the experimenter approached and tested the participants. They knew they were part of a survey and might have felt special or may have been unintentionally influenced by the experimenter. Second, there may have been a selective loss of

employees who were most dissatisfied with the new program. Third, we know nothing about those who left nor how they compare with those who remained at the site.

Measures and Analysis Procedures

Employees were asked to indicate the extent to which they were participating in the activities of the intervention along a 5-point Likert-type scale ranging from *not at all* to *a very great extent* (coded from 1 to 5).... As a checking measure, when employees responded to this question they were subsequently asked to elaborate on why they responded in a particular manner.... The following classification was used: Employees whose response was either *not at all* or *not much* (coded as 1 and 2, respectively) were aware of the intervention and had received communication about the intervention when it was launched. These employees had not received training and effectively were not (as yet) participating in the intervention.... Individuals who responded in the *to a great extent* and *to a very great extent* (coded 4 and 5, respectively) categories had received training by their supervisors and were participating in teams with the aim of making improvements in their work areas. The remaining employees who responded in the *to some extent* (coded 3) category were not participating in teams. However, they were trained in the principles of TQM by their supervisors and participating at a more informal (unstructured) level, such as monitoring internal customer requirements or instigating corrective action based on problems identified by another improvement team.

A sample of the remaining scale items, the number of items in the scale, and Cronbach's alpha coefficient for the scales are shown in Table 6.1.

Table 6.1 Measurement of Variables

Variable Name and Sample Survey Items	*Number of Items*	*Alpha*
Supervisory participative style	7	.84
The person I normally report to		
Encourages people to participate in important decisions.		
Encourages people to speak up when they disagree with a decision.		
Allows people to use their own judgment in solving problems.		
Is successful in getting people to work together.		
Supports me in getting my job done.		
Organizational commitment	6	.78
I am quite proud to tell people I work for [name of organization].		
I feel myself to be part of [name of organization].		

To know that my own work had made a contribution to the good of [name of organization] would please me.		
Even if [name of organization] was not doing too well financially, I would be reluctant to change to another employer.		
Perceived management commitment to quality	5	.84
Management is genuinely committed to improving quality.		
Management sets examples of quality performance in their daily activities.		
Management has attempted to involve everyone in continuous improvement.		
Management provides support for quality improvement throughout the organization.		
Improved support for TQM compared to a year ago.	5	.79
Top management is more committed to total quality.		
Visible progress has been made in improving things at this site.		
Top management is more supportive of suggestions to improve the way things are done around here.		
Total quality is a greater priority at this site.		
People are encouraged more to say how they think things could be done better.		
Perceived benefit of TQM	4	.75
There is no benefit for me in [name of TQM intervention].		
[Name of intervention] is a management initiative to get people to do more work[a].		

Note: TQM = total quality management.

a. Reverse scored.

▶ *(It is noted that most scale items were adapted from published scales.)*

Finally, respondents were asked to give details on their age, gender, organizational tenure, and job tenure. Respondents were asked at Time 2 and Time 3 whether they had experienced a change in supervisor. The hypotheses were tested using hierarchical regressions. In each equation, the control variables were entered in Step 1, as these variables could potentially affect both the independent variables and the dependent variables. For example, perceived management commitment to quality may have an effect on employee participation in TQM and organizational commitment. Subsequently, the independent variable of interest is entered into the equation.

7. Are there any questionable aspects of the scales used to measure participation, perceived participation and commitment of supervisors, or perceived benefits of TQM?

No. Most items were adapted from other scales, and Cronbach's alphas are reasonable. But no mention is made about the order in which the scales were presented. If they were not counterbalanced, it is possible that a carryover effect might affect the responses on some of the scales.

Results

Descriptive statistics and correlation coefficients of the main variables are reported in Table 6.2.

▶ *(Note that 36 correlation coefficients have been presented with no corrected alpha level. The adjusted alpha level for the highest coefficient, .71, is .05/36 = .001. Because the author only states that significance for coefficients greater than .23 is* $p < .01$*, it is difficult to know which coefficients are significant. Therefore, I did* t *tests for several of the coefficients to determine which are significant at the adjusted level. For* $r = .32$*, the adjusted alpha level is .05/20 = .0025 and* $t = r\sqrt{N - 2/1 - r^2} = .32\sqrt{118 - 2/1 - .32^2} = 3.638$*,* $p < .001$*. None of the lower coefficients are significant at the adjusted level.)*

Table 6.2 Descriptive Statistics and Correlations for Main Study Variables

	M	*SD*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Organizational commitment (Time 1)	5.39	0.90								
Supervisory participative style (Time 1)	4.98	1.12	.16							
Management commitment to quality (Time 1)	5.07	1.09	.48	.48						
Improved support for TQM (Time 2)	5.03	1.06	.32	.41	.40					
Participation in TQM (Time 1-Time 2)	2.56	1.10	.08	.26	.14	.36				
Perceived benefit of intervention (Time 2)	4.16	1.26	.22	.19	.23	.35	.40			
Organizational commitment (Time 2)	5.50	0.94	.69	33	.47	.51	.22	.28		
Organizational commitment (Time 3)	5.46	0.97	.56	.27	.29	.38	.14	.20	.71	
Participation in TQM (Time 1-Time 2)	2.74	1.25	27	.24	.18	.26	.24	.28	.35	.37

Note: Correlations greater than .17 are significant at $p < .05$. Correlations greater than .23 are significant at $p < .01$. [TQM = total quality management.]

8. Examine the coefficients, and interpret the ones relevant to the hypotheses.

The first hypothesis predicts a positive correlation between supervisor's participative style before TQM and employees' participation in the program. That coefficient is .24 and is not significant. The second hypothesis predicts a positive correlation between employees' participation in TQM and their perceived benefits of it. The correlation for measurements taken at Times 1 and 2 is .40 and is significant. The correlation for measurements taken later (for participation only) is .28 and is not significant. The third hypothesis predicts a positive correlation between employees' participation in TQM and their commitment to the organization. Measurements of these variables at Times 1 and 2 yielded a coefficient of .22, which is not significant, and a coefficient of .37 at the later time, which is significant.

9. Why is it inappropriate to use the coefficients to retain or reject the hypotheses?

These are zero-order coefficients and include the effects of some of the other independent variables. The regression analyses partial out the unwanted effects.

Hypothesis 1 predicted that perceived supervisory participative style would be positively related to employee participation in TQM. Table 6.3 presents the results. In the first step, participation in TQM (Time 2) was regressed on several control variables: age, gender, job tenure, organizational tenure, change of supervisor, organizational commitment, and perceived management commitment to quality. When supervisory participative style (Time 1) was entered in the equation, it produced a significant beta coefficient ($\beta = .24$, $p < .01$), indicating that it explained unique variance of participation that was not accounted for by the other variables, which supports Hypothesis 1.

▶ *(You should be looking at the values listed in the first column. Now examine the second column, all representing new values when that variable is added to the equation.)*

When improved support for TQM (Time 2) was entered in a subsequent step, it produced a significant beta coefficient ($\beta = .34$, $p < .01$) and reduced the effect of supervisory participative style (Time 1). However, the effect of improved support is likely to be inflated, as it was measured at Time 2, in contrast to the measurement of supervisory participative style at Time 1. An additional regression equation (not reported here) establishes a significant positive relationship between supervisory participative style (Time 1) ($\beta = .31$, $p < .01$) and improved support for TQM (Time 2). This suggests

Table 6.3 Hierarchical Regressions Predicting Participation in and Perceived Benefit of Total Quality Management at Time 2 ($N = 116$)

Independent Variables	*Participation in TQM (Time 2)*		*Perceived Benefit of TQM (Time 2)*
Step 1			
Age	–.02 ns	.00 ns	.00 ns
Gender	.00 ns	–.03 ns	.03 ns
Job tenure	.08 ns	.11 ns	–.14 ns
Organizational tenure	–.09 ns	–.12 ns	.06 ns
Change of supervisor	–.14 ns	–.11 ns	.10 ns
Organizational commitment	.02 ns	–.05 ns	.18 ns
Perceived management commitment to quality	.02 ns	–.05 ns	.10 ns
Supervisory participative style	–	–	.02 ns
Change in R^2 for Step 1	.00 ns	.06 ns / $F\,\Delta$ 0.99	.09 ns / $F\,\Delta$ 1.36
Step 2			
Supervisory participative style	.24**	.13 ns	–
Participation in TQM (Time 2)	–	–	.40**
Change in R^2 for Step 2	.04* / $F\,\Delta$ 5.08	–	.15**/F Δ 20.72
Step 3			
Improved support for TQM (Time 2)	–	.34**	–
Change in R^2 for Step 3	–	.08** / $F\,\Delta$ 10.84	–
Overall adjusted R^2	.04	.12	.18

Note: Entries beside main variables are standardized regression coefficients. Significant F and beta coefficient *$p < .05$; **$p < .01$ level. [TQM = total quality management.]

that the participative style of the supervisor is important in shaping employee perceptions of the degree of support for TQM in the organization. Taken together, these results indicate that the behavior of the first-line supervisor plays an important yet overlooked role in eliciting employee participation in TQM.

10. In Table 6.3, what is the difference between the first two columns of numbers, with participation in TQM as the dependent variable?

The first column represents standardized regression coefficients after supervisory participative style had been added as a predictor variable in Step 2. The second column represents standardized regression coefficients after improved support for TQM then was added as another predictor variable in Step 3.

11. Interpret $\beta = .24$ and .34.

$\beta = .24$ indicates that every unit increase in perceived supervisory participative style is accompanied by a .24 unit increase in employees' participation in TQM. $\beta = .34$ indicates that every unit increase in perceived management's improved support for TQM 6 months after it was introduced is accompanied by a .34 unit increase in participation by employees.

12. Interpret $R^2 = .12$, taking into account results of Step 3 and the regression equation reported in the text.

Twelve percent of variability in employee participation in TQM is associated with perceived supervisory participative style and perceived management's improved support for TQM.

Hypothesis 2a posited that participation in TQM would be positively related to perceived benefit of TQM. To test this hypothesis, the control variables and supervisory participative style were entered in the equation initially and participation in TQM entered in a subsequent step. The results shown in Table 6.3 reveal that participation in TQM produced a significant beta coefficient ($\beta = .40$, $p < .01$), explaining an additional 15% variance in perceived benefit of TQM, supporting Hypothesis 2a.

13. What finding is taken as support for Hypothesis 2a?

The significant $\beta = .40$ indicates that employees' participation in TQM 6 months after its introduction predicts their perceived benefit of it.

Hypothesis 2b predicted that employees' assessments of the benefits accruing from TQM (Time 2) would be more important than employees' initial participation (Time 2) in explaining subsequent participation in TQM (Time 3). To test this hypothesis, two regressions were conducted. The control variables were entered in Step 1, participation in TQM (Time 2) was entered in Step 2, and perceived benefit of TQM (Time 2) in Step 3. The second regression reversed the entry of the variables, with perceived benefit of TQM entered in Step 2 and participation in TQM in Step 3. Reversing the order in which the variables are entered into the equation permits an examination of the relative importance of each of the predictors. [In either case, the] beta coefficient $\beta = .23$, $p < .05$. These results suggest that perceived benefit of TQM (Time 2) is more important than participation in TQM (Time 2) in explaining subsequent participation in TQM (Time 3), thus supporting Hypothesis 2b.

14. When testing Hypothesis 2b, what was the logic of entering perceived benefit of TQM after employees' participation in TQM at Time 2 and, in a separate regression, adding it after participation to predict participation in TQM 32 months after its introduction?

If perceived benefit is a significant predictor in both instances, relative to participation, it is a more important predictor of continued, later participation in the program.

Hypothesis 3 posited that participation in TQM would be positively related to organizational commitment. As the effects of employee participation in TQM may take time to materialize, this hypothesis was tested twice using different measurement occasions. In the first regression, organizational commitment (Time 2) was regressed on the control variables (including organizational commitment at Time 1) in Step 1 and participation in TQM (Time 2). The same procedure was followed regressing organizational commitment (Time 3) on the control variables (including organizational commitment at Time 2) in Step 1 and participation in TQM (Time 3) in Step 2.... Irrespective of the time period examined, participation in TQM does not explain unique variance in organizational commitment and does not produce a significant beta coefficient at either time period. Thus, Hypothesis 3 is not supported.

15. Why was it concluded that the last hypothesis was not supported?

The beta coefficients for employees' participation in TQM at Times 2 and 3 were not significant–that is, participation did not predict commitment to the organization 6 or 32 months after TQM was introduced

Discussion

... The data suggest that supervisors have a positive role to play in getting employees involved in TQM. The extent of employee involvement is positively related to the assessment of benefits of TQM. Furthermore, how employees assess the beneficial impact of TQM is more important in predicting subsequent participation in TQM than is their initial participation. However, employee participation was not found to enhance commitment toward the organization.

The finding that supervisory behavior is positively related to employee participation in TQM is not surprising and is consistent with the more general research

on employee participation and empowerment... yet, within the TQM literature, the role of first-line supervisors receives scant attention.... In this study, employee involvement in TQM was unproblematic where supervisors were participative prior to the introduction of TQM. However, the training and education as part of the TQM change process did little to change the behavior of supervisors operating in a traditional "direct and control" manner.

The effect of participation on perceived benefit of the intervention is broadly consistent with prior research... and supports the view that TQM can provide benefit to employees.... In this study, the findings... suggest that the greater employee participation in TQM, the more likely the intervention will be judged to be beneficial.... It would be naive to conclude that the consequences of TQM for employees are entirely beneficial. Clearly, there are trade-offs and... TQM may simultaneously lead to greater work effort and enhanced job satisfaction.

A commonly held assumption in empirical studies of voluntary employee participation programs is that employees are likely to withdraw their participation if they become disillusioned with the program as a result of unmet expectations. This study finds empirical support for the assumption that employees who do not see a change intervention as beneficial in the early stages of implementation are unlikely to participate subsequently. Therefore, when employees exercise choice in participating in a change intervention, the degree to which they assess it as beneficial may be pivotal to their decision to participate.

▶ *(Note that the author does recognize the probability of a selective loss of those employees who were dissatisfied with the introduction of TQM. This recognition, however, still does not tell us who they were or how they might have completed the questionnaires had they remained.)*

The enhancement of organizational commitment did not occur as a consequence of employee participation in TQM. In view of the specific limits of employee involvement under TQM, this type of narrowly focused participation may limit the extent to which enhanced commitment could be reasonably expected to occur....

As with the majority of studies, the design of the current study is subject to limitations. The issue of generalizability of the findings is one limitation, particularly in view of the potentially different practices implemented as part of TQM. A second issue is the small sample size, due to the mortality effects inherent in conducting longitudinal studies....

16. What were the author's major conclusions?

Supervisors play a major role in getting employees to participate in TQM. Employees' perception of the benefits of TQM predicts their participation in it. But commitment to the organization is not enhanced by participation.

17. To what extent were the conclusions justified?

The use of hierarchical analyses was appropriate for testing the hypotheses. The effects of independent variables that might have masked the critical effects were entered first and were therefore controlled by having their effects partialled out. Although zero-order coefficients relating supervisors' participatory style and participation in TQM by employees were not significant, the significant beta coefficient for supervisory style showed that it predicts participation. Likewise, the zero-order correlation between participation and perceived benefits of TQM was not significant, but the significant beta coefficient for participation showed that it predicts perceived benefits. Further regressions showed early perceived benefits to be a more important predictor of later participation than early participation in TQM. Finally, regression analysis revealed that participation in TQM does not predict early or later commitment to the organization, even though zero-order correlations between these two variables were significant.

18. What factors weaken the tenability of the conclusions?

First, there is the probability of a selective loss of employees who were nonparticipators in TQM. Inclusion of their data might have had positive or negative effects on the outcomes. If they would not have been affected by their supervisor's participative style, Hypothesis 1 may not have been supported. Too, they might not be likely to perceive benefits of TQM. Ironically, this would strengthen support for Hypothesis 2a. But, if they did not want to participate yet perceived the benefits of it, this would weaken support. Furthermore, their data may have had the same beneficial or detrimental effects on Hypothesis 2b. Finally, it is difficult to hypothesize what effect their data may have had on Hypothesis 3. Second, responses on some of the scales may have been affected by a knowledge that these employees had been selected for the surveys, by unintentional effects of the author, or by the sequence of the scales, given that counterbalancing was not mentioned.

19. To what population may the results generalize?

These results would generalize to employees in the United Kingdom working on similar jobs in similar organizations and who are willing to participate in TQM.

STUDY EXAMPLE 6.2: "SELF-TRANSCENDENCE AND ACTIVITIES OF DAILY LIVING: THE WOMAN WITH THE PINK SLIPPERS"

This study, to be evaluated by you, is concerned with the relationship between independence of older adults and factors associated with it. The association was determined by MRA.

The Study

Upchurch, S. (1999). Self-transcendence and activities of daily living: The woman with the pink slippers. *Journal of Holistic Nursing*, *17*(3), 251–266. Copyright © 1999 by Sage.

Understanding factors that influence older adults' ability to remain active and independent will become increasingly important in the next 20 to 30 years as the United States experiences a major demographic change. Persons older than 65 now represent nearly 12% of the population. The elderly are predicted to comprise 20% of the population by 2030. . . .

As people age, chronic health problems become a major concern. Of persons 65 years and older, 85% have at least one chronic problem; 69% have more than one. . . . Chronic health problems influence the well-being of older adults and may lead to dependency. Dependency influences functional well-being. . . . For many older individuals, the loss of independence is their primary worry. . . . The degree to which a person remains independent in activities of daily living (ADL) is affected by personal and environmental factors. . . . Even in the face of chronic health problems and potential dependency, differences between older adults' ability to perform ADL remain varied. . . . Why do some older adults continue to remain independent, regardless of their health status, whereas others become dependent?

. . . In each phase of life, various resources emerge that allow people to cope with life's challenges. In this context, aging is perceived as a developmental, not a decremental, experience. . . . A major resource of developmental maturity is self-transcendence (ST). Reed . . . defines [ST] as the capacity to extend personal boundaries multidimensionally and to be oriented toward perspectives, activities, and purposes beyond the self without negating the value of the self. [ST] is the expansion of self-boundaries, inwardly in introspective experiences; outwardly through concerns for others' welfare; and temporally, whereby the past and future are integrated into the present. . . . This study builds on the work of Reed to explore the relationship of a developmental resource, that is, [ST], to the physical domain. . . . [ST] is a resource of successful aging by which a person has the capacity to extend self-boundaries

and become oriented toward activities greater than self and to make decisions and choices as life changes. . . . The purpose of this study was to explore the relationships among ST, [Self-Rated Health Subindex] (SHS), and ADL in older adults.

. . . [ST], a resource of successful aging, affords a person the potential to extend self-boundaries and become oriented toward activities, such as ADL, despite changes in health status. The following research question directed this study: Is there a relationship between [ST], [SHS], and [ADL] in noninstitutionalized older adults?

. . . Only one study could be found that directly related [ST] to physical health and functioning. . . . In a group of 46 HIV-positive individuals with the mean age of 37.8, . . . [ST] and health and functioning are significantly related. Higher [ST] scores were related to better health and functioning. To further explore the relationship between physical [transcendence] and [ST], the following research question was posed for this study: Is there a relationship between [ST], [SHS], and ADL in older community-dwelling adults?

Method

Samples and Procedure

Eighty-eight men and women, 65 years of age or older, who were participants in senior citizen and community center organizations completed the study. Nonprobability, purposive sampling was used. To be included in the study, participants had to be older adults living in the community who were oriented to person, place, and time and who could read and write English. The sample was selected because it exemplified older adults who were successful in remaining independent. The study was in compliance with the rules and regulations of the Human Research Review Committee. Agency permission was obtained. Older adults were asked to complete questionnaires about their ability to stay active and take care of themselves. At center meetings, the investigator described the study and distributed consent forms and the questionnaires, in packets, to those who agreed to participate. The participants completed the forms and returned them to the investigator at the end of the meetings. One hundred and ten packets were distributed, and 88 usable packets were returned. Participants took an average of 15 minutes to complete the forms.

Instruments

. . . [ST] was measured with Reed's . . . Self-Transcendence Scale (STS). The . . . SHS was used to assess health status. . . . The instrument for measuring ADL was Lawton's Instrumental Activities of Daily Living Scale (IADL). . . . Demographic data also were collected.

Self-Transcendence Scale. The STS is a 15-item summated scale. . . . The STS was constructed to measure the developmental resource, [ST]. . . . The purpose of the scale is to evaluate [ST]. [ST] refers to the capacity to expand personal boundaries and be oriented toward perspectives, activities, and purposes beyond the self without negating the self. The scale has been used mainly with older adults. Responses to the 15-item instrument are based on a 4-point scale ranging from 1 for *not at all* to 4 for *very much*. The responses are then summed for a total score. . . .

Reliability as estimated by Cronbach's alpha ranges from .80 . . . to .93. . . . Support for construct validity is confirmed with scores from other related measures. . . .

Self-Rated Health Subindex. The SHS is a Likert-type scale that is a subindex of the Multilevel Assessment Instrument (MAI). . . . The MAI was constructed with concepts related to the well-being of the older person. . . . The SHS is a part of the physical health domain. . . . The SHS has a total of four items. The items are composed of a checklist format of three to four alternative responses to each question. The score for each item ranges from a 4 for *excellent* to a 1 for *poor*. The scores from each item are added for a total score for the subscale. The authors reported an internal consistency of .76 for the four-item self-rated scale and a 3-week test–retest reliability of .92. . . .

Activities of Daily Living. The [IADL] offers a cumulative score of ability to perform a set of ADL. The purpose of the scale is to evaluate the functional abilities of older persons on different levels of competence—in particular, physical and instrumental autonomy of activities of daily living. . . . [which] include housekeeping, shopping, food preparation, telephoning, laundry, use of transportation, and financial behaviors. . . .

The IADL is a nine-item Guttman scale. Individual items are scored from 1 to 3. The item scores are then added together for a total score. The higher the total score, the more independent the individual. . . . Reliability as estimated by Cronbach's alpha was .91. Construct validity was established by existing knowledge about the concept and the domains of ADL. . . . Validity also was tested by comparing results with three other instruments. . . .

Demographics. A demographic sheet was used to collect information on age, gender, ethnicity, marital status, income, and education. All data were collected by the author.

Results

Characteristics of the Sample

The sample of 88 older adults ranged in age from 65 to 93 years. More than 50% were younger than 75 years of age. Women outnumbered men by a ratio of 3:1. All but 2 of the participants were non-Hispanic White; 2 were Hispanic. The majority were widowed, and 48% reported incomes of less than $2,000 per month.

Sixteen of the participants did not respond to the monthly income question. The group was fairly well educated (M = 13.2 years); the most frequently occurring number of years of education was 12. In short, a typical participant was 73 years of age, female, non-Hispanic White, widowed, with 13 years of education and a monthly income less than $2,000.

Research Question

This research was conducted to determine the relationships among [ST], [SHS], and ADL. As can be seen in Table 6.4, the mean score for the STS scale was 52 (SD = 5.1), indicating the group possessed a fairly high degree of [ST]. . . . SHS had an average score of 9.9 (SD = 1.8), suggesting that the participants viewed their health more positively than negatively. The composite score for the IADL scale ranged from 19 to 27, with a mean score of 25.7 (SD = 1.7). Forty-seven percent produced a score of 27, the highest possible score. The overall scores indicated a very capable group in terms of IADL.

The relationship between variables was explored by means of Pearson correlations. The results revealed that health status, SHS (r = 47, p < .001), and self-transcendence, STS (r = .39, p < .001), were significantly correlated with the . . . IADL.

[MRA] was employed to predict variance on activities of daily living associated with SHS and STS. Inasmuch as SHS had the highest correlation with ADL, it was entered into the regression equation first and accounted for 22.6% of the explained variance. . . . STS was entered into the analysis next; its unique contribution in explaining ADL was approximately 6% and was statistically significant (F change = 6.65, p < .05). The multiple correlation coefficient was .53, $F(2, 85) = 16.66$, p < .001; that is, the percentage of variance accounted for by the two predictors was approximately 28%. High multicollinearity was not observed, due to a moderate, though significant, correlation between the two predictors (r = .36, p < .01). . . . Results are summarized in Table 6.5.

Table 6.4 Mean Scores, Standard Deviations, and Cronbach's Alpha of the Self-Transcendence Scale, the Self-Rated Health Subindex, and the Instrumental Activities of Daily Living Scale

	Range	*M*	*SD*	*Alpha*
STS	30–60	52.0	5.1	.72
SHS	4–13	9.9	1.8	.69
IADL	19–27	25.7	1.7	.69

Note: IADL = Instrumental Activities of Daily Living Scale; M = mean, SD = standard deviation; SHS = Self-Rated Health Subindex; STS = Self-Transcendence Scale.

Table 6.5 [MRA] of IADL on SHS and STS

Step Variable Entered	*R*	R^2	*F*	*R Change*	*F Change*
SHS	.475	.226	25.02**	–	–
STS	.531	.282	16.66**	.056	6.65*

Note: IADL = Instrumental Activities of Daily Living Scale; MRA = multiple regression analysis; SHS = Self-Rated Health Subindex; STS = Self-Transcendence Scale.

*p < .05; **p < .001.

Discussion

Discussion is directed toward two perspectives, theoretical and practical. Theoretically, this study contributed to an understanding of the theory of [ST]. Reed . . . proposed that health and human functioning are integrally related to developmental resources. The study operationalized and lent support to Reed's . . . proposition. . . . The results showed that health (SHS) and a developmental resource, . . . ST, correlated with and contributed to functioning (IADL).

From a clinical perspective, some older persons may continue to remain independent despite their health status because of their ability to engage in or experience [ST]. Results showed that IADL and SHS were significantly correlated, with SHS explaining 22.6% of the variation. These findings are not surprising, because logically one would expect health status to account for some of the ability to perform ADL. . . . The results of this study showed that [ST] contributed another 6% toward explaining the ability to perform IADL. The idea that [ST] contributes to ADL in the older adult had not been explored previously. [ST] has been shown to contribute to the well-being of the older adult and to mediate illness distress in persons with serious illnesses. . . . [ST] has been shown to negatively correlate with depressive symptoms. . . . Depressive symptoms have been associated with a greater risk of the onset of disability in activities of daily living, even when taking into consideration health and social status. . . . Consequently, [ST] may assist older adults to remain able to perform activities of daily living through the mediating effects of well-being.

. . . Exploring resources within the older adult, like self-transcendence, is most important work. The population is aging; the potential for improving the emotional well-being and the ability to perform activities of daily living in older adults [would] improve the quality of life for a large number of people. However, this study has several limitations. The very exploratory nature of the study limits interpretation. Only a small number of variables were explored for a very complex problem, older adults and independence. The homogeneity of the sample and the limited variability of the dependent variables places restrictions on the testing of the relationship and the generalizability of the findings.

CRITIQUE OF STUDY EXAMPLE 6.2

1. What was the rationale for the study?
2. What was the purpose of the study?
3. Who took part in the study?
4. Is the sample representative of noninstitutionalized adults?
5. What was the general procedure?
6. What information is missing?
7. What can you say about the 20% of nonusable questionnaires?
8. Is there any concern about the three scales?
9. What are the general characteristics of the sample?
10. How does Table 6.4 show the select nature of the sample?
11. Interpret the correlation coefficients between SHS and IADL and STS and IADL.
12. What kind of MRA was performed? How can you tell?
13. Because interest was in only the relationship between IADL and the two predictor variables, was it necessary to conduct a MRA?
14. What did the author conclude?
15. Is the conclusion justified?
16. To what population do these results generalize?

For answers to these questions, see page **362**.

SUGGESTED READINGS

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Chapter 7

Factor-Analytic Studies

Factor analysis is a set of procedures that attempts to reduce a large set of correlated variables to a smaller set of derived variables, hypothetical characteristics, traits, or factors that underlie the correlations. Sometimes, the purpose of factor analysis is to determine the minimum number of factors accounting for the correlations. This is exploratory factor analysis. What may start out as 45 correlations between 10 variables with redundant information may result in three factors that contain the information in the original variables. Sometimes, the purpose of the analysis is to determine the underlying factor structure of the original variables (i.e., their underlying traits), which gives meaning to the factors. And at other times, the intent is to test a hypothesis that certain factors account for the observed variables. This is confirmatory factor analysis.

Of the various methods for simplifying data, the most popular is **principal components**: an attempt to determine the main factors (components) accounting for the largest proportion of variability in the scores of all of the variables. The method is designed to summarize the data in such a way that the first factor accounts for the bulk of variability in all of the scores of all variables. The remaining factors account for progressively less of the variability. But you end up with as many factors as there were variables, although all will not be used in the final interpretation. An important assumption, here, is that all of the factors are orthogonal, uncorrelated, or independent. Each factor measures something that is measured by (i.e., common to) the variables but also measures something unique. The advantage is parsimony or the simplest explanation of the observed data. The disadvantage is that the factors, in reality, may be correlated.