

Linking Theory Construction and Theory Testing: Models with Multiple Indicators of Latent Variables

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An overview of a methodological paradigm that enhances the integration of theory construction and theory testing is presented. This paper discusses the conceptual advantages of that paradigm and provides an illustration of its use in both exploratory and confirmatory phases of research.

The philosophers of science, Hempel (1952) and Feigl (1970), view scientific theory as a complex spatial network in which hypotheses link theoretical constructs one to another, correspondence rules link theoretical constructs to derived and empirical concepts, and derived and empirical concepts are given meaning through operational definitions. An important implication of this view of the structure of theory is that the integration of theory construction and theory testing is of major importance.

A major criterion proposed by philosophers of science to evaluate the adequacy of theoretical constructions is empirical testability (Popper, 1959), verifiability (Dodd, 1968), or confirmability (Clark, 1969). Meeting this standard requires a clear and explicit specification of theoretical construct definitions and operationalizations. However, historically in many social sciences, methodological paradigms that allow the theorist and empirical researcher to forge strong links have had many deficiencies.

One major shortcoming of past procedures arises from the fact that the bulk of research in

management (as in other behavioral and social sciences) has addressed relationships between and among theoretical constructs that are not directly observable (e.g., labor productivity, employee satisfaction, management style, and motivation factors). As a consequence, if a test of theory is desired, variables that can be observed must be found to use as proxies for the unobservable constructs.

The inability of the researcher to measure variables of interest directly presents especially challenging problems. Two strategies have commonly been used to address these problems. The first is the careful selection, for each theoretical construct, of a single measurable variable that the researcher believes captures the important facets of the construct. Since in many cases it is unrealistic to expect that a single indicator can provide a valid and reliable measure of a complex construct, a second strategy is the construction of an index formed from some combination of two or more observable indicator variables.

A major problem inherent in both approaches is that the measured variables (even when in the form of indices) usually contain at least moderate amounts of error. As Goldberger (1971) has pointed out, when such measures are used in linear models (e.g., analysis of variance and co-

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variance, regression, and path analysis models), the coefficients obtained will be biased, most often in unknown degree and direction.

Several statistical models recognize that theoretical constructs of interest often are not directly measurable but must instead be estimated from multiple indicator measures. Among them are: latent structure analysis (Goodman, 1974); partial least squares (Wold, 1980); and the most widely used algorithm, LISREL (Jöreskog, 1973; Jöreskog & Sörbom, 1981). There are two major strengths in these latent variable methods of analysis—one technical, the other conceptual. Technically these models provide researchers with a method both for estimating structural relationships among unobservable constructs and for assessing the adequacy with which those constructs have been measured. Conceptually, the use of these models entails a mode of thinking about theory construction, measurement problems, and data analysis that is helpful in stating theory more exactly, testing theory more precisely, and yielding a more thorough understanding of the data.

Management literature/research has been criticized for failure to integrate theory construction and theory testing. Miner, for example, states:

theories have suffered badly from measurement failures that remain to this day (1982, p. 444).

Vague constructs tend to give birth to poor measures, as in the case of contingency theory, or to no measures at all, as in the case of classical management theory (1982, p. 444).

Although problems of measurement and construct validity are often so closely intertwined that they cannot be separated, there is still sufficient independent evidence that all of the theories suffer somewhat from problems of construct definition (1980, p. 394).

In fields such as sociology, marketing, and political science, the use of latent variable models to address similar problems is becoming relatively common. However, such techniques have not been widely reported in the management literature. (Exceptions are Bagozzi & Phillips, 1982; Gladstein, 1984; Van de Ven & Walker, 1984; Walker & Weber, 1984.)

This paper presents a general introduction to latent variable models in the context of a study of the relationship between evaluation and knowledge of job enrichment. The authors believe that using latent variables to represent theoretical constructs in models, illustrated here by the LISREL methodology, will be used increasingly by management researchers in investigating measurement issues and in testing and refining theories. This discussion may introduce that approach to a larger audience of management scholars.

Overview

An introduction to models with multiple indicators of latent variables will be presented within the context of an example application which permits an explanation of the use of such models in both exploratory and confirmatory research phases.

In the exploratory stages of research, relevant theoretical models are either missing or at a primitive stage of development. Here the researcher's interest is directed at clearly defining the theoretical constructs of interest, providing operational definitions for them, and linking the observed variables to the unobservable theoretical constructs. In this stage, a latent variable methodology can be used to examine various measurement models as an aid in selecting indicator variables, assessing construct validity, and investigating differences among models that specify alternate hypotheses about the relationships among the theoretical constructs of interest. The LISREL algorithm provides several statistics that can be used in an exploratory fashion, for example, to suggest ways in which the theoretical model might be modified, to assess the dimensionality of the constructs, and to estimate the reliabilities of the observed indicator variables in measuring model constructs.

In confirmatory studies, the researcher formulates a model representing hypothesized relationships (a) among theoretical constructs and (b) between the theoretical constructs and the measures used to operationally define them.

Direct tests involving latent variables (which represent the theoretical constructs) are used to make inferences and to draw conclusions about the theoretical constructs. LISREL provides both overall measures of the fit of the hypothesized model to the data (such as goodness-of-fit statistics) and measures that can be used to test specific elements of the model such as structural parameters.

The LISREL Model

The general LISREL model can be viewed as a synthesis of techniques of econometrics and psychometrics (Goldberger, 1971) that subsumes many models as special cases: for example, regression analysis, path analysis, factor analysis, and structural equation models for directly observed variables.

In the most general form of the LISREL model, the researcher posits a causal structure among a set of unobservable constructs. These constructs are represented by latent variables, which are empirical measures of the constructs. Each latent variable is measured by a set of observable indicator variables. Observable variables may be assumed to be measured with error.

The formal LISREL model describes the structural and measurement assumptions of the researcher and consists of two parts, the latent variable (or structural equation) model and the measurement model. The latent variable model specifies the hypothesized causal structure among the unobserved theoretical constructs. The measurement model specifies how the latent variables are measured in terms of the observed variables and represents the correspondence rules by which the unobservable constructs are related to the observed variables.

In a linear model containing variables that are measured with error, the coefficients represent empirical associations. In contrast, multiple indicator latent variable models permit the explicit modeling and estimation of errors in measurement. Thus, the coefficients in the structural equation model in LISREL represent theoretical cause and effect relationships among the unobservable constructs (as represented by the latent variables)

and, as such, are the parameters of interest to the researcher.

Exploring Measurement Issues

In order to emphasize the advantages of LISREL (and similar methodologies) in exploring measurement issues, data were chosen from an existing study of job enrichment by Price (1978) in which there had been no consideration of measurement issues prior to data collection. In the management literature, the use of job enrichment as a motivating technique has been the subject of some controversy. Studies such as Herzberg (1968), Paul, Robertson, and Herzberg (1969), Sirota and Greenwood (1971), Miles (1975), and O'Connor and Barrett (1980) support the concept. Others—for example, Winpisinger (1972), Fein (1974), Blood and Hulin (1967), and Umstot, Bell, and Mitchell (1976)—contend that the relationship between job enrichment and motivation is at best unproven and possibly misleading. The use of latent variable methods, which enhance the integration of theory construction and theory testing, offers management scholars the opportunity to pursue the resolution of this and other similar controversies with the rigor advocated by Miner (1980, 1982).

Price surveyed all presidents or presiding officers of unions or national associations that were on record with the United States Department of Labor, Bureau of Labor Statistics (1976). One hundred fourteen complete questionnaires were obtained from the total population of 229 unions or national associations. Below, six measures of knowledge of job enrichment (K1–K6) and eight measures of attitudes toward job enrichment (A1–A8) that were obtained in the original survey (Table 1) are utilized to illustrate the use of LISREL in exploring measurement issues.

Assessing Measurement Properties

Tests of substantive theory (i.e., hypothesized relationships among theoretical constructs) necessarily involve an "auxiliary measurement theory" (Blalock, 1982, p. 25) concerning relationships among theoretical constructs and their

Table 1
Knowledge and Attitude Questions

<i>Knowledge</i>	
I believe that job enrichment, if used properly, could:	
K1.	Be directly responsible for providing promotion opportunities for our membership.
K2.	Assist management in recognizing the individual achievement of our membership.
K3.	Make the work more challenging for the individual member.
K4.	Provide more responsibility to the individual member.
K5.	Create better communication channels between the employee and his supervisors.
K6.	Decrease the close supervision by management of our membership.
<i>Attitude</i>	
A1.	I feel that job enrichment concepts if used properly would benefit our membership.
A2.	I feel that most firms with which I bargain do not fully understand the theory and proper application of job enrichment.
A3.	I think that job enrichment should be a bargaining issue.
A4.	I believe that the benefits claimed for job enrichment in publications have been overstated.
A5.	I feel that use of job enrichment benefits management rather than the worker.
A6.	I believe that the majority of our membership would favor the application of job enrichment to their jobs.
A7.	I believe the real motive of management for implementing job enrichment programs is to get more output for the same pay.
A8.	I believe the use of job enrichment instills a sense of pride in the individual's work and product.
Note. Questions were coded using a 5-point Likert-type scale with 1 = strongly agree and 5 = strongly disagree.	

indicators. When the auxiliary measurement theory is strong, empirical analysis can lead to a greater understanding of the phenomenon under investigation. However, weak associations between theoretical constructs and observed variables may lead to incorrect inferences and misleading conclusions about relationships among the underlying theoretical constructs of interest.

Factor analysis has frequently been used for studying measurement properties. Traditionally it has been employed primarily in the exploratory mode — as a technique to help identify constructs that underlie a set of observed variables. However, except for specifying the number of common factors and stating whether all factors are correlated or all factors are uncorrelated, researchers using the exploratory factor model are extremely limited with respect to the specification and testing of hypotheses concerning model structure.

The type of factor model that allows the researcher to specify hypotheses and that provides information to determine whether the observed data confirm the hypothesized model structure is called a confirmatory factor analysis model.

LISREL can be used to specify and analyze such models.

Consider, for example, the confirmatory factor analysis model shown in Figure 1. It depicts two latent variables (ξ_1 and ξ_2) and posits that ξ_1 (knowledge of job enrichment) and ξ_2 (attitude toward job enrichment) are unidimensional constructs defined by the observed variables K1–K6 and A1–A8, respectively. The parameter ϕ_{12} allows for correlated constructs (i.e., oblique factors); the λ_i parameters are analogous to factor loadings; the random variables $\delta_1 - \delta_{14}$ represent unique factors or errors in measurement, and the variances and covariances of these measurement errors are parameters of the model.

Flexibility in imposing constraints motivated by substantive theory differentiates confirmatory factor analysis models from traditional exploratory models. The model shown in Figure 1 incorporates the structural constraints that factor loadings of variables across common factors are zero (e.g., the loading of the variable K1 on the latent variable ξ_2) and that correlations among unique factors also are zero.

Assessing the strength of the auxiliary measurement theory involves a consideration of some

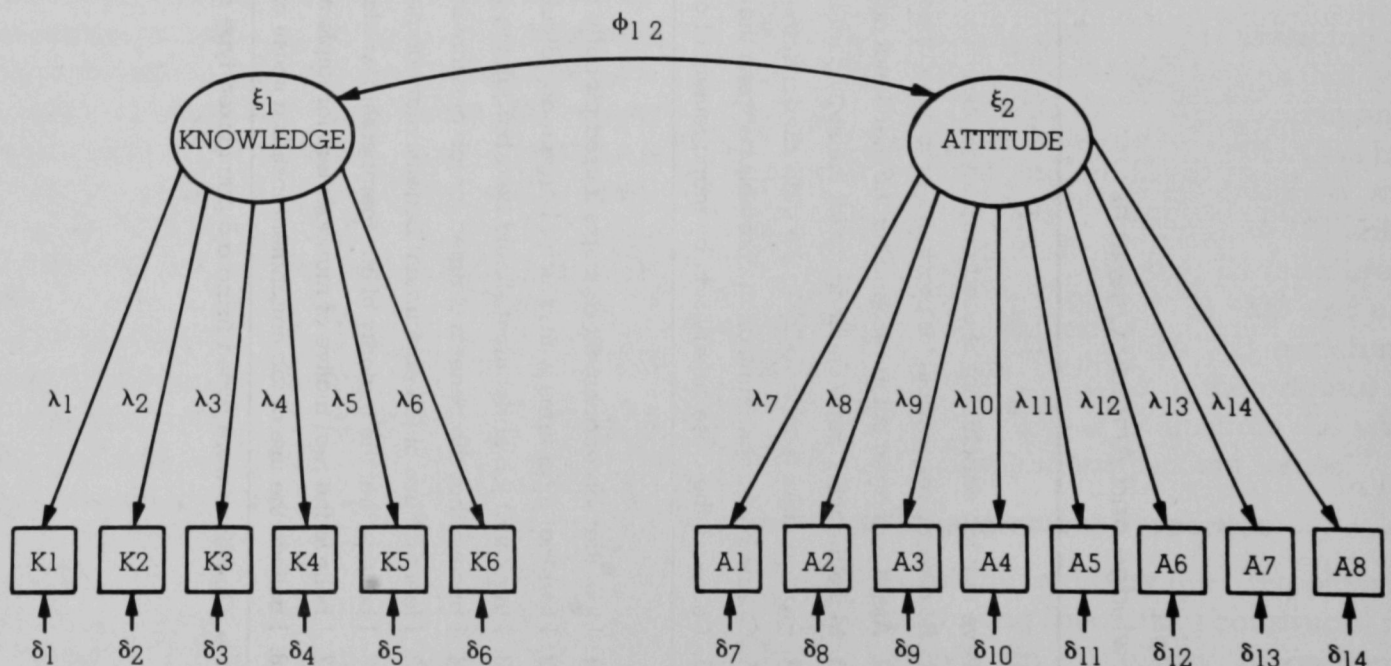


Figure 1. Two construct confirmatory factor analysis model.

facets of construct validity that are related to measurement and that can be explored within the framework of confirmatory factor analysis. Construct validity, the degree to which a construct achieves theoretical and empirical meaning within the overall structure of one's theory, is a necessary prerequisite for theory development and testing (Bagozzi, 1980). The Campbell and Fiske (1959) multitrait-multimethod (MTMM) matrix has been the most widely used procedure for construct validation. Multiple indicator latent variable models offer a more rigorous methodology that permits statistical testing and provides additional useful information as well. (See Bagozzi, 1978, and Bagozzi & Phillips, 1982, for a more detailed discussion of the limitations of the MTMM methodology.)

Below, using the model of Figure 1 as a base, an illustration is given of how LISREL can be used to explore two aspects of construct validity—internal consistency (dimensionality and reliability) and discriminant validity—and to assist the researcher in refining the measurement model.

Dimensionality

If one is to obtain an unambiguous, meaningful test of a theory, the multiple indicators of each latent variable in the model should converge to measure a single construct; that is, the set of empirical measures of each single construct should, ideally, be unidimensional. The χ^2 statistic provided by the LISREL algorithm can be used to assess dimensionality. The p -value associated with this χ^2 is the probability of obtaining a χ^2 value larger than the value actually obtained, under the hypothesis that the model specified is a true reflection of reality. Small p -values indicate that the hypothesized structure is not confirmed by the sample data. For the model in Figure 1, the χ^2 of 255.72 with 76 df ($p = 0.000$) indicates that the observed data does not adequately fit the hypothesized model. One reason for this bad fit could be that the sets of measures of the latent variables are not unidimensional. An examination of the reliabilities of the measures can provide additional insights.

Reliability

Empirical measures used to operationalize unobservable constructs should be reliable, that is, as free from random error as possible. Reliable measures assist the researcher in obtaining a clear picture of true relationships; random errors tend to obscure relationships. In classical test score theory, the reliability of a variable is a measure of the degree of true-score variation relative to the observed-score variation. It is defined as the squared correlation between the true score (i.e., the latent construct for which that variable is assumed to be an indicator) and the observed variable. Reliability can be interpreted as the proportion of the observed variable that is free from error (Lord & Novick, 1968). It would be difficult to justify a proposed indicator of a latent variable in exploratory research if its reliability were less than .50, for in that case more than 50 percent of its variance would be error variance.

Table 2 specifies the reliability of each indicator for the latent variables in the model of Figure 1. Using a cutoff of .50, it would appear that the latent variable, knowledge, can be reliably operationalized using the five measures K1–K5. The attitude construct presents a more complex problem. Only A1, A6, and A8 have reliabilities above .50. One reason why this may have occurred is that the eight observed variables (A1–A8) may not converge to measure a single underlying attitude construct.

Reformulation of Model

A further examination of the attitude questions in Price's survey (Table 1) shows that only five of the indicators directly address job enrichment attitudes. The three indicators that exhibit high reliabilities in the model of Figure 1 (A1, A6, and A8) are measures of evaluations of job enrichment and its consequences. As such, these three questions reflect an expectancy-value operationalization of attitude. In contrast, questions A5 and A7 refer to attitudes of respondents toward management in its implementation of job enrichment.

Table 2
Reliabilities for Model in Figure 1

Knowledge indicator	Reliability	Attitude indicator	Reliability
K1	.59	A1	<u>.83</u>
K2	.68	A2	.00
K3	.71	A3	.10
K4	.51	A4	.31
K5	.67	A5	.29
K6	<u>.34</u>	A6	<u>.52</u>
		A7	.15
		A8	<u>.72</u>

The remaining three questions do not appear to be measures of attitude toward job enrichment. Question A2 concerns respondents' opinions of firms' understanding of job enrichment; question A3 concerns bargaining table priorities; and question A4 concerns opinions regarding claimed benefits.

Based on these assessments, the model was reformulated as shown in Figure 2. This model has a χ^2 of 50.44 with 32 degrees of freedom ($p = 0.020$), which does not indicate a good fit of the data to this model. However, model evaluation should never be based solely on the χ^2 statistic, because it may indicate a bad fit even though specific relationships in the model may reflect initial hypotheses (or vice versa). An assessment of whether the attitude construct as originally formulated comprises the two constructs, attitude toward job enrichment and attitude toward management, thus is dependent on additional considerations.

If the attitude constructs in Figure 2 are highly correlated, then, empirically at least, it is difficult to support the hypothesis that they represent distinct concepts. This is a question of discriminant validity, that is, the degree to which a concept differs from other concepts (Campbell & Fiske, 1959).

A test of discriminant validity can be performed by comparing the model in Figure 2 with a model in which the correlation between the two attitude constructs is restricted to 1. The restricted

model is a special case of (i.e., nested in) the Figure 2 model. Two degrees of freedom are lost with this restriction because it logically dictates the additional restriction that $\phi_{12} = \phi_{13}$.

A difference-of- χ^2 test provides statistical evidence of whether the model of Figure 2 provides a significant improvement over the more restricted model. The restricted model has a χ^2 with 34 *df* of 123.63. The significant difference of χ^2 's (73.19 with 2 *df*) between the model in Figure 2 and the restricted model provides support for the reformulation of the attitude construct into two distinct constructs.

Further evidence to support the model in Figure 2 may be obtained by examining the estimates of the λ_i parameters (i.e., the structural relationships between the indicators and their associated latent variables). Conventional tests for the hypothesis that each $\lambda_i = 0$ result in *t* values ranging from 6.35 to 12.19, supporting the hypothesis that all indicators exhibit a statistically significant positive relationship with the constructs they were hypothesized to measure.

Correlated Errors of Measurement

In any specific research study, some factors may not be explicitly modeled; for example, theories may not be developed to the point of giving a complete model specification, the researcher may be unable to obtain the required measures, or excluded factors may be extraneous to the structural relationships of substantive

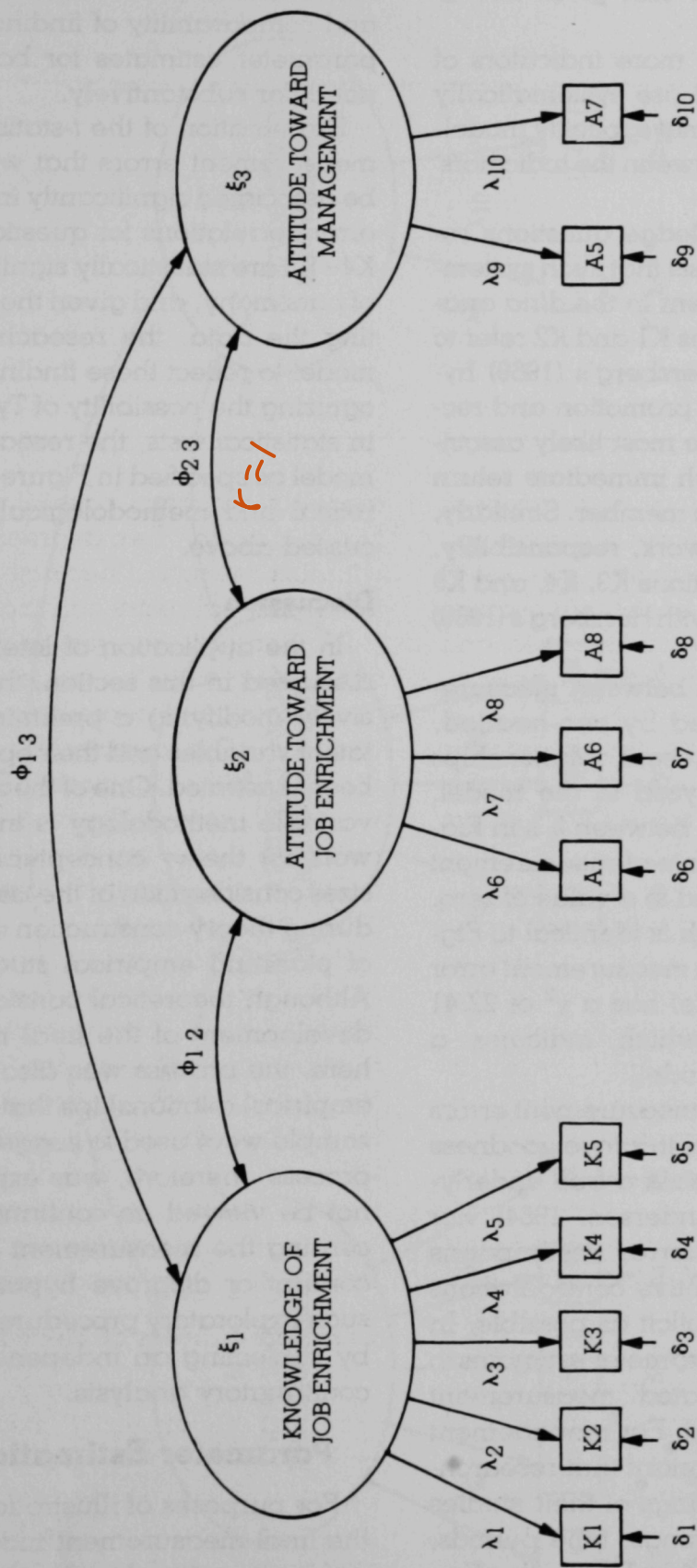


Figure 2. Three construct confirmatory factor analysis model.

interest in the investigation. This gives rise to model specification error.

In cases in which two or more indicators of latent variables in a model are systematically influenced by a factor that is not explicitly modeled, correlations may exist between the indicators' measurement errors.

Examination of the knowledge questions remaining in the model suggests that such systematic influences may be present in the data analyzed in this paper. Questions K1 and K2 refer to concepts associated with Herzberg's (1969) hygiene factors. References to promotion and recognition for achievement are most likely associated by the respondents with immediate return in monetary form to the union member. Similarly, references to challenge of work, responsibility, and communication in questions K3, K4, and K5 refer to concepts associated with Herzberg's (1969) motivational factors.

Hypothesized correlations between measurement errors are represented by two-headed, curved arrows, which represent relationships that are not explicitly analyzed in the model. The absence of such arrows between δ_i 's in Figure 2 indicates that all errors-of-measurement correlations were constrained to a value of zero. The model of Figure 3 (which is identical to Figure 2 with the addition of the measurement error correlations discussed above) has a χ^2 of 22.41 with 28 df ($p = 0.762$), which indicates a good fit of the data to the model.

The addition of correlated measurement errors to a model will nearly always improve goodness of fit; however, it can also mask a true underlying structure (Gerbing & Anderson, 1984). For this reason, measurement error assumptions should be based on substantive considerations and should be made as explicit as possible. In addition, the sensitivity of parameter estimates to the specification of correlated measurement errors should be investigated. For management theory to advance, it is important that researchers be able to compare findings of their studies with others that differ in settings, time periods, and so on. Instability in underlying structure

raises serious questions about the generalizability and comparability of findings. Table 3 contains parameter estimates for both models; they do not differ substantively.

Examination of the t -statistics for each pair of measurement errors that were hypothesized to be associated significantly indicates that only the error correlations for question pairs K3-K4 and K4-K5 are statistically significant. In the interest of parsimony, and given the possibility of overfitting the data, the researcher may modify the model to reflect these findings. Alternately, recognizing the possibility of Type II errors inherent in statistical tests, the researcher may retain the model as specified in Figure 3 based on the theoretical and methodological considerations discussed above.

Discussion

In the application of latent variable methods discussed in this section, the process of successively modifying a preliminary specification of latent variables and their operationalizations has been illustrated. One of the major values of latent variable methodology is in providing a framework for theory conceptualization that emphasizes consideration of the issues discussed above during theory construction and in the first stages of planning empirical studies to test theories. Although theoretical considerations guided the development of the final measurement model here, the process was also data-driven; that is, empirical relationships that were manifest in the sample were used to suggest modifications. The process, therefore, was exploratory and should not be viewed as confirming hypotheses concerning the measurement models. Evidence to confirm or disprove hypotheses generated by such exploratory procedures should be obtained by subjecting an independent set of data to a confirmatory analysis.

Parameter Estimation and Testing

For purposes of illustration, it is assumed that the final measurement model developed in the previous section has been deemed acceptable.

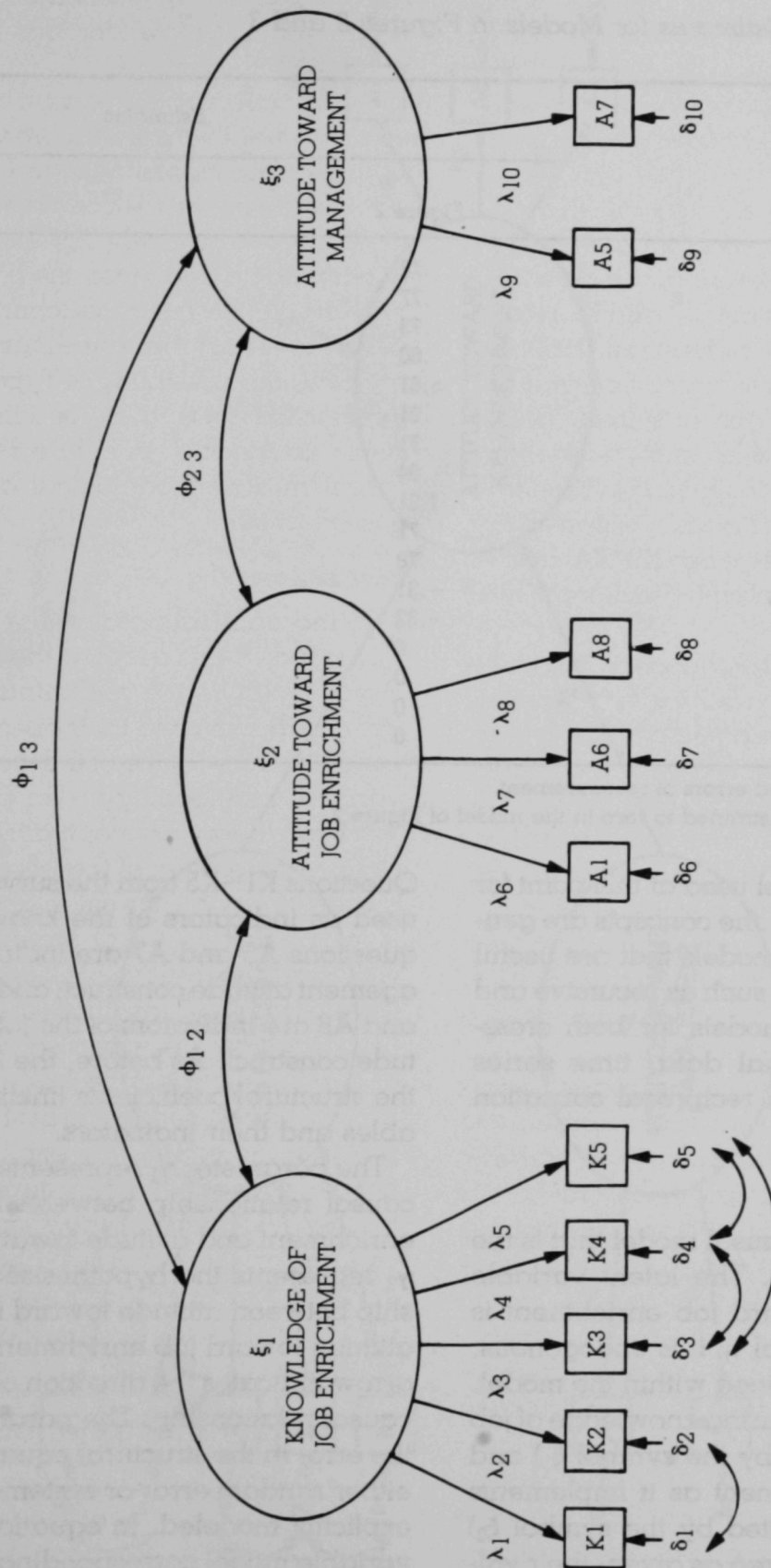


Figure 3. Three construct confirmatory factor analysis model with correlated errors of measurement.

Table 3
Standardized Parameter Estimates for Models in Figures 2 and 3

Parameter	Estimates	
	Figure 2	Figure 3
λ_1	.78	.81
λ_2	.77	.80
λ_3	.73	.67
λ_4	.60	.50
λ_5	.81	.77
λ_6	.91	.91
λ_7	.71	.71
λ_8	.84	.84
λ_9	1.21	1.21
λ_{10}	.71	.71
ϕ_{12}	.78	.79
ϕ_{13}	-.31	-.30
ϕ_{23}	-.52	-.52
θ_{12}^a	0 ^b	.01
θ_{34}	0	.19
θ_{35}	0	.06
θ_{45}	0	.14

^a LISREL notation for correlated errors of measurement.

^b All correlated errors are constrained to zero in the model of Figure 2.

Although the causal model used at this point for illustration is a simple one, the concepts are generalizable to a variety of models that are useful in management research, such as recursive and nonrecursive structural models for both cross-sectional and longitudinal data, time series models, and models with reciprocal causation structures.

The Causal Model

Figure 4 specifies the causal model that is the subject of the discussion. The latent variable measuring attitudes toward job enrichment is represented by the symbol η ; it is endogenous, that is, its value is determined within the model. The latent variables measuring knowledge of job enrichment (represented by the symbol ξ_1) and attitude toward management as it implements job enrichment (represented by the symbol ξ_2) are exogenous, that is, taken as given; their values are determined by factors outside the model.

Questions K1–K5 from the survey instrument are used as indicators of the knowledge construct; questions A5 and A7 are indicators of the management attitude construct; and questions A1, A6, and A8 are indicators of the job enrichment attitude construct. As before, the λ_i parameters are the structural coefficients linking the latent variables and their indicators.

The parameter γ_1 represents the hypothesized causal relationship between knowledge of job enrichment and attitude toward job enrichment; γ_2 represents the hypothesized causal relationship between attitude toward management and attitude toward job enrichment. The head of the arrow indicates the direction of the hypothesized causal relationship. The parameter ζ represents the error in the structural equation resulting from either random error or systematic influences not explicitly modeled. In equation form, the latent variable model corresponding to Figure 4 is $\eta = \gamma_1\xi_1 + \gamma_2\xi_2 + \zeta$.

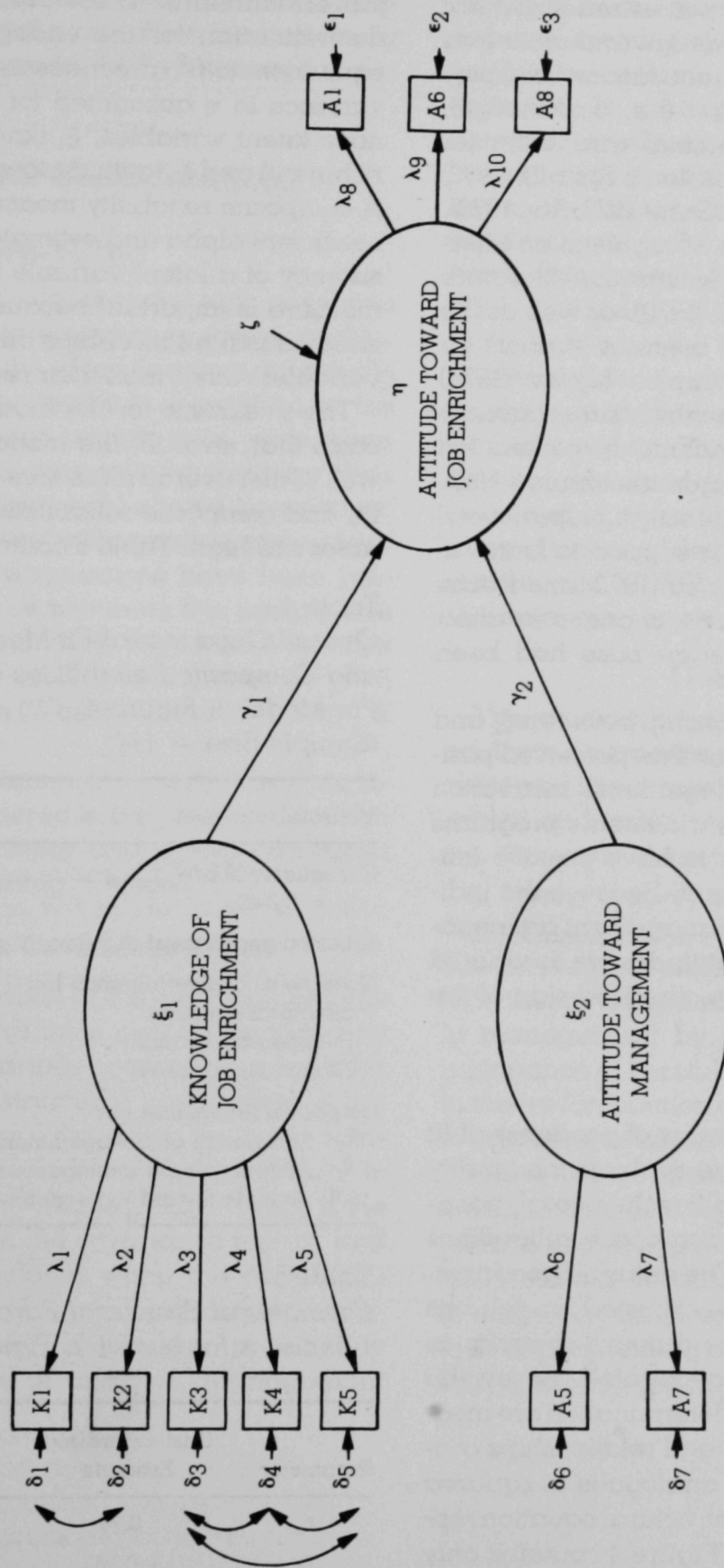


Figure 4. Three construct causal model.

The rationale for the hypothesized structural relationship between knowledge and attitude is based on marketing communications and psychology models of cognition (i.e., knowledge), affect (i.e., attitude/evaluation) and behavior (Cacioppo & Petty, 1979; Kiesler & Sproull, 1982; Lavidge & Stienner, 1961; McGuire 1976; Ray 1973). A positive causal influence of cognition on affect is hypothesized. The job satisfaction literature (Locke, Cartledge, & Knerr, 1970), as well as the job enrichment literature, contains support for that hypothesis. For example, Myers (1971) reports an extreme case in which subsequent to the introduction of job enrichment, workers felt that a union was no longer necessary. Here knowledge preceded and directly (i.e., positively) influenced attitude. Similar support is found in Smith (1973), *Work in America* (1973), and Roche and MacKinnon (1970); there changes in affect occurred after the knowledge base had been established.

The hypothesized relationship between ξ_2 and η is based on the assumption that perceived positive attitudes toward management's motivation for implementing job enrichment programs would cause respondents to have positive attitudes toward job enrichment. Because the indicators of attitude toward management are negatively coded (i.e., positive attitudes are associated with lower scores), the hypothesized sign of the relationship is negative.

Analysis

LISREL provides a hierarchy of goodness-of-fit statistics that can be used to evaluate the quality of the model. Table 4 specifies the overall goodness-of-fit measures and composite reliabilities for the model of Figure 4. The adjusted goodness-of-fit statistic is a measure, adjusted for degrees of freedom, of the relative amount of variance and covariance jointly accounted for by the model. The coefficients of determination are measures of the strength of several relationships considered jointly. They are analogous to squared multiple correlations. The structural equation represented by the model in Figure 4 contains only one endogenous variable (η = attitude toward

job enrichment). Therefore, the coefficient of determination for the endogenous variable is equivalent to R^2 and measures the proportion of variance in η accounted for by the two exogenous latent variables, ξ_1 (knowledge of job enrichment) and ξ_2 (attitude toward management). A composite reliability measure is analogous to coefficient alpha and estimates the internal consistency of a latent variable (Bagozzi, 1981); the measure is important because tests of hypothesized causal relationships directly involve latent variables rather than their respective indicators.

The χ^2 statistic for the model in Figure 4 indicates that, overall, the model fits the data very well. Other overall measures also indicate a good fit, and composite reliabilities of the latent variables are high. Table 5 contains estimates of the

Table 4
Overall Goodness-of-Fit Measures
and Composite Reliabilities of Latent Variables
For Model in Figure 4
(Sample Size = 114)

Measure	Value
Chi-square (29 df) ($p = 0.362$)	31.07
Adjusted goodness-of-fit index	0.90
Coefficients of determination for:	
Structural equation	0.68
Endogenous variable	0.90
Exogenous variables	1.00
Composite reliabilities for:	
ξ_1 - Knowledge of job enrichment	0.88
ξ_2 - Attitude toward management	0.84
η - Attitude toward job enrichment	0.86

Table 5
Estimates of Structural Parameters and
t-Statistics for Model in Figure 4

Parameter	Unstandardized Estimate	Standardized Estimate	t-value
γ_1	0.78	0.74	7.47
γ_2	- 0.26	- 0.36	- 3.50

structural parameters and their associated t -statistics. Both structural parameters are statistically significant with signs in the hypothesized directions.

Additional Considerations

Assessing Goodness-of-Fit

Two cautions should be noted with respect to use of the χ^2 statistic in assessing goodness-of-fit. First, the ability of the χ^2 test to detect departures of the data from the model is dependent on the sample size. For large sample sizes, even when the residuals are quite small, the test very often will indicate that the model should be rejected. The converse occurs with small sample sizes. Various descriptive measures have been proposed that reduce or eliminate this sample size dependency. They include the normed fit index (Bentler & Bonett, 1980) and the ratio of χ^2 to degrees of freedom (Wheaton, Muth  n, Alvin, & Summers, 1977).

Second, as mentioned previously, the χ^2 statistic should be considered in an integrated fashion with other test statistics and model parameter estimates in evaluating a model.

Correlation Versus Covariance Matrix

Either the covariance or the correlation matrix for the observed variables may be analyzed by LISREL. The covariance matrix must be used when comparing structural parameters either across different populations (for the same variables) or across time for the same population. In addition, the χ^2 is a valid test statistic only if the analysis is based on the covariance matrix, and t -values may be inflated when the correlation matrix is analyzed. However, use of the correlation matrix has many advantages, particularly in the early stages of analysis. Management

researchers are more accustomed to thinking in terms of correlation coefficients, which can be interpreted in terms of proportion of "explained" variance. In addition, measures of most constructs in management have not been sufficiently standardized or refined to give substantive meaning to the unstandardized coefficients that are obtained when the covariance matrix is analyzed. (See James, Mulaik, & Brett, 1982; Blalock, 1982; and Long, 1983, for additional discussion.)

Table 6 contains the correlation matrix and standard deviations for the variables used in this analysis so that interested readers can reproduce the results. The covariance matrix, which can be calculated from the given information, was used in all analyses in this paper. (A summary of technical details, including model specifications and LISREL code, will be provided by the authors upon request.)

Conclusion

The major conceptual advantages of a methodological paradigm within which both measurement and latent construct linkages can be represented and tested are:

1. Statement of theory is more exact.
2. Testing of theory is more precise.
3. Communication of theory is enhanced.

Use of methods such as LISREL may enhance both theory construction and empirical research in management by focusing attention on the importance of careful consideration of testability in theory formulation and construct development in empirical analysis.

Wider use of latent variable methods, which demand an explicit specification of operationalizations and of hypothesized functional relationships among constructs, may be valuable to management scholars as they attempt to improve their understanding of complex processes in the field of management.

Table 6
Correlations and Standard Deviations

	K1	K2	K3	K4	K5	K6	A1	A2	A3	A4	A5	A6	A7	A8
K1	1.00													
K2	.71	1.00												
K3	.62	.66	1.00											
K4	.44	.50	.71	1.00										
K5	.59	.70	.68	.62	1.00									
K6	.47	.45	.50	.45	.52	1.00								
A1	.61	.58	.60	.48	.54	.32	1.00							
A2	.08	.08	.07	.03	.10	.27	.05	1.00						
A3	.28	.29	.20	.21	.10	.26	.30	.30	1.00					
A4	-.37	-.31	-.31	-.37	-.24	-.05	-.49	.30	.00	1.00				
A5	-.27	-.21	-.28	-.26	-.21	.01	-.47	.28	.11	.70	1.00			
A6	.53	.50	.40	.37	.39	.26	.67	.08	.42	-.37	-.36	1.00		
A7	-.16	-.15	-.21	-.20	-.14	.06	-.31	.35	.16	.59	.65	-.17	1.00	
A8	.58	.58	.54	.50	.56	.34	.78	.09	.31	-.40	-.44	.60	-.33	1.00
Std														
Dev	1.00	.92	.87	.85	.99	1.08	.99	.85	1.16	1.10	1.23	.98	1.08	.98

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