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The Impact of Structure, Environment, and Interdependence on the Perceived Usefulness of Management Accounting Systems

Robert H. Chenhall and Deigan Morris

ABSTRACT: This paper examines the effect of structural decentralization, perceived environmental uncertainty, and organizational interdependence on Management Accounting Systems [MAS] design. MAS design was defined in terms of the perceived usefulness of several information characteristics which may be associated with an MAS. These characteristics were scope, timeliness, level of aggregation, and information which assists integration. In addition to examining the direct effects of contextual variables, the study sought to determine how the independent variables interacted. Hypotheses were generated for both direct and indirect effects of contextual variables and were tested using data collected from 68 managers. The findings indicated that: 1) Decentralization was associated with a preference for aggregated and integrated information; perceived environmental uncertainty with broad scope and timely information; organizational interdependence with broad scope, aggregated, and integrated information. 2) The effects of perceived environmental uncertainty and organizational interdependence were, in part, indirect through their association with decentralization.

In recent years, a succession of authors have called for more research which examines the influence of contextual settings on the effective design of Management Accounting Systems (MAS) [Sathe, 1975; Gordon and Miller, 1976; Ansari, 1977, 1979; Amigoni, 1978; Gordon, et al., 1978; Waterhouse and Tiessen, 1978; Banbury and Nahapiet, 1979]. While a variety of contingency (contextual) frameworks have been suggested, they generally share a concern with organizational factors such as the external environment, organizational size, diversity, technology, and formal structure.

Although considerable emphasis has been placed on potential benefits of contingency theory applications to accounting research, only a few empirical investigations exist [e.g., Khandwalla, 1972; Bruns and Waterhouse, 1975; Gordon and Narayanan, 1984; Kenis, 1979; Merchant, 1981; Hayes, 1977; Rockness and Shields, 1984; Govindarajan, 1984]. Perhaps empirical research is scarce because of both the complex interrelationships among contextual variables and the difficulties in developing theories of how these complex interactions influence the design

Robert H. Chenhall is a Professor at La Trobe University and Visiting Professor, INSEAD, and Deigan Morris is Associate Professor at INSEAD.

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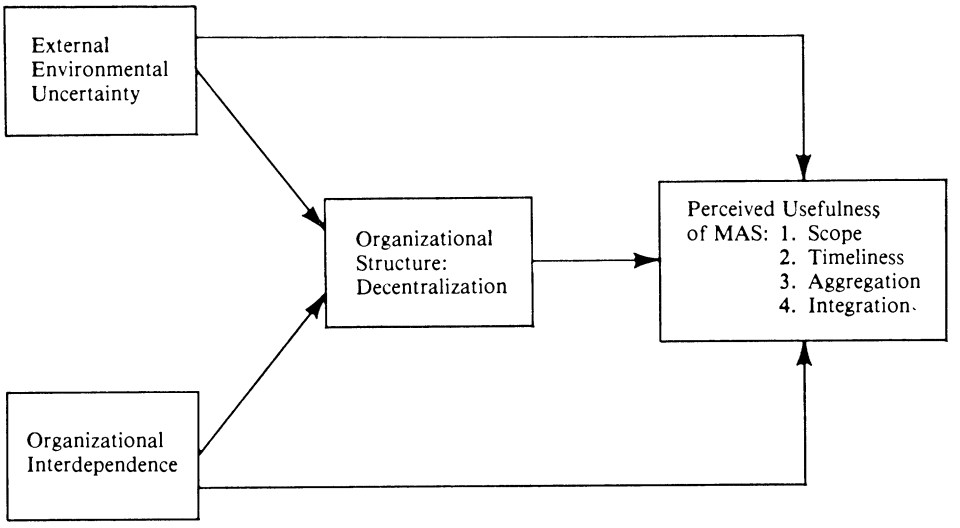
FIGURE 1
A CONTINGENCY MODEL OF PERCEIVED USEFULNESS OF MAS



of MAS [Waterhouse and Tiessen, 1978; Otley, 1980; Merchant, 1981]. Only Gordon and Narayanan [1984] have examined the effect of interactions between contextual variables on the design of MAS. They examined the effects on MAS design of perceived environmental uncertainty and organizational structure acting singly and in combination. This approach has particular promise in unravelling the complex effects of interacting contextual variables on MAS design. This paper reports the results of a study aimed at providing additional evidence on the effects of potentially interacting contextual variables on the design of MAS.

The framework for the research is presented in Figure 1. The study has three main purposes. First, it considers MAS design in terms of several broad information characteristics including 1) scope, 2) timeliness, 3) levels of aggregation (including an orientation to formal decision models) and 4) information on how activities are integrated. Second, the study investigates the relationship between managers' perceptions of the usefulness of these MAS information characteristics and 1) organizational structure, defined as the level of decentralized decision autonomy; 2) managers' perceptions of the uncertainty in their operating environments; and 3) organizational interdependence, defined as the extent of exchanges between different sections within the subunit.[1] In addition, the study examines interactions between the three contextual variables and their consequent combined effects on the perceived usefulness of information. Third, the re-

[1] Studies into perceived usefulness of information posit that individuals have sufficient self-insight into their decision process so as to understand the importance of information to their task activity [Ashton, 1974; Bruns, 1968; Joyce, 1976]. While some evidence exists that self-insight is poor [Slovic and Lichtenstein, 1971; Nisbett and Wilson, 1977], use of "real world" decision makers as respondents is likely to improve the quality of managerial self-insight [Larcker, 1981]. See Wright [1977] for discussion of the self-insight issue.

search represents a partial replication of a recent study by Gordon and Narayanan [1984].

The next section of the paper presents the experimental variables considered in the research and a theoretical discussion of the direct and indirect effects of contextual variables on perceived usage, including a statement of hypotheses. The following sections address the research method, results, discussion, and conclusions.

Experimental Variables and Hypotheses

This section derives six hypotheses for empirical investigation. First, the selected contextual variables are identified. A review of the literature related to the potential effects of contextual variables on the perceived usefulness of each information characteristic follows. Next, the indirect effects on perceived information usefulness of perceived environmental uncertainty and organizational interdependence acting through decentralization are examined.

The Independent Variables

The variables of decentralization, perceived environmental uncertainty, and organizational interdependence were identified as important dimensions of context in the study of MAS design.

Decentralization refers to the level of autonomy delegated to managers. Decentralization provides managers with greater responsibility over planning and control activities and greater access to information not available to the corporate body [Waterhouse & Tiessen, 1978]. The importance of decentralization as an element of context in designing MAS is stressed by Lorsch [1970] and Watson [1975], who refer to MAS as supportive mechanisms which should be consistent with the intent of the formal structural arrangements.

Perceived environmental uncertainty has been identified as an important contextual variable because it makes managerial planning and control more difficult [Burns & Stalker, 1961; Lawrence & Lorsch, 1967; Weick, 1969; Duncan, 1972]. Planning becomes problematic in uncertain operating situations because of the unpredictability of future events. Control activities are also likely to be influenced by uncertainty. For example, sub-units which face unpredictable change may find that static budgets are ineffective control devices because the initial standards rapidly become out of date.

Organizational interdependence refers to the exchange of output that takes place between segments within a sub-unit. Thompson [1967] separated situations of no exchanges between segments (pooled) from interdependent situations which involve either sequential or reciprocal exchanges.[2] Organizational interdependence is an important element of context in the design of MAS because of the increased problems of coordinating interdependent compared with pooled situations [Baumler, 1971; Watson, 1975].

Dependent Variables—Information Characteristics

Four dimensions of information were selected because of theoretical links between decentralization, perceived environmental uncertainty, organizational interdependence, and the perceived use-

[2] Sequential interdependence involves the outputs of one segment becoming the inputs of other segments (one segment cannot act prior to receiving input from other segments) and reciprocal exchanges exist where segments exchange their output with each other (a segment provides outputs to other segments and receives inputs from other segments).

FIGURE 2
INFORMATION CHARACTERISTICS

Scope	: External information : Nonfinancial information : Future-oriented (e.g., probabilistic)
Timeliness	: Frequency of reporting : Speed of reporting
Aggregation	: Aggregated by time period : Aggregated by functional area : Analytical or decision models (e.g., marginal analysis, DCF, inventory models)
Integration	: Precise targets for activities and their interrelationship within sub-unit : Reporting on intra-sub-unit interactions

FIGURE 3
SUMMARY OF PROPOSED DIRECT EFFECTS OF CONTEXTUAL VARIABLES ON DEPENDENT VARIABLES

	Perceived Usefulness of Information Characteristics			
Context	*Scope*	*Timeliness*	*Aggregation*	*Integration*
Decentralization	X	N.R.	X	X
Perceived environmental uncertainty	X	X	X	N.R.
Organizational Interdependence	X	N.R.	N.R.	X

N.R. = not relevant to that information characteristic.

fulness of these information dimensions. The dimensions are scope, timeliness, aggregation, and integration. A summary of the information characteristics is provided in Figure 2.

This section first describes the information characteristics and identifies potential direct effects of contextual variables on the perceived usefulness of each information variable. This is followed by an examination of possible indirect effects of perceived environmental uncertainty and organizational interdependence acting through decentralization. A summary of the proposed direct effects of contextual variables on the various information dimensions is presented in Figure 3.

Scope

The scope of an information system refers to the dimensions of focus, quantification, and time horizon [Gorry and Scott Morton, 1971; Larcker, 1981; Gordon and Narayanan, 1984]. A traditional MAS provides information which focuses on events within the organization, is quantified in monetary terms, and relates to historical data. A broad scope MAS provides information related to the exter-

nal environment which may be economic (such as G.N.P., total market sales, and a company's share of that market) or non-economic (such as demographic factors, consumer tastes, competitors' actions, and technological advances). Broad scope MAS would include non-monetary measurement of many of these external environmental characteristics [Gordon and Miller, 1976]. In addition, broad scope MAS would provide estimates of the likelihood of future events occurring, possibly in probabilistic terms [ASOBAT, 1966, p. 55].

It is proposed that all three contextual variables will influence the exent to which managers perceive broad scope information as useful. First, in decentralized sub-units it seems plausible that broad scope information would be useful in servicing the diversity of decisions faced by the decentralized manager and in providing localized environmental information [Horngren, 1982, pp. 9–13; Lander et al., 1983, p. 43]. In an early study, Simon, et al. [1954] referred to the usefulness of broadly based "attention directing" and "problem solving" information to assist decentralized managers in areas such as pricing, marketing, inventory control, and labor negotiations.

Secondly, evaluation of performance in sub-units which have high levels of organizational interdependence is likely to be assisted by broad scope, nonfinancial information. Hayes [1977] found that performance measures of highly interdependent sub-units were most useful if they included measures to assess managers' reliability, cooperation, and flexibility.

Lastly, the difficulties caused by perceived environmental uncertainty to both planning and control may be alleviated by provision of broad scope information. While it cannot be claimed unequivocally that the provision of future-oriented and analytical information (aggregations) improves the outcomes of decision making, there is some evidence that managers who perceive their environments as uncertain find this type of information useful. Gordon and Narayanan [1984] reported the importance of future-oriented information to managers facing uncertainty. It is also likely that broad scope information would aid control in uncertain situations by focusing information on the sources of uncertainty. Both Hayes [1977] and Govindarajan [1984] indicated that traditional financial evaluation measures are ineffective for evaluation of boundary-spanning activities which are particularly susceptible to environmental uncertainty. Hayes found that in research and development, department managers sought evaluative measures which related directly to the environment such as stability, diversity, dealer opinions, market share, and planning ability.

In summary, it may be proposed that MAS which provide broad scope information will be perceived as useful by managers of decentralized sub-units, by those operating sub-units with high levels of organizational interdependence, and by those who perceive their operating situation as uncertain.

Hypothesis 1:

There is a direct relationship between the perceived usefulness of the MAS characteristic of broad scope and the three contextual variables of 1) decentralization, 2) perceived environmental uncertainty, and 3) organizational interdependence.

Timeliness

A manager's ability to respond quickly to events is likely to be influenced by the timeliness of the MAS. Timeliness is usually specified in terms of the provision of

information on request and the frequency of reporting systematically collected information. Timely information enhances the facility of MAS to report upon the most recent events and to provide rapid feedback on decisions.

Of the three contextual variables included in this study, only perceived environmental uncertainty is expected to influence the perceived usefulness of timely information. In uncertain situations, managers are likely to find that they need to respond rapidly to unpredictable change and, as a consequence, they would find timely information particularly useful. Amey [1979] argued that MAS should provide dynamic and exogenous information to enable managers to respond effectively to environmental uncertainty. Moreover, he claims that this type of information is largely ignored in traditional MAS.

Hypothesis 2:

There is a direct relationship between the perceived usefulness of the MAS characteristic of timeliness and the contextual variable of perceived environmental uncertainty.

Aggregation

MAS may provide information in various forms of aggregation ranging from provision of basic raw, unprocessed data to a variety of aggregations around periods of time or areas of interest such as responsibility centers, or functional areas. An additional type of aggregation refers to summation in formats consistent with formal decision models such as discounted cash flow analysis for capital budgeting, simulation and linear programming in budgetary applications, cost-volume-profit analysis, and inventory control models. In the current study, aggregated information is a composite of temporal and functional summation (e.g., sales area, cost center, marketing and production departments), and information produced specifically for formal decision models.

It is proposed that the contextual variables of decentralization and perceived environmental uncertainty will influence the perceived usefulness of aggregated information. The aggregations to be affected by decentralization are those concerned with performance measures. Decentralized managers are likely to prefer to be evaluated on performance measures which are aggregated in ways which reflect their area of responsibility [Gordon, 1963; Pick, 1971; McNally, 1980; Horngren, 1982]. Lower morale and increased conflict have been seen as potential consequences of using conventional accounting evaluation measures that do not reflect the autonomy of, and integration between, sub-unit activities [Ansari, 1979; Shillinglaw, 1972, p. 426].

Many decision models have been designed to assist the management of uncertainty. Management accounting textbooks provide numerous examples of formal models to assist planning and statistical techniques to analyze uncertainty (e.g., Horngren [1982]). Amigoni [1978] asserted that financial simulation models should be provided by an MAS in highly turbulent environments. Pfeffer and Leblebici [1973] found that high levels of environmental competitiveness increased managers' demands for formal decision procedures.

In summary, aggregated information will be perceived as useful by decentralized managers and by managers who perceive their environments as uncertain.

Hypothesis 3:

There is a direct relationship between the perceived usefulness of the MAS characteristic of aggregation and the two contextual variables of 1) decen-

tralization, and 2) perceived environmental uncertainty.

Integration

An important aspect of organizational control is coordination of the various segments within a sub-unit. MAS characteristics which may assist coordination would include the specification of targets which account for the effects of interacting segments and information on the impact that decisions in one area have on operations throughout the sub-unit.

It is proposed that the perceived usefulness of integrated information will be influenced by the contextual variables of decentralization and organizational interdependence. As sub-units become more decentralized, it is likely that the diversity of activities will increase. If this is the case, then presumably integrated information would be helpful in coordinating the increased diversity of operating decisions.

Organizational interdependence tends to affect planning and control with high levels of interdependence, complicating the task of coordination. Therefore, in highly interdependent situations, managers are likely to find MAS which provide integrative information—such as the impact of decisions throughout the sub-unit—to be particularly useful, while in pooled situations, such information is likely to be less relevant [Baumler, 1971; Galbraith, 1973, p. 32]. There is also a possibility of poor morale if evaluation measures do not reflect the integration between sub-unit activities [Ansari, 1979; Shillinglaw, 1972, p. 426].

To summarize, integrative information will be perceived as useful by managers in decentralized sub-units and by managers operating in situations of high organizational interdependence.

Hypothesis 4:

There is a direct relationship between the perceived usefulness of the MAS characteristic of integration and the two contextual variables of 1) decentralization and 2) organizational interdependence.

Indirect Effects

The previous section has considered the direct effects of contextual variables on the perceived usefulness of information. If both perceived environmental uncertainty and organizational interdependence can be linked to decentralization, then indirect effects on the information dimensions of the former contextual variables acting through decentralization may be proposed.

Perceived Environmental Uncertainty —Decentralization

This section proposes that perceived environmental uncertainty induces decentralization, and therefore the effects of the former on information characteristics may be, in part, due to the indirect path through decentralization. The information characteristics which may be influenced by this indirect effect are those which are proposed to be directly related to both perceived environmental uncertainty and decentralization. From consideration of the previous hypotheses, these characteristics are broad scope (hypothesis 1) and aggregation (hypothesis 3).

Several authors have argued that an appropriate structural response for organizations facing uncertainty is to encourage managers to "differentiate" their segments with respect to their sub-unit's environment [Lawrence and Lorsch, 1967; Lorsch and Allen, 1973; Walker and Lorsch, 1968]. These managers will have more decentralized authority to develop their own goals and management styles. Such arrangements are aimed at improving performance by encouraging managers to develop distinctive competences for deal-

ing with uncertainty. Thompson [1967] also stresses the need for "localized" decentralized sub-units as a structural response to unpredictable environments. Similarly, Galbraith [1973] claims that, in uncertain situations, relevant information is required at the time and place of task execution and, further, that decentralized structure facilitates this information processing. From an accounting viewpoint, both Waterhouse and Tiessen [1978] and Gordon and Miller [1976] suggest that decentralization is an appropriate response to dynamic environments and that broad scope, nonfinancial information is required in such settings. Thus, it may follow that managers operating in uncertain situations will have more autonomy over decision making and therefore have demands for information relevant to decentralized sub-units. As a consequence, the association between perceived environmental uncertainty and the information variables may be partly due to the effect of decentralization.

Hypothesis 5:

There is an indirect relationship between the perceived usefulness of the two MAS characteristics of 1) broad scope and 2) aggregation, and perceived environmental uncertainty acting through decentralization.

Organizational Interdependence—Decentralization

Part of the association between organizational interdependence and perceived MAS usefulness may be indirect through the effect of interdependence on decentralization. The information characteristics influenced by this indirect effect are broad scope and integration, both of which have direct effects with decentralization and organizational interdependence (hypotheses 1 and 4).

According to March and Simon [1958] and Thompson [1967], organizations with segments that are highly interdependent seek to minimize coordination costs by grouping the interdependent segments together and by providing a manager with sufficient autonomy to administer the resultant sub-unit. In situations with low levels of interdependence there are fewer integration problems and, as a consequence, less need to provide managers with decentralized authority. Thompson [1967, p. 75] argued that in the absence of strong, continuing interdependence, organizations are likely to centralize decision making for scheduling the work of different independent segments. Galbraith [1973] provides further support, asserting that the costs and difficulties associated with information processing to coordinate interdependence are reduced by containing the interdependence within decentralized sub-units. Several of the Aston studies identified a positive association between high levels of work-flow integration (the degree of automated, interdependent, fixed-sequence operations) and delegated authority [Pugh, et al., 1969; McMillan, et al., 1973]. Thus, organizational interdepenence may induce decentralization and, as a consequence, the association between interdependence and the information characteristics may be due, in part, to the effects of decentralization.

Hypothesis 6:

There is an indirect relationship between the perceived usefulness of the two MAS characteristics of 1) broad scope and 2) integration, and organizational interdependence acting through decentralization.

Research Method

Sixty-eight managers drawn from 36 different manufacturing organizations in the Sydney metropolitan area participated in the study. The unit of analysis

was sub-units within organizations. Managers were at middle to upper levels in their organization's formal hierarchy, and all were actively involved in both revenue-generating and cost-incurring activities for their sub-unit. This broadly based sample assured a wide range of environmental characteristics, production technologies, and levels of managerial autonomy. The organizational sub-units ranged in size from 50 to 220 employees.

Data were gathered by interviews based on structured questionnaires. Of the 68 respondents, 56 percent held qualifications at the post-high-school level, and all had attended some executive training program which included a finance-accounting segment within the previous five years.[3] The average age was 34.2 years, and the average time spent in their current organization was 7.2 years.

The Measurements

The interview questionnaire was developed from existing studies, where possible, to enhance the validity and reliability of measures. However, in the case of information qualities, a set of questions suited to the study was constructed.

Contextual Variables

Decentralization was measured by the abbreviated Aston measures of "Concentration of Authority" [Inkson, et al., 1970]. Concentration of authority is measured using a series of standard decisions and identifies whether managers have decision autonomy. The Cronbach alpha statistic of internal reliability was 0.82 on this measure [Cronbach, 1951].

Perceived environmental uncertainty was measured using an instrument developed by Duncan [1972] and revised by Sathe [1974]. The instrument measures perceived uncertainty by focusing on lack of information on environmental factors, inability to assign probabilities with confidence as to how the environment will affect success or failure, and not knowing the outcome of a decision in terms of how much the organization would lose if the decision were incorrect. The instrument measures the frequency with which 12 items occur in the respondent's job, using a five-point scale ranging from never to always. The internal reliability of the 12-item scale was 0.71 using the Cronbach alpha statistic.

Organizational interdependence was measured using a slightly modified version of the "interdependence of work-flow" instrument developed by Pugh, et al. [1969]. This asked respondents to indicate which one of the three descriptions of intra-sub-unit work-flow integration most nearly applied to their sub-unit. The three descriptions corresponded with pooled, sequential, and reciprocal interdependence discussed earlier. Reciprocal and sequential modes were combined to indicate relatively higher independence than the pooled category.

Dependent Variable

The managers' perceptions of the information characteristics of MAS were measured using a self-scoring instrument which involved rating the extent to which a series of information items would be useful to them in carrying out the overall tasks of their sub-unit. The five-point scale ranged from "not at all useful" to "most useful." A set of questions was developed for each of the four information dimensions from discussions with numerous managers, professional management accountants, and academics during the early stages of the research. After considerable testing on an initial 40 items covering all information dimensions, the questionnaire was reduced to 24 items.

[3] Initial contact was made through executive programs at Sydney-based institutions.

TABLE 1
FACTOR LOADINGS ON INFORMATION CHARACTERISTICS

*Factors***	*Factor Loadings (Rounded)*			
	I	*II*	*III*	*IV*
I. Scope				
External information (4)	.74	.11	−.04	−.06
Noneconomic information (3)	.59	−.09	.08	.13
Future-oriented (1)	.47	−.03	.11	−.07
Nonfinancial-market (5b)	.44	−.13	.16	.04
Probabilistic (2)	.42	.02	.39	.05
Nonfinancial-production (5a)	.40	−.09	.21	.07
II. Timeliness				
Speed of reporting (6)	−.07	.79	.04	.09
Frequency of reporting (8)	.04	.71	.10	.05
Automatic receipt (7)	−.02	.47	.06	−.03
Immediate reporting (9)*	−.12	.32	.15	.02
III. Aggregation				
Separate fixed/variable costs (16)	−.06	.01	.89	−.09
Summary reports-sections (13a)	.09	−.05	.71	.29
Sectional reports (10)	.05	−.03	.62	.36
Temporal reports (11)	.07	.12	.58	−.02
Decision models: incremental (15b)	.14	.06	.53	−.08
"What-if" statements (14)	.17	.02	.49	−.05
Decision models: DCF (15a)	.11	.07	.47	.06
Effect of events on functions (12)*	.13	.09	.36	.31
Summary reports-organization (13b)*	.09	.02	.21	.31
Decision models: inventory (15c)*	.21	−.06	.18	.24
credit policy (15d)*	.17	−.04	.16	.14
IV. Integration				
Precise targets (18)	−.09	.07	.17	.71
Organizational effects (19)	.04	.01	.09	.53
Sub-unit interaction (17)	.11	.03	.31	.44
Percentage of variance	37.82	17.71	15.96	7.31

* Excluded from final scales because factor loadings <.40.
** Numbers in parentheses refer to Appendix A.

These items are presented in Appendix A. Data from this questionnaire were factor analyzed to confirm the theoretical groupings (construct validity) of items as specified in Figure 2 [Kerlinger, 1964]. The initial principal factor matrix was rotated orthogonally (varimax) to reach a final solution. Four factors with eigenvalues greater than one were extracted which accounted for 78.80 percent of the total variance. Table 1 shows the factor loadings after rotation, the percentage of variance explained by each factor, and a descriptive factor title. Measures for each information characteristic were calculated by taking arithmetic averages of scores on those items which loaded greater than 0.40 on the relevant factor. Averages were used to enhance the face validity of the characteristics and to aid interpretation of the scores. Cronbach alpha statistics of 0.76 for broad scope, 0.71 for timeliness, 0.81 for aggregation, and 0.73 for integration indicated satisfactory internal reliability for the information scales.

TABLE 2
DESCRIPTIVE STATISTICS FOR INFORMATION AND CONTEXTUAL VARIABLES

	Mean	*Standard Deviation*	*Range*
Perceived usefulness of MAS information:			
Broad Scope	23.11	7.94	6-30
Timeliness	11.73	2.87	3-15
Aggregation	24.46	8.73	7-35
Integration	10.08	2.15	3-15
Contextual Variables			
Decentralization	13.46	4.31	0-23
Uncertainty	25.32	8.16	12-60
Interdependence	0.68	0.19	0-1

Table 2 presents descriptive statistics for information and contextual variables.

RESULTS

To test the direct effects of contextual variables on perceived usefulness of information (hypotheses 1, 2, 3, and 4), the following four regressions were estimated:

$$X_{4i}=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3 \qquad (1)$$

where

X_1 = decentralization,
X_2 = perceived environmental uncertainty,
X_3 = organizational interdependence, and
X_{4i} = perceived usefulness of broad scope information ($i=1$), timely information ($i=2$), aggregated information ($i=3$), and integrated information ($i=4$).[4]

The results of these regressions are presented in Table 3.

To test the indirect effects on perceived information usefulness of the uncertainty and interdependence variables acting through decentralization (hypotheses 5 and 6), a path analysis was used. The model is presented in Figure 4.

In the path analysis, the relationships between variables were specified by a series of path coefficients (p_{ij}) which are equivalent to the standardized beta coefficients found by first regressing X_4 against X_1, X_2, and X_3, and then X_1 against X_2 and X_3 [Duncan, 1966; Heise, 1969]. The first regression equation was presented above (equation 1) while the second is:

$$X_1=\alpha_1+\alpha_2X_2+\alpha_3X_3. \qquad (2)$$

The results of both regressions including the beta coefficients are presented in Table 3. In Figure 4, R_k denotes the unexplained variance associated with decentralization and perceived usefulness of information characteristics.

The model may be presented in equation form as follows:

$$X_4=p_{41}X_1+p_{42}X_2+p_{43}X_3+p_{4b}R_b,$$
and
$$X_1=p_{12}X_2+p_{13}X_3+p_{1a}R_a$$

The direct and indirect effects of contextual variables are found by combining the path coefficients and the zero-order correlations as in Figure 5.

[4] Correlations between information dimension scores were not significant, thereby ensuring that the four regressions were independent tests.

TABLE 3
RESULTS OF REGRESSIONS

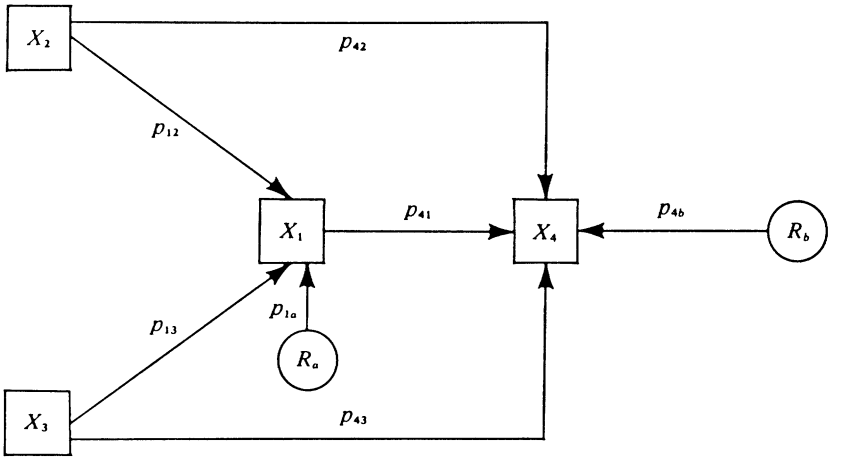
	Coefficient	Value	Standard Error	t	Probability
Equation 1: X_4, against X_1, X_2, X_3					
Hypothesis 1. *Scope*					
Decentralization	β_1	0.04	0.108	0.37	n.s.
Uncertainty	β_2	0.35	0.110	3.17	<.01
Interdependence	β_3	0.33	0.115	2.88	<.01
$R^2=0.27$, $F=7.86$, $p<.01$					
Hypothesis 2. *Timeliness*					
Decentralization	β_1	0.02	0.105	0.19	n.s.
Uncertainty	β_2	0.39	0.118	3.31	<.01
Interdependence	β_3	0.00	0.007	0.41	n.s.
$R^2=0.16$, $F=4.08$, $p<.05$					
Hypothesis 3. *Aggregated*					
Decentralization	β_1	0.37	0.112	3.30	<.01
Uncertainty	β_2	0.03	0.094	0.32	n.s.
Interdependence	β_3	0.32	0.108	2.95	<.01
$R^2=0.33$, $F=10.60$, $p<.01$					
Hypothesis 4. *Integrated*					
Decentralization	β_1	0.27	0.121	2.23	<.05
Uncertainty	β_2	0.04	0.108	0.37	n.s.
Interdependence	β_3	0.36	0.127	2.82	<.01
$R^2=0.25$, $F=7.00$, $p<.01$					
Equation 2: X_1 against X_2 and X_3					
Decentralization					
Uncertainty	α_2	0.24	0.111	2.16	<.05
Interdependence	α_3	0.32	0.113	2.84	<.01
$R^2=0.17$, $F=6.89$, $p<.01$					

Results of Direct Effect Hypotheses 1, 2, 3, and 4

The results of regression equation 1 reported in Table 3 indicate that broad scope information was significantly associated with perceived environmental uncertainty and organizational interdependence, but not with decentralization. These results allow rejection of the implied null hypothesis of no relationship for two of the three proposed associations specified in hypothesis 1. The significant association between timeliness and environmental uncertainty supports rejection of the null for hypothesis 2.

The results related to aggregated information support only part of the proposed effects specified in hypothesis 3. Aggre-

FIGURE 4
PATH ANALYSIS—STRUCTURAL MODEL



gated information was significantly associated with decentralization and organizational interdependence. The association with decentralization was proposed; however, the significant relationship with organizational interdependence was unexpected. The hypothesized association between aggregation and uncertainty was not supported by the regression analysis.

The results of the regression analysis as applied to the integrated information variable allowed rejection of the null of hypothesis 4 that proposed an association between integrated information and both decentralization and organizational interdependence.

Results of Indirect Effect Hypotheses 5 and 6

The results of the path analysis presented in Table 4 provide support for rejection of the null for several of the hypothesized indirect effects. Hypothesis 5 proposed an indirect effect of perceived environmental uncertainty acting through decentralization for the information characteristics of broad scope and aggregation. Section 1 of Table 4 indicates that there were indirect effects for aggregated information, but not for broad scope information.

The observed correlation between the uncertainty variable and aggregated information, $r_{24}=0.16$, decomposed into a 0.03 direct effect, a 0.10 indirect effect through decentralization, and a 0.03 spurious correlation. In considering this result it should be noted that the overall effect of uncertainty on aggregation was not significant (hypothesis 3). The association between broad scope information and perceived environmental uncertainty, $r_{24}=0.39$, was mainly a direct effect of 0.35 with a 0.01 indirect effect and a 0.03 spurious correlation. The absence of an indirect effect can be explained by the insignificant relationship between decentralization and broad scope information.[5] These results allow

[5] While the association between decentralization and broad scope was not statistically significant, it can be seen from Section 3 of Table 4 that the influence of decentralization acting alone was minimal and that the ob-

TABLE 4
DECOMPOSITION OF EFFECTS

Section 1. Hypothesis 5: Decomposition of correlation between perceived environmental uncertainty and information characteristics.

	Observed Correlation r_{24}	*Direct Effect*	*Indirect Effect through Decentralization*	*Spurious**
Scope	0.39	0.35	0.01	0.03
Timeliness	0.40	0.39	0.01	
Aggregation	0.16	0.03	0.10	0.03
Integration	0.14	0.04	0.07	0.03

Section 2. Hypothesis 6: Decomposition of correlation between organizational interdependence and information characteristics.

	Observed Correlation r_{34}	*Direct Effect*	*Indirect Effect through Decentralization*	*Spurious*
Scope	0.37	0.33	0.01	0.03
Timeliness	0.04	0.001	0.007	0.03
Aggregation	0.45	0.32	0.13	
Integration	0.48	0.36	0.09	0.02

Section 3. Additional Analysis: Decomposition of correlation between decentralization and information characteristics.

	Observed Correlation r_{14}	*Direct Effect*	*Indirect Effect through Uncert. & Interdep.*		*Spurious*
Scope	0.26	0.04	0.10	0.11	0.01
Timeliness	0.13	0.02	0.11	0.007	
Aggregation	0.49	0.37	0.01	0.11	
Integration	0.39	0.27	0.01	0.11	

The correlation between perceived environmental uncertainty and decentralization (r_{21}) was 0.27, and between organizational interdependence and decentralization (r_{31}) was 0.34.

* See Asher [1976] for a discussion of spurious effects. It is also noted that path analysis provides evidence on empirical relations found in the data. These do not represent proof of the direction or significance of direct and indirect effects.

non-rejection of the hypothesized indirect relationship between perceived environmental uncertainty and the perceived usefulness of aggregated information. Hypothesis 6 states that organizational interdependence will have an indirect effect through decentralization on broad scope and integrated information. Section 2 of Table 4 provides support for the indirect effect of organizational interdependence for the integration dimension, but not for broad scope. The observed correlation between integrated information and organizational interdependence, $r_{34}=0.48$, decomposed into a 0.36 direct effect and a 0.09 indirect effect through decentralization. For broad

served correlations were due largely to the effects of other contextual variables which related significantly to decentralization. The correlation between decentralization and broad scope information, $r_{14}=0.26$, was due mainly to the influence of perceived uncertainty, 0.10, and technological interdependence, 0.11.

FIGURE 5
DIRECT AND INDIRECT EFFECTS FROM PATH ANALYSIS

Combinations of Variables	*Observed Correlation*		*Decomposition of association*		
			Direct effects		*Indirect effects*
X_2 with X_1	r_{21}	=	p_{12}		
X_3 with X_1	r_{31}	=	p_{13}		
X_2 with X_4	r_{24}	=	p_{42}	+	$p_{41}r_{21}$
X_3 with X_4	r_{34}	=	p_{34}	+	$p_{41}r_{31}$
X_1 with X_4	r_{14}	=	p_{41}	+	$p_{42}r_{21}+p_{43}r_{31}$

scope information, the observed correlation with organizational interdependence of $r_{34}=0.37$ was mainly a direct effect of 0.33, with 0.01 indirect and 0.03 spurious correlation. These results allow non-rejection of hypothesis 6 for the integrated information dimension. It is also apparent from section 2 of Table 4 that there was a strong indirect effect of organizational interdependence acting through decentralization for the aggregated information dimension. The observed correlation between aggregation and organizational interdependence of $r_{34}=0.45$ comprised a 0.32 direct effect and a 0.13 indirect effect through decentralization. This indirect effect, which was not hypothesized, is a consequence of the unexpected finding that there was a significant direct association between aggregated information and organizational interdependence (hypothesis 3).

DISCUSSION OF RESULTS

This study sought to improve our understanding of the characteristics of MAS perceived by managers to be potentially useful to their administrative tasks. Specifically, the goal was to relate a selection of information characteristics to the context of managers' operating situations. The results of the study assist in understanding how contextual variables act singly and in combination.

Research findings provided by Gordon and Miller [1976], Larcker [1981], Gordon and Narayanan [1984], and the current study suggest that it is helpful to consider MAS design in terms of general information characteristics. Schemes which identify dimensions of information, such as the one developed in this research, can sensitize the designers of technical facets of MAS (such as budgetary planning and control systems) to the underlying qualities of information perceived by managers to be useful.

The study indicates that organizational interdependence is important when designing an MAS. Broad scope, aggregated and integrated information were perceived as useful by managers of subunits who had interdependent operations. The results relating the perceived usefulness of broad scope and timely information to perceived environmental uncertainty are consistent with claims that managers facing uncertainty should be provided with information to improve their decision response time and to aid in environmental scanning [Ansoff, 1964; Thompson, 1967; Cannon, 1968; New-

man and Logan, 1971; Khandwalla, 1977]. More specifically, the association between broad scope and perceived environmental uncertainty is similar to the findings of Gordon and Narayanan [1984]. Aggregated information was not, however, associated with perceived uncertainty. This result is surprising, given that aggregated and analytical information is often generated to assist in analyzing uncertainty. Perhaps the items used to measure this variable were not sufficiently focused on the analytical aspects helpful to managing uncertainty. In summary, the findings suggest that attempts by the designers of MAS to improve response time and to assimilate information from many sources into a broad scope MAS are of particular relevance to managers who perceive their operating situation as uncertain.

The study also indicates that aggregated and integrated information is perceived favorably by decentralized managers. This supports the view that responsibility accounting systems should aggregate and integrate information in ways that recognize the complexities and interdependencies found in many decentralized operations [Horngren, 1982; Pick, 1971; Ferrara, 1964]. It is noteworthy that broad scope and timely information were not significantly associated with decentralization. Apparently, centralized managers found that these information characteristics could be applied just as readily to their more limited decision set.

An important result of the study is the relationships between contextual variables. These findings support the view that organizations consider the level of organizational interdependence and environmental uncertainty before decentralizing [Thompson, 1967]. Of particular interest was the effect that organizational interdependence had both directly on the perceived usefulness of broad scope, aggregated, and integrated information, and a strong secondary or indirect effect on aggregated and integrated information through its influence on decentralization. Perceived environmental uncertainty had an indirect effect through decentralization on aggregated information only.

Several limitations of the current study may be noted. While established measurement instruments were used in most of the study, the perceived information questionnaire is novel. While considerable attention was paid to the issue of validity, further work is needed to refine this instrument. The study examined statistical associations at one point in time, and statements about the direction of relationships can only be made in terms of consistency of results with the effects proposed in the theoretical discussion.

In addition to replications of this study with more refined theoretical linkages and measurement instruments, further research should relate information characteristics to particular aspects of MAS such as budgetary planning and control systems, and to different types of managerial work such as pricing, investment, evaluating, investigating, and negotiating. Perhaps, most importantly, the effect of different types of MAS on managers' performance should be investigated. It is hoped that such approaches will enhance our abilities to understand what types of MAS are appropriate in different situations and, as a result, to improve the likelihood that MAS will help managers improve their performance and that of their organizations.

Appendix A*

Scope

1. Information which relates to possible future events (if historical information is most suitable for your needs, mark the lower end of the scale).
2. Quantification of the likelihood of future events occurring (e.g., probability estimates).
3. Noneconomic information, such as customer preferences, employee attitudes, labor relations, attitudes of government and consumer bodies, competitive threats, etc.
4. Information on broad factors external to your organization, such as economic conditions, population growth, technological developments, etc.
5. Nonfinancial information that relates to the following areas:
   (a) production information such as output rates, scrap levels, machine efficiency, employee absenteeism, etc.
   (b) market information such as market size, growth share, etc. (If you find that a financial interpretation of production and marketing information is most useful for your needs, please mark the lower end of the scale.)

Timeliness

6. Requested information to arrive immediately upon request.
7. Information supplied to you automatically upon its receipt into information systems or as soon as processing is completed.
8. Reports are provided frequently on a systematic, regular basis: e.g., daily reports, weekly reports (for less frequent reporting, mark lower end of scale).
9. There is no delay between an event occurring and relevant information being reported to you.

Aggregation

10. Information provided on the different sections or functional areas in your organization, such as marketing and production, or sales, cost, or profit centers.
11. Information on the effect of events on particular time periods (e.g., monthly/quarterly/annual summaries, trends, comparisons, etc.).
12. Information which has been processed to show the influence of events on different functions, such as marketing or production associated with particular activities or tasks.
13. Information on the effect of different sections' activities on summary reports such as profit, cost, revenue reports for:
    (a) your particular sections _____
    (b) the overall organization _____
14. Information in forms which enable you to conduct "what-if" analysis.
15. Information in formats suitable for input into decision models such as:
    (a) discounted cash flow analysis _____
    (b) incremental or marginal analysis _____
    (c) inventory analysis _____
    (d) credit policy analysis _____
16. Costs separated into fixed and variable components.

*Questions were randomized in actual questionnaire.

Integration

17. Information on the impact that your decision will have throughout your department, and the influence of other individuals' decisions on your area of responsibility.
18. Precise targets for the activities of all sections within your department.
19. Information that relates to the impact that your decisions have on the performance of your department.

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