Measuring organizational responsiveness: the development of a validated survey instrument

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Abstract

Purpose – The paper aims to develop the survey utilized in this research as a data collection tool for the study of organizational responsiveness.

Design/methodology/approach – Drawing from the operations and strategic management literature, measurement scales were developed in order to empirically test five proposed enablers of organizational responsiveness: environmental scanning, strategic planning, flexible manufacturing infrastructures, supply chain governance mechanisms, and multi-skilled workers.

Findings – The survey produced a total of 66 responses from 59 companies in three industries: automotive suppliers, instrumentation equipment, and semiconductor components. Three of the five enablers were found to be bi-dimensional, which produced a survey instrument with eight separate measurement scales. Coefficient alpha was observed to be within the acceptable range for all construct scales and factor analysis confirmed unidimensionality for each construct.

Research limitations/implications – The survey instrument presented in this paper provides a better understanding of the processes that enable organizational responsiveness. This measurement scale will serve as a tool that will allow future researchers to more accurately operationalize the enablers of organizational responsiveness.

Practical implications – The ability of firms to quickly respond to changes in their external environment is a primary determinant of firm performance. This research provides important practical implications for firms wishing to maximize their levels of agility and flexibility in responding to changing environmental conditions.

Originality/value – Few measurement scales currently exist that can be utilized to measure and predict rates of organizational responsiveness. The survey instrument developed as part of this research provides important insights into various organizational factors that enable organizational responsiveness.

Keywords Competitive strategy, Strategic planning, Flexible manufacturing systems, Supply chain management, Multiskilling, Employees

Paper type Research paper

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Introduction

Organizational responsiveness is a central issue in determining business success (Webb and Pettigrew, 1999). In particular, the ability of firms to quickly respond to changes in their external environment is a primary determinant of firm performance (Kuratko *et al.*, 2001; Liao *et al.*, 2003). Organizational responsiveness enables companies to quickly detect market changes, reconfigure their processes to meet new market requirements, share information across organizational borders, take maximum advantage of information processing systems, and adopt new product and process technologies ahead of their competition. Thus, it is critical to understand the organizational conditions that contribute to, or support, the ability of firms to quickly and effectively respond to environmental change (Daft *et al.*, 1988). Unfortunately, few empirical studies have been conducted to determine the various enablers of organizational responsiveness (Gunasekaran, 1998). While responsiveness is a critical factor in allowing organizations to develop a competitive advantage, our knowledge regarding the various components of responsiveness is rather limited (Yu, 2001).

Given the amount of uncertainty that may be present in a firm's operating environment, it is not surprising that organizational agility has been found to be a key factor in promoting financial and competitive success (Webb and Pettigrew, 1999). Thus, the scope of this study consisted primarily of organizations operating in highly uncertain environments. As companies compete more vigorously on the dimension of responsiveness, it is important to understand how certain organizational conditions enable firms to develop the ability to respond to change. These conditions have been referred to as "enablers of agility" because their presence in the organization appears to support the ability to thrive in environments that are uncertain and dynamic (Dove, 1995; Goldman, 1994; Goldman and Nagel, 1993). Although classical research confirms the theoretical role that these enablers play (Ramanujam *et al.*, 1986; Van de Ven, 1986; Waller *et al.*, 1995), there is no empirical support for their multivariate relationship with agility. In this paper, we present a validated survey instrument to measure these enablers utilizing a survey performed on companies operating in uncertain and dynamic environments.

The primary purpose of this study was to develop and pre-test a survey instrument designed to measure the presence of five potential enablers of organizational responsiveness: environmental scanning, strategic planning, flexible manufacturing infrastructures, supply chain governance mechanisms, and multi-skilled workers. Environmental scanning alerts firms to impending changes in their external environment (Hambrick, 1982). Strategic planning systems allow firms to cope more effectively with environmental uncertainty (Pearce *et al.*, 1987). Flexible manufacturing systems support a company's ability to respond to changing market demand (Steiner and Solem, 1988). Supply chain governance mechanisms promote flexible relationships between buyers and suppliers by enhancing mutual respect and trust (Hoyt and Huq, 2000). Finally, multi-skilled workers are more capable of making operational decisions, which leads to fewer levels of management and increased levels of strategic flexibility (Goldman and Nagel, 1993). In the following section, we discuss the relationship between several dimensions of the external environment and the need for organizational responsiveness.

Literature review

The external environment can be broadly defined as "the totality of physical and social factors that are taken directly into consideration in the decision-making behavior of individuals in organizations" (Duncan, 1972, p. 314). As environmental uncertainty increases, firms need to be flexible in order to adapt to changing environmental conditions (Burns and Stalker, 1961). Extending earlier conceptualizations of the environment, Dess and Beard (1984) employed three environmental dimensions in conceptualizing environmental uncertainty: dynamism, munificence, and complexity. Combining the concepts of dynamism, munificence, and complexity, one can assume that complex environments with high levels of dynamism and low levels of munificence produce the highest need for agile performance. On the contrary, simple environments with low levels of dynamism and high levels of munificence produce the lowest need for agility. Companies operating in dynamic environments with low munificence and complex internal and external organizational linkages were considered to be the most desirable for validating the survey instrument. We define the environments that satisfy these conditions to be: "hostile-dynamic-complex."

Mechanisms through which manufacturing organizations respond to hostile-dynamic-complex environments have been documented extensively in the literature. This paper develops a survey instrument to measure the presence of five of these potential enablers of organizational responsiveness: environmental scanning, strategic planning, flexible manufacturing infrastructures, supply chain governance mechanisms, and multi-skilled workers. The following discussion illustrates the role that each of these five dimensions plays in contributing to heightened levels of organizational responsiveness.

Environmental scanning

Research shows that scanning tends to be more important in dynamic environments and less important when the environment is stable (Albright, 2004; Elenkov, 1997). For example, Daft *et al.* (1988) concluded that an organization's ability to acquire superior information about the environment was an important factor for competing in a dynamic environment. Kefalas and Schoderbek (1973) showed that managers in dynamic industries (farm machinery) scanned more than managers in a stable industry (meat packing). Functional departments, on the other hand, have been shown to focus their scanning efforts on sectors of the environment that they perceive to be the most relevant to the company's overall strategy (Hambrick, 1982). Hambrick (1982) found that business success was positively correlated with the ability to process and act on the information collected through scanning. Boyd and Fulk (1996) found that strategic importance was the primary determinant of environmental scanning. Researchers have also shown that the scanning process in successful companies tends to be closely aligned with the planning process (Daft *et al.*, 1988; Fahey *et al.*, 1981).

Strategic planning

Planning's relationship to performance has been well documented (Ansoff, 1965; Hopkins and Hopkins, 1997; Miller and Cardinal, 1994). Planning provides a mechanism for organizations to monitor and cope with uncertainty and change (Grant, 2003; Ramanujam *et al.*, 1986). Anderson (2004) found that planning was associated with higher levels of firm performance in dynamic environments. Sinha (1990) described planning as a system involving two linkages. The first link includes inputs that flow from top management to the strategic decision process. The second link also directs inputs from top management to the strategic decision function, but these inputs rely more on interpersonal communication processes. Sinha's model is significant because it identifies the presence of two distinct planning processes in an organization: formal and informal. Failure to discriminate between these functions has been suggested as an underlying cause of contradictory results in planning research (Sinha, 1990).

Flexible manufacturing infrastructures

Manufacturing responsiveness is an important factor in promoting firm performance (Liker and Morgan, 2006; Zhang *et al.*, 2003). Gupta and Buzacott (1989) argued that flexibility is achieved through a combination of physical characteristics, operating policies, and management practices involving the total manufacturing organization and its interface with other functions. This notion suggests that flexible manufacturing infrastructures tend to optimize the relationship between product variety and manufacturing cost, which is an important characteristic of agility (Dove, 1995; Grinyer and Al-Bazzaz, 1986). Carlsson (1991) defines two dimensions of flexibility:

(1) Static flexibility, which includes the ability to deal with predictable changes such as demand changes and interruptions in the production process with an emphasis on costs due to inventory and backup systems.

(2) Dynamic flexibility, which includes the organization's ability to deal with uncertainty created by new products or new competitors.

The first dimension (static flexibility) considers equipment changeover times and inventory management, while the second (dynamic flexibility) focuses on interdepartmental, personal communication processes.

Supply chain governance mechanisms

Supply chain governance mechanisms cover a range of contingencies from "arm's length" single-transaction relationships based on market price to "cooperative" relationships where the suppliers are few in number and the products are specialty items (Ellram, 1992; Fawcett *et al.*, 2006; Negrelli, 2004). The methods through which an organization elects to transact for its manufacturing inputs are a function of uncertainty in the environment, asset specificity, competition in the suppliers market, and the level of trust that exists between parties (Williamson, 1979). Mechanisms for dealing with the risk of transacting across organizational boundaries are explained by Williamson's (1979) transaction cost economics (TCE). TCE recognizes the fact that agreements between organizations will bear the risk of opportunistic behavior unless some form of governance mechanism precludes such actions (John, 1984). Walker and Weber (1984) cite uncertainty and asset specificity as the two most important factors that determine the optimal structure of these relationships. For example, in competitive markets with low asset specificity, the buyer can easily dissolve the relationship if the supplier fails to meet his obligations or the buyer's need for the resource is terminated (John, 1984).

If the relationship involves large initial investments and there are few suppliers in the market, the agreements will tend to be more complex and less flexible. These types of agreements generally involve some form of long-term agreement between the parties, which might inhibit the ability to respond to market changes if the agreement cannot be easily modified (John, 1984). TCE suggests that the existence of formal contracts between the buyer and seller should be negatively correlated with agile performance because once they are drafted they are not easily revised. Informal agreements based on trust, therefore, should be positively correlated with agility because they tend to be more easily revised. Those organizations that have achieved close relationships often employ bi-lateral governance mechanisms (Heide and John, 1990) which, in turn, support efficient exchanges of information vital to agile organizations (John, 1984).

Multi-skilled workers

Multi-skilled workers are able to utilize a variety of job related skills to perform numerous tasks for organizations (Houghton and Portougal, 2005; Hulya Yazici, 2005). They tend to be self-motivated and capable of enacting process changes that promote organizational agility (Goldman and Nagel, 1993; Van de Ven, 1986). These skills are obtained either through selective hiring or training programs provided by the organization. However, they can also be achieved through cross training programs (Garvin, 1993) that develop redundant personnel functions within the organization (Van de Ven, 1986). Lateral rotation of employees within the organization is another method that expands the range of employee skills. Research has shown how informal communication channels encourage the exchange of information (Song and Parry, 1993), which, in turn, leads to an improved workflow across functional boundaries (Havatny and Pucik, 1981). In addition, rotation of personnel creates socialization processes that help personnel in one department to understand the specific practices and responsibilities of another department (Havatny and Pucik, 1981; Song and Parry, 1993).

Survey instrument design

The research findings presented in the preceding literature review suggest that planning, flexible manufacturing infrastructure, and supply chain governance mechanisms are bi-dimensional constructs, while scanning and multi-skilled employees are unidimensional. As a result of these observations, a survey instrument with eight scales was developed. Each scale was developed using a series of bi-polar adjectives separated by a seven point interval referred to as the "semantic differential" (Sproull, 1988). The question set for each scale was developed in accordance with the recommendations of Churchill (1979) and Jolliffe (1986). The individual survey scale items are shown in the Appendix. The dimensional characteristics and the number of facets to be measured for each scale are discussed below.

Environmental scanning

The scanning construct (SCAN) represents the processes through which an organization collects data pertaining to the potential threats and opportunities in its task and general environments. These data include competitive activity, changes in market demand, social activity, and legal activity. The literature suggests that environmental scanning may have as many as three dimensions which describe the degree to which a company scans the environment (Bourgeois, 1980; Daft *et al.*, 1988; Hambrick, 1982; Waller *et al.*, 1995). The first dimension refers to information collected through personal interactions at trade shows, technical conventions, or interactions with other knowledgeable individuals (Daft *et al.*, 1988; Waller *et al.*, 1995). The second dimension includes the collection of information from archival or published data such as marketing reports and government publications (Hambrick, 1982; Jain, 1984; Kefalas and Schoderbek, 1973). The third dimension measures the formal aspects of the scanning process and management's support for intelligence gathering activities (Kefalas and Schoderbek, 1973). In a survey of small companies, these dimensions may be distinctly obvious while in large companies they tend to merge into a single factor if the availability of resources permits the use of all three (Diffenbach, 1983). Companies studied with this instrument produced a single unidimensional scale for this construct.

Strategic planning

The planning construct defines the strategy creating activities of the organization. We identified two dimensions, or facets, for this construct (Grinyer and Al-Bazzaz, 1986; Venkatraman and Ramanujam, 1987). The first dimension portrays interpersonal communication processes that support the informal development and communication of planning information throughout the organization with a focus on short-term objectives (PLANPERS). This dimension represents the personal interactions that support the development of short-term, tactical plans (Shrader *et al.*, 1989). The second dimension refers to the level of formality within the planning process exemplified by documented policies and procedures (PLANFORM). This dimension of planning is more closely associated with long-term strategic planning activities. It represents the formal aspects of the process and includes items such as the existence of a formal planning function, management support for the process, and funding (Grinyer and Al-Bazzaz, 1986; Shrader *et al.*, 1989; Woo, 1984).

Flexible manufacturing infrastructures

Flexibility of the manufacturing infrastructure is defined as the ability to achieve economies of scope (Cox, 1989; Venkatraman and Ramanujam, 1987) and is also a bi-dimensional construct (Carlsson, 1991; Cox, 1989; Dove, 1995; Figenbaum and Karnani, 1991). The first dimension represents dynamic interaction processes such as cooperation and communication between functional departments on issues of design change, manufacturability, and market requirements (FLEXPERS). This dimension measures the existence of personal interaction and communication processes that support effective and efficient exchanges of information between different functional departments (Dove, 1995; Figenbaum and Karnani, 1991; Parthasarthy and Sethi, 1992). The second dimension includes the use of flexible manufacturing technology that supports reduced cycle times and responsiveness (FLEXTECH). This dimension reflects the presence of processes and equipment that reduce cycle and set up times (Grinyer and Al-Bazzaz, 1986).

Supply chain governance mechanisms

This construct includes the policies and procedures, which promote flexible and supportive relationships with suppliers while, at the same time, minimizing the risk of opportunism. For this scale, we were mainly interested in the "relational" processes between the buyer and supplier. In other words, we wanted to measure whether the relationship was "arm's length" or "collaborative" based on trust. This scale was developed with Transaction Cost Theory in mind because "arm's length" relationships are notoriously inflexible while "collaborative" relationships are enablers of flexibility (i.e. agility). Two sub-dimensions of this construct are discussed in the literature (Ellram, 1992; Goldhar and Lei, 1991; Goldman and Nagel, 1993; Walker and Weber, 1984; Williamson, 1979; Youssef, 1992): policies and procedures for dealing with suppliers of commodity-type products and policies where there are few qualified suppliers for specialized products and asset specificity is high. The first dimension (SGCOM) describes the degree of control a company exerts over its suppliers when the product is a commodity and competition in the supplier's market is high. The second dimension of the construct (SGSPEC) describes the degree of cooperation and trust that exists between buyer and supplier companies when the products are specialized, tooling investments are high, and qualified suppliers are few. SGCOM should be associated with a low probability of opportunism while SGSPEC should be more appropriately associated with a higher risk of opportunism.

Multi-skilled workers

This construct represents the organizational processes and policies that support the hiring, training, and retention of a workforce with a variety of skills and knowledge. It also represents the presence of opportunities that permit the employee to apply these skills in the performance of his/her job. The multi-skilled worker scale (MSW) measures employee skill sets and the willingness of management to support the development of these capabilities. As such, it is measured in terms of existing skills, employee selection policies, the existence of training programs, and opportunities within the organization for employees to apply these skills to a variety of tasks (Cox, 1989; Garvin, 1993; Goldman and Nagel, 1993; Van de Ven, 1986). This MSW scale was found to be unidimensional.

Development of the survey instrument

The instrument was pilot tested in a survey that produced 31 usable responses. The questionnaire was distributed to member organizations of the Agile Aerospace Manufacturing Research Center (AAMRC), the Texas Manufacturing Assistance Center (TMAC) groups at the Automation and Robotics Research Institute of UT Arlington, and a sample of companies in the Dallas-Ft Worth Metroplex. Surveys were sent to 70 companies and 39 responses were returned. Of the 39 responses received, 31 were considered usable for validation (eight were excluded because annual sales revenue was less than $4 million). Respondents were top executives in the position of president, senior vice president, or general manager. Company size ranged from $12 million to $50 million annual sales, and all were engaged in some form of manufacturing process.

A statistical test was performed to assess construct validity and reliability. Cronbach's Alpha (Churchill, 1979), which provides a measure of reliability and unidimensionality of the individual scale responses, was tested using factor analysis (Kumar *et al.*, 1993). Additional validations such as content validity (Churchill, 1979) were supported through a rigorous specification of the construct's domain (Sethi and King, 1994) and subsequent evaluation by industry experts and judges. Face validity of the instrument was assessed by distributing the survey to a panel of reviewers, including industry experts and academic personnel through the Automation and Robotics Research Institute (ARRI). These individuals reviewed and reported on the overall layout of the survey in addition to the quality and readability of the questions. Results are summarized in Table I.

Purification of the survey instrument

The pilot test revealed several opportunities to improve the survey scales. These changes were incorporated into a revised instrument, which was then sent out to a second, more homogeneous sample of companies operating in environments that met the criteria of hostile-dynamic-complex. These industries all shared similar environments such as: intense competition for a limited number of customers, strong customer demand for responsiveness and choice, limited resources, and competitive rivalry based on price and quality. Samples were drawn from three different industry groups that exhibited these characteristics:

(1) Automotive parts and accessories (SIC 3465, 3592, 3647, 3691, 3694, 3714).

(2) Instrumentation equipment (SIC 3825, 3823, 3826).

(3) Semiconductor components (SIC 3674).

This choice was supported by the US Department of Commerce publication *US Industry and Trade Outlook 2000* (US Department of Commerce, 2000). It regards these industries to be under intense pressure to reduce prices, increase quality, and improve responsiveness.

Names of the respondents were obtained through financial reports drawn from Moody's Investor Services Reports and Dow Jones Company Reports. The CEO or President was selected as the primary respondent in accordance with the recommendations of Maidique and Zirger (1984), who argue that the CEO is the ideal respondent because they set the strategic orientation of the organization. To improve inter-rater reliability, a second respondent, the VP of Operations, was chosen as the preferred alternative respondent because many of the questions dealt with manufacturing issues. The knowledge base of the respondents was determined by asking how long the respondent had been in his/her current position.

Construct	Alpha	Pilot test results % of var	No. items	ev
PLANFORM	0.760	71.3	3	2.14
PLANPERS	0.913	74.6	5	3.73
SGCOM	0.791	61.7	4	2.47
SGSPEC	0.864	55.6	7	3.89
MSW	0.818	52.5	6	3.15
FLEXPERS	0.738	56.2	4	2.25
FLEXTECH	0.734	79.0	2	1.58
SCAN	0.709	54.0	4	2.16

Table I.
Pilot test results

Tests for non-response bias

Non-response bias was tested with a Chi-squared test of independence. The respondents and the non-respondents were classified into three groups: financially successful, financially unsuccessful, and a midrange group. The midrange group of companies was created to insure that the successful and unsuccessful companies were mutually exclusive. The designation of companies as successful and non-successful was accomplished in a three step process. In the first round of classifications, companies with negative operating margins were immediately classified as non-successful and removed from the sample. In the second classification phase, a composite ranking of companies was developed using gross margin, operating margin, return on assets, sales to assets ratio, and sales to inventory ratio. Companies that consistently appeared in the top quartile of these comparative rankings were removed from the sample and designated as successful. Companies that consistently appeared in the lowest quartiles were removed from the sample and designated as unsuccessful. This action compressed the data set to a more homogeneous group of companies that could be dealt with more effectively by data envelopment analysis (DEA).

The third method, DEA, was the most quantitative of the three classification techniques. It ranked companies on the basis of their relative efficiencies when compared to other companies in the same industry group sample. The results of the DEA analysis suggested the following groupings:

(1) *Automotive suppliers*:
- successful (15 companies);
- midrange (three companies); and
- unsuccessful (20 companies).

(2) *Instrumentation*:
- successful (21 companies);
- midrange (five companies); and
- unsuccessful (28 companies).

(3) *Semiconductor*:
- successful (19 companies);
- midrange (five companies); and
- unsuccessful (20 companies).

Inputs to the DEA model were cost of goods sold (CGS), general selling and administrative expenses plus research and development (G + R), and inventory (INV). DEA model outputs were sales (SLS), gross margin (GM), and operating margin (OM). Each variable was normalized by dividing the observed value for each company by the average for the industry group. Assets were deleted as an input because of the negative correlations discussed above. Operating margin was assumed to be the most important output because it provides the best overall measure of a company's financial performance. Gross margin was assumed to be the second most important indicator of performance because it provides a proxy measure of manufacturing and supply chain efficiencies. Each industry group was classified in a separate DEA analysis to eliminate any effects of aggregation in the data.

In the Chi-squared test of independence, if the computed Chi-square test statistic is higher than the Chi-square critical statistic, the respondents and non-respondents are assumed to be from the same population and the results of the survey can be extended to the non-respondent group of companies. Chi-squared test results confirmed that non-response bias was not a significant factor in the data collection. See Table II for results of the Chi-square test.

Threats to construct validity

Other threats to the validity of the survey were addressed as follows:

- *Mono operation bias*. This occurs when a single item scale is used to measure a particular construct. In this survey instrument all scales are multi-item (Cook and Campbell, 1976). SGCOM is a three-item scale while all other constructs have at least four items.
- *Hypothesis guessing*. This motivates the respondent to second-guess the purpose of the survey causing the mean response to shift away from the theoretical mean (Cook and Campbell, 1976; McGrath *et al.*, 1982). This problem was addressed by first sending a formal invitation to each respondent asking them to participate in the study and at the same time explaining the objectives of the study. A pre-survey phone call was then made to each of the respondents to further explain the purpose of the survey. Finally, a cover letter was sent with each survey restating the objectives of the study.
- *Inadequate pre-operational analysis*. This contributes to a general inability to understand the construct sufficiently (Babbie, 1989; Churchill, 1979). Each construct was thoroughly researched to identify its relationship with organizational performance for hostile-dynamic-complex environments.

Inspection of the data

A total of 139 surveys were sent out in the first mailing and 98 were sent out in a second wave to the non-respondents. The combined mailings produced a total of 66 responses from 59 companies. The automotive supplier group (100-series companies) returned 19, the instrumentation equipment group (200-series companies) returned 20, and the semiconductor component group (300-series companies) returned 20 replies. Three companies declined to participate and a fourth survey was returned as non-deliverable. Three responses were deleted because of missing data (no. 152, no. 317 and no. 318), a fourth response was deleted because of company size (no. 165), and a fifth was deleted because it was no longer involved in manufacturing (no. 338). Allowing for these adjustments, approximately 47 percent of the companies that were contacted responded to the survey. Companies in the sample ranged in size from $5 million in sales to $663 million in sales and the average size of all the companies was

Table II.
Chi-square test of independence results

	Responses	Non-responses	Totals
Successful	19	31	50
Mid-range	4	10	14
Non-successful	35	31	66
Totals	58	72	130

$110 million in sales. The primary respondent was the company president or other senior executive. Figure 1 displays a graphic presentation of the total revenues for the sample companies.

All scales demonstrated acceptable reliability for an instrument at this stage of development. Coefficient alpha was observed to be within the acceptable range for all construct scales (Churchill, 1979) and factor analysis confirmed unidimensionality for each construct. Favorable reliability plus unidimensionality supported the internal consistency and construct validity of the eight constructs selected in this study (Churchill, 1979; Sethi and King, 1994). A summary of the final survey results is presented in Table III.

Deriving enabler scores from the survey data

The individual item scores for each construct scale were converted into a single composite score through the use of factor analysis. This is accomplished by deriving a factor score coefficient matrix for each dimension of the construct defined as:

$$B = R^{-1}A$$

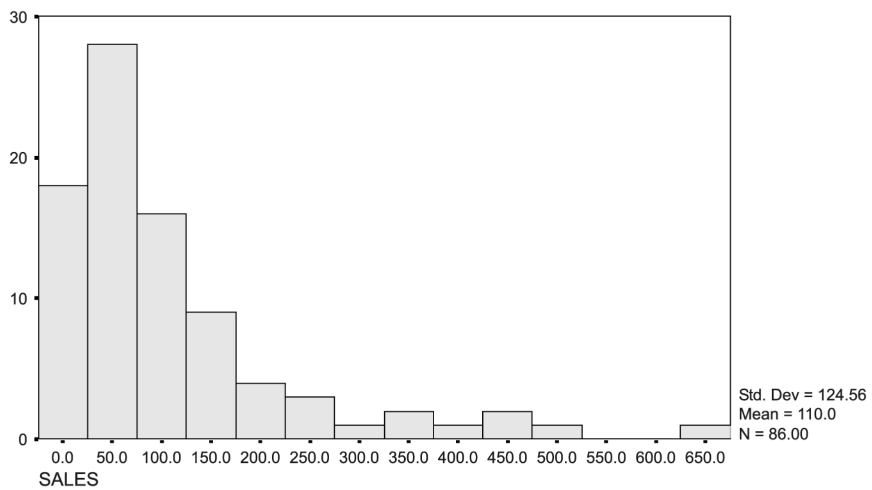

Figure 1. Sample company characteristics (sales = millions)

Construct	Alpha	% of var	No. items	ev
PLANFORM	0.756	59.6	4	2.14
PLANPERS	0.817	58.4	5	3.73
SGCOM	0.759	67.5	3	2.21
SGSPEC	0.752	58.2	4	2.44
MSW	0.771	48.4	6	3.18
FLEXPERS	0.712	54.2	4	2.17
FLEXTECH	0.656	50.3	4	2.01
SCAN	0.701	53	4	2.12

Table III. Final survey results

where R^{-1} is the inverse of the correlation matrix, A is the matrix of correlations between the factors and the variables (factor loading matrices) and B is a matrix of factor score coefficients. To calculate an enabler's score (F) for a particular observation, the standardized scores of the scale items (Z) are multiplied by the factor score matrix coefficients (B) as defined by:

$$F = ZB.$$

For each observation, there will be a set of F scores that corresponds to each enabler. F is an $(n) \times (m)$ matrix where $n =$ the number of observations and $m =$ the number of factors (Tabachnick and Fidell, 1989). In this study, where there are single factors for each construct (i.e. unidimensionality), F will be an $(n) \times (1)$ matrix with each row representing each organization's score for that dimension of the construct. These scores are useful as predictor variables in a discriminant, regression, ANOVA, or logistic regression analysis to test their significance in the model.

The primary predictor variables

Factor score coefficient matrices were calculated from survey data. Table IV presents a summary of these results.

A set of standardized scores for each construct was calculated using factor analysis. Standardized scores have the advantage of a common interval scale that accounts for variability in the observations (Tabachnick and Fidell, 1989); however, interpretation is more difficult. A listing of the standardized scores for each enabler is presented in Table V.

Discussion

As the level of uncertainty and dynamism in the environment increases, the need for organizations to be more agile will also increase. Yet little is known regarding the empirical relationships between various enablers of agility and organizational responsiveness. The survey instrument developed in this study provides one means to achieve a better understanding of these relationships. The instrument measured the presence of eight enablers of agility:

(1) scanning;
(2) formal planning;
(3) informal planning;
(4) dynamic manufacturing flexibility;
(5) static manufacturing flexibility;
(6) supply chain relationships for commodity products;
(7) supply chain relationships for specialty products; and
(8) multi-skilled employees.

The survey was developed in accordance with published recommendations on the subject in an effort to achieve a reliable and valid instrument. It was pilot tested, purified and then retested in a final survey. Reliability of the final instrument scales ranged from 0.656 (FLEXTECH) to 0.817 (PLANPERS) and all eight scales were unidimensional. These results support the construct validity of all the enablers. The

	Item	Score
SCAN	sc2	0.38151
	sc3	0.35575
	sc5	0.34352
	sc6	0.28504
PLANFORM	pl1	0.31741
	pl2	0.29951
	pl3	0.35388
	pl4	0.32231
PLANPERS	pl5	0.23326
	pl6	0.28329
	pl7	0.2535
	pl8	0.26226
	pl9	0.27310
MSW	ms1	0.18440
	ms2	0.25226
	ms3	0.26796
	ms4	0.28759
	ms5	0.23868
	ms8	0.18784
SGCOM	sg1	0.40330
	sg2	0.42043
	sg3	0.39318
SGSPEC	sg6	0.33348
	sg7	0.35824
	sg8	0.33442
	sg9	0.28019
FLEXTECH	fm2	0.33642
	fm4	0.40485
	fm6	0.30441
	fm9	0.35617
FLEXPERS	fm1	0.38357
	fm7	0.31412
	fm8	0.34898
	fm10	0.30674

Table IV. Enabler factor score coefficients

data were tested for non-response bias and the non-respondents were determined to be no different from the respondents. Each scale item of the survey was researched prior to construction in an effort to minimize threats to validity from mono operational bias, hypothesis guessing, and inadequate pre-operational analysis.

When used in combination with other methods such as interview and archival data, this survey instrument provides an opportunity to triangulate measurements taken from a sample of organizations. Although the instrument provides a useful set of measurements, the authors recognize the potential for further refinements to the instrument. For example, additional scales (such as information processing, supply chain communication systems, and enterprise resource planning systems) would be beneficial for measuring the presence of other potential enablers within the organization.

There were several limitations of this study. First, the analyses cited in the study were performed utilizing cross-sectional data. The use of longitudinal studies where

Company	SCAN	FLEXPERS	FLEXTECH	PLANFORM	PLANPERS	MSW	SG COM	SG SPEC
121	1.335	−1.165	−0.653	−2.309	−1.529	−0.970	−0.585	1.102
127	−0.526	−2.147	−2.272	−0.571	−1.306	−1.490	−0.398	−2.704
130	0.736	0.867	−0.290	0.901	0.558	0.330	0.091	0.075
132	−0.597	−1.047	0.124	−0.238	0.005	0.160	1.406	−0.148
133	1.830	1.363	1.358	1.800	1.219	0.910	1.771	1.088
142	−0.197	0.716	−0.340	0.708	0.666	−0.060	−0.469	0.062
143	−0.395	0.048	0.524	0.486	1.078	0.590	−1.171	1.088
144	−1.875	−0.736	−1.205	0.706	−0.802	−1.790	0.226	−0.671
146	−0.082	1.083	0.451	0.152	−0.058	1.460	0.406	1.353
147.1	−0.698	−1.092	−1.352	1.938	0.798	−1.480	−1.307	0.334
148	−0.615	0.158	0.196	0.546	−0.138	−0.520	0.164	0.837
150.1	0.616	0.867	0.080	1.108	1.243	1.090	−0.422	0.850
151	0.616	−0.284	−0.590	0.522	0.239	0.710	−0.958	−0.400
161	−0.201	1.577	1.021	−1.098	−2.350	0.080	−1.683	0.641
162.1	0.799	−0.844	−0.489	−0.712	−1.452	0.730	−0.786	−0.421
163	−1.126	0.651	−1.043	−0.125	0.263	−0.500	−0.108	0.090
166	−2.133	0.361	−0.702	0.018	−1.288	0.470	−0.608	−0.134
167	0.799	−0.890	−0.561	1.073	1.219	0.130	−1.334	1.102
201	−1.938	−0.503	−0.112	−1.294	−0.125	1.010	−0.425	0.857
207	−0.334	0.361	−0.069	−1.023	−0.671	0.050	−0.232	−1.678
216	1.331	0.630	2.022	0.519	1.197	1.160	2.122	1.102
217	0.205	−0.424	−0.141	1.356	0.284	0.160	−0.205	−0.896
218	1.081	0.222	−1.876	1.292	0.746	−0.890	0.150	0.341
227	0.464	−2.472	0.690	−1.471	−0.390	0.160	−1.180	1.611
228	0.416	−1.717	−0.682	−2.056	−2.289	−1.890	−1.683	−0.665
234	0.370	1.083	1.194	1.075	0.913	1.590	−0.469	0.348
235	0.758	−1.263	0.515	−0.966	−0.196	0.210	1.606	0.138
240	2.013	0.934	0.751	0.153	1.396	1.590	1.266	0.885
242	−0.604	1.146	0.837	0.569	0.271	−0.270	1.030	−1.426
245	−0.013	−0.575	0.451	−0.746	−0.019	0.670	−1.147	−0.909
247	−0.397	−1.058	−0.613	−1.608	−0.279	0.700	0.639	−0.127
255	−0.542	0.287	−0.576	−0.717	−1.773	−0.840	−0.220	−1.943
257	0.039	0.009	1.049	0.349	1.043	1.160	−0.771	−0.685
258	−1.338	−1.145	−0.705	−0.183	−1.736	−0.690	0.730	1.102
259	−1.921	0.715	0.060	1.073	0.595	0.740	0.500	−2.201
262	0.764	−0.284	−0.969	−0.125	0.698	0.250	0.678	0.341
265	0.683	0.931	1.352	0.014	1.197	2.260	−0.309	0.341
302	1.647	1.148	1.715	1.465	1.396	0.230	0.461	0.592
306	−1.051	0.641	0.601	−1.330	0.558	−0.240	1.592	0.864
307	0.588	−1.255	−0.748	−0.435	−1.284	−2.580	1.945	−1.147
309	0.239	0.641	1.122	1.294	1.019	0.900	−0.771	0.837
314	0.187	−0.994	−0.340	0.373	−0.437	−0.030	−0.022	1.102
322	0.239	−1.156	−0.107	0.625	0.146	−1.710	−0.282	−1.433
329	1.447	−0.408	2.022	−1.721	−0.612	−0.090	1.832	−0.896
330	−1.921	1.148	−0.358	−0.238	0.535	−0.200	1.769	0.358
334	0.039	−1.156	−2.074	−1.217	−0.622	−0.160	0.493	0.341
335	−0.322	1.298	1.801	0.233	1.089	1.030	−1.506	−1.440
336	0.897	1.148	−0.176	0.078	0.701	−0.350	−0.795	1.353
337	0.335	−0.287	−0.374	−0.763	−1.111	−0.950	−0.445	−0.421
341	−0.467	0.641	0.472	−0.379	−0.817	−1.610	−0.807	−0.896
340	−1.697	0.867	1.265	0.765	1.197	0.470	−0.414	0.585
342	0.634	0.440	−1.241	−0.707	−0.077	−1.080	−0.576	0.334
343	0.239	0.134	−0.233	0.741	0.393	−0.290	0.531	−0.658
347	−0.373	1.362	−0.783	0.103	0.098	−0.320	0.680	−0.155

Table V.
Calculated scores for the enablers

the data were collected in the survey and compared to performance two to five years into the future would be useful. Second, there are issues that affect the validity of the survey instrument. For example, the measurement scale was developed with sampling data taken from companies in dynamic environments. It would be interesting to also survey companies in stable environments to see if the same results are achieved. This represents a logical extension of the study and would help increase the generalizability of the overall results. There may also be additional scales that could be added or additional items could be added to the individual scales.

Three avenues of research are possible from this point. First, additional survey scales could be added to enhance the overall usefulness of the instrument. Second, additional items could be added to the individual scales which would further increase their reliability. Finally, the survey should be tested on companies in other industries and possibly with an even larger sample. Each of these options would further enhance the performance characteristics of the survey instrument and add to its value for research into organizational responsiveness. A combination of survey data and archival data provides an opportunity to conduct empirical studies of those conditions that are alleged to support organizational responsiveness. For example, the statistical significance of each enabler was tested using logistic regression to determine its relationship with financial performance and it produced some statistically significant results. The study revealed a bipolar relationship between the two planning constructs and the two flexible manufacturing infrastructure constructs. In each case, the constructs (PLANFORM-PLANPERS and FLEXTECH-FLEXPERS) were found to be significant ($\alpha \leq 0.05$). However, the coefficients of each pair were opposite in sign and approximately equal in magnitude. The supply chain governance construct pair was not significant at $\alpha \leq 0.05$, but there were indications of possible significance at a higher value of alpha. Neither SCAN nor MSW were found to be significant.

Failure of the last four constructs to demonstrate statistical significance is a testimony to the complexity of the research into agile organizations. While we would expect scanning to be a significant predictor, its failure to be correlated with organizational success suggests that other measurements may be needed to fully operationalize the scanning construct (SCAN). Likewise, the failure of the multi-skilled workers (MSW) construct to show significance is equally puzzling (Hoyt and Matuszek, 2001). This survey instrument is a first step toward a better understanding of the very complex nature of organizations that prosper in hostile-dynamic-complex environments.

Conclusion

Responsiveness is one of the most important characteristics necessary for today's companies to possess. Therefore, it is imperative that researchers develop the means to accurately determine if companies have established systems and organizational structures that enable this responsiveness. While Gunasekaran (1998) developed a theoretical framework for conceptualizing the enablers of agility, few studies have empirically tested the various factors that enable organizations to develop high levels of responsiveness. Needless to say, a better understanding of these organizations and the presence/absence of these enablers has considerable implications for the study of management. For example, a survey instrument that measures the probability that a company is truly responsive could have an immediate influence on supplier selection, distribution channel decisions, TQM programs, and even investment decisions. The survey instrument presented in this paper is one attempt to explore these research questions more closely and to provide a better understanding of the processes that enable organizational responsiveness.

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Appendix. Development of the survey instrument

The survey instrument measures each dimension of the constructs developed in this study. All of the items are reported on a seven-point semantic differential scale in accordance with the recommendations suggested by Sproull (1988). Question items for each construct are presented below.

Scanning

Organizations that actively scan their environment can be expected to perform or engage in the following activities:

(1) Attend trade shows to meet with customers and gain knowledge of new product requirements and customer needs.

   (sc2) We attend trade shows because they are a source of information on new product technology.

(2) Participate in industry trade shows to learn about new technology.

   (sc3) We attend trade shows to learn of new customer requirements.

(3) Study government publications to monitor government regulations.

   (sc5) We monitor government publications on trade and regulations.

(4) Collect data on economic trends and changes in the financial markets to deal effectively with potential threats and opportunities.

   (sc6) We monitor technology and economic reports closely.

Planning

Companies that support effective planning processes should exhibit the following characteristics:

(1) A documented, formal set of planning policies and procedures.

(pl1) Our firm's actions are based more on formal plans than on intuition (PLANFORM).

(2) They have an established and dedicated planning function with adequate resources.

(pl2) We have a manager or department specifically dedicated to planning (PLANFORM).

(pl3) Our planning operation is adequately funded (PLANFORM).

(3) Manufacturing operations should participate directly in the process of developing tactical and operational plans for the organization.

(pl4) Manufacturing operations is an important contributor to the planning process (PLANFORM).

(4) All levels of management should be aware of the organizational plans.

(pl5) We have specific, short-term goals that are known to all managers (PLANPERS).

(pl6) We have broad, medium range goals that are known to all managers (PLANPERS).

(5) Development and modification of the plans should be conducted in a professional manner.

(pl7) We hold regular planning meetings to review and revise our goals and objectives (PLANPERS).

(6) There should be no resistance within the management hierarchy to the planning function.

(pl8) Management is a strong supporter of the planning function in our company (PLANPERS).

(7) There should be a written plan for short-term strategies.

(pl9) We have a written plan for the next 12 months (PLANPERS).

Flexible manufacturing infrastructure

Responsiveness of the manufacturing infrastructure can be measured with the following items:

(1) A marketing information system that provides production planning with real-time updates on changes in product design and volume changes.

(fm1) Changes in product demand are communicated quickly to operations (FLEXPERS).

(2) An ability to respond to dynamic changes in the market along the "time" dimension with reliance on computerized manufacturing equipment such as NC, CNC and robots.

(fm2) Our production setup times are lower than the industry average (FLEXTECH).

(3) Low cost product changeovers are important for flexible manufacturing operations.

(fm4) Our manufacturing equipment is easily reconfigured to run new products and subassemblies (FLEXTECH).

(4) Computer technology is essential for rapid processing of manufacturing instructions and plans.

(fm6) Our production process relies heavily on computer technology (FLEXTECH).

(5) Product design and manufacturing engineering must interact closely to facilitate design and tooling changes and to create test specifications.

(fm7) Our design engineers and manufacturing engineers collaborate to exchange information (FLEXPERS).

(6) The master production plan, inventory system, and scheduling systems must constitute an interactive process working from a common data base.

(fm8) Design changes are implemented quickly and with minimal conflict between departments (FLEXPERS).

(7) An ability to respond efficiently and effectively to changes in output demand.

(fm9) Our production is proficient at responding to changes in output demand (FLEXTECH).

(8) The organization structure should promote the efficient and effective exchange of information between functional departments.

(fm10) Marketing personnel never meet with manufacturing personnel to exchange information (FLEXPERS).

Supply chain governance mechanisms

For those situations where the product is a commodity and there is high competition in the supplier's market we measure supply chain conditions with the following items:

(1) Delivery capability and low price are the determining factor.

(sg1) These suppliers are chosen mainly on the basis of price (SGCOM).

(sg2) Our purchase agreements with these suppliers are normally a standard purchase order (SGCOM).

(2) Purchase agreements tend to be enacted on a non-exclusive basis.

(sg3) We normally purchase these products from several suppliers (SGCOM).

When initial tooling investments are high and there are few qualified suppliers for a specialty type product we measure conditions in the supply chain with the following items:

(3) There will be significant levels of joint action between buyer and seller.

(sg6) We work closely with these suppliers to develop prototypes and test subassemblies (SGSPEC).

(sg7) We work closely with these suppliers to develop long range plans and market forecasts (SGSPEC).

(sg8) We share technical information with these suppliers (SGSPEC).

(4) There will be a high level of trust and cooperation between the buyer and supplier.

(sg9) We monitor the performance of these suppliers very closely (SGSPEC).

Multi-skilled workers
We measure a company's attitude toward and policies that support a workforce with multiple skills with the following items:

(1) Training programs add to the employee's portfolio of job skills.

(ms1) We have an intensive employee training program.

(2) Employees should have the opportunity to apply their skills to a wide range of tasks.

(ms2) Our employees use a broad range of skills in the performance of their job.

(3) Job rotation and lateral transfers should expand an employee's overall knowledge of the job and its peripheral responsibilities.

(ms3) Our employees are regularly rotated to different jobs.

(4) Redundant functions create backup capabilities that improve the company's ability to respond to demand changes. Likewise these qualities should also exist in employees with cross functional skills.

(ms4) Our workers have redundant skills that can be applied to other tasks when needed.

(ms5) Our workers have a good understanding of how their own job relates to the overall manufacturing operation.

(5) Flexible manufacturing involves a program of upskilling workers to expand their responsibilities to problem solving rather than relying on them for simple physical work.

(ms8) We offer incentives to encourage our employees to upgrade their skills and training.

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