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EXPLORING THE RELATIONSHIP BETWEEN EXTERNAL ENVIRONMENT, INTERNAL ENVIRONMENT, AND MANUFACTURING PRACTICES: AN INDUSTRIAL / POST-INDUSTRIAL PERSPECTIVE

by

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Submitted as partial fulfillment of the requirements for

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Manufacturing Management

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An Abstract of

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The purpose of this research is to explore the relationship among the firms' (1) external environment, (2) internal environment (managerial beliefs and attitudes and organizational structure), and (3) manufacturing practices. The research intends to identify the critical aspects of external environment, managerial beliefs and attitudes, and organizational structure, and develop valid and reliable instruments that measure these critical aspects in terms that are more manufacturing specific. Ultimately the research attempts to demonstrate that firms operating in a post-industrial environment have different managerial beliefs and attitudes,

organizational structure, and manufacturing practices than firms operating in an industrial environment. Firms operating in a post-industrial external environment would exhibit a higher level of integrity based managerial beliefs and attitudes, organic organizational structure, and time-based manufacturing practices, than firms operating in an industrial external environment. Integrity based managerial beliefs and attitudes, organic organizational structure, and time-based manufacturing practices would also have positive relationships among themselves.

Through the literature review, 16 sub-constructs for external environment, managerial beliefs and attitudes, and organizational structure were identified. Potential measurement items were generated through a literature review and from construct definitions. The measurement items developed for these 16 sub-constructs were tested through structured interviews with five practitioners, two Q-sorting rounds, pre-testing by eight reviewers, and through pilot-study with 40 responses. Final testing of the instruments was performed through responses from 224 manufacturing firms. Time-based manufacturing practices measurement items were adopted from Koufteros et al. (1998). Structural equation modeling (LISREL) methodology and analysis of variance (ANOVA) were used for the preliminary testing of relationships among constructs. Research findings support the notion that manager's perception on external environment would affect their managerial beliefs and attitudes and organizational structure. It also supports the relationship between managerial beliefs and attitudes and organizational structure, and

between organizational structure and manufacturing practices. It did not support, however, the relationship between external environment and manufacturing practices, or between managerial beliefs and attitudes and manufacturing practices. The nature of these two relationships appears to be indirect rather than direct, being mediated through organizational structure. Recommendations for future research and implications for managers are provided.

DEDICATION

I dedicate this dissertation to

God my Father,

Jesus Christ my Lord and Savior,

and Holy Spirit my Counselor and Guide.

To Him who is One and Only

be glory and honor forever. Amen.

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TABLE OF CONTENTS

ABSTRACT ---------- iii

DEDICATION ---------- vi

ACKNOWLEDGEMENTS ---------- vii

TABLE OF CONTENTS ---------- ix

LIST OF TABLES ---------- xiii

LIST OF FIGURES ---------- xv

LIST OF APPENDICES ---------- xvi

CHAPTER 1. INTRODUCTION ---------- 1

CHAPTER 2. THEORY DEVELOPMENT ---------- 7

2.1. External Environment ---------- 11

2.1.1. External Environment in Organizational Literature ---------- 11
2.1.2. External Environment in Post-Industrial Manufacturing Literature ---------- 15
2.1.3. Identification of Sub-Constructs for External Environment -- 16
2.1.3.1. Level of Market Heterogeneity ---------- 16
2.1.3.2. Degree of Market Segmentation ---------- 18
2.1.3.3. Length of Product Life Cycle ---------- 19
2.1.3.4. Driving Force for Manufacturing Technology ---------- 19
2.1.3.5. Number of Customer Requirements ---------- 20

2.2. Managerial Beliefs and Attitudes ---------- 21

2.2.1. Organizational Culture in Organizational Literature ---------- 21
2.2.2. Infrastructure / Social Systems in Manufacturing Literature - 25
2.2.3. Identification of Sub-Constructs for Managerial Beliefs and Attitudes ---------- 27
2.2.3.1. Goals for Investing in Facilities and Equipment ---------- 30
2.2.3.2. Organization of Work ---------- 32
2.2.3.3. Scope in Decision Making ---------- 33
2.2.3.4. Management Mechanism ---------- 34
2.2.3.5. Focus of Managerial Tasks ---------- 36
2.2.3.6. Focus of Supplier Relationships Management ---------- 36

2.3. Organizational Structure ---------------------------------- 37

2.3.1. Organizational Structure in Organizational Literature ------ 37
2.3.2. Organizational Structure in Manufacturing Literature ------ 40
2.3.3. Identification of Sub-Constructs for Organizational Literature -- 42
2.3.3.1. Locus of Decision Making -------------------- 42
2.3.3.2. Degree of Discretion in Rules and Regulations ------ 44
2.3.3.3. Number of Layers in Hierarchy ------------------ 44
2.3.3.4. Level of Horizontal Integration ------------------ 45
2.3.3.5. Level of Communication ---------------------- 45

2.4. Manufacturing Practices --------------------------------- 46

2.4.1. Shop Floor Employee Involvement in Problem Solving- ---- 47
2.4.2. Re-engineering Setups ----------------------------- 47
2.4.3. Cellular Manufacturing ----------------------------- 47
2.4.4. Quality Improvement Efforts ------------------------ 49
2.4.5. Preventive Maintenance ---------------------------- 49
2.4.6. Dependable Suppliers ----------------------------- 49
2.4.7. Pull Production ---------------------------------- 50

2.5. Theoretical Model and Hypotheses ---------------------- 50

2.5.1. External Environment and Managerial Beliefs and Attitudes ------------------------------------- 50
2.5.2. External Environment and Organizational Structure ------- 51
2.5.3. External Environment and Manufacturing Practices ------- 53
2.5.4. Managerial Beliefs and Attitudes and Manufacturing Practices ------------------------------------- 54
2.5.5. Organizational Structure and Manufacturing Practices ----- 55
2.5.6. Managerial Beliefs and Attitudes and Organizational Structure ------------------------------------- 56

CHAPTER 3: INSTRUMENT DEVELOPMENT PHASE I: ITEM GENERATION AND PILOT STUDY ---------------- 58

3.1. Item Generation --------------------------------------- 59

3.1.1. Item Generation for External Environment ------------- 59
3.1.2. Item Generation for Managerial Beliefs and Attitudes ----- 61
3.1.3. Item Generation for Organizational Structure ----------- 62
3.1.4. Item Generation for Manufacturing Practices ----------- 63

3.2. Structured Interviews ----------------------------------- 63

3.3. The Q-Sort Method -- 65

3.3.1. Sorting Procedures ---------------------------------- 66
3.3.2. Inter-Rater Reliability ------------------------------- 66
3.3.3. Results of First Sorting Round ----------------------- 67
3.3.4. Results of Second Sorting Round --------------------- 71

3.4. Pre-Testing of Questionnaire --------------------------- 75

3.5. Pilot Study --- 77

3.5.1. Methods for Pilot Study ----------------------------- 78

3.5.2. Results for Pilot Study ------------------------------ 79

3.5.2.1. External Environment Instrument- ---------------- 80
3.5.2.2. Managerial Beliefs and Attitudes Instrument- -------- 86
3.5.2.3. Organizational Structure Instrument- -------------- 93
3.5.2.4. Manufacturing Practices Instrument- -------------- 99

CHAPTER 4: INSTRUMENT DEVELOPMENT PHASE II: EXPLORATORY DATA ANALYSIS ---------------- 102

4.1. Research Methods -- 105

4.2. Large Scale Measurement Results- ----------------------- 108

4.2.1. External Environment Instrument- --------------------- 108
4.2.2. Managerial Beliefs and Attitudes Instrument- ------------ 114
4.2.3. Organizational Structure Instrument- ------------------ 122
4.2.4. Manufacturing Practices Instrument- ------------------ 125

4.3. Summary of Measurement Analysis- ---------------------- 129

CHAPTER 5: CAUSAL MODEL AND HYPOTHESES TESTING- ---- 134

5.1. The Causal Model- --------------------------------------- 134

5.2. Results of Testing the Causal Model- ------------------- 135

5.3. Results of Analysis of Variance (ANOVA)- ----------------- 141

CHAPTER 6: SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH - - - - - - - - - - - - - - - - - - 146

6.1. Summary - - - - - - - - - - - - - - - - - - 146

6.2. Recommendations for Future Research - - - - - - - - - - 150

6.2.1. Recommendations and Discussion of Measurement Issues- 150
6.2.2. Recommendations and Discussion of Structural Issues - - - - 152

6.3. Implications for Managers - - - - - - - - - - - - - - 154

REFERENCES - 157

LIST OF TABLES

Table **Page**

2.1. List of Sub-Constructs for External Environment - - - - - - - - - - - - - - - - 17
2.2. List of Sub-Constructs for Managerial Beliefs and Attitudes - - - - - - - 31
2.3. List of Sub-Constructs for Organizational Structure - - - - - - - - - - - - - 43
2.4. List of Sub-Constructs for Manufacturing Practices - - - - - - - - - - - - - 48
3.3.3.1. Inter-Judge Raw Agreement Scores: First Sorting Round - - - - - 68
3.3.3.2. Items Placement Ratios: First Sorting Round - - - - - - - - - - - - - - - 69
3.3.3.3. Inter-Judge Agreements - 70
3.3.4.1. Inter-Judge Raw Agreement Scores: Second Sorting Round - - - 73
3.3.4.2. Items Placement Ratios: Second Sorting Round - - - - - - - - - - - - 74
3.5.2.1.1. Purification for External Environment (Pilot) - - - - - - - - - - - - - - - 81
3.5.2.1.2. Factor Loadings (Within Each Sub-construct) for the Retained External Environment Items (Pilot) - - - - - - - - - - - - - - 84
3.5.2.1.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for External Environment (Pilot) - - - 85
3.5.2.2.1. Purification for Managerial Beliefs and Attitudes (Pilot) - - - - - - - 87
3.5.2.2.2. Factor Loadings (Within Each Sub-construct) for the Retained Managerial Beliefs and Attitudes Items (Pilot) - - - - - - 90
3.5.2.2.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Managerial Beliefs and Attitudes (Pilot) - - - - - 91
3.5.2.3.1. Purification for Organizational Structure (Pilot) - - - - - - - - - - - - - 94
3.5.2.3.2. Factor Loadings (Within Each Sub-construct) for the Retained Organizational Structure Items (Pilot) - - - - - - - - - - - - 96
3.5.2.3.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Organizational Structure (Pilot) - 97
3.5.2.4.1. Purification for Manufacturing Practices (Pilot) - - - - - - - - - - - - - 100
3.5.2.4.2. Factor Loadings (Within Each Sub-construct) for the Retained Manufacturing Practices Items (Pilot) - - - - - - - - - - - - - 101
4.1. Description of Sample - 103
4.2. Chi-square Test of Response / Non-response Bias - - - - - - - - - - - 106
4.2.1.1. Purification for External Environment (Large Scale) - - - - - - - - - - 109
4.2.1.2. Exploratory Factor Analysis for Retained External Environment Items (Large Scale) - 112
4.2.1.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for External Environment (Large Scale) - - - - - - - - - 113
4.2.2.1. Purification for Managerial Beliefs and Attitudes (Large Scale) - - 115
4.2.2.2. Exploratory Factor Analysis for the Retained Managerial Beliefs and Attitudes Items (Large Scale) - - - - - - - - - - - - - - - - - - 118
4.2.2.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Managerial Beliefs and Attitudes (Large Scale) - 121
4.2.3.1. Purification for Organizational Structure (Large Scale) - - - - - - - - 123

4.2.3.2. Exploratory Factor Analysis for the Retained Organizational Structure Items (Large Scale) ---------------------------- 124
4.2.3.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Organizational Structure (Large Scale) ------- 126
4.2.4.1. Purification for Manufacturing Practices (Large Scale) -------- 127
4.2.4.2. Exploratory Factor Analysis for the Retained Manufacturing Practices Items (Large Scale) ---------------------------- 130
4.2.4.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Manufacturing Practices (Large Scale) ------- 131
4.3.1. Summary of Measurement Analysis ------------------------ 133
5.2.1. Summary of LISREL Generated Data for Indicators ------------ 137
5.2.2. Summary of LISREL Generated Data for Hypotheses Testing ---- 139
5.2.3. Decomposition of Effects (Standardized Coefficients and *t*-values) -140
5.3.1. Results of ANOVA on Managerial Beliefs and Attitudes, Organizational Structure, and Manufacturing Practices --------- 142
5.3.2. Comparison of Group 1 and 2 ---------------------------- 142
5.3.3. Results of ANOVA on Sub-construct Level (Level of Significance)- -145

LIST OF FIGURES

Figure		Page
2.1.	Research Framework	8
4.3.1.	Revised Research Framework	132
5.1.1.	Primary Causal Model	136
5.2.1.	Result of LISREL Analysis	138

LIST OF APPENDICES

Appendix **Page**

A. Measurement Items Entering Q-Sort ---------------------- 175
B. Cohen's Kappa and Moore and Benbasat Coefficient ------------ 181
C. List of Contextual and Performance Variables ----------------- 186
D. Acronyms Used for Coding of Items in Each Sub-construct -------- 188
E. Measurement Items After the Pilot Study ---------------------- 189
F. Measurement Items After the Large Study -------------------- 194

CHAPTER 1: INTRODUCTION

Manufacturing firms are operating in a changing environment. Huber (1984) describes this change from an industrial to a post-industrial environment in broad, societal terms. Skinner (1985) and Doll and Vonderembse (1991) describe it in terms specific to manufacturing. In an industrial environment, firms compete in a homogeneous national market with competitors having access to the same resources and suppliers. Market segments are large and stable, and product life cycles are long. Economy-of-scale is the hallmark of leading companies operating in the industrial environment, and these companies often compete on a single criterion, costs (Utterbach and Abernathy, 1975; Vonderembse et. al, 1997).

In a post-industrial environment, firms compete in heterogeneous global markets where competitors have access to various types of resources and strategies. In this environment, market segments are narrowing and constantly changing. Product life cycles are relatively short as new products are introduced with increasing speed. Leading companies exhibit economy-of-scope (Goldhar andJelinek, 1983), and these companies compete simultaneously on multiple criteria, such as cost, quality, product variety, and time (Anderson et. al, 1989; Corbett and Van Wassenhove, 1993; Ferdows and De Meyer, 1990).

In response, manufacturers operating in an industrial environment have cultivated a set of managerial beliefs and attitudes, structural attributes, and manufacturing practices to be congruent with their environment (Ward et al., 1996; Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992). These firms have managerial beliefs and attitudes that focus on improving productivity and lowering cost (Skinner, 1985). Their organizational structure exhibits a functional orientation, has a multiple-level hierarchy, and emphasizes sequential workflow. A powerful planning department and managerial staff carry out most of the planning tasks, which in effect separates work planning from work doing (Doll and Vonderembse, 1991). Typical management style is command and control, and performance measures are generally localized to individuals or departments. The manufacturing function is buffered from changing customer demands through restricted customer contact (Chase and Tansik, 1983). Technology is applied for localized optimization, and project justification is usually based on anticipated cost reductions.

Manufacturers operating in a post-industrial environment exhibit different managerial beliefs and attitudes as well as structural attributes. Their focus is to deliver value-to-customers. Their organizational structure is process oriented, with relatively few layers in the hierarchy and concurrent workflows. Workers plan and execute their work, and the management style emphasizes collaboration and consensus (Badore, 1992; Walton, 1985). These companies apply performance measures that are company-wide rather than individual or localized measures (Doll and Vonderembse, 1991). Many functions in the company have direct contact with the customers (Chase et al., 1992), and technology is applied mainly for the purpose of providing value to customers (Vonderembse et. al, 1997). Project justification is based on expected increase in competitive advantages, rather than expected cost savings.

The manufacturing practices may be different for industrial and post-industrial firms (Ward et al., 1996; Nemetz and Fry, 1988). Manufacturing enterprises operating in an industrial environment tend to have narrow product lines with relatively long production runs. They deal with fluctuations in demand by buffering the technical core with inventory, and their 'schedule push' production is based on demand forecasts from the planning department. Their typical production layout is based on sequence of steps to manufacture a product. Responsibilities for quality control in these companies fall heavily upon separate quality control function, with finished-goods inspection being a primary means for ensuring quality. Maintenance is carried out whenever there is a need, i.e., a machine breakdown. Multiple suppliers are maintained, the lowest cost supplier being the primary supplier for the company.

In contrast, manufacturing practices of firms operating in a post-industrial environment are characterized by broad product lines with short production runs and quick change-over (De Meyer et al., 1989; Gerwin, 1993; Hall and Nakane, 1990). They deal proactively with demand fluctuations through building increased level of flexibility in their production volume and product mix. Their product-oriented layout is based on families of parts rather than the process-oriented layout where similar machine types are grouped together (Wemmerlov and Hyer, 1989; Huber and Brown, 1991). Quality is ensured through self-checking of each operator, and more emphasis is placed on designing and manufacturing quality products rather than inspecting finished goods (Deming, 1981, 1982, 1986). Demand-pull is the primary form of production. Preventive maintenance is carried out to reduce the level of machine breakdown (Nakajima, 1988). Relatively few suppliers, and in some cases a single supplier, are used with the relationship geared toward strategic alliances between the company and the supplier.

The characteristics of a post-industrial environment can be thought of as exhibiting a higher level of uncertainty compared to that of an industrial environment. Therefore theoretical support for this research can be gained from the rich amount of research done in the field of strategy and organization theory that explores the relationships between environmental uncertainty, managerial beliefs and attitudes, and organizational structure. However, concepts that are used in these literatures are usually defined in broad, general terms, aimed to be applied in many different situations. Use of such broad, general terms may have the strength of generalizability, but it may overlook some of the critical aspects of external environment that are more manufacturing specific.

Post-industrial manufacturing literature (Skinner, 1985; Doll and Vonderembse, 1991; Vonderembse et al., 1997; Koufteros et al., 1998), on the other hand, has defined these critical aspects of external environment in manufacturing terms, such as heterogeneous global market, narrow market segments, short product life cycle, multiple customer criteria, and economies of scope as the driving force for adopting manufacturing technology. One limitation of post-industrial manufacturing literature, however, is lack of empirical research that encompasses environmental and managerial, as well as manufacturing, aspects of post-industrial manufacturing. Skinner (1985) and Doll and Vonderembse's (1991) discussions were largely theoretical in nature. Vonderembse et al. (1997) discussed the importance of integrating the information flow before automating the manufacturing process, and supported their theory based on four case studies. Koufteros et al. (1998) studied the importance of time-based manufacturing practices through large-scale survey research, but their research model does not include the external environment or the internal environment (managerial beliefs and attitudes and organizational structure) of firms.

The purpose of this research is to explore the relationship among the firms' (1) external environment, (2) internal environment (managerial beliefs and attitudes and organizational structure), and (3) manufacturing practices. The research intends to identify the critical aspects of external environment, managerial beliefs and attitudes, and organizational structure, and develop valid and reliable instruments that measure these critical aspects in terms that are more manufacturing specific. In the course of doing so, this research attempts to demonstrate that firms operating in a post-industrial environment have different managerial beliefs and attitudes, organizational structure, and manufacturing practices than firms operating in an industrial environment.

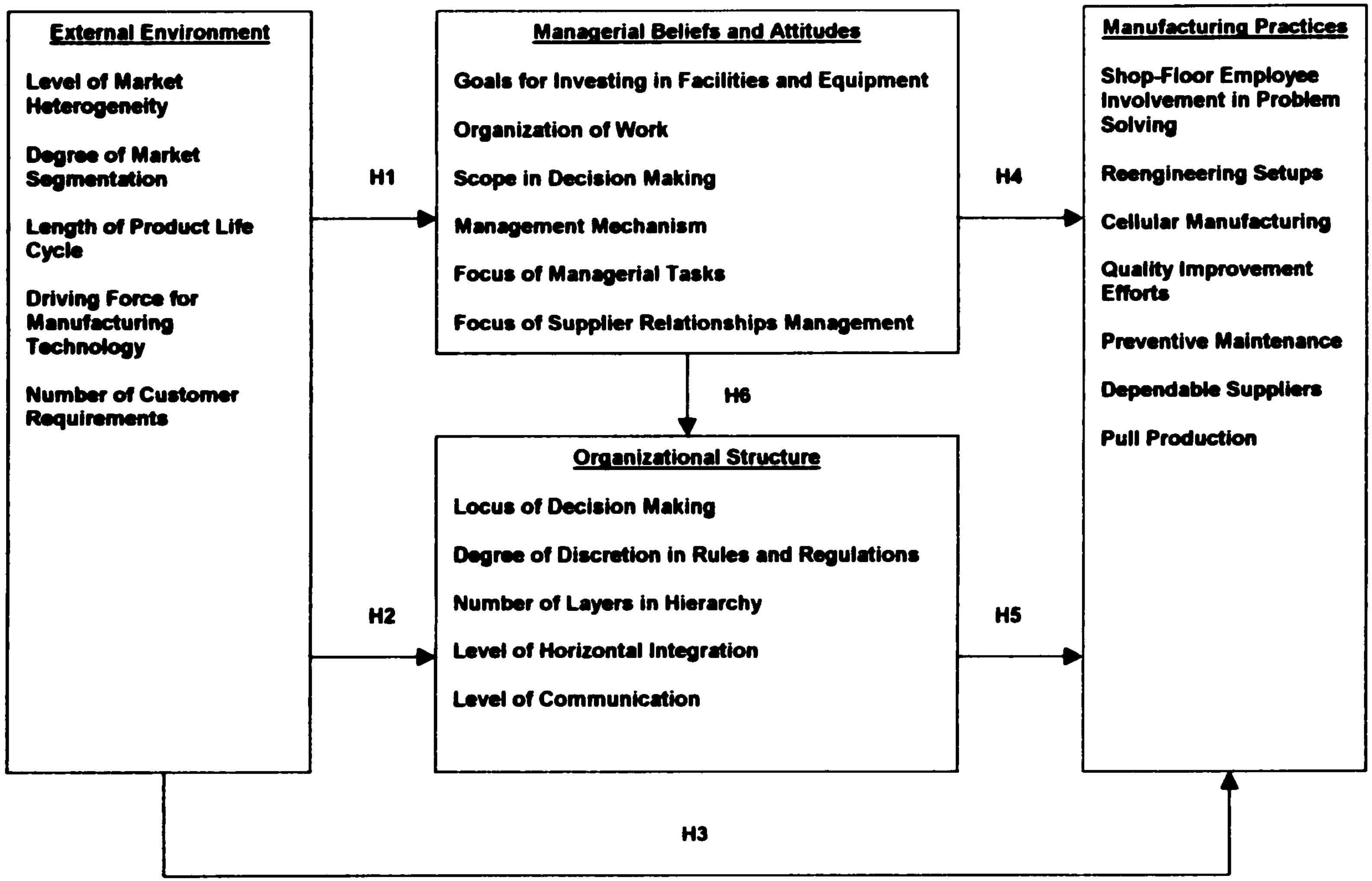
The overall framework that depicts the relationships between constructs and its theoretical support are presented in Chapter 2. The research methodology for generating items appears in Chapter 3. This methodology includes interviews with practitioners, expert evaluation, Q-sort method, and a pilot study with 40 firms. Large-scale survey methods, reliability and validity results are reported in Chapter 4. In Chapter 5, the results of hypotheses testing are shown, using LISREL methodology. Chapter 6 concludes with summary of research findings and major contributions, recommendations for future research, and implications for managers.

CHAPTER 2: THEORY DEVELOPMENT

The research framework in Figure 2.1 depicts the relationship among the firms' external environment, internal environment (managerial beliefs and attitudes and organizational structure), and manufacturing practices. The external environment includes the level of market heterogeneity, the intensity of market forces, the importance of technology, and the diversity of customer requirements (Bayus, 1994; Chase et al., 1992; Doll and Vonderembse, 1991; Ferdows and De Meyer, 1990; Lawrence and Dyer, 1983; Manufacturing Studies Board, 1986; Nobel, 1995; Skinner, 1985; Vonderembse et al., 1997; MacDuffie et al., 1996; Young, 1985). "Post-industrial environment" is defined as an external environment, perceived by the managers, as having high degrees of: (1) heterogeneity in their market, (2) many narrow market segments, (3) short product life cycle, (4) economies of scope as driving force for adopting manufacturing technology, and (5) multiple criteria for customer satisfaction. The terminology "post-industrial environment" is derived from Huber (1984) who, in the course of describing the characteristics of post-industrial organizations, describes the characteristics of post-industrial society within which post-industrial organizations need to operate and cope with for their survival.

The environment drives changes in the organization's internal

Figure 2.1. Research Framework



environment including its managerial beliefs and attitudes and its organizational structure. Managerial beliefs and attitudes include the organization's approach to managing its internal resources (e.g., equipment and employees), organization of work, scope of decision-making, and the focus of managing its relationships with customers and suppliers (Clark et al., 1987; Gerwin and Kolodony, 1992; Leonard-Barton, 1992; Nemetz and Fry, 1988; Van de Ven, 1986; Walton, 1985; Wheelwright and Hayes, 1985). Managerial beliefs and attitudes of firms in the post-industrial stage is defined as having the characteristics of: (1) investments in facilities and equipment for intellectual work, (2) team-work on integrative tasks, (3) decision making based on integrated perspective, (4) management based on collaboration and consensus, (5) focus on value to customers, and (6) long-term strategic partnership with suppliers. Since there is no specific terminology that encompasses all these dimensions at the same time, we would call it, in this research, as "integrative managerial beliefs and attitudes." The terminology is derived from the fact that these managerial beliefs and attitudes of firms in the post-industrial stage focus on upgrading and bring together the skills and intellectual capacity of its employees and suppliers (integration of resources) by means of teamwork and collaboration (integration of processes) for the single purpose of providing value to customers (integration of purposes).

Organizational structure includes the centralization of authority, the degree of formalization, and patterns of communication (Blau, 1970; Dewar and Werbel, 1979; Germain, 1996; Germain et al., 1994; Gerwin and Kolodony, 1992; Ruekert et al., 1985; Swamidass and Newell, 1987; Walton, 1985). Organizational structure of firms in the post-industrial stage is defined as having the characteristics of: (1) decentralized decision making for operational decisions, (2) rules and regulations that encourages creative, autonomous work and learning, (3) few layers in organizational hierarchy, (4) high level of horizontal integration, and (5) high level of vertical and horizontal communication. Many researchers have called organizational structure that has these characteristics "organic structure," as opposed to "inorganic" or "mechanistic structure" (Daft, 1995; Lawrence and Lorsch, 1967; Nahavandi, 1993; Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992; Doll and Vonderembse, 1991).

An organization's managerial beliefs and attitudes and its organizational structure impact the ability of the firm to develop manufacturing practices that are appropriate for the environment. Manufacturing practices include the extent to which employees participate in problem solving efforts, manufacturing processes are altered to achieve faster response to customer needs, and suppliers are integrated into the manufacturing process (Ansari and Modaress, 1988; Brown and Mitchell, 1991; Deming, 1986; Garvin, 1983; Hall, 1987; Huber and Hyer, 1985; Huber and Brown 1991; Juran, 1991; Koufteros et al, 1998; Monden 1983; Schonberger, 1986; Shingo, 1985; Suzaki, 1987). Manufacturing practices adopted by manufacturing firms in the post-industrial stage are: (1) shop-floor employee involvement in problem solving, (2) reengineering setup, (3) cellular manufacturing, (4) quality improvement efforts, (5) preventive maintenance, (6) dependable suppliers, and (7) pull production. These are called "time-based manufacturing practices," and are thought of as manufacturing practices that became prominent as the nature of external environment shifted from industrial to post-industrial (Koufteros, 1995; Koufteros et al., 1998).

Before developing measures for these variables and testing their relationships, it is theoretically sound to first identify, define, and discuss various constructs. We also need to have sufficient theoretical support for the hypothetical relationships between these variables. This is done through the following review of literature and theoretical rationale.

2.1. EXTERNAL ENVIRONMENT

External environment is defined as the external context of a manufacturing enterprise, as perceived by its managers. External environment is an important variable in the organization theory and post-industrial manufacturing literature.

2.1.1. External Environment in Organizational Literature

In the organizational literature, environmental uncertainty has been a central concept in seeking to explain the relationship between organizations and their environments (Milliken, 1987). In their review paper, Jauch and Kraft (1986) summarized three different approaches to environmental uncertainty that have been adopted by researchers; classical views, transition views, and process views. Classical views think of external environment as a source of uncertainty; reality of the objective environment influences decisions, structure, and performance (March and Simon, 1958; Burns and Stalker, 1961; Chandler, 1962;

Cyert and March, 1963; Emery and Trist, 1965). From the transition perspective, the source of uncertainty is both external and internal; some also suggest that decision-makers have choices and influence the environment (Thompson, 1967; Terreberry, 1968; Perrow, 1970; Child, 1972; Galbraith, 1973). There are also process views, which tend to ignore objective properties of the environment. They argue that the decision-maker's perceptions, influenced by internal factors, mediate the link between uncertainty and system characteristics (Lawrence and Lorsch, 1967; Duncan, 1972, 1973; Downey and Slocum, 1975; Van de Ven et al., 1976; Downey et al., 1977; Tung, 1979).

This review shows that research work on environmental uncertainty has shifted away from "objective" to "subjective" or "perceived" environmental uncertainty (Jauch and Kraft, 1986). The reason for this shift was that researchers were widely in agreement that perceived environmental uncertainty mediates the relationship between the objective environment and a firm's strategic response (Jauch and Kraft, 1986; Matthews and Scott, 1995). This does not mean, however, that the objective environment is not an important factor for organizational design or performance. As Jauch and Kraft (1986) have pointed out, "to argue that 'objective' reality has no impact is as foolish as to argue that perception of the environment has no influence" (Jauch and Kraft, 1986: p. 784). Tinker (1976) has also warned that to study perceptions alone would reduce the study of organizations to a "problem of psychoanalysis of actors" (Tinker, 1976).

In order to avoid the problem, an expanded model that includes both the objective and perceived environmental uncertainty has been proposed (Jauch and Kraft, 1986). Alternatively, some have suggested that it is necessary to measure environmental uncertainty objectively as a means of attempting to validate the perceptual measures (Aldag and Storey, 1975; Starbuck, 1976). Attempts to do so, however, have resulted in inconsistent findings (Tosi et al., 1973; Snyder and Glueck, 1982). Moreover, Buchko (1994) found that while the perceived environmental uncertainty scale demonstrated internal consistency, stability as measured by test-retest correlations was inadequate. He states:

> "Perceptions of environmental uncertainty may be a key variable in understanding managers' actions, but those perceptions may vary over time and be easily influenced by events in the environment of an organization... It is possible that perceptions of environmental uncertainty are inherently fragile and unstable and likely to change very quickly as a result of changes in the external environment of an organization" (Buchko, 1994).

This literature review shows that the issue of adopting either an objective or perceived environmental uncertainty construct should be approached with caution. It also shows that if we were to adopt the perceived environmental uncertainty construct, then careful reasoning and efforts should be made to increase the stability of the measurement scale.

Another aspect of environmental uncertainty construct worth mentioning is the differing perspectives on the construct that remain common in the literature. Matthews and Scott (1995) points out that "multiple definitions of uncertainty have been offered in the literature, including lack of knowledge for decision-making (Duncan, 1972; Lawrence and Lorsch, 1967; Thompson, 1967); choice

(Child, 1972); complexity (Galbraith, 1973); unpredictability (Cyert and March, 1963); and turbulence (Emery and Trist, 1965)." While some have proposed different types of perceived environmental uncertainty (e.g., state, effect, and response uncertainty, proposed by Milliken, 1987), a number of researchers have proposed a further differentiation of the construct by the source of uncertainty (Duncan, 1972; Jauch et al., 1980; Khandwalla, 1977; Tosi and Slocum, 1984) For example, Matthews and Scott (1995) investigated how the perception of environmental uncertainty in each of eight environmental sectors (customers, suppliers, distributors, competitors, government, public attitudes, technology, and financial markets) differentially affects strategic and operational planning in small business firms. Recent research on environmental uncertainty is moving toward the direction of considering these different dimensions of environmental uncertainty and their effects separately (Gerloff et al., 1991; Fahey and Narayanan, 1986; Miller, 1992, 1993; Werner et al., 1996; Matthews and Scott (1995).

This variety of research streams in the organizational literature in relation to environmental uncertainty demonstrates the fact that in the future, there could be lots of avenues to explore the external environment variable. Within the current stage of research in the post-industrial literature, it seems sufficient to identify the multiple dimensions / sub-constructs of the variable and their varying levels of effect on internal environment and manufacturing practices of manufacturing firms.

2.1.2. External Environment in Post-Industrial Manufacturing Literature

In the post-industrial literature, Huber (1984) describes how society is moving from an industrial to a post-industrial era. As the rate of change in life style and technology accelerates, a greater challenge is presented to organizations that operate in the post-industrial stage. Management is pressed with the burden to acquire a greater amount of information to make the "best" decisions. Thus, decision-makers should create a structure where they can cope with the equivocality in the environment and consistently make appropriate decisions for their organization (Huber, 1984; Daft and Lengel, 1986).

The overall change of society from industrial to post-industrial is affecting manufacturing firms as well. Doll and Vonderembse (1991) claim that the driving force for the change from craft to industrial was technology, particularly mass production. This was also accompanied by growth in domestic market, which enabled firms to produce standardized products in large volume and sell them to customers, who demanded low-cost, quality products. As society moved from an industrial to a post-industrial environment, the scope of the market became global, and the customer requirements became more diverse. With the increase in competition, firms need to deliver products/services to customers who now require satisfaction across multiple criteria, such as cost, quality, delivery, flexibility, time, and service, all at the same time. Also occurring is the development and sophistication of flexible manufacturing technology, which is enabling firms to satisfy those multiple customer requirements, simultaneously.

It is interesting to note the similarities and differences between organizational literature and post-industrial manufacturing literature in dealing with the external environment. Both streams of research think of external environment as an important variable in relation to organizational change, organizational design, and performance. Post-industrial manufacturing literature, however, has not gone deep enough to distinguish between objective versus perceived attributes of external environment and its effect on the organization. The post-industrial manufacturing literature has not adequately developed or operationalized multiple sub-constructs for the external environment.

2.1.3. Identification of Sub-Constructs for External Environment

The sub-constructs focus on the difference between an industrial and a post-industrial environment. Some theoretical descriptions of industrial and post-industrial environment can be found in Doll and Vonderembse (1991), Huber (1984) and Vonderembse et al. (1997), but they were not broken down to sub-constructs and operationalized for research. This provides both challenge and opportunity for researchers in post-industrial manufacturing. This research takes the challenge by focusing on the managers' perception on the external environment. It attempts to identify and verify the various dimensions of external environment. The list of sub-constructs, along with their definitions and supporting literature, are provided in Table 2.1.

2.1.3.1. Level of Market Heterogeneity

The "level of market heterogeneity" is the degree to which markets exhibit

Table 2.1. List of Sub-Constructs for External Environment

Constructs	Definitions	Literature
Level of Market Heterogeneity	The degree to which markets exhibit differences and similarities with respect to competitors and customers.	Doll and Vonderembse, 1991; Johansson et al., 1993; Lawrence and Dyer, 1983; Manufacturing Studies Board, 1986; Skinner, 1985; Young, 1985
Degree of Market Segmentation	The degree to which the market segments are narrow versus large.	Bayus, 1994; Doll and Vonderembse, 1991; Skinner, 1985; Vonderembse et al., 1997
Length of Product Life Cycle	The degree to which the time span of a product's market introduction to its decline is short versus long.	Bayus, 1994; Doll and Vonderembse, 1991; Vonderembse et al., 1997
Driving Force for Manufacturing Technology	The degree to which the adoption of manufacturing technology is driven by economies of scope versus economies of scale.	Doll and Vonderembse, 1987, 1991; Goldhar and Jelinek, 1983; MacDuffie et al., 1996; Skinner, 1985; Vonderembse et al., 1997;
Number of Customer Requirements	The degree to which customer satisfaction depends upon many versus few criteria.	Chase and Garvin, 1989; Chase et al., 1992; De Meyer et al., 1989; Doll and Vonderembse, 1991; Ferdows and De Meyer, 1990; Noble, 1995

differences and similarities with respect to competitors and customers. In the industrial stage, a firm competes in national markets where its competitors often have the same labor costs and problems, a common supplier base, and similar overhead costs. In many cases, a firm may hire key employees from its competitors so that management's approach is often similar to its competitors. This significantly reduces the dimensions of competition (Vonderembse et al., 1997). Skinner (1985) describes how the American self-concept of industrial leadership was shaken severely during the 60's and 70's as foreign competitors entered the market place. Manufacturing capabilities have spread worldwide rapidly (Manufacturing Studies Board, 1986), resulting in a growing global competition that is changing our "mind set" of how the management of manufacturing should be carried out (Young, 1985; Doll and Vonderembse, 1991; Johansson et al., 1993). In this new post-industrial era, markets are increasingly complex, changing, and uncertain (Lawrence and Dyer, 1983; Doll and Vonderembse, 1991). As a result, markets that were similar on many dimensions of competition have become very different.

2.1.3.2. Degree of Market Segmentation

The "degree of market segmentation" is the degree to which market segments are narrow versus large." Market segments in the industrial age are characterized by their large size and stability, which enabled manufacturing firms to produce standardized products in mass volume (Skinner, 1985). This makes investments in hard automation attractive and causes competition to focus on achieving economies of scale. In the post-industrial age, accelerated rate of market change and increased market variety results in segmented markets (Bayus, 1994; Vonderembse et al., 1997). Industrial stage firms are seeing their markets constantly shrinking as competitors design and build high-quality products at lower costs to satisfy a specific market niche (Doll and Vonderembse, 1991; Vonderembse et al., 1997).

2.1.3.3. Length of Product Life Cycle

The "length of product life cycle" is the degree to which the time span from a product's market introduction to its decline is short versus long. Accelerated rate of market change and increased competition in the post-industrial age are resulting in the shortening of the product life cycle (Bayus, 1994). Affluent and discriminating customers demand for greater choice in new and different products (Doll and Vonderembse, 1991). Products made in the post-industrial age may have greater durability (e.g., automobiles), but changing customer preferences are shortening the period of a product's life cycle. This is forcing companies to develop new products and to improve existing ones continuously (Bayus, 1994; Vonderembse et al., 1997).

2.1.3.4. Driving Force for Manufacturing Technology

The "driving force for manufacturing technology" is the degree to which the adoption of manufacturing technology is driven by economies of scope versus economies of scale. The history of manufacturing in the industrial age is the history of perfecting the art of mass production. Applying division of labor, scientific management, and hard automation for a narrow scope of standardized products resulted in U.S. manufacturing leadership until the 60's (Skinner, 1985). However, these inflexible production and management systems were unable to perform effectively in the post-industrial era (Vonderembse et al., 1997). The concept of economies of scope is requiring firms to build volume across a production facility by quickly and economically producing a variety of product at decreased volume per product (Goldhar and Jelinek, 1983; MacDuffie et al., 1996; Vonderembse et al., 1997; Doll and Vonderembse, 1991). Technological advances such as CAD, robots, and flexible manufacturing systems (FMS) and ideas such as economies of scope appear to offer opportunities to capture flexibility and efficiency at the same time (Goldhar and Jelinek, 1983; Doll and Vonderembse, 1987).

2.1.3.5. Number of Customer Requirements

The "number of customer requirements" is the degree to which customer satisfaction depends upon many versus few criteria. In the industrial age, customer focused the product price and sometimes its high quality. However, customer purchase decisions are increasingly based on a combination of criteria, such as price, product performance and features, quality, delivery, and service (Doll and Vonderembse, 1991; Chase and Garvin, 1989; Chase et al., 1992). The advancements in manufacturing technology are enabling firms to overcome the traditional notion of trade-offs (Skinner, 1969) to exhibit multiple competitive capabilities at the same time (De Meyer et al., 1989; Ferdows and De Meyer, 1990; Noble, 1995). These heighten capabilities and continuing competitiveness are enabling already affluent and discriminating customers to demand greater choice and satisfaction (Doll and Vonderembse, 1991).

2.2. MANAGERIAL BELIEFS AND ATTITUDES

The external environment, as perceived by the managers, has an effect on their managerial beliefs and attitudes. Managerial beliefs and attitudes are a set of values and norms of behavior widely shared among managers that affect their way of thinking, decision-making, and work. A discussion of the related organizational and manufacturing literature helps to define managerial beliefs and attitudes.

2.2.1. Organizational Culture in Organizational Literature

Managerial beliefs and attitudes are a part of the organizational culture. The following definitions of organizational culture, as summarized by Pepper (1995), help to clarify the relationship.

> A focus on culture helps us focus on the assumptions that drive the way things are done in the organization (Smircich, 1985).
>
> Culture is a set of important assumptions (often unstated) that members of a community share (Sathe, 1983).
>
> Culture shapes the character of an organization (Morgan, 1986).
>
> Culture is a basic pattern of assumptions... that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems. (Schein, 1986).

> Culture consists of the publicly and privately accepted meanings of a given group that serve to define their understanding of reality (Pettigrew, 1979).
>
> Culture is the way things get done in the organization (Deal and Kennedy, 1982)

How the organizational culture is defined may depend upon where the investigator believes culture comes from (Pepper, 1995; Smircich, 1983). First, culture may be viewed as an external variable, imported into the organization from outside. In this view, the organization tends to reflect the beliefs, values, and attitudes of the host culture. Second, culture may be viewed as an internal variable. In this view, organizational culture is a social reality that results from the unique transactions of the participants within the organization, which may or may not reflect the culture outside the organization. Third, culture may be viewed as a root metaphor. In this view, organizational culture is no longer a variable, but rather an extension of psychodynamic processes of organization members (Smircich, 1983).

Besides these differing views on where the culture comes from, Allaire and Firsirotu (1984) have identified eight major schools of thought relating to corporate culture, each with its own major theorists and research traditions. Given this diversity in approaches to organizational culture and the different terminology they employ, researchers seem to "take a stand" in defining culture in their respective research. For example, in investigating industry determinants of organizational culture, Gordon (1991) states that his view of culture is "(in accordance with) the cognitive and ecological-adaptationist schools of thought, as defined by (Allaire and Firsirotu, 1984)."

Schein (1986, 1992) further defines three different levels of cultural phenomena in organizations. At the surface we have the level of *artifacts*, which are visible organizational structures and processes. This includes all the phenomena that one sees, hears, and feels when one encounters a new group with an unfamiliar culture. Below this is the level of *espoused values*, which are manifested as strategies, goals, and philosophies, and their espoused justifications. This represents the sense of what "ought to be," as distinct from "what is." Even below that is the level of *basic underlying assumptions*, which are unconscious, taken-for-granted beliefs, perceptions, thoughts, and feelings. This is the ultimate source of values and actions (Schein, 1986, 1992).

To illustrate his point, Schein (1992) gives an example of how an individual beliefs and actions can go through the cognitive transformation to become part of an organizational culture:

> "For example, in a young business if sales begin to decline, a manager may say, 'We must increase advertising' because of her belief that advertising always increases sales. The group, never having experienced this situation before, will hear that assertion as a statement of that manager's values: 'She believes that when one is in trouble it is a *good* thing to increase advertising.' What the leader initially proposes, therefore, cannot have any status other than a value to be questioned, debated, challenged, and tested.
>
> If the manager convinces the group to act on her belief and if the solution works and if the group has a shared perception of that success, then the perceived value that advertising is 'good' gradually starts a process of *cognitive transformation*. First, it will be transformed into a *shared value or belief* and, ultimately, into a *shared assumption* (if action based on it continues to be successful). If this transformation process occurs – and it will occur only if the proposed solution continues to work, thus implying that it is in some larger sense 'correct' and must reflect an accurate picture of reality – group members will tend to forget that originally

> they were not sure and that the proposed course of action was at an earlier time debated and confronted" (Schein, 1992).

According to Schein (1992), "the essence of a culture lies in the pattern of basic underlying assumptions, and once one understands those, one can easily understand the other more surface levels and deal appropriately with them." In other words, even though the levels of artifacts and espoused values *reflects* culture, only the third is the *essence* of culture (Schein, 1992). But as Gordon (19991) has pointed out, researchers have considered each level to be an important part of the study and understanding of organizational culture (Barney, 1986; Broms and Gahmberg, 1983; Tunstall, 1985). Therefore, in one's study, a researcher may focus on the level of "espoused values" instead of the "basic underlying assumptions" level of organizational culture.

Researchers have developed many culture dimensions over the years (Deal and Kennedy, 1982; Buono and Bowditch, 1989; Nahavandi and Malekzadeh, 1988; Denison, 1990; Rousseau, 1990; Zammuto and Krakower, 1991; O'Reilly et al., 1991). Some examples are: degree of risk and speed of feedback (Deal and Kennedy, 1982), thick (strong) versus thin (weak) culture (Buono and Bowditch, 1989), multiculturalism versus uniculturalism (Nahavandi and Malekzadeh, 1988), group, developmental, hierarchical, and rational culture (Zammuto and Krakower, 1991). One of the most comprehensive list comes from the Organizational Culture Profile (OCP), which is composed of 54 item sets, and categorized as innovation, stability, respect of people, outcome orientation, attention to detail, team orientation, and aggressiveness (O'Reilly et al., 1991). The Organizational Culture Inventory developed by Human Synergistics Inc. describes twelve generic dimensions of culture (achievement, self-actualizing, humanistic and encouraging, affiliative, approval, conventional, dependent, avoidance, oppositional, power, competitive, and perfectionistic) that are arranged in three styles with four dimensions for each group: constructive, passive-defensive, and aggressive-defensive, respectively (Cooke and Szumal, 1993). The field is moving toward the direction of establishing a robust set of culture dimensions, which would enable researchers to make meaningful comparisons across organizations and industries (Chatman and Jehn, 1994).

2.2.2. Infrastructure/Social Systems in Manufacturing Literature

Technological determinism, which claims there is always one best way of managing technology, is the basis of work design for firms in the industrial stage. Accordingly, this optimal arrangement of technology results in maximum efficiency and productivity. Once accomplished, the social system (people) adapts to technical systems. Sociotechnical systems (STS) theory is in contrast with technological determinism. STS provides a useful way of thinking about the role of social systems in post-industrial manufacturing (Gerwin and Kolodny, 1992; Susman and Chase, 1986; Huber and Brown, 1991). STS asserts that social and technical aspects of work design should be considered simultaneously. People and machines are complementary, and there is more than one way to design the organization (Gerwin and Kolodny, 1992).

As more and more manufacturing firms adopt advanced manufacturing technology, the nature of work is becoming increasingly intellectual (Doll and Vonderembse, 1991; Zuboff, 1984; Weick, 1990). Because of this change, manufacturing firms are challenged by internal issues that deal with the growing equivocality of high process/product technology (Zuboff, 1984; Weick, 1990). Post-industrial firms need to learn continually from past experiences, from outside sources, through experimentation, and by transferring knowledge throughout the organization (Garvin, 1993; Leonard-Barton, 1992; Levitt and March, 1988; Cohen and Levinthal, 1990). This enhances flexibility and improves their response to changing customer needs and advancing technology. To cope with these socio-system issues, post-industrial manufacturing firms are organizing their workers into self-directed work groups (Doll and Vonderembse, 1991; Gerwin and Kolodny, 1992). Shop floor employees are encouraged to participate in problem solving activities (Koufteros et al., 1998). Middle managers are encouraged to take the transformational role, which includes path finding, problem solving, and implementation (Beatty and Lee, 1992). The work management is moving from control model to commitment model, with the transitional model of worker involvement is observed in greater scale (Walton, 1985). The reward systems are designed to encourage working in teams (Doll and Vonderembse; 1991).

Social systems change is a compelling concern as firms shift from industrial to post-industrial manufacturing. Researchers have reported on the significance of social systems in the success of CIM implementation (Doll and Vonderembse, 1987; Twigg et al., 1992), AMT implementation (Ramamurthy and

King, 1992; Maffei and Meredith, 1994, 1995; Beatty, 1992; Beatty and Lee, 1992; Zammuto and O'Connor, 1992), FMT implementation (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992), just-in-time (JIT) and time-based manufacturing implementation (Koufteros et al., 1998), and organizational innovation implementation (Leonard-Barton, 1988; Nord and Tucker, 1987). The concept of product-focused actions, self-regulating work groups, and multi-skilled workers are enabling factors for manufacturing/assembly cells, flexible manufacturing/assembly systems, and flexible focused factories (Gerwin and Kolodny, 1992). Empowering and motivating shop floor employees to participate in problem solving is the basis of TQM and JIT (Sugimori et al., 1977; Hall, 1987, 1993). Organizational culture and structure that encourages employee participation and flexibility is suggested as a necessary condition for success in FMT/AMT implementation (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992). These literatures are in agreement that excellence in manufacturing in the post-industrial era can be achieved only through changes in mindset that values the flexibility and creativity of people.

2.2.3. Identification of Sub-Constructs for Managerial Beliefs and Attitudes

The organizational literature focuses on the assumptions underlying culture while the manufacturing literature focuses on the artifacts and espoused values of culture (as described and distinguished by Schein, 1986, 1992). This is understandable, for manufacturing literature has more interest in observing what is actually present (e.g., organizational structures and processes) and evaluating the underlying values (e.g., strategies, goals, and philosophies) that would lead to excellence in manufacturing. Organizational literature, however, rightfully argues that what really matters is the underlying (and thus deeply hidden) assumptions in organizational culture, for this is the ultimate source of values and actions (which are more manifested and thus observable), not visa versa (Schein, 1992).

Skinner (1985) helps to bridge this gap between the organizational perspective and the manufacturing perspective. He describes changes in external environment that forced the managers to change their fundamental perspectives at the level of basic underlying assumptions:

> "During the next twenty years (1960-1980), the American self-concept of industrial leadership was severely shaken, first by a growing inability to compete in the steel and auto industries and the resulting flood of imports, then by similar catastrophes in dozens of other industries led by the electrical machinery, machine tools, textile equipment, and consumer electronics industries.
>
> By 1980 there were many indications that nationwide confidence in manufacturing leadership had largely collapsed. The business periodicals ran countless articles on our 'industrial malaise,' 'the loss of the work ethic,' and the need for 'reindustrialization'... Industrial analysts and managers returned from Japan to report that we were outthought and outclassed in every area of production management... The turnabout in results was only outleveraged by the total cave-in of pride in U.S. industrial might, matched, in some instances, with scathing criticism of the people who had managed 'our way to industrial decline'...." (Skinner, 1985).

Here, we read a vivid description of how the changes in external environment resulted in the changes in managerial beliefs and attitudes, at the level of basic underlying assumptions. This understanding and changes in basic assumptions, though, does not come very easily. Gordon (1991) describes the cultural inertia, especially at the level of underlying assumptions, in the following passage:

> "When a company's industry environment changes in terms of the competitive environment, customer requirements, or societal expectations, behaviors based on past assumptions and values are likely to be ineffective; thus, the company is likely to experience negative results. Such a condition creates a pressure for change, but the culture, based upon successful lessons from the past, resists change.
>
> Fortunately, environmental changes rarely require cultural changes *at the level of assumptions,* because these would involve a total restructuring of an industry. Such changes can be brought about, for example, by changes in societal expectations (including regulation or deregulation), the addition of significant new technologies or substitutes, the entrance of different types of competitors, or, possibly, the maturation of an industry. Even with such powerful influences as these, however, cultural change at the level of assumptions may not be possible unless many of the people, or their positions, change..." (Gordon, 1991).

This understanding of cultural inertia at the assumption level provides both challenges and insights for this research. Skinner (1985) describes great changes in the external environment that began in the early 20^{th} century, accelerated after World War II, and culminated in the 1970s. It would be logical to assume that changes in the external environment would have been observed and appropriate actions would be taken. Cultural inertia and management's perception of culture may help to explain the delays in implementation. This provides some rationale for the research, which focuses on managerial beliefs and attitudes. It provides some theoretical rationale for defining "external environment" on the basis of manager's perspective, instead of the objective nature of the construct. How managers view their external environment has a significant bearing on how they think the firm should be managed. The nature of external environment, as perceived by the managers, would have a direct relationship with their managerial beliefs and attitudes. Sub-constructs for managerial beliefs and attitudes are described in the following sections. The six sub-constructs, along with their definitions and supporting literature, are shown in Table 2.2.

2.2.3.1. Goals for Investing in Facilities and Equipment

The "goals for investing in facilities and equipment" is the degree to which the objective for investing in facilities and equipment is to leverage intellectual work among workers versus to control costs. Nemetz and Fry (1988) have distinguished and compared what they call "mass production technology organizations" with "flexible manufacturing technology (FMT) organizations" in terms of environment, strategy and organizational design. They proposed that mass production technology organizations function well in stable environment with little change and low complexity, long product life cycle, and low differentiation in product features. The fitting strategy then would be to control the environment, accomplish economies of scale, and cost leadership. FMT organizations, however, is more fitting in turbulent and complex environment with dynamic changes, short product life cycle, and highly differentiated products. The strategy of choice then would be to adapt to environment, achieve economies of scope, and pursue competitive advantages in product quality, low cost, dependability, and flexibility (Nemetz and Fry, 1988).

Table 2.2. List of Sub-Constructs for Managerial Beliefs and Attitudes

Constructs	Definitions	Literature
Goals for Investing in Facilities and Equipment	The degree to which the objective for investing in facilities and equipment is to leverage intellectual work among workers versus to control costs.	Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Ramamurthy and King, 1992; Skinner, 1985
Organization of Work	The degree to which workers are expected to work together in integrative tasks versus work individually on specialized tasks.	Davenport and Nohria, 1994; Doll and Vonderembse, 1991; Gerwin and Kolodny, 1992; Vonderembse et al. 1997
Scope in Decision Making	The degree to which decisions are expected to be based on integrated perspective versus functional perspective.	Doll and Vonderembse, 1991; Skinner, 1969; Van de Ven, 1986; Vonderembse et al. 1997; Wheelwright and Hayes, 1985;
Management Mechanism	The degree to which management tasks are expected to be carried out by collaboration and consensus versus by command and control.	Doll and Vonderembse, 1991; Leonard-Barton, 1992; Noe and Ford, 1992; Noe et al., 1994; Pfeffer, 1994; Skinner, 1985; Walton, 1985
Focus of Managerial Tasks	The degree to which management focuses on providing value to customers versus controlling costs.	Doll and Vonderembse, 1991; Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Skinner, 1985
Focus of Supplier Relationships Management	The degree to which the focus of supplier relationships management is to achieve long-term strategic partnership for competitive advantage versus short-term reduction in costs.	Clark, 1989; Clark et al., 1987; Doll and Vonderembse, 1991; Jones, 1992; Koufteros, 1995

Parthasarthy and Sethi (1992) also proposed, and later verified through their empirical research (1993), that performance of an flexible automation firm is higher when its business strategy reflects scope flexibility choices, speed flexibility and/or quality leadership choices, but is lower when its business strategy involves cost leadership (Parthasarthy and Sethi, 1992, 1993). Ramamurthy and King (1992) have found, through their case studies of firms that have implemented computer integrated manufacturing (CIM), that financial considerations still tend to dominate corporate strategies in the U.S. However, they quote on one manager's comment that "traditional evaluation methods, focusing largely on savings in direct labor costs, is misleading." Managers report that it was extremely difficult to justify CIM purely on economic / financial considerations, for benefits were more intangible and qualitative (Ramamurthy and King, 1992). Skinner (1985) argues that manufacturing leadership (in the post-industrial era) will be more successful if it can let go of its heritage of a unidimensional framework of productivity and standardization and see the factory as an instrument for competitive success. The factory would handle a continuous shifting of manufacturing tasks as they are presented by the changes in technology, the competitive situation, and the firm's strategy.

2.2.3.2. Organization of Work

The "organization of work flow" is the degree to which workers are expected to work together in integrative tasks versus work individually on specialized tasks. Vonderembse et al. (1997) state that "... competing successfully in the post-industrial environment requires firms to reexamine their approach to integration and automation." They suggest that firms should first examine the relationships between the parts of the manufacturing system before automating those parts. If manufacturing systems are to be designed and operated to be responsive to the "voice of the customer", collaborative efforts are necessary among a variety of individuals with different backgrounds and training (Doll and Vonderembse, 1991).

This is in sharp contrast with the industrial way of organizing work, which is based on division of labor. Throughout the industrial age, the emphasis has been on seeking efficiencies through the functional specialization of jobs. To increase responsiveness to customers, firms are combining, not dividing labor (Davenport and Nohria, 1994). Self-regulating work groups and multi-skilled workers are thought to be the enabling factor for manufacturing/assembly cells, flexible manufacturing/assembly systems, and flexible focused factories (Gerwin and Kolodny, 1992). Workers are put into teams to learn from each other, and become flexible in work assignment and in response to changing customers needs (Doll and Vonderembse, 1991).

2.2.3.3. Scope in Decision Making

The "scope in decision making" is the degree to which decisions are expected to be based on integrated perspective versus functional perspective. In the industrial age, work was divided into individual and functional tasks and decisions were made with the goal of local and functional optimization. As this approach was applied to automation, islands of automation were created because management did not have a system perspective (Van de Ven, 1986; Vonderembse et al., 1997). When Skinner (1969) applied this attitude to the process of strategic decision making, he recognized manufacturing strategy as the missing link in corporate strategy (Skinner, 1969). Prior to this, manufacturing usually had the role of "minimizing manufacturing's negative potential," or, at best, "achieving parity with competitors." (Wheelwright and Hayes, 1985).

The fast-moving, turbulent environment of the post-industrial age requires managers to have decisions based on holistic and integrative perspectives. Employees should be capable of seeing the whole in the part and making decisions that add value to customers (Van de Ven, 1986). This is the goal of cross-training in post-industrial firms (Vonderembse et al., 1997). From a functional perspective, manufacturing should "provide credible support to the business strategy" and even "pursue a manufacturing-based competitive advantage" (Wheelwright and Hayes, 1985).

2.2.3.4. Management Mechanism

"Management mechanism" is the degree to which management tasks are expected to be carried out by collaboration and consensus versus by command and control. Walton (1985) describes and contrasts two different models for work force management. The traditional model, refined and institutionalized over the first half of this century, focuses on subdividing work into small tasks, clearly fixing job responsibilities, and holding individuals accountable for specific job requirements. The primary vehicle for management in this model was command and control. However, a new model of work force management is emerging, where jobs are designed to be broader and to combine planning and implementation activities. Individual responsibilities are often contingent upon changing conditions. Teams, rather than individuals, often are the unit accountable for performance. The common thread of the policy elements of the new model is first to elicit employee commitment and then to expect effectiveness and efficiency to follow as second-order consequences (Walton, 1985).

In the industrial age, work was primarily unskilled, manual labor with functionally specialized intellectual work carried out by a few engineers, specialists, and managers. Workers were required to execute their tasks in the "one best way" specified by the management (Doll and Vonderembse, 1991). Workers were generally viewed as unhappy, incompetent, and not committed to work; a potentially annoying force that needs to be controlled (Skinner, 1985). In the post-industrial manufacturing firms, however, work is primarily intellectual. The work groups are capable of self-direction because they understand how their activities add value to the customers (Doll and Vonderembse, 1991). Workers are viewed as capable of learning from past experiences, from outside sources, through experimentation, and by transferring knowledge throughout the company (Leonard-Barton, 1992), a potential source for competitive advantage (Walton, 1985; Noe and Ford, 1992; Noe et al., 1994; Pfeffer, 1994).

2.2.3.5. Focus of Managerial Tasks

The "focus of managerial tasks" is the degree to which management focuses on providing value to customers versus controlling costs. In an industrial environment, where customers' requirements are well known and market conditions are stable, management can focus on the issue of efficiency and productivity (Skinner, 1985; Doll and Vonderembse, 1991). In this environment, cost leadership was the strategy of choice (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993). In the post-industrial environment, where customer requirements are complex and constantly changing, listening to the "voice of the customers" becomes the most critical aspect of business management (Doll and Vonderembse, 1991). All aspects of managerial tasks, including technology implementation, work organization, and strategy formulation, focuses on responding to the changing customer needs (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993).

2.2.3.6. Focus of Supplier Relationships Management

The "focus of supplier relationships management" is the degree to which the focus of supplier relationships management is to achieve long-term strategic partnership for competitive advantage versus short-term reduction in costs. In industrial manufacturing firms, purchasing departments seek multiple sources of supply to ensure availability and keep purchase price low. To maximize purchasing performance, buyers squeeze suppliers for price reductions and offer little in return. Short-term contracts are the norm, and this discourages suppliers from developing capabilities to satisfy specific customer needs (Koufteros, 1995). In post-industrial manufacturing firms, suppliers are viewed as an extension of the manufacturing enterprise (Doll and Vonderembse, 1991). Japanese automobile manufacturers are reported to have developed and managed superior supplier relationships, characterized as long-term, strategic partnership, which resulted in significant fraction of advantage in new product development lead time and cost (Clark, 1989; Clark et al., 1987). Having less number of suppliers, and adoption of supplier evaluation system, is described as an important part of lean production system (Jones, 1992).

2.3. ORGANIZATIONAL STRUCTURE

Organizational structure is the way responsibility and power are allocated, and work procedures are carried out, among organizational members. Organizational structure is examined as an important variable within organizational and manufacturing literature.

2.3.1. Organizational Structure in Organizational Literature

Daft (1995) states that "significant changes are occurring in organizations in response to changes in the society at large." He called the old paradigm as mechanistic management, and the new paradigm as organic paradigm. He explains:

> "In the old paradigm, environments were more certain than they are today, technologies tended to be routine manufacturing processes, and organizations were suited to large size and efficient production in which employees were treated as just another

exploitable resource. Internal structures tended to be vertical, functional, and bureaucratic. The organization could use rational analysis and be guided by patriarchal values reflected in the vertical hierarchy and superior-subordinate power distinctions.

The new paradigm recognizes the unstable, even chaotic nature of the external environment. Technologies are typically nonroutine, and small size is as important as large size, with more emphasis on effectiveness and work cultures that empower employees and nurture a multicultural work force. In the new paradigm, organizations are based more on teamwork, clan control, face-to-face interactions, frequent innovations, and a learning approach. Qualities traditionally considered egalitarian – equality, empowerment, horizontal relationships, and consensus building – are particularly important in the new, organic paradigm" (Daft, 1995).

One theme that has been continuously investigated in the organizational literature is the relationship between environmental uncertainty and organizational structure. Researchers suggest that organizational structure is substantially determined by external environment (Pugh et al., 1969; Duncan, 1972; Hrebiniak and Snow, 1980, Lawrence and Lorsch, 1967; Miles et al., 1974; Bourgeois et al., 1978). They have further suggested that firms organized to deal with reliable and stable markets will not be as effective in a complex, rapidly changing environment (Gordon and Narayanan, 1984; Spekman and Stern, 1979). The more certain the environment, the more likely the firm's organizational structure will have a centralized hierarchy, with formalized rules and procedures (Lawrence and Lorsch, 1967). Organizations that operate with a high degree of environmental uncertainty will decentralize their hierarchical structure (Ruekert et al., 1985) and rely less on formal rules and policies (Jaworski, 1988; Nahavandi, 1993).

Researchers have also found that organizations, under threat, tend to adopt a rigid stance and enforce higher levels of control and resource conservation, even though this strategy may not be the most effective one (D'Aunno and Sutton, 1992; Hambrick and D'Aveni, 1988; Staw et al., 1981). According to Paswan et al. (1998), these results have caused some scholars (Schoonhoven, 1981) to "raise serious doubts regarding the causal links between environment and structure." They also mention that some researchers have proposed reciprocal links between environmental uncertainty and organizational structure. Researchers argue that as environmental characteristics become known to decision-makers through perceptual processing, such perceptions are fundamentally influenced by the structure within which the manager functions (Huber et al., 1975; Bourgeois et al., 1978; Child, 1972; Yasai-Ardekani, 1986; Miles et al., 1974). Based on these literatures, Paswan et al. (1998) have hypothesized that environmental uncertainty would increase bureaucratization (i.e., centralization in decision making) in the distribution channel structure, and their research results supports this claim. They do admit that results may be different if the research is directed toward inner organizational structure, not channel structure.

Researchers have defined multiple dimensions for organizational structure. A rather thorough list is provided by Daft (1995): formalization, specialization, standardization, hierarchy of authority, complexity, centralization, professionalism, and personnel ratios. Germain (1996) focuses on specialization, decentralization, and integration in describing the role of context and structure in adopting logistical innovations. Paswan et al. (1998) use formalization, centralization, and participation in explaining linkages among relationalism, environmental uncertainty, and bureaucratization in distribution channels. Koufteros and Vonderembse (1998) focus on centralization, formalization, and complexity in describing the impact of organizational structure on JIT attainment. Germain et al. (1994) focus on integration, performance control, specialization, and decentralization in their research on the effect of JIT selling on organizational structure. Lysonski et al. (1995) focus on degree of centralization of decision making, formalization of rules and procedures, and structural differentiation in their investigation of the environment uncertainty and organizational structure from a product management perspective.

2.3.2. Organizational Structure in Manufacturing Literature

In the manufacturing strategy literature, Swamidass and Newell (1987) have empirically demonstrated that environmental uncertainty is positively related to top management's pursuit of flexibility and centralized decision. In comparing the environment, strategy, structure and infrastructure of mass production organizations and flexible manufacturing organizations, Nemetz and Fry (1988) suggested that mechanistic structure is more fitting with the former, whereas organic structure is with the latter. Other researchers have also used the mechanistic-organic continuum (Burns and Stalker, 1961) in explaining the effect of FMT implementation on organizational structure (Parthasarthy and Sethi, 1992, 1993) and the role of organizational structure in AMT implementation success (Zammuto and O'Connor, 1992). Ward et al. (1996) have conceptualized the configuration of environment, structure, and strategic manufacturing capabilities along with organizations of four different competitive strategies, namely, niche differentiator, broad market differentiator, cost leader, and lean competitor.

The manufacturing strategy literature describes the relationships between external environment, strategy, technology and organizational structure. Child (1972) conceptually distinguishes the models of structural determination with models of structural variation, and argues that while the environment is not a direct source of variation in organizational structure, decision-makers' evaluation and action is (Child, 1972). This again raises the significance of dominant coalition's perspective on the external environment and their managerial beliefs and attitudes. While the actual external environment may not be in direct relationship with the organizational structure, dominant coalition's perspective on the nature of external environment and their managerial beliefs and attitudes would have a greater chance of being so.

In the post-industrial manufacturing literature, Doll and Vonderembse (1991) describes that workers are being organized in self-organizing and self-directed work groups so that they could learn from each other, response flexibly to changing markets, and provide value to customers. Walton (1985) explains that in the traditional control model of management, layering in hierarchy develops and is justified by control consideration. However, in the newly developed commitment model, the management system tends to be flat, relies upon shared goals for control and lateral coordination, bases influence on expertise and information rather than position, and minimizes status differences (Walton, 1985).

2.3.3. Identification of Sub-Constructs for Organizational Structure

The nature of external environment, as perceived by the managers and their managerial beliefs and attitudes, has a significant bearing upon organizational structure. Majority of the literature also suggests that the nature of organizational structure in industrial versus post-industrial firms could be distinguished as mechanistic (inorganic) versus organic (Daft, 1995; Lawrence and Lorsch, 1967; Nahavandi, 1993; Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992; Doll and Vonderembse, 1991). The following sub-constructs for organizational structure are developed with this distinction in mind. The list of five sub-constructs, along with their definitions and supporting literature, are shown in Table 2.3.

2.3.3.1. Locus of Decision Making

The "locus of decision making" is the degree to which decisions are made high versus low in the organizational hierarchy. Walton (1985) states firms operating under the control model of management emphasize management prerogatives and positional authority and allocate status symbols to reinforce the hierarchy. Firms operating in a uncertain environment, should delegate decision to the level where workers may quickly adjust to the changing situations and provide value to their customers (Doll and Vonderembse, 1991). When

Table 2.3. List of Sub-Constructs for Organizational Structure

Constructs	Definitions	Literature
Locus of Decision Making	The degree to which decision are made high versus low in the organizational hierarchy.	Daft, 1995; Doll and Vonderembse, 1991; Germain, 1996; Germain et al., 1994; Paswan et al., 1998; Ruekert et al., 1985; Swamidass and Newell, 1987; Walton, 1985
Degree of Discretion in Rules and Regulations	The degree to which workers are provided with rules and procedures that encourage versus deprive creative, autonomous work and learning.	Blau, 1970; Dewar and Werbel, 1979; Miner, 1982
Number of Layers in Hierarchy	The degree to which an organization has few versus many layers in hierarchy.	Walton, 1985
Level of Horizontal Integration	The degree to which departments and workers are integrated versus functionally specialized in their works, skills, and training.	Davenport and Nohria, 1994; Doll and Vonderembse, 1991; Gerwin and Kolodny, 1992; Vonderembse et al., 1997; Walton, 1985
Level of Communication	The degree to which vertical and horizontal communications are fast, easy, and abundant versus slow, difficult, and few.	Doll and Vonderembse, 1991; Walton, 1985

organizational uncertainty is high, strategic decision-making authority may be centralized (Swamidass and Newell, 1987; Paswan et al., 1998), but operational decision-making authority may be decentralized (Ruekert et al., 1985; Daft, 1995). The locus of decision-making for operating decisions may be high in industrial firms versus low in post-industrial firms.

2.3.3.2. Degree of Discretion in Rules and Regulations

The "degree of discretion in rules and regulations" is the degree to which workers are provided with rules and procedures that encourage versus deprive creative, autonomous work and learning. Organizational theory literature divide formalization as high versus low where a high level of formalization is related to mechanistic structure and a low level of formalization is related to organic structure. However, review of some literature (Dewar and Werbel, 1979; Blau, 1970; Miner, 1982) and structured interviews with several practitioners have revealed that depending on its nature, formalization may be restrictive or supportive of decentralization, flexibility and autonomous work. One manager claimed that even though ISO-9000 and ASQ-9000 have greatly increased the amount of formalization in terms of written rules and procedures, the nature of it has actually facilitated the decentralization of decision making authority to lower level operators.

2.3.3.3. Number of Layers in Hierarchy

The "number of layers in hierarchy" is the degree to which an organization has few versus many layers in hierarchy. Walton (1985) states that as firms are moving from control model to commitment model of management, management system tends to be flat, having few layers in hierarchy.

2.3.3.4. Level of Horizontal Integration

The "level of horizontal integration" is the degree to which departments and workers are integrated versus functionally specialized in their works, skills, and training. In accordance with the spirit of division of labor, industrial firms usually separate functional department so that work may be carried out in a sequential manner (Davenport and Nohria, 1994). In order to respond to the changing environment and to provide value to customers, workers and departments in post-industrial firms are being brought together in autonomous work teams, cross-functional teams, and task forces (Doll and Vonderembse, 1991; Gerwin and Kolodny, 1992; Walton, 1985; Davenport and Nohria, 1994). Workers are usually cross-trained so they understand the entire process better and are flexible to the changing needs of customers (Vonderembse et al., 1997).

2.3.3.5. Level of Communication

The "level of communication" is the degree to which vertical and horizontal communications are fast, easy, and abundant versus slow, difficult, and few. In a control model of management, vertical and horizontal communications would be slow, difficult, and few. As managers move towards commitment model of management, level of communications would naturally increase both vertically and horizontally (Walton, 1985). This becomes the basis of learning and responsiveness to customers (Doll and Vonderembse, 1991).

2.4. MANUFACTURING PRACTICES

Time, as a strategic variable, emerged from evolving manufacturing practices beginning with Frederick Taylor who proposed the use of time study to improve productivity. Each job was broken down into smaller elements, and each element had a standard time that was determined by experts (Niebel, 1988). Henry Ford successfully embedded these techniques into his auto assembly lines and developed the world's most efficient and timely system for producing cars (Bockerstette and Shell, 1993). Toyota developed a system capable of diversified, small quantity production to eliminate waste and reduce costs. The success of this production system brought about a revolution in manufacturing, the principles of JIT (Monden, 1983).

Time-based manufacturing focuses on time compression to improve responsiveness and enhance competitiveness (Koufteros et al., 1998). Time-based manufacturing and JIT address the same phenomena but with different emphases. "Time-based manufacturing is an externally focused production system that emphasizes quick response to changing customer needs. Its primary purpose is to reduce end-to-end time in manufacturing. Monden (1983) describes JIT as an internally focused production system that produces parts on demand. It eliminates unnecessary elements in production, and its primary purpose is cost reduction" (Koufteros et al., 1998: 22). Blackburn (1991) claims that JIT is the genesis of time-based competition as JIT innovators recognized its ability to increase flexibility and shorten response time. Koufteros et al. (1998) develop a framework for time-based manufacturing and define a set of seven practices. The constructs, definitions, and supporting literature are listed in Table 2.4.

2.4.1. Shop Floor Employee Involvement in Problem Solving

Involvement is an antecedent to reengineering setups, cellular manufacturing, preventive maintenance, quality improvement efforts, dependable suppliers, and pull production (Koufteros et al., 1998). Employee intelligence is critical to design and execute these practices to achieve rapid response and product variety.

2.4.2. Reengineering Setups

Monden (1983) suggests that setup time is a primary determinant of shop floor responsiveness. Compressed setup time permits firms to quickly switch between products and incur minimal penalties, thus increasing flexibility and enhancing responsiveness to changing customer needs (Ohno, 1988). Reengineering setups can eliminates wastes, which benefits customers directly through cost reductions.

2.4.3. Cellular Manufacturing

Cellular manufacturing enables firms to cut setup time, increase equipment utilization, and streamlines management. Group technology principles

Table 2.4. List of Sub-Constructs for Manufacturing Practices

Constructs	Definitions	Literature
Shop Floor Employee Involvement in Problem Solving	The extent to which first-level employees participate in activities to define and solve problems.	Hall, 1987, 1993; Huber and Brown, 1991; Showalter and Mulholland, 1992; Sugimori et al., 1977; Suzaki, 1987
Re-engineering Setups	The extent to which efforts are taken to reduce setup time.	Monden, 1981a, 1983; Schonberger, 1982, 1986; Shingo, 1985
Cellular Manufacturing	The extent to which units are produced in a product oriented layout.	Brown and Mitchell, 1991; Huber and Brown, 1991; Huber and Hyer, 1985; Hyer and Wemmerlow, 1984
Quality Improvement Efforts	The extent to which methods are developed and used to reduce defects and enhance quality.	Deming, 1981, 1982, 1986; Garvin, 1983; Juran, 1981; Saraph et al., 1989
Preventive Maintenance	The extent to which equipment is routinely maintained on a proactive basis.	Monden, 1983; Nakajima, 1988; Schonberger, 1986
Dependable Suppliers	The extent to which suppliers facilitate customer needs for service quality.	Ansari and Modaress, 1986, 1988; Lee and Ansari, 1985; O'Neal, 1987, 1989
Pull Production	The extent to which production is driven by demand from the next station and ultimately from the customer.	Monden, 1981b, 1983; Schonberger, 1983, 1986; Sugimori et al., 1977

are used to group parts with similar design characteristics and processing requirements. A cell is created that has the equipment needed to produce one or more groups. This reduces materials handling time and costs, reduces work-in-process inventory, and shortens throughput time (Hyer and Wemmerlov, 1984).

2.4.4. Quality Improvement Efforts

A central theme of quality management is to do things right the first time (Dean, 1994). Quality improvement efforts reduce throughput time, cut costs, and improve product performance (Juran, 1989).

2.4.5. Preventive Maintenance

Unreliable machines and processes lead to expanded throughput time, missed production deadlines, reduced product quality, and increased production costs. Scheduling preventive maintenance and allowing operators to complete it should increase equipment reliability and system availability (Bockerstette and Shell, 1993).

2.4.6. Dependable Suppliers

Shortages and quality problems in supplier parts are additional sources of production delay. Evidences show that dependable suppliers can help cut throughput time, increase quality, and improve manufacturing competitiveness (Cusumano and Takeishi, 1991; Blackurn, 1991; Handfield and Pannesi, 1992).

2.4.7. Pull Production

A pull production system signals production based on the demand at a succeeding workstation and ultimately from the final customer. Pull systems can greatly reduce the time parts stay in the system, especially the non-value-added waiting time, and it can speed parts to customers. (Monden, 1983; Schonberger, 1986).

2.5. THEORETICAL MODEL AND HYPOTHESES

This research focuses on the relationships among external environment, managerial beliefs and attitudes, organizational structure, and time-based manufacturing practices, as depicted in Figure 2.1. Firms operating in a post-industrial environment should have integrity-based/post-industrial managerial beliefs and attitudes, an organic/post-industrial structure, and time-based/post-industrial manufacturing practices. Based on this research design, the following six hypotheses are derived.

2.5.1. External Environment and Managerial Beliefs and Attitudes

That environment affects organization culture is obviously related to the claim that organizations, in general, are affected by their environments (Gordon, 1991). Such relationships are central, for instance, to the open-systems perspective advanced by Katz and Kahn (1966). The ties between organization and environment may be loosely coupled, as described by Weick (1979), Pfeffer and Salancik (1978), and Gordon (1991). However, the relationship is important to the extent that a company's survival and prosperity depends on whether it can develop culture and forms (strategies, structure, and processes) that are appropriate to the industry imperatives (Gordon, 1991).

Organizational literature has long-supported the notion that decision-maker's perception on environmental uncertainty has significant relationship with system characteristics (Lawrence and Lorsch, 1967; Duncan, 1972, 1973; Downey and Slocum, 1975; Van de Ven et al., 1976; Downey et al., 1977; Tung, 1979). As the external environment of manufacturing firms are perceived as having the characteristics of post-industrial, managers would move toward exhibiting integrative managerial beliefs and attitudes (Doll and Vonderembse, 1991; Vonderembse et al., 1997). However, as managers perceive their external environment as being industrial, they would maintain beliefs and attitudes that are more typical in an industrial organization.

Hypothesis 1: Firms operating in a post-industrial environment will exhibit a higher level of integrative managerial beliefs and attitudes than firms operating in an industrial environment.

2.5.2. External Environment and Organizational Structure

Another important system characteristic besides managerial beliefs and attitudes is organization structure. This research is consistent with the stream of research that suggests that organizational structure is substantially determined by external environment (Pugh et al., 1969; Duncan, 1972; Hrebiniak and Snow, 1980, Lawrence and Lorsch, 1967; Miles et al., 1974; Bourgeois et al., 1978; Child, 1975). It is generally argued that increased uncertainty makes an administrative task more complex and non-routine (Miller and Dröge, 1986). This, in turn, is said to require less formalized and more flexible structures (Burns and Stalker, 1961), a more complex and diverse array of departments and roles (Lawrence and Lorsch, 1967), more intensive face-to-face liaison devices to promote collaboration and resolve differences (Galbraith, 1973), and more power delegated to lower-level managers who specialize in certain complex tasks (Burns and Stalker, 1961). As stated by Miller and Dröge (1986), the relationships have received enough attention to warrant further investigation, although past researches on these relationships did not enjoy consistent empirical support (Mintzberg, 1979).

Manufacturing literature have generally supported the notion that organic structure is more fitting in the context of high environment uncertainty and high degree of competition, whereas inorganic/mechanistic structure is plausible in a stable environment with low degree of competition (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992; Ward et al., 1996). Swamidass and Newell (1987) have empirically demonstrated that environmental uncertainty is positively related to top management's pursuit of flexibility. Nemetz and Fry (1988) suggested that mechanistic structure is more fitting with mass production strategy in a stable environment, whereas organic structure is with flexible manufacturing strategy in a turbulent environment.

Ward et al. (1996) have conceptualized that in forming appropriate manufacturing strategy, it is important to have a fit between the nature of external environment and organizational structure. Doll and Vonderembse (1991) describes that workers are being organized in self-organizing and self-directed work groups so that they could learn from each other and response flexibly to the changing markets. Walton (1985) explains that in the newly developed commitment model of management, the management system tends to be flat, relies upon shared goals for control and lateral coordination, bases influence on expertise and information rather than position, and minimizes status differences, which are all important elements of organizational structure.

Hypothesis 2: Firms operating in a post-industrial environment will exhibit a higher level of organic organizational structure than firms operating in an industrial environment.

2.5.3. External Environment and Manufacturing Practices

Koufteros et al. (1998) states that expanding global competition, rapidly changing markets, and the worldwide spread of advanced manufacturing technology are creating a complex and uncertain environment (Bayus, 1994; Lawrence and Dyer, 1983; Manufacturing Studies Board, 1986). Confronted with this changes in environment, manufacturing firms face a paradigm shift from industrial systems, driven by efficiency, to post-industrial systems, driven by quick response to customer demands for a variety of high-quality products (Doll and Vonderembse, 1991; Hayes et al., 1988; Huber, 1984; Naisbitt, 1982; Skinner, 1985). Time is becoming the next competitive battle-ground (Blackburn, 1991).

Time-based manufacturing is one weapon for time-based competitors (Koufteros et al., 1998). Success in the post-industrial environment hinges on satisfying multiple performance measures as enterprises anticipate markets and respond quickly and efficiently with products that provide high value to customers (Doll and Vonderembse, 1991; Koufteros, 1995). As managers perceive their environment as having the characteristics of a post-industrial environment, manufacturing firms will move toward adopting time-based manufacturing practices. However, as managers who perceive their environment as being post-industrial would be less motivated to change their manufacturing practices.

Hypothesis 3: Firms operating in a post-industrial environment will exhibit a higher level of time-based manufacturing practices than firms operating in an industrial environment.

2.5.4. Managerial Beliefs and Attitudes and Manufacturing Practices

Vast amount of organizational and manufacturing literature points out to the importance of top and middle management support for successful implementation of TQM (Saraph et al., 1989; Rao et al., 1993; Adam et al, 1994; Ahire et al., 1996), AMT/CIM/CAD/CAM (Ramamurthy and King, 1992; Twigg et al., 1992; Chen and Small, 1994; Beatty and Lee, 1992), and implementation of organizational innovation in general (Nutt, 1986). Likewise, time-based manufacturing practices cannot exist in a vacuum; it must come from the supporting managerial beliefs and attitudes.

Adoption of commitment model of management, as advocated by Walton (1985), would facilitate time-based manufacturing practices. Prevalence of control model, however, would have an adversarial effect on them. It seems all too reasonable, therefore, to hypothesize the significant, positive relationship between integrative managerial beliefs and attitudes and time-based manufacturing practices. In firms where their managerial beliefs and attitudes are more industrial in nature, we assume that we will see less degree of time-based manufacturing practices in place.

Hypothesis 4: Firms having a higher level of Integrative managerial beliefs and attitudes will exhibit a higher level of time-based manufacturing practices than firms having a lower level of integrative managerial beliefs and attitudes.

2.5.5. Organizational Structure and Manufacturing Practices

Manufacturing literature has generally supported the notion that organic structure is more fitting for the implementation of flexible manufacturing (Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993), AMT implementation (Zammuto and O'Connor, 1992), and strategic pursuit of lean manufacturing (Ward et al., 1996). In general, the literature is in agreement that having an appropriate organizational structure is an important factor for successful implementation of hard and soft manufacturing technologies.

It seems reasonable to assume, therefore, that organic structure will have a significant, positive relationship with time-based manufacturing practices. However, in firms that have inorganic/mechanistic structure, we assume that we will see less degree of time-based manufacturing practices in place.

Hypothesis 5: Firms having a higher level of organic organizational structure will exhibit a higher level of time-based manufacturing practices than firms having a lower level of organic organizational structure.

2.5.6. Managerial Beliefs and Attitudes and Organizational Structure

Organizational literature has long held the view that organizational culture shapes the character of (Morgan, 1986), and the way things get done in, an organization (Smircich, 1985; Deal and Kennedy, 1982). Schein (1986, 1992) states that there are three different levels of cultural phenomena in organizations. At the surface we have the level of *artifacts,* which are visible organizational structures and processes. Below this is the level of *espoused values*, which are manifested as strategies, goals, and philosophies, and their espoused justifications. Even below that is the level of *basic underlying assumptions*, which are unconscious, taken-for-granted beliefs, perceptions, thoughts, and feelings. Schein (1992) further states, "the essence of a culture lies in the pattern of basic underlying assumptions, and once one understands those, one can easily understand the other more surface levels and deal appropriately with them." This implies that three levels of cultural phenomena are interrelated among themselves.

Using Schein's (1992) classification, managerial beliefs and attitudes are at the level of *espoused values*, whereas organizational structure is at the level of *artifacts*, the very surface level of cultural phenomena in an organization. Organizational structure can be thought of as an external expression of a firm's managerial beliefs and attitudes. Therefore, integrative managerial beliefs and attitudes will have a significant, positive relationship with organic structure. Firms in which their managers possess more of an industrial mindset would exhibit inorganic/mechanistic structure.

Hypothesis 6: Firms having a higher level of Integrative managerial beliefs and attitudes will exhibit a higher level of organic organizational structure than firms having a lower level of integrative managerial beliefs and attitudes.

CHAPTER 3: INSTRUMENT DEVELOPMENT PHASE I: ITEM GENERATION AND PILOT STUDY

Recently, there has been a growing interest in empirical research in operations management (Melnyk and Handfield, 1998). For instance, the Journal of Operations Management has recently dedicated one whole issue on empirical research (Volume 16, Issue 4, July 1998). Researchers are called to build the operations management theory through survey (Malhotra and Grover, 1998), case study and field research (Meredith, 1998). Empirical assessment of construct validity (O'Leary-Kelly and Vokurka, 1998) and scale development techniques (Hensley, 1999) are also gaining interest.

In this research, the development of instruments was carried out in three stages. In the pre-pilot stage, potential items were generated through theory development and a literature review. Items were examined and evaluated through structured interviews and the Q-sort methodology. Then a pre-test was completed using experts from academia and industry. Many discussions were carried out among dissertation committee members to reach a confident level of content validity for each sub-construct of the first three variables. The second stage was the examination of reliability and validity of measurement items using data collected through a pilot study. The third stage, reported in the next chapter, was the exploratory data analysis from a large-scale survey.

3.1. ITEM GENERATION

The purpose of item creation was to generate a pool of items that would cover the sampling domain of each dimensions / sub-constructs (Churchill, 1979). The emphasis was placed on ensuring content validity (Nunally, 1967). Determination of content validity is subjective.

Item generation was first carried out by searching the literature for existing items that may possibly fit into the sub-constructs identified in the previous chapter. When no such items were found, measurement items were constructed from scratch. Definitions of sub-constructs, as provided in Tables 2.1 to 2.4, were utilized in this process, as well as theoretical discussions from the supporting literature.

The measurement items developed through this process ask respondents to indicate the extent to which the statement is true or false in his/her company. A five-point Likert scale was used with the anchors being "1 = Not at all" and "5 = To a great extent."

3.1.1. Item Generation for External Environment

The most widely used construct in the literature for external environment is environmental uncertainty (Milliken, 1987). Buchko (1994) states that his review of the literature indicated persistent difficulties in measuring the construct. Lawrence and Lorsch's (1967) measure focuses on a particular job or function within an organization, making it inappropriate for use when the unit of analysis is an organization (Milliken, 1987; Buchko, 1994). Duncan's (1972) scale consists of two dimensions: complexity and dynamism. However, empirical assessments by Downey et al. (1975) and Tosi et al. (1973) have revealed significant weaknesses of measurement properties of these scales (Buckho, 1994).

Miller and Dröge (1986), Germain et al. (1994), Germain (1996) and Pagell and Krause (1999) use a simplified scale (4 or 5 items for environmental uncertainty). Some of their items were used in this research as the basis of creating new items for product life cycle and number of customer requirements sub-constructs. Paswan et al.'s (1998) scales were worded in general terms, making them widely applicable and robust in diverse areas of research. However, the scales had some limitations in adequately capturing the manufacturing specific aspects of external environment. Ganesan's (1994) scales had the strength of being worded in more marketing specific terms, fitting for their original research design. They had a limitation, though, of being applicable mainly for research in the field of marketing. Different research focus was also observed, such as Souder et al.'s (1998) and Damanpour's (1996) way of measuring environmental uncertainty through dichotomously measured scales (e.g., 1=high and 0=low), or Matthew and Scott's (1995) approach to measure the construct separately for environmental sectors, such as customers, suppliers, distributors, competitors, government, financial markets, etc.

As seen in this literature review, most of the existing scales did not fit with the definition of sub-constructs for external environment as provided in Table 2.1, or with the research design of this research. Therefore, new measurement items were constructed, using the definitions of sub-constructs and their supporting literature as provided in Table 2.1.

3.1.2. Item Generation for Managerial Beliefs and Attitudes

The managerial beliefs and attitudes construct corresponds with the *espoused values* level of organizational culture, according to Schein's (1992) classification. Searching the literature for questionnaire items that may be fitting for the sub-constructs of managerial beliefs and attitudes resulted in similar difficulties as was with external environment: Most of the measurement items appeared to be either too general for use in this research, or were measuring different constructs.

The Organizational Culture Profile (OCP) by O'Reilly et al. (1991) and the Organizational Culture Inventory (OCI) by Cooke and Szumal (1993) appear to be very general in their definitions and wordings. While having the strength of being robust, they did not seem to be fitting for use in this particular research. This was also the case with the Culture Gap Survey by Kilman and Saxton (1983), the Organizational Beliefs Questionnaire by Sashkin (1984), and the Corporate Culture Survey by Glaser (1983). Xenilkou and Furnham (1996) went through a correlational and factor analytic study of four questionnaire measures of organizational culture (OCI by Cooke and Lafferty, 1989; Culture Gap Survey by Kilman and Saxton, 1983; Organizational Beliefs Questionnaire by Sashkin, 1984; Corporate Culture Survey by Glaser, 1983), and report that there was quite an amount of overlap among these scales. This result indicates that the limitation OCI had for this research applies to other three measures as well.

Sub-constructs and measurement items that appeared to be more similar to this research were found in Taylor and Bowers (1972), Sakakibara et al. (1997), and Bates et al. (1995). Sub-constructs such as "supervisors as team leaders" and "small group problem solving" from their studies were very similar to "management mechanism" and "organization of work" sub-constructs in this research, so their measurement items were modified and included in this research, as well as being used as the basis of creating new additional items. For most of the remaining sub-constructs, new measurement items were constructed, using their definitions and their supporting literature as provided in Table 2.2.

3.1.3. Item Generation for Organizational Structure

Ford and Slocum (1976) have stated that there seems to be some agreement that the three main dimensions of structure are complexity, formalization, and centralization. Most of the measurement items that researchers have developed over the years appear to be within this stream of research. The construct of "decentralization" was understood as reverse of centralization (Miller and Dröge, 1986). Often times "specialization" was included, depending on the research design (Miller and Dröge, 1986; Germain et al., 1994; Germain, 1996).

Miller and Dröge (1986) measured decentralization by having the respondents answer to the appropriate level that has the authority to decide on a list of decisions, the method that was also used in Germain et al. (1994) and

Germain (1996). Miller and Dröge (1986) measured formalization through several dichotomously measured scales (i.e., Yes/No).

Paswan et al. (1998), Bates et al. (1995), and Hayes (1994) used perceptual measures (1=strongly agree and 5=strongly disagree, or 1=always and 5=never) to measure constructs such as centralization, formalization, participation, communication, and empowerment. It was in these perceptual measures that similarity in definitions was found with the sub-dimensions of organizational structure in this research. Thus, these measures were adapted or used as basis for constructing questionnaire items for locus of decision-making (Hayes, 1994; Paswan et al., 1998), level of communication (Bates et al., 1995), and degree of discretion in rules and regulations (Paswan et al., 1998). New measurement items were constructed, using the definitions and their supporting literature as provided in Table 2.3.

3.1.4. Item Generation for Manufacturing Practices

All of the sub-constructs in manufacturing practices variable were brought in directly from Koufteros (1995) and Koufteros et al. (1998). Similar items for set-up time reduction and pull system were also found in Sakakibara et al. (1997) and McLachlin (1997).

3.2. STRUCTURED INTERVIEWS

Once the item pools were created, items for the various sub-constructs were re-evaluated through structured interviews with practitioners from five different manufacturing firms. The focus was to check the relevance of each sub-construct's definition and clarity of words. Since the measurement items for time-based manufacturing practice were adopted from Koufteros (1995) and Koufteros et al. (1998), only the measurement items for the sub-constructs of the first three variables were reevaluated. The interviewees were:

- An owner / CEO of a small, mechanical engineering firm
- A line supervisor of a major windows manufacturing firm
- A senior engineer of a mid-size mechanical engineering firm
- A senior engineer of a global oil refinery firm
- A senior line supervisor of a major automobile firm's transmission plant

Based on their feedback, redundant or ambiguous items were either modified or eliminated. New items were added whenever deemed necessary. The list of items developed for external environment, managerial beliefs and attitudes, and organizational structure is reported on Appendix A. The result was the following number of items in each pool entering a Q-sort analysis.

External Environment		
Level of Market Heterogeneity	10	
Degree of Market Segmentation	8	
Length of Product Life Cycle	10	
Driving Force for Manufacturing Technology	10	
Number of Customer Requirements	10	
Sub-Total		48
Managerial Beliefs and Attitudes		
Goals for Investing in Facilities and Equipment	10	
Organization of Work	10	
Scope in Decision Making	11	
Management Mechanism	10	
Focus of Managerial Tasks	10	
Focus of Supplier Relationships Management	10	
Sub-Total		61
Organizational Structure		
Locus of Decision Making	12	

Degree of Discretion in Rules and Regulations	10	
Number of Layers in Hierarchy	8	
Level of Horizontal Integration	12	
Level of Communication	12	
Sub-Total		54
<u>Total</u>		163

3.3. THE Q-SORT METHOD

Items placed in a common pool were subjected to two Q-sorting rounds by two independent judges per round. The objective was to pre-assess the convergent and discriminant validity of the scales by examining how the items were sorted into various sub-construct categories.

The basic procedure was to have practitioners from industry act as judges and sort the items into separate sub-constructs, based on similarities and differences among items. An indicator of construct validity was the convergence and divergence of items within the categories. If an item was consistently placed within a particular category, then it was considered to demonstrate convergent validity with the related construct, and discriminant validity with the others. Analysis of inter-judge disagreements about item placement identified both bad items as well as weaknesses in the original definitions of constructs. Based on the misplacements made by the judges the items could then be examined and inappropriately worded or ambiguous items could be either modified or eliminated.

Two judges for the first round were from the group that participated in the structured interview, and the second two judges were new judges who were not involved previously. The judges were:

- An owner / CEO of a small, mechanical engineering firm (1st round)
- A line supervisor of a major windows manufacturing firm (1st round)
- A plant manager of a 1st tier automobile parts supplier (2nd round)
- A senior engineer of a major automobile assembly plant (2nd round)

3.3.1. Sorting Procedures

Each item was printed on a 3 x 5 -inch index card. The cards were shuffled into random order for presentation to the judges. Each judge sorted the cards into categories. A "not available" category definition was included to ensure that the judges did not force any item into a particular category. Prior to sorting the cards, the judges were briefed with a standard set of instructions. Judges were allowed to ask as many questions as necessary to ensure they understood the procedure.

3.3.2. Inter-Rater Reliabilities

To assess the reliability of the sorting conducted by the judges, three different measures were made. First, for each pair of judges in each sorting step, the inter-judge raw agreement scores were calculated. This was calculated by counting the number of items that both judges agree to place on certain categories. An item was included as item with agreement, though the category in which the item was sorted together by both judges may not be the originally intended category. Second, item placement ratios were calculated by counting all the items that were correctly sorted into the theoretical category by each of the judges, and dividing them by twice the total number of items. Third, the level of agreement between the two judges in categorizing the items was measured using Cohen's Kappa (Cohen, 1960). This index is a method of eliminating chance agreements, thus evaluating the true agreement score between two judges. A description of the Cohen's Kappa concept and methodology is included in Appendix B.

3.3.3. Results of First Sorting Round

In the first round, the inter-judge raw agreement scores averaged 0.74 (Table 3.3.3.1), the initial overall placement ratio of items within the target constructs was 84 % (Table 3.3.3.2), and the Kappa scores averaged 0.73. A summary of the first round inter-judge agreement indices is shown in Table 3.3.3.3. Following the guidelines of Landis and Koch (1977) for interpreting the Kappa coefficient, the value of 0.73 indicates a moderate, but almost excellent level of agreement beyond chance for the judges in the first round. This value is slightly lower than the value for raw agreement, which is 0.74 (Table 3.3.3.1). The level of item placement ratios averaged 84%. For instance, the lowest item placement ratio value was 67% for the "level of communication" sub-construct, indicating a low degree of construct validity. On the other hand, several sub-constructs ("driving force for manufacturing technology" and "number of layers in hierarchy") obtained a 100% item placement ratio, indicating a high degree of construct validity.

Table 3.3.3.1. Inter-Judge Raw Agreement Scores: First Sorting Round

	Judge 1																
Judge 2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	NA
1	6	2			1												
2		6			1												
3			8	1													
4				11													
5	2			1	9												
6						6											
7						1	5	3	1	1							
8							4	6	3	1							
9							1		7								
10						1				8	1						
11								1			9						
12												8		2			
13												2	9		2		
14														8			
15												1	1		10		
16														3	2	5	1
NA							1	1									

Total Items Placement: 163	Number of Agreements:121	Agreement Ratio: 0.74

1. Level of market heterogeneity
2. Degree of market segmentation
3. Length of product life cycle
4. Driving force for manufacturing technology
5. Number of customer requirements
6. Goals for investing in facilities and equipment
7. Organization of work
8. Scope in decision making
9. Management mechanism
10. Focus of managerial tasks
11. Focus of supplier relationships management
12. Locus of decision making
13. Degree of discretion in rules and regulations
14. Number of layers in hierarchy
15. Level of horizontal integration
16. Level of communication

Table 3.3.3.2. Items Placement Ratios: First Sorting Round

	Actual Categories																		
Theoretical		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	NA	T	%
	1	16	1			3													20	80%
	2	1	14			1													16	88%
	3			17	3														20	85%
	4				20														20	100%
	5				1	19													20	95%
	6						14	2			2	2							20	70%
	7							15	3	2									20	75%
	8							5	16									1	22	73%
	9								3	16								1	20	80%
	10								2	1	17								20	85%
	11								1		1	18							20	90%
	12												19	3	2				24	79%
	13												1	18		1			20	90%
	14														16				16	100%
	15												1	1		22			24	92%
	16													1	3	3	16	1	24	67%
Total Items Placement: 326							Number of Hits: 273						Overall Hit Ratio: 84%							

1. Level of market heterogeneity
2. Degree of market segmentation
3. Length of product life cycle
4. Driving force for manufacturing technology
5. Number of customer requirements
6. Goals for investing in facilities and equipment
7. Organization of work
8. Scope in decision making
9. Management mechanism
10. Focus of managerial tasks
11. Focus of supplier relationships management
12. Locus of decision making
13. Degree of discretion in rules and regulations
14. Number of layers in hierarchy
15. Level of horizontal integration
16. Level of communication

Table 3.3.3.3. Inter-Judge Agreements

Agreement Measure	Round 1	Round 2
Raw Agreement	**0.74**	**0.80**
Cohen's Kappa	**0.73**	**0.78**
Placement Ratio Summary		
Level of market heterogeneity	80%	86%
Degree of market segmentation	88%	93%
Length of product life cycle	85%	81%
Driving force for manufacturing technology	100%	95%
Number of customer requirements	95%	85%
Goals for investing in facilities and equipment	70%	100%
Organization of work	75%	93%
Scope in decision making	73%	69%
Management mechanism	80%	86%
Focus of managerial tasks	85%	94%
Focus of supplier relationships management	90%	100%
Locus of decision making	79%	83%
Degree of discretion in rules and regulations	90%	100%
Number of layers in hierarchy	100%	81%
Level of horizontal integration	92%	91%
Level of communication	67%	75%
Average	**84%**	**88%**

In order to improve the Cohen's Kappa measure of agreement, an examination of the off-diagonal entries in the placement matrix (Table 3.3.3.2) was conducted. Any ambiguous items (fitting in more than one category) or too indeterminate items (fitting in no category) were either deleted or reworded. Overall, 29 items were deleted, and 25 items were reworded. The remaining number of items for each sub-construct after the first round of Q-sort was as follows:

External Environment		
Level of Market Heterogeneity	7	
Degree of Market Segmentation	7	
Length of Product Life Cycle	8	
Driving Force for Manufacturing Technology	10	
Number of Customer Requirements	10	
Sub-Total		42
Managerial Beliefs and Attitudes		
Goals for Investing in Facilities and Equipment	7	
Organization of Work	7	
Scope in Decision Making	8	
Management Mechanism	7	
Focus of Managerial Tasks	8	
Focus of Supplier Relationships Management	10	
Sub-Total		47
Organizational Structure		
Locus of Decision Making	9	
Degree of Discretion in Rules and Regulations	9	
Number of Layers in Hierarchy	8	
Level of Horizontal Integration	11	
Level of Communication	8	
Sub-Total		45
Total		134

3.3.4. Results of Second Sorting Round

Again, two judges were involved in the second sorting round, which included the reworded items developed after the first sorting round. In the second round the inter-judge raw agreement scores averaged 0.80 (Table 3.3.4.1), the initial overall placement ratio of items within the targets constructs was 88 % (Table 3.3.4.2), and the Kappa scores averaged 0.78. A summary of the second round inter-judge agreement indices is shown in the second column of Table 3.3.3.3. The value for Kappa coefficient of 0.78 is higher than the value obtained in the first round, and indicates an excellent fit, based on the guidelines of Landis and Koch (1977) for interpreting the Kappa coefficient. The level of item placement ratios averaged 88%. The lowest item placement ratio value was that of 69% for the "scope in decision making" sub-construct, indicating a low degree of construct validity. Again several sub-constructs ("goals for investing in facilities and equipment," "focus of supplier relationships management," and "degree of discretion in rules and regulations") obtained a 100% item placement ratio, indicating a high degree of construct validity.

In order to further improve convergent and discriminant validity, an examination of the off-diagonal entries in the placement matrix (Table 3.3.4.2) was conducted. Again, any ambiguous items (fitting in more than one category) or too indeterminate items (fitting in no category) were either deleted or reworded. Overall, 29 items were further deleted, and 15 items were reworded. The remaining number of items for each sub-construct after the second round of Q-sort was as follows:

Table 3.3.4.1. Inter-Judge Raw Agreement Scores: Second Sorting Round

		Judge 3																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	NA
Judge 4	1	5	1			1												
	2	1	6															
	3		1	6	1													
	4				10													
	5				1	7												2
	6						7				1							
	7							6	3	1								
	8								3		1	1						
	9								2	5								
	10										7							
	11											10						
	12												7			1		
	13												2	9		1		
	14												1		5			
	15													1		9		
	16													1		1	5	
	NA														2			
Total Items Placement: 134						Number of Agreements:107							Agreement Ratio: 0.80					

1. Level of market heterogeneity
2. Degree of market segmentation
3. Length of product life cycle
4. Driving force for manufacturing technology
5. Number of customer requirements
6. Goals for investing in facilities and equipment
7. Organization of work
8. Scope in decision making
9. Management mechanism
10. Focus of managerial tasks
11. Focus of supplier relationships management
12. Locus of decision making
13. Degree of discretion in rules and regulations
14. Number of layers in hierarchy
15. Level of horizontal integration
16. Level of communication

Table 3.3.4.2. Items Placement Ratios: Second Sorting Round

Theoretical	Actual Categories																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	NA	T	%
1	12	1			1													14	86%
2	1	13																14	93%
3		1	13	2														16	81%
4			1	19														20	95%
5				1	17												2	20	85%
6						14												14	100%
7							13		1									14	93%
8							3	11		1	1							16	69%
9								2	12									14	86%
10						1				15								16	94%
11											20							20	100%
12												15	2		1			18	83%
13													18					18	100%
14												1		13			2	16	81%
15													2		20			22	91%
16												2	1		1	12		16	75%

Total Items Placement: 268 | Number of Hits: 237 | Overall Hit Ratio: 88%

1. Level of market heterogeneity
2. Degree of market segmentation
3. Length of product life cycle
4. Driving force for manufacturing technology
5. Number of customer requirements
6. Goals for investing in facilities and equipment
7. Organization of work
8. Scope in decision making
9. Management mechanism
10. Focus of managerial tasks
11. Focus of supplier relationships management
12. Locus of decision making
13. Degree of discretion in rules and regulations
14. Number of layers in hierarchy
15. Level of horizontal integration
16. Level of communication

External Environment		
Level of Market Heterogeneity	5	
Degree of Market Segmentation	6	
Length of Product Life Cycle	7	
Driving Force for Manufacturing Technology	7	
Number of Customer Requirements	7	
Sub-Total		32
Managerial Beliefs and Attitudes		
Goals for Investing in Facilities and Equipment	7	
Organization of Work	7	
Scope in Decision Making	5	
Management Mechanism	7	
Focus of Managerial Tasks	7	
Focus of Supplier Relationships Management	7	
Sub-Total		40
Organizational Structure		
Locus of Decision Making	6	
Degree of Discretion in Rules and Regulations	7	
Number of Layers in Hierarchy	6	
Level of Horizontal Integration	8	
Level of Communication	6	
Sub-Total		33
Total		105

At this point, we stopped the Q-sort method at round two, for the raw agreement score of 0.80, Cohen's Kappa of 0.78, and the average placement ratio of 88% were considered as an excellent level of inter-judge agreement, indicating high level of reliability and construct validity.

3.4. PRE-TESTING OF QUESTIONNAIRE

Having generated 105 questionnaire items for the three major variables, these items were again distributed to eight reviewers (six from the academia and two from industrial companies), who reviewed each item and indicated either to keep, delete, or modify. The focus of analysis was to assess whether the items were thought of measuring the proposed sub-constructs according to the definitions provided, and if any additional domain needs to be covered.

Based on the feedback from these eight reviewers, 4 items were further deleted, 27 items were modified, and 10 new items were added. As a result, the number of items for each sub-construct was as follows:

External Environment		
Level of Market Heterogeneity	5	
Degree of Market Segmentation	8	
Length of Product Life Cycle	5	
Driving Force for Manufacturing Technology	7	
Number of Customer Requirements	7	
Sub-Total		32
Managerial Beliefs and Attitudes		
Goals for Investing in Facilities and Equipment	7	
Organization of Work	8	
Scope in Decision Making	5	
Management Mechanism	7	
Focus of Managerial Tasks	10	
Focus of Supplier Relationships Management	9	
Sub-Total		46
Organizational Structure		
Locus of Decision Making	5	
Degree of Discretion in Rules and Regulations	9	
Number of Layers in Hierarchy	5	
Level of Horizontal Integration	8	
Level of Communication	6	
Sub-Total		33
Total		111

Added to this were 9 items for contextual variables, 33 items for time-based manufacturing practices, and 13 performance variables. These questionnaire items were adopted from Koufteros (1995), Tracey (1996), and Rondeau (1997). Overall, 166 questionnaire items were ready to be sent out for pilot survey. The measurement items for 9 contextual variables and 13 performance variables are listed in Appendix C. Measurement items used in the pilot study for the external environment, managerial beliefs and attitudes, organizational structure, and manufacturing practices can be found in Table 3.5.2.1.1, Table 3.5.2.2.1, Table 3.5.2.3.1, and Table 3.5.2.4.1, respectively, in the following section.

3.5. PILOT STUDY

Prior to the administration of a large-scale survey, a pilot survey was carried out. A pilot study provides a final opportunity to find problem items and remove “bugs” from the instrument. It also provides a vehicle for assessing preliminary reliability and validity of the measurement scales.

The 166 questionnaire items developed in the previous stage were administered to a sample of 500 manufacturing executives/managers who represent the target respondents. They were from four industries: SIC codes 34-37 "Fabricated metal products," "Industrial machinery and equipment," "Electronic and other electric equipment," and “Transportation equipment." The company size ranged from small to large, but only the companies with 100 or more employees were included in the sample. The sample list of 3,500 was obtained through the Society of Manufacturing Engineers (SME). The pilot study participants were randomly selected from this list. The pilot survey was administered twice, resulting in 40 responses (response rate: 8%).

3.5.1. Methods for Pilot Study

Once the data was collected, it was analyzed with the following objectives in mind: purification, unidimensionality, reliability, convergent and discriminant validity if measurement items. The methods that were used for each analysis are: corrected-item to total correlation (CITC) (for purification), exploratory factor analysis (for the internal rule of unidimensionality), Cronbach's alpha (for reliability), and correlation analysis (for convergent and discriminant analysis).

The need to purify the items (i.e., getting rid of "garbage items") before administering factor analysis is emphasized by Churchill (1979). When items are put into factor analysis before going through the purification, factor analysis tends to result in multiple dimensions, making the interpretation of each factor difficult. Purification was carried out through corrected-item total correlation (each item's correlation with the sum of other items in its category). Items were deleted if their corrected-item total correlation score was below 0.5, unless there are clear reasons for keeping the items in spite of low item total correlation.

After purifying the items, an exploratory factor analysis of the remaining items in each category was conducted to assess the internal rule of unidimensionality of the retained items. The purpose is to eliminate items that were not factorially pure (Weiss, 1970). Items that were not factorially pure (loading on more than one factor at 0.40 or above) were considered as candidates for elimination. The items in each category were assumed to be measures of the same construct. If a factor analysis reveals more than one factor, it had to be determined whether to eliminate the additional factors or conclude that the construct is more complex than originally anticipated.

Once dimensionality was determined, the reliability (internal consistency) of the remaining items comprising each dimension was examined using Cronbach's alpha, as recommended for empirical research by Flynn et al. (1990). Items were eliminated if deleting of such items would result in close to or higher than 0.8 alpha score and the content of the scale was not significantly altered. Following the guidelines established by Nunnally (1978), a higher than 0.7 for alpha was pursued in maintaining or deleting questionnaire items, although in certain cases, alpha level of 0.5 to 0.6 was also regarded as adequate, considering the exploratory nature of this work.

Finally, convergent and discriminant validity were assessed through correlation analysis. For a scale to have convergent validity, inner-scale item-to-item correlations should be statistically significant. Discriminant validity was assessed at the item-level using a single-method, multiple-trait approach (Campbell and Fiske, 1959). This method compares the minimum inner-scale item-to-item correlation with the correlations of item to outer-scale-items. If the number of "violations" (i.e., cases where correlation of item to outer-scale-items being higher than the minimum inner-scale item-to-item correlation) is less than half of all comparisons, we determine that the scale has discriminant validity.

3.5.2. Results of Pilot Study

In presenting the results of pilot study, the following acronyms were used to number the questionnaire items in each sub-construct. These acronyms are also listed in Appendix D.

	<u>External Environment</u>
E/MH	Level of Market Heterogeneity
E/MS	Degree of Market Segmentation
E/LC	Length of Product Life Cycle
E/DT	Driving Force for Manufacturing Technology
E/CR	Number of Customer Requirements
	<u>Managerial Beliefs and Attitudes</u>
B/GI	Goals for Investing in Facilities and Equipment
B/OW	Organization of Work
B/DM	Scope in Decision Making
B/MM	Management Mechanism
B/FM	Focus of Managerial Tasks
B/SM	Focus of Supplier Relationships Management
	<u>Organizational Structure</u>
O/LD	Locus of Decision Making
O/NF	Degree of Discretion in Rules and Regulations
O/NL	Number of Layers in Hierarchy
O/HI	Level of Horizontal Integration
O/CO	Level of Communication
	<u>Manufacturing Practices</u>
M/EI	Shop-floor Employee Involvement in Problem Solving
M/RS	Reengineering Setups
M/CM	Cellular Manufacturing
M/QM	Quality Improvement Efforts
M/PM	Preventive Maintenance
M/SR	Dependable Suppliers
M/PP	Pull Production

3.5.2.1. External Environment Instrument

The analysis began with purification using the corrected-item total correlation (CITC) analysis. The CITCs for each item are shown in Table 3.5.2.1.1. In assessing the CITC, three sub-constructs "Degree of Market Segmentation," "Length of Product Life Cycle," and "Driving Force for Manufacturing Technology" were especially troublesome, for if all items with

Table 3.5.2.1.1. Purification for External Environment (Pilot)

Coding	Items	CITC-1	CITC-2
	Level of Market Heterogeneity: alpha = .79 (initial), .83 (final)		
E/MH1	**Our competitors are primarily U.S. companies (corporate headquarters located in U.S.). (reverse)**	**.72**	**.76**
E/MH2	**Our competitors are primarily foreign companies (corporate headquarters located in foreign countries).**	**.66**	**.72**
E/MH3	**Our competitors sell their products in a multinationial, global market.**	**.64**	**.59**
E/MH4	**Our products are sold in a multinational, global market.**	**.60**	**.60**
E/MH5	Our customers get their supplies from all over the world.	.30	-
	Degree of Market Segmentation: alpha = .73 (initial), .74 (final)		
E/MS1	Our market is divided into small market segments.	.38	-
E/MS2	Our market segments are being divided into smaller ones over the years.	.35	-
E/MS3	**The number of market segments is increasing over the years.**	**.43**	**.60**
E/MS4	**We have different market segments to serve.**	**.62**	**.58**
E/MS5	**We serve many, small market segments.**	**.49**	**.54**
E/MS6	Each of our market segments has distinctive characteristics.	.23	-
E/MS7	We offer many products.	.55	-
E/MS8	We have customers with specific needs.	.37	-
	Length of Product Life Cycle: alpha = .69 (initial), .73 (final)		
E/LC1	**Products last in the market for a long time in our industry (more than 5 years). (reverse)**	**.51**	**.59**
E/LC2	**Products quickly become obsolete in our industry.**	**.43**	**.67**
E/LC3	**Product life cycles are getting shorter in our industry.**	**.55**	**.42**
E/LC4	In our industry, we start developing next generation of products right after we introduce new products into the market.	.35	-
E/LC5	Our products rapidly go through the period of market introduction, growth, maturity, and decline in our industry.	.38	-
	Driving Force for Manufacturing Technology: alpha = .58 (initial), .73 (final)		
E/DT1	To produce few, standardized products in large volume if the goal of adopting manufacturing technology in our industry. (reverse)	.17	-
E/DT2	Firms with technology to produce few, standardized products in large volume are leaders in our industry. (reverse)	.27	-
E/DT3	**Firms with technology to produce variety of products efficiently are leaders in our industry.**	**.43**	**.49**
E/DT4	To be able to make frequent changes in set-up is one of the goals of adopting manufacturing technology in our industry.	.33	-
E/DT5	**To produce variety of products efficiently is the goal of adopting manufacturing technology in our industry.**	**.42**	**.60**
E/DT6	**To be able to respond quickly to design changes is one of the goals of adopting manufacturing technology in our industry.**	**.30**	**.48**
E/DT7	**To be able to respond quickly to volume changes in demand is one of the goals of adopting manufacturing technology in our industry.**	**.30**	**.53**

Table 3.5.2.1.1. Purification for External Environment (Pilot) (continued)

Coding	Items	CITC-1	CITC-2
	Number of Customer Requirements: alpha = .73 (initial), .69 (final)		
E/CR1	Our customers' requirements are quite simple. (reverse)	.39	-
E/CR2	**Our customers' requirements are always the same as before. (reverse)**	**.53**	**.48**
E/CR3	**Our customers' requirements are becoming more complicated over the years.**	**.63**	**.62**
E/CR4	**Our customers require satisfaction upon multiple criteria at the same time.**	**.51**	**.41**
E/CR5	Our customers are asking us to do more than before.	.32	-
E/CR6	**We have to do well in all areas to satisfy our customers.**	**.49**	**.43**
E/CR7	Our customers are now requiring dependable delivery, flexibility, and service, as well as low cost and high quality.	.34	-

Note: Items in bold were retained for further analysis.

CITC lower than 0.5 were to be deleted, the sub-construct would be left with less than two items. In case of "Degree of Market Segmentation," the problem was easily resolved, for when CITCs were recalculated after sequentially eliminating items with the lowest CITCs, three items (E/MS3, 4, and 5) resulted in higher than 0.50.

Applying the same approach, "Length of Product Life Cycle" also resulted in three items (E/LC1, 2, and 3), although E/LC3 resulted in a CITC score of 0.42 in its final run. Careful examination of the item did not reveal any particular reason for this, and the item was retained in order to ensure that each sub-construct has at least three measurement items. The level of Cronbach's alpha for the three items was 0.73, an improvement from initial level of 0.69, providing certain level of confidence with the reliability of the scale. In case of "Driving Force for Manufacturing Technology," four items (E/DT3, 5, 6, and 7) were retained, although the recalculation of CITC for E/DT3 and 6 resulted in slightly lower than 0.50 (0.49 and 0.48, respectively), for the overall alpha resulted in 0.73, a significant improvement from the initial level of 0.58. In a similar case, four items (E/CR2, 3, 4, and 6) were retained for "Number of Customer Requirements," although the recalculation of CITC for E/CR2, 4, and 6 resulted in lower than 0.50 (0.48, 0.41, and 0.43, respectively), for the overall alpha score resulted in 0.69.

The factor analyses of the retained items in each of the scales are shown in Table 3.5.2.1.2. All of the retained items for each scale loaded on to a single factor, indicating unidimensionality within each block of items. The lowest factor loading score was 0.67 for item E/CR4. Since all of the scales loaded on to a single factor, recalculation of Cronbach's alpha for newly discovered dimensions was unnecessary; the final alpha scores reported in Table 3.5.2.1.1 were accepted as the final level of reliability for each scale.

Next, a correlation matrix (Table 3.5.2.1.3) of the 18 items retained for further assessment was examined for evidence of convergent and discriminant validity. The smallest within sub-construct (factor) correlations were: level of market heterogeneity = 0.388 ($p<0.01$), degree of market segmentation = 0.463 ($p<0.01$), length of product life cycle = 0.334 ($p<0.05$), driving force for manufacturing technology = 0.296 ($p<0.05$), and number of customer requirements = 0.222 ($p<0.1$). All were significantly different from zero at $p<0.01$ or $p<0.05$, except for number of customer requirements, which had a p-score of 0.087. The magnitude of the correlation indicated that, having had a larger sample, it would have been significant.

Table 3.5.2.1.2. Factor Loadings (Within Each Sub-construct) for the Retained External Environment Items (Pilot)

Coding	Items	Factor Loading
	Level of Market Heterogeneity	
E/MH1	Our competitors are primarily U.S. companies (corporate headquarters located in U.S.). (reverse)	.88
E/MH2	Our competitors are primarily foreign companies (corporate headquarters located in foreign countries).	.85
E/MH3	Our competitors sell their products in a multinational, global market.	.75
E/MH4	Our products are sold in a multinational, global market.	.78
	Degree of Market Segmentation	
E/MS3	The number of market segments is increasing over the years.	.83
E/MS4	We have different market segments to serve.	.82
E/MS5	We serve many, small market segments.	.79
	Length of Product Life Cycle	
E/LC1	Products last in the market for a long time in our industry (more than 5 years). (reverse)	.84
E/LC2	Products quickly become obsolete in our industry.	.88
E/LC3	Product life cycles are getting shorter in our industry.	.69
	Driving Force for Manufacturing Technology	
E/DT3	Firms with technology to produce variety of products efficiently are leaders in our industry.	.73
E/DT5	To produce variety of products efficiently is the goal of adopting manufacturing technology in our industry.	.81
E/DT6	To be able to respond quickly to design changes is one of the goals of adopting manufacturing technology in our industry.	.70
E/DT7	To be able to respond quickly to volume changes in demand is one of the goals of adopting manufacturing technology in our industry.	.75
	Number of Customer Requirements	
E/CR2	Our customers' requirements are always the same as before. (reverse)	.73
E/CR3	Our customers' requirements are becoming more complicated over the years.	.81
E/CR4	Our customers require satisfaction upon multiple criteria at the same time.	.67
E/CR6	We have to do well in all areas to satisfy our customers.	.68

Table 3.5.2.1.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for External Environment (Pilot)

	E/MH1	E/MH2	E/MH3	E/MH4	E/MS3	E/MS4	E/MS5	E/LC1	E/LC2	E/LC3	E/DT3	E/DT5	E/DT6	E/DT7	E/CR2	E/CR3	E/CR4	E/CR6
E/MH1	1.000																	
E/MH2	0.905	1.000																
E/MH3	0.434	0.388	1.000															
E/MH4	0.475	0.424	0.697	1.000														
E/MS3	-0.019	0.058	0.231	0.361	1.000													
E/MS4	0.179	0.144	0.196	0.296	0.537	1.000												
E/MS5	-0.132	-0.075	-0.055	-0.023	0.479	0.463	1.000											
E/LC1	0.397	0.355	0.078	0.158	0.127	0.126	-0.041	1.000										
E/LC2	0.332	0.267	0.055	0.067	0.050	0.128	-0.086	0.596	1.000									
E/LC3	-0.207	-0.261	-0.132	-0.129	0.120	-0.085	-0.119	0.334	0.428	1.000								
E/DT3	-0.083	-0.097	0.014	-0.080	-0.192	0.115	-0.119	-0.032	0.315	0.382	1.000							
E/DT5	-0.118	-0.128	-0.008	0.142	0.050	0.030	0.009	-0.153	0.123	0.172	0.523	1.000						
E/DT6	-0.079	-0.128	0.104	0.132	0.063	0.066	0.152	0.116	0.272	0.084	0.296	0.414	1.000					
E/DT7	-0.276	-0.255	-0.167	-0.005	0.052	-0.052	-0.043	-0.027	0.119	0.165	0.367	0.442	0.429	1.000				
E/CR2	0.188	0.239	0.273	0.186	-0.018	0.160	-0.092	0.145	0.338	-0.125	0.113	-0.044	0.185	-0.102	1.000			
E/CR3	0.116	0.160	0.307	0.122	0.083	0.213	-0.106	-0.065	0.189	-0.049	0.330	0.177	0.237	0.010	0.617	1.000		
E/CR4	-0.278	-0.174	-0.033	-0.200	-0.063	0.169	0.003	-0.302	-0.111	-0.099	0.348	0.031	-0.187	-0.077	0.222	0.321	1.000	
E/CR6	-0.163	-0.116	0.102	-0.012	-0.235	-0.107	-0.251	0.006	-0.089	-0.090	0.386	0.250	0.014	0.112	0.222	0.342	0.471	1.000
	E/MH1	E/MH2	E/MH3	E/MH4	E/MS3	E/MS4	E/MS5	E/LC1	E/LC2	E/LC3	E/DT3	E/DT5	E/DT6	E/DT7	E/CR2	E/CR3	E/CR4	E/CR6
Mean	2.46	2.59	4.21	3.74	2.53	3.05	2.76	2.49	2.44	2.84	4.08	4.03	4.21	4.08	4.21	3.90	4.36	4.46
SD	1.33	1.27	0.92	1.31	1.06	1.14	1.00	1.50	1.31	1.08	0.81	0.74	0.92	0.96	0.98	0.82	0.74	0.64
# of violations	1	0	0	0	0	0	0	2	1	1	5	0	0	0	3	3	1	2

Note: None of the count of violations for each item exceeds half of the potential comparisons.
Total # of violations = 19

An examination of the correlation matrix to assess discriminant validity was carried out by counting the number of item to outer-scale item correlations greater than the minimum inner-scale item-to-item correlation. If such number of "violations" exceeded half of the potential comparisons, it was taken as an indication of poor discriminant validity. This analysis for external environment items revealed a total of 19 violations out of 258 total comparisons. None of the count of violations for each item exceeded half of the potential comparisons, indicating high degree of discriminant validity. Further examination of the pattern of violations revealed that item E/DT3 was involved in 8 out of 19 total violations.

Before moving to the administration of the instrument to a large-scale survey, the scales were evaluated in scope of the results from the pilot study. Items showing low level of corrected-item total correlation or multiple violations in discriminant analysis were carefully examined and reworded in an attempt to improve clarity, reliability and convergent/ discriminant validity. Overall, out of 32 original items used in the pilot study for the external environment construct, 8 items were kept as it is, 17 items were modified, 7 items were deleted, and 2 items were added, resulting in 27 items being proposed after the pilot study (Appendix E). Each scale (sub-construct) had at least four items.

3.5.2.2. Managerial Beliefs and Attitudes Instrument

The analysis began with purification using the corrected-item total correlation (CITC) analysis. The CITCs for each item are shown in Table 3.5.2.2.1. Overall, the CITC level was high, after the purification; only one item

Table 3.5.2.2.1. Purification for Managerial Beliefs and Attitudes (Pilot)

Coding	Items	CITC-1	CITC-2
	Goals for Investing in Facilities and Equipment: alpha = .62 (initial), .92 (final)		
B/GI1	Through investments in facilities and equipment, we want to reduce direct labor costs. (reverse)	-.42	-
B/GI2	Through investments in facilities and equipment, we want to reduce the number of workers. (reverse)	-.04	-
B/GI3	**Through investments in facilities and equipment, we want to encourage our workers to work in innovative ways.**	**.62**	**.83**
B/GI4	**Through investments in facilities and equipment, we want to increase intellectual work among our workers.**	**.65**	**.82**
B/GI5	**Through investments in facilities and equipment, we want to increase creativity among our workers.**	.71	**.86**
B/GI6	Through investments in facilities and equipment, we want to support product improvement efforts among our workers.	.54	-
B/GI7	Through investments in facilities and equipment, we want to support process improvement efforts among our workers.	.56	-
	Organization of Work: alpha = .52 (initial), .78 (final)		
B/OW1	We believe that jobs should be done in sequences, being passed on from one person to another. (reverse)	.31	-
B/OW2	We believe that jobs should be done in time sequences, from one stage to another. (reverse)	-.05	-
B/OW3	We believe that jobs should be done simultaneously, in a concurrent manner.	.16	-
B/OW4	**We believe that several functional departments should work together as a team.**	.35	.70
B/OW5	**We believe that workers should work together with workers from other functional departments.**	**.39**	**.65**
B/OW6	**We believe that workers should possess multiple skills, often beyond their functional boundaries.**	**.44**	**.52**
B/OW7	We believe that workers should understand the nature of work in other departments.	.35	-
B/OW8	We believe a job should be done by one person from beginning to end.	.14	-
	Scope of Decision Making: alpha = .83 (initial), .87 (final)		
B/DM1	We believe that in making important decisions, departments should discuss with other departments.	.43	-
B/DM2	**We believe that in making certain decisions, department managers should be willing to yield for the benefit of the whole company.**	.77	.70
B/DM3	**We believe that in making certain decisions, the overall effects of that decision should be considered.**	**.80**	**.90**
B/DM4	**We believe that decisions should be based on overall company objectives.**	**.62**	.70
B/DM5	We believe that we should be willing to make sub-optimal decisions in local scale for maximum performance in global scale.	.55	-

Table 3.5.2.2.1. Purification for Managerial Beliefs and Attitudes (Pilot) (continued)

Coding	Items	CITC-1	CITC-2
	Management Mechanism: alpha = .81 (initial), .91 (final)		
B/MM1	**We believe that managers should take tight control upon their subordinates. (reverse)**	**.68**	**.80**
B/MM2	**We believe that command and control is the best way to manage. (reverse)**	**.68**	**.85**
B/MM3	**We believe that workers should simply follow the directions given by their managers. (reverse)**	**.68**	**.85**
B/MM4	We believe that poorly performing employees and those making mistakes should be counseled rather than criticized.	.19	-
B/MM5	We believe that managers should manage subordinates by means of collaboration and consensus.	.52	-
B/MM6	We believe that the best way to manage subordinates is to "buy them in."	.44	-
B/MM7	We believe that managers should manage subordinates by listening to them with an open mind.	.63	-
	Focus of Managerial Tasks: alpha = .70 (initial), .86 (final)		
B/FM1	We believe that managers should focus on controlling costs. (reverse)	-.01	-
B/FM2	We believe that once the internal tasks are optimized and production costs controlled, we would be providing value to customers. (reverse)	.05	-
B/FM3	We believe that managers should focus on finding customer wants and needs.	.47	-
B/FM4	We believe that managers should focus on finding ways to satisfy our customers.	.62	-
B/FM5	**We believe that managers should focus on providing value to customers.**	**.61**	**.62**
B/FM6	We believe that optimizing our internal tasks is useless unless they provide value to customers.	.38	-
B/FM7	We believe that controlling production costs is useless unless they provide value to customers.	.04	-
B/FM8	**We believe that managers should meet with customers or customer representatives regularly.**	**.52**	**.67**
B/FM9	**We believe that we should strive to get closer to our customers.**	**.63**	**.81**
B/FM10	**We believe that customer contact is important to our company.**	**.47**	**.74**

Table 3.5.2.2.1. Purification for Managerial Beliefs and Attitudes (Pilot) (continued)

Coding	Items	CITC-1	CITC-2
	Focus of Supplier Relationships Management: alpha = .83 (initial), .91 (final)		
B/SM1	We believe that we should maintain multiple suppliers to have them compete and supply us at minimum costs. (reverse)	.05	-
B/SM2	We believe that the best suppliers are low cost suppliers. (reverse)	.26	-
B/SM3	We believe that suppliers should be our strategic partners in improving quality.	.39	-
B/SM4	**We believe that our suppliers can be part of our success in our business.**	.71	.76
B/SM5	**We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.**	.67	.73
B/SM6	**We believe that our suppliers are strategic partners in building up our competitive capabilities.**	.69	.79
B/SM7	**We believe that the best suppliers are the ones who enables us to provide value to customers.**	.69	.76
B/SM8	**We believe that suppliers should be involved in decision making about product design.**	.81	.77
B/SM9	**We believe that suppliers should be involved in decision making about process design.**	.73	.78

Note: Items in bold were retained for further analysis.

(B/OW6) had a CITC lower than 0.60. As a result, level of Cronbach's alpha was also high, ranging from 0.78 to 0.92.

The factor analyses of the items in each of the scales are shown in Table 3.5.2.2.2. Factor analyses revealed that all scales seemed to be unidimensional; only one factor emerged for each scale (sub-construct). The loadings were relatively high for each scale. Since none of the scales revealed multiple dimensions, the final Cronbach's alpha score reported in Table 3.5.2.2.1 was accepted as the level of reliability for each scale.

Next, a correlation matrix (Table 3.5.2.2.3) of the 22 items retained for further assessment was examined for evidence of convergent and discriminant validity. The smallest within sub-construct (factor) correlations were: goal for

Table 3.5.2.2.2. Factor Loadings (Within Each Sub-construct) for the Retained Managerial Beliefs and Attitudes Items (Pilot)

Coding	Items	Factor Loading
	Goals for Investing in Facilities and Equipment	
B/GI3	Through investments in facilities and equipment, we want to encourage our workers to work in innovative ways.	.92
B/GI4	Through investments in facilities and equipment, we want to increase intellectual work among our workers.	.92
B/GI5	Through investments in facilities and equipment, we want to increase creativity among our workers.	.94
	Organization of Work	
B/OW4	We believe that several functional departments should work together as a team.	.89
B/OW5	We believe that workers should work together with workers from other functional departments.	.86
B/OW6	We believe that workers should possess multiple skills, often beyond their functional boundaries.	.76
	Scope of Decision Making	
B/DM2	We believe that in making certain decisions, department managers should be willing to yield for the benefit of the whole company.	.85
B/DM3	We believe that in making certain decisions, the overall effects of that decision should be considered.	.96
B/DM4	We believe that decisions should be based on overall company objectives.	.87
	Management Mechanism	
B/MM1	We believe that managers should take tight control upon their subordinates. (reverse)	.91
B/MM2	We believe that command and control is the best way to manage. (reverse)	.93
B/MM3	We believe that workers should simply follow the directions given by their managers. (reverse)	.93
	Focus of Managerial Tasks	
B/FM5	We believe that managers should focus on providing value to customers.	.77
B/FM8	We believe that managers should meet with customers or customer representatives regularly.	.81
B/FM9	We believe that we should strive to get closer to our customers.	.91
B/FM10	We believe that customer contact is important to our company.	.87
	Focus of Supplier Relationships Management	
B/SM4	We believe that our suppliers can be part of our success in our business.	.85
B/SM5	We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.	.84
B/SM6	We believe that our suppliers are strategic partners in building up our competitive capabilities.	.88
B/SM7	We believe that the best suppliers are the ones who enables us to provide value to customers.	.83
B/SM8	We believe that suppliers should be involved in decision making about product design.	.82
B/SM9	We believe that suppliers should be involved in decision making about process design.	.84

Table 3.5.2.2.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Managerial Beliefs and Attitudes (Pilot)

	B/GI3	B/GI4	B/GI5	B/OW4	B/OW5	B/OW6	B/DM2	B/DM3	B/DM4	B/MM1	B/MM2	B/MM3	B/FM5	B/FM8	B/FM9	B/FM10	B/SM4	B/SM5	B/SM6	B/SM7	B/SM8	B/SM9
B/GI3	1.000																					
B/GI4	0.758	1.000																				
B/GI5	0.811	0.796	1.000																			
B/OW4	0.191	0.348	0.302	1.000																		
B/OW5	0.483	0.455	0.540	0.693	1.000																	
B/OW6	0.417	0.426	0.330	0.508	0.450	1.000																
B/DM2	0.427	0.359	0.314	0.597	0.717	0.479	1.000															
B/DM3	0.403	0.363	0.391	0.501	0.619	0.380	0.774	1.000														
B/DM4	0.281	0.172	0.329	0.390	0.512	0.226	0.521	0.802	1.000													
B/MM1	0.251	0.332	0.286	0.406	0.396	0.110	0.454	0.554	0.373	1.000												
B/MM2	0.280	0.289	0.281	0.222	0.304	0.069	0.426	0.623	0.354	0.761	1.000											
B/MM3	0.256	0.354	0.323	0.331	0.370	0.263	0.484	0.661	0.450	0.763	0.823	1.000										
B/FM5	0.462	0.353	0.475	0.321	0.526	0.180	0.485	0.581	0.571	0.230	0.205	0.270	1.000									
B/FM8	0.413	0.306	0.329	0.118	0.341	0.439	0.473	0.539	0.409	0.126	0.174	0.301	0.544	1.000								
B/FM9	0.453	0.440	0.382	0.269	0.514	0.353	0.510	0.631	0.537	0.374	0.298	0.380	0.539	0.664	1.000							
B/FM10	0.407	0.342	0.321	0.233	0.538	0.245	0.555	0.641	0.595	0.299	0.287	0.298	0.543	0.532	0.813	1.000						
B/SM4	0.221	0.209	0.219	0.433	0.386	0.524	0.386	0.447	0.475	0.327	0.256	0.373	0.174	0.264	0.332	0.185	1.000					
B/SM5	0.312	0.306	0.289	0.257	0.238	0.382	0.312	0.407	0.547	0.198	0.164	0.291	0.152	0.319	0.385	0.297	0.722	1.000				
B/SM6	0.242	0.219	0.239	0.274	0.276	0.421	0.331	0.458	0.551	0.221	0.234	0.320	0.223	0.369	0.427	0.260	0.800	0.893	1.000			
B/SM7	0.509	0.459	0.440	0.516	0.623	0.377	0.746	0.793	0.695	0.454	0.363	0.408	0.628	0.521	0.621	0.586	0.600	0.548	0.600	1.000		
B/SM8	0.544	0.539	0.520	0.386	0.524	0.439	0.549	0.730	0.624	0.440	0.366	0.529	0.584	0.602	0.614	0.464	0.547	0.565	0.558	0.703	1.000	
B/SM9	0.606	0.522	0.460	0.497	0.545	0.612	0.681	0.656	0.452	0.330	0.326	0.400	0.503	0.673	0.513	0.363	0.618	0.504	0.582	0.736	0.806	1.000
	B/GI3	B/GI4	B/GI5	B/OW4	B/OW5	B/OW6	B/DM2	B/DM3	B/DM4	B/MM1	B/MM2	B/MM3	B/FM5	B/FM8	B/FM9	B/FM10	B/SM4	B/SM5	B/SM6	B/SM7	B/SM8	B/SM9
Mean	3.75	3.30	3.45	4.13	3.93	3.92	4.13	4.08	4.40	3.50	3.70	3.70	4.00	3.43	3.85	4.13	4.18	3.95	3.93	3.88	3.45	3.38
SD	1.10	1.04	1.13	0.88	1.02	0.96	0.99	1.02	0.74	1.11	1.24	1.36	0.91	1.20	1.05	1.04	0.81	0.93	0.89	0.99	1.26	1.29
# of violations	0	0	0	4	12	3	6	11	7	0	0	0	4	3	4	5	1	1	1	10	11	8

Note: The count of violations for 4 items exceeded half of the potential comparisons, indicating low level of discriminant validity for these 4 items.
Total # of violations = 91

investments in facilities and equipment = 0.758, organization of work = 0.450, scope of decision making = 0.521, management mechanism = 0.761, focus of managerial tasks = 0.532, and focus of supplier relationships management = 0.504. All of them were significantly different from zero at $p<0.01$.

An examination of the correlation matrix to assess discriminant validity revealed a total of 91 violations out of 396 total comparisons. Four out of 22 items exceeded half of the potential comparisons, indicating low level of discriminant validity for these four items. Further examination of the pattern of violations revealed that three items in the focus of supplier relationships management sub-construct (B/SM7, 8, and 9) were involved in 50 out of 91 total violations. Since there were six items in the focus of supplier relationships management scale, elimination of these three problem items would enhance discriminate validity of the scale.

A lot of correlation was found between the scales of organization of work, scope in decision making, and focus of managerial tasks. The correlation could be explained theoretically, for as firms focus their efforts in providing value to customers, work would be more integrated together to enhance quick response and flexibility, while their scope in decision making would be more global. However, as firms focus their efforts to reduce cost, they would gear more toward adopting division of labor and making localized decisions.

Before moving to the administration of the instrument to a large-scale survey, the scales were re-examined in scope of the results from the pilot study and, where appropriate, scales were augmented with modifications and with additional items. Special care was given to items showing low level of discriminant validity; they were carefully examined and reworded in an attempt to improve clarity and convergent/ discriminant validity. Overall, out of 46 original items used in this pilot study for the managerial beliefs and attitudes construct, 23 items were kept as it is, 11 items were modified, 12 items were deleted, and 3 items were added, resulting in 37 items being proposed after the pilot study (Appendix E). Each scale (sub-construct) had at least five items.

3.5.2.3. Organizational Structure Instrument

The analysis for the organizational structure instrument begins with purification. The CITCs for each item are shown in Table 3.5.2.3.1. After going through purification, CITC level was generally high except for one item (O/HI2), which had a CITC of 0.47. Cronbach's alpha, after the purification, ranged from 0.80 to 0.91.

The factor analyses of the items in each scale are shown in Table 3.5.2.3.2. Factor analyses revealed that all scales seemed to be unidimensional; only one factor emerged for each scale (sub-construct). The loadings were relatively high for each scale. Since none of the scales revealed multiple dimensions, the final Cronbach's alpha score reported in Table 3.5.2.3.1 was accepted as the level of reliability for each scale.

Next, a correlation matrix (Table 3.5.2.3.3) of the 20 items retained for further assessment was examined for evidence of convergent and discriminant validity. The smallest within sub-construct (factor) correlations were: locus of

Table 3.5.2.3.1. Purification for Organizational Structure (Pilot)

Coding	Items	CITC-1	CITC-2
	Locus of Decision Making: alpha = .87 (initial), .87 (final)		
O/LD1	Our work teams cannot take significant actions without supervisors or middle management's approval. (reverse)	.56	-
O/LD2	**Our workers have the authority to correct problems when they occur.**	**.69**	**.70**
O/LD3	**Our workers handle job-related problems by themselves.**	**.70**	**.71**
O/LD4	**Our work teams have control over their job.**	**.78**	**.76**
O/LD5	**Our supervisors or middle management are supportive of the decisions made by our work teams.**	**.77**	**.77**
	Degree of Discretion in Rules and Regulations: alpha = .85 (initial), .91 (final)		
O/NF1	Our workers are always expected to follow the existing rules and procedures. (reverse)	.02	-
O/NF2	Our rules and procedures point to the one-best-way of doing things. (reverse)	.12	-
O/NF3	**Our workers are encouraged to make suggestions to change current rules and procedures.**	**.66**	**.76**
O/NF4	**Our rules and procedures show how workers can make suggestions to changes.**	**.69**	**.82**
O/NF5	**Our rules and procedures show how workers can make adjustments on their job.**	**.78**	**.79**
O/NF6	Our rules and procedures show how workers can experiment with their job.	.65	-
O/NF7	**Our rules and procedures encourage workers to be creative in dealing with problems at work.**	**.68**	**.69**
O/NF8	**Our work teams are involved in writing policies and procedures.**	**.82**	**.77**
O/NF9	**Our work teams are involved in developing standard methods.**	**.75**	**.71**
	Number of Layers in Hierarchy: alpha = .86 (initial), .91 (final)		
O/NL1	There are many layers for organizational decision making. (reverse)	.34	-
O/NL2	**There are many management layers between plant operators and the CEO (more than 6). (reverse)**	**.72**	**.74**
O/NL3	**There are few layers in our organizational hierarchy.**	**.83**	**.82**
O/NL4	**We are a lean organization.**	**.71**	**.76**
O/NL5	**There are only few management layers between plant operators and the CEO.**	**.85**	**.89**
	Level of Horizontal Integration: alpha = .78 (initial), .80 (final)		
O/HI1	Jobs ar distinguished by departmental boundary. (reverse)	.40	-
O/HI2	**Our tasks are done through cross-functional teams.**	**.62**	**.47**
O/HI3	Our workers are organized into work groups.	.73	-
O/HI4	**Our workers are cross-trained for multi-skills.**	**.53**	**.73**
O/HI5	**Our workers are capable of switching jobs with one another.**	**.63**	**.75**
O/HI6	Our managers are rotated regularly to other departments.	.27	-
O/HI7	Our workers are assigned to complete a task from beginning to end.	.21	-
O/HI8	Our work teams are assigned to complete a task from beginning to end.	.53	-

Table 3.5.2.3.1. Purification for Organizational Structure (Pilot) (continued)

Coding	Items	CITC-1	CITC-2
	Level of Communication: **alpha = .83 (initial), .86 (final)**		
O/CO1	Boundaries between departments inhibit inter-departmental communications. (reverse)	.47	-
O/CO2	The level of communications between functional departments is high.	.56	-
O/CO3	Workers can easily meet and communicate with workers from other departments.	.51	-
O/CO4	**Strategic decisions are quickly passed on to relevant work groups.**	**.65**	**.67**
O/CO5	**Communication between different levels in hierarchy is easy.**	**.73**	**.78**
O/CO6	**Workers can easily meet and communicate with upper management.**	**.72**	**.74**

Note: Items in bold were retained for further analysis.

decision making = 0.571, degree of discretion in rules and regulations = 0.512, number of layers in hierarchy = 0.605, horizontal integration = 0.436, and level of communication = 0.600. All of them were significantly different from zero at $p<0.01$.

An examination of the correlation matrix to assess discriminant validity revealed a total of 73 violations out of 314 total comparisons. Three out of 20 items exceeded half of the potential comparisons, indicating low level of discriminant validity for these three items. Further examination of the pattern of violations revealed that three items in the horizontal integration sub-construct (O/HI2, 4, and 5) were involved in 39 out of 73 total violations. Also problematic was the discriminate validity between the two scales, locus of decision making and degree of discretion in rules and regulations. The number of violations between these two scales amounted in 31 violations.

The high level of correlation between locus of decision making and degree of discretion in rules and regulations can be explained theoretically. As managers choose to empower their employees to make important decisions

Table 3.5.2.3.2. Factor Loadings (Within Each Sub-construct) for the Retained Organizational Structure Items (Pilot)

Coding	Items	Factor Loading
	Locus of Decision Making	
O/LD2	Our workers have the authority to correct problems when they occur.	.83
O/LD3	Our workers handle job-related problems by themselves.	.84
O/LD4	Our work teams have control over their job.	.88
O/LD5	Our supervisors or middle management are supportive of the decisions made by our work teams.	.88
	Degree of Discretion in Rules and Regulations	
O/NF3	Our workers are encouraged to make suggestions to change current rules and procedures.	.84
O/NF4	Our rules and procedures show how workers can make suggestions to changes.	.89
O/NF5	Our rules and procedures show how workers can make adjustments on their job.	.86
O/NF7	Our rules and procedures encourage workers to be creative in dealing with problems at work.	.78
O/NF8	Our work teams are involved in writing policies and procedures.	.85
O/NF9	Our work teams are involved in developing standard methods.	.79
	Number of Layers in Hierarchy	
O/NL2	There are many management layers between plant operators and the CEO (more than 6). (reverse)	.85
O/NL3	There are few layers in our organizational hierarchy.	.90
O/NL4	We are a lean organization.	.86
O/NL5	There are only few management layers between plant operators and the CEO.	.95
	Level of Horizontal Integration	
O/HI2	Our tasks are done through cross-functional teams.	.71
O/HI4	Our workers are cross-trained for multi-skills.	.91
O/HI5	Our workers are capable of switching jobs with one another.	.92
	Level of Communication	
O/CO4	Strategic decisions are quickly passed on to relevant work groups.	.84
O/CO5	Communication between different levels in hierarchy is easy.	.91
O/CO6	Workers can easily meet and communicate with upper management.	.89

Table 3.5.2.3.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Organizational Structure (Pilot)

	O/LD2	O/LD3	O/LD4	O/LD5	O/NF3	O/NF4	O/NF5	O/NF7	O/NF8	O/NF9	O/NL2	O/NL3	O/NL4	O/NL5	O/HI2	O/HI4	O/HI5	O/CO4	O/CO5	O/CO6
O/LD2	1.000																			
O/LD3	0.571	1.000																		
O/LD4	0.615	0.682	1.000																	
O/LD5	0.681	0.625	0.695	1.000																
O/NF3	0.651	0.534	0.475	0.760	1.000															
O/NF4	0.591	0.502	0.545	0.662	0.797	1.000														
O/NF5	0.504	0.496	0.489	0.590	0.640	0.817	1.000													
O/NF7	0.620	0.477	0.670	0.603	0.555	0.670	0.582	1.000												
O/NF8	0.604	0.633	0.530	0.571	0.571	0.618	0.714	0.566	1.000											
O/NF9	0.567	0.654	0.615	0.728	0.604	0.535	0.512	0.569	0.768	1.000										
O/NL2	0.593	0.485	0.210	0.348	0.570	0.444	0.344	0.288	0.349	0.309	1.000									
O/NL3	0.530	0.538	0.319	0.472	0.565	0.457	0.344	0.331	0.290	0.401	0.741	1.000								
O/NL4	0.411	0.242	0.274	0.320	0.346	0.470	0.375	0.277	0.280	0.290	0.605	0.634	1.000							
O/NL5	0.357	0.377	0.196	0.315	0.381	0.375	0.225	0.165	0.121	0.203	0.696	0.828	0.826	1.000						
O/HI2	0.334	0.590	0.284	0.436	0.525	0.413	0.534	0.294	0.458	0.387	0.460	0.301	0.088	0.150	1.000					
O/HI4	0.463	0.526	0.511	0.440	0.548	0.527	0.358	0.565	0.334	0.448	0.422	0.443	0.370	0.453	0.436	1.000				
O/HI5	0.479	0.661	0.688	0.559	0.545	0.538	0.496	0.565	0.443	0.560	0.440	0.433	0.259	0.322	0.466	0.810	1.000			
O/CO4	0.170	0.278	0.195	0.356	0.411	0.450	0.364	0.327	0.162	0.309	0.260	0.314	0.282	0.326	0.448	0.381	0.297	1.000		
O/CO5	0.352	0.329	0.331	0.362	0.383	0.468	0.374	0.292	0.219	0.337	0.410	0.522	0.496	0.460	0.226	0.294	0.331	0.647	1.000	
O/CO6	0.302	0.239	0.284	0.431	0.307	0.280	0.091	0.221	0.063	0.398	0.309	0.382	0.413	0.361	0.132	0.375	0.341	0.600	0.750	1.000
	O/LD2	O/LD3	O/LD4	O/LD5	O/NF3	O/NF4	O/NF5	O/NF7	O/NF8	O/NF9	O/NL2	O/NL3	O/NL4	O/NL5	O/HI2	O/HI4	O/HI5	O/CO4	O/CO5	O/CO6
Mean	3.45	2.80	3.00	3.38	3.70	3.30	3.05	2.83	2.83	3.28	3.68	3.38	3.15	3.30	2.88	3.20	3.18	2.95	3.20	3.60
SD	1.08	1.02	0.96	0.81	1.07	1.22	1.04	1.04	1.26	1.09	1.27	1.17	1.17	1.36	0.94	0.94	0.93	0.96	0.97	1.03
# of violations	5	4	3	5	**8**	5	2	5	4	5	0	0	0	0	6	**10**	**11**	0	0	0

Note: The count of violations for 3 items exceeded half of the potential comparisons, indicating low level of discriminant validity for these 3 items.
Total # of violations = 73

related to their job, the nature of formal rules and procedures in that organization would tend to encourage creative problem solving, flexibility and experimentation in the work place. If the managers prefer not to empower their workers, their rules and procedures would reflect such preferences. Therefore, the high level of correlation between these two sub-constructs should not come as a surprise.

However, in order to enhance discriminant validity between the two scales, a thorough examination of each item was carried out. As a result, four items (O/NF3, 7, 8, and 9) from degree of discretion in rules and regulations scale were modified and transferred to be part of locus of decision making. The remaining two items (O/NF4 and 5) were also reworded. To ensure that all aspects of the sub-construct would be captured through the scale, one item that was dropped in the previous stage (O/NF6) was reworded and included in the scale, as well as two new items (O/NF10 and 11).

The high correlation between the level of horizontal integration and locus of decision making/ degree of discretion in rules and regulations could also be explained theoretically. As managers push their decision making authority down the organizational hierarchy and set up rules and procedures that would encourage creative work and experimentation in the work place, it seems quite natural for organizations to have their workers organized into cross-functional teams. Therefore, the high level of correlation should not come as a surprise. However, careful examination of the questionnaire items in the level of horizontal integration scale revealed that the wordings were not clear enough to catch the unique aspects of the sub-construct. Therefore, the items were carefully reworded to enhance discriminant validity.

Overall, out of 33 original items used in this pilot study for the construct of organizational structure, 11 items were kept as it is, 12 items were modified, 4 items were modified and transferred to another scale, 6 items were deleted, and 2 items were added, resulting in 29 items being proposed after the pilot study (Appendix E). Each scale (sub-construct) had at least four items.

3.5.2.4. Manufacturing Practices Instrument

The analysis for the manufacturing practices instrument begins with purification. The CITCs for each item are shown in Table 3.5.2.4.1. Overall, CITC level was high, the lowest CITC being 0.46 for M/CM5. Cronbach's alpha ranged from 0.82 to 0.95.

The factor analyses of the items in each scale are shown in Table 3.5.2.4.2. Factor analyses revealed that all scales seemed to be unidimensional; only one factor emerged for each scale (sub-construct). The loadings were relatively high for each scale.

Since the items were adopted from previous studies (Koufteros et al., 1998), this process of purification was not necessary. Even so, the analysis was conducted to demonstrate the reliability and unidimensionality of the scale. The results were satisfactory. Thus, all 33 items were proposed to be included in the large-scale survey (Appendix E).

Table 3.5.2.4.1. Purification for Manufacturing Practices (Pilot)

Coding	Items	CITC
	Shop Floor Employee Involvement in Problem Solving: alpha = .88	
M/EI1	Shop-floor employees are involved in problem solving efforts.	.79
M/EI2	Shop-floor employees are involved in suggestion programs.	.54
M/EI3	Shop-floor employees are involved in designing processes and tools that focus on improvement.	.68
M/EI4	Shop-floor employees are involved in improvement efforts.	.84
M/EI5	Shop-floor employees are involved in problem solving teams.	.80
	Re-engineering Setup: alpha = .91	
M/RS1	Employees work on setup improvement.	.82
M/RS2	Employees redesign or reconfigure equipment to shorten setup time.	.83
M/RS3	Employees redesign jigs or fixtures to shorten setup time.	.80
M/RS4	We use special tools to shorten setup.	.74
M/RS5	Our employees are trained to reduce setup time.	.72
	Cellular Manufacturing: alpha = .83	
M/CM1	Products that share similar design or processing requirements are grouped into families of products.	.75
M/CM2	Products are classified into groups with similar processing requirements.	.61
M/CM3	Products are classified into groups with similar routing requirements.	.63
M/CM4	Equipment is grouped to produce families of products.	.71
M/CM5	Families of products determine our factory layout.	.46
	Quality Improvement Efforts: alpha = .89	
M/QM1	We use fishbone type diagrams to identify causes of quality problems.	.65
M/QM2	We use design of experiments (i.e., Taguchi methods).	.82
M/QM3	Our employees use quality control charts (e.g., SPC charts)	.83
M/QM4	We conduct process capability studies.	.75
	Preventive Maintenance: alpha = .95	
M/PM1	We emphasize good preventive maintenance.	.85
M/PM2	Records of routine maintenance are kept.	.88
M/PM3	We do preventive maintenance.	.87
M/PM4	We do preventive maintenance during non-productive time.	.79
M/PM5	We maintain our equipment regularly.	.89
	Dependable Suppliers: alpha = .91	
M/SR1	We receive parts from suppliers on time.	.62
M/SR2	We receive the correct number of parts from suppliers.	.81
M/SR3	We receive the correct type of parts from suppliers.	.81
M/SR4	We receive parts from suppliers that meet our specifications.	.85
M/SR5	Our suppliers accommodate our needs.	.83
M/SR6	We receive high quality parts from suppliers.	.59
	Pull Production: alpha = .82	
M/PP1	Production is "pulled" by the shipment of finished goods.	.56
M/PP2	Production at stations is "pulled" by the current demand of the next stations.	.68
M/PP3	We use a "pull" production system.	.82

Table 3.5.2.4.2. Factor Loadings (Within Each Sub-construct) for the Retained Manufacturing Practices Items (Pilot)

Coding	Items	Factor Loadings
	Shop Floor Employee Involvement In Problem Solving	
M/EI1	Shop-floor employees are involved in problem solving efforts.	.89
M/EI2	Shop-floor employees are involved in suggestion programs.	.67
M/EI3	Shop-floor employees are involved in designing processes and tools that focus on improvement.	.81
M/EI4	Shop-floor employees are involved in improvement efforts.	.91
M/EI5	Shop-floor employees are involved in problem solving teams.	.88
	Re-engineering Setup	
M/RS1	Employees work on setup improvement.	.89
M/RS2	Employees redesign or reconfigure equipment to shorten setup time.	.90
M/RS3	Employees redesign jigs or fixtures to shorten setup time.	.88
M/RS4	We use special tools to shorten setup.	.84
M/RS5	Our employees are trained to reduce setup time.	.81
	Cellular Manufacturing	
M/CM1	Products that share similar design or processing requirements are grouped into families of products.	.87
M/CM2	Products are classified into groups with similar processing requirements.	.78
M/CM3	Products are classified into groups with similar routing requirements.	.78
M/CM4	Equipment is grouped to produce families of products.	.81
M/CM5	Families of products determine our factory layout.	.62
	Quality Improvement Efforts	
M/QM1	We use fishbone type diagrams to identify causes of quality problems.	.79
M/QM2	We use design of experiments (i.e., Taguchi methods).	.90
M/QM3	Our employees use quality control charts (e.g., SPC charts)	.91
M/QM4	We conduct process capability studies.	.86
	Preventive Maintenance	
M/PM1	We emphasize good preventive maintenance.	.91
M/PM2	Records of routine maintenance are kept.	.93
M/PM3	We do preventive maintenance.	.92
M/PM4	We do preventive maintenance during non-productive time.	.87
M/PM5	We maintain our equipment regularly.	.93
	Dependable Suppliers	
M/SR1	We receive parts from suppliers on time.	.71
M/SR2	We receive the correct number of parts from suppliers.	.87
M/SR3	We receive the correct type of parts from suppliers.	.88
M/SR4	We receive parts from suppliers that meet our specifications.	.91
M/SR5	Our suppliers accommodate our needs.	.90
M/SR6	We receive high quality parts from suppliers.	.71
	Pull Production	
M/PP1	Production is "pulled" by the shipment of finished goods.	.78
M/PP2	Production at stations is "pulled" by the current demand of the next stations.	.87
M/PP3	We use a "pull" production system.	.93

CHAPTER 4: INSTRUMENT DEVELOPMENT PHASE II: EXPLORATORY DATA ANALYSIS

As a result of the pilot study, the original 144 questionnaire items were purified and reduced into 126 items: 27 for external environment, 37 for managerial beliefs and attitudes, 29 for organizational structure, and 33 for time-based manufacturing practices. These items are listed in Appendix E. The 9 contextual variables and 13 performance variables are listed in Appendix C. These questionnaire items were administered to a sample of 3,000 manufacturing executives/managers from four industries: SIC codes 34-37 "Fabricated metal products," "Industrial machinery and equipment," "Electronic and other electric equipment," and "Transportation equipment". Only the companies with 100 or more employees were included in the sample, so that the organizational structure variables could be interpreted with confidence. The Society of Manufacturing Engineers (SME) provided the mailing list. The survey was administered twice, with two weeks interval, resulting in 224 responses (response rate: 7.5%).

Sample characteristics are shown on Table 4.1. Respondents coming from the four manufacturing industries (SIC 34, 35, 36, and 37) account for 98% of the respondents. SIC code 34 accounted for 49% of respondents.

The respondents were asked to identify their positions within the firm. The

Table 4.1. Description of Sample

(1) RESPONDENTS BY SIC CODE:

SIC Code	Name		Percent
34	Fabricated Metal Products		49%
35	Industrial Machinery		15%
36	Electric and Electronic Equipment		17%
37	Transportation Equipment		16%
N/A	No Response		2%
		TOTAL	**100%**

(2) RESPONDENTS BY POSITION:

Position		Percent
Presidents / CEO		1%
Vice Presidents		15%
Directors		19%
Managers		59%
Miscellaneous / No response		6%
	TOTAL	**100%**

(3) FIRMS BY SIZE:

Number of Employees		Percent
100 to 249		38%
250 to 499		29%
500 to 999		19%
1,000 to 2,499		8%
2,500 and over		6%
	TOTAL	**100%**

Table 4.1. Description of Sample (continued)

(4) TYPE OF OPERATION:

OPERATION	Percent
Projects	5%
Job shop	23%
Batch processing	12%
Manufacturing Cells	24%
Assembly line	12%
Flexible manufacturing	9%
High volume, discrete part production	7%
Continuous flow process	8%
No response	1%
TOTAL	100%

(5) DEGREE OF COMPETITION:

Competition	Percent
Little competition	1%
Moderately competitive	11%
Quite competitive	40%
Very competitive	47%
No response	1%
TOTAL	100%

(6) DEGREE OF PRODUCT / PROCESS COMPLEXITY:

Product Complexity	Percent	Process Complexity	Percent
Very low	0%	Very low	1%
Low	7%	Low	6%
Moderate	40%	Moderate	46%
High	35%	High	32%
Very High	18%	Very High	13%
No response	0%	No response	1%
TOTAL	100%	TOTAL	100%

majority of the respondents stated their position as managers (59%), while 34% stated they are directors, vice presidents or presidents.

The respondents also identified the size of their firm. The majority of the firms were small; about 67% of the responding firms had less than 500 employees. Firms with more than 1,000 employees accounted for only 13% of the sample.

When asked to rate the level of competition in their major industry, 87% of the respondents answered either "quite competitive" or "very competitive." 53% and 45% of the respondents said the level of complexity was above average ("high" or "very high") for their major product / process, respectively.

Response / non-response biases were checked by comparing the SIC group distribution and firm size for the (1) sample population and total responses and (2) responses from 1st and 2nd mailing, using the chi-square test of homogeneity. The results are shown in Table 4.2. The analysis indicates that total responses were unbiased with respect to firm size and biased toward SIC 34 group (fabricated metal products). The analysis showed no evidence of non-response bias in SIC code or firm size when 1st and 2nd mailings were evaluated.

4.1. RESEARCH METHODS

224 responses were analyzed with the following objectives in mind: purification, unidimensionality, reliability, convergent and discriminant validity. The methods that were used are: corrected-item to total correlation (for purification), exploratory factor analysis (for unidimensionality), Cronbach's alpha

Table 4.2. Chi-square Test of Response / Non-response Bias

(1) RESPONSE BIAS

SIC	Total Sample Distribution	Response	Expected Frequency	Chi-square
34	0.274	110	60.03	41.605
35	0.254	34	55.64	8.419
36	0.235	39	51.56	3.058
37	0.236	36	51.77	4.806
Total	1.000	219	219.00	57.888

Sample population and response group are not homogeneous in SIC code distribution at df = 3, $\alpha = 0.05$ (Chi-square critical value = 7.815).

# of Employees	Total Sample Distribution	Response	Expected Frequency	Chi-square
100-249	0.440	86	98.64	1.620
250-499	0.260	65	58.14	0.810
500-999	0.151	43	33.80	2.507
1000-2499	0.077	17	17.16	0.002
Over 2500	0.073	13	16.26	0.655
Total	1.000	224	224.00	5.593

Sample population and response group are homogeneous in firm size at df = 4, $\alpha = 0.05$ (Chi-square critical value = 9.488).

(2) NON-RESPONSE BIAS

SIC	1st Mailing	Percent	2nd Mailing	Expected Frequency	Chi-square
34	60	0.492	50	47.70	0.110
35	18	0.148	16	14.31	0.199
36	24	0.197	15	19.08	0.873
37	20	0.164	16	15.90	0.001
Total	122	1.000	97	97.00	1.183

Response group from 1^{st} and 2^{nd} mailing are homogeneous in SIC code distribution at df = 3, $\alpha = 0.05$ (Chi-square critical value = 7.815).

# of Employees	1st Mailing	Percent	2nd Mailing	Expected Frequency	Chi-square
100-249	45	0.360	41	35.64	0.806
250-499	35	0.280	30	27.72	0.188
500-999	25	0.200	18	19.80	0.164
1000-2499	12	0.096	5	9.50	2.134
Over 2500	8	0.064	5	6.34	0.282
Total	125	1.000	99	99.00	3.573

Response group from 1^{st} and 2^{nd} mailing are homogeneous in firm size at df = 4, $\alpha = 0.05$ (Chi-square critical value = 9.488).

(for reliability), and correlation analysis (for convergent and discriminant analysis). Items were deleted, during the purification stage, if their corrected-item total correlation score was below 0.5.

The examination of factor structure was then carried out through exploratory factor analysis. Items that have significantly low factor loadings (below 0.60) or that were not factorially pure (having cross-loadings at 0.40 or above yet being below 0.60 on all factor loadings) were considered as candidates for elimination. When items loaded onto certain factor above 0.60 yet have cross-loading on other factors on or above 0.40, a careful examination of each item was carried out to determine whether to keep or delete that item.

The reliability of the remaining items comprising each sub-construct was examined using Cronbach's alpha. In general, a higher than 0.7 level for alpha was regarded as evidence of a reliable scale (Nunnally, 1978).

Finally, convergent and discriminant validity were assessed through correlation analysis. For a scale to have convergent validity, inner-scale item-to-item correlations should be statistically significant. Discriminant validity was assessed at the item-level using a single-method, multiple-trait approach (Campbell and Fiske, 1959). If the number of "violations" (i.e., correlation of item to outer-scale-items being higher than the minimum inner-scale item-to-item correlation) is less than half of all comparisons, it was taken as evidence of discriminant validity.

4.2. LARGE SCALE MEASUREMENT RESULTS

The following sections provide the results of applying the methodology described above to the 224 responses received through large-scale survey.

4.2.1. External Environment Instrument

The analysis began with purification using the corrected-item total correlation (CITC) analysis. The CITCs for each item are shown in Table 4.2.1.1.

In assessing CITC, the "Degree of Market Segmentation" sub-construct was especially troublesome, for if all items with CITC lower than 0.50 were to be deleted, no item would remain for this sub-construct. Careful examination of the items and data revealed two possible reasons for this result. First, items E/MS1, 2, and 5 mention market segments being small or becoming smaller, while E/MS3 mentions number of market segments increasing over the years. These items were meant to capture the growing diversity of market segments. The logic was that as market diversity increases, market segments would grow in numbers while simultaneously decreasing in size (Bayus, 1994; Doll and Vonderembse, 1991; Vonderembse et al., 1997). However, as market internationalization occurs, market segments' size may not necessarily decrease, but actually increase. Firms that serve global market may need to deal with different market segments, as represented by different countries or regions, sometimes as large as continents; in this context, firms may be confronted with both growing number *and* size of market segments. Therefore, market segment *size* may not be a proper criterion to measure market segmentation together with *number* of market

Table 4.2.1.1. Purification for External Environment (Large Scale)

Coding	Items	CITC-1	CITC-2
	Level of Market Heterogeneity: alpha = .80		
E/MH1	**Our competitors are primarily U.S. companies (corporate headquarters located in U.S.). (reverse)**	**.57**	
E/MH2	**Our competitors are primarily foreign companies (corporate headquarters located in foreign countries).**	**.67**	
E/MH3	**Our competitors sell their products in a global market.**	**.61**	
E/MH4	**Our products are sold in a global market.**	**.60**	
	Degree of Market Segmentation: alpha = .13 (initial); N/A (final)		
E/MS1	Our market segments are narrow.	-.04	-
E/MS2	Our market segments' size are getting smaller.	-.04	-
E/MS3	**The number of market segments is increasing over the years.**	**-.03**	-
E/MS4	We have different market segments to serve.	.21	-
E/MS5	We serve many, small market segments.	.21	-
	Length of Product Life Cycle: alpha = .78 (initial), .80 (final)		
E/LC1	**Products last in the market for a long time in our industry (more than 5 years). (reverse)**	**.44**	**.53**
E/LC2	**Products quickly become obsolete in our industry.**	**.61**	**.70**
E/LC3	**In our industry, product life cycles are getting shorter.**	**.50**	**.51**
E/LC4	In our industry, we begin developing the next generation of products as soon as we introduce the current one.	.43	-
E/LC5	**In our industry, products rapidly go through market introduction, growth, maturity, and decline.**	**.65**	**.56**
E/LC6	**In our industry, product life cycles are short.**	**.60**	**.64**
E/LC7	In our industry, product development is a continuing activity.	.36	-
	Driving Force for Manufacturing Technology: alpha = .79		
E/DT3	**In our industry, firms have the technology to produce a variety of products efficiently.**	**.53**	
E/DT4	**In our industry, firms have the technology to make frequent set-up changes.**	**.55**	
E/DT5	**In our industry, firms have the technology to produce new products quickly.**	**.67**	
E/DT6	**In our industry, firms have the technology to make design changes quickly.**	**.58**	
E/DT7	**In our industry, firms have the technology to respond quickly to changes in volume demanded by customers.**	**.54**	
	Number of Customer Requirements: alpha = .76 (initial), .79 (final)		
E/CR1	**Our customers' requirements are complex.**	**.57**	**.60**
E/CR2	**Our customers' requirements are rarely the same as before.**	**.52**	**.61**
E/CR3	**Our customers' requirements are becoming more complicated.**	**.69**	**.70**
E/CR4	Our customers require satisfaction on multiple criteria.	.59	-
E/CR6	We have to do well in all areas to satisfy our customers.	.42	-
E/CR7	Our customers require dependable delivery, flexibility, and service, as well as low cost and high quality.	.28	-

Note: Items in bold were retained for further analysis.

segments.

Second, when asked how many percentages of their sales were industrial versus commercial, respondents answered (on average) 56% industrial and 44% commercial. Given that market segmentation is a concept more relevant in a commercial market rather than in industrial sales, some of our respondents might not have had proper understanding or concern about market segmentation. Because of these reasons, it was decided to retain only one item (E/MS3) for this sub-construct. The item seems to represent our concept of market segmentation without having potential problems of market segment size.

This analysis also raised concern for the name and definition of "Level of Market Heterogeneity" sub-construct. Carefully examination of the four items (E/MH1 – 4) retained for the sub-construct revealed that the items were measuring, more specifically, the level of market internationalization. Therefore, the name of the sub-construct was modified as "Level of Market Internationalization," with the new definition: "The degree to which a firm's market has foreign competitors and customers." To main consistency, the acronym (E/MH) used for measurement items was continually used in the following analysis.

Two items (E/LC4 and 7) from the "Length of Product Life Cycle" sub-construct had low CITCs (below 0.50). Careful examination of items revealed that the two items were more focused on product development rather than the length of product life cycle. These items were thus eliminated from further analysis.

Also three items (E/CR4, 6, and 7) from "Number of Customer Requirements" resulted in having low level of CITCs (below 0.50). Comparing these items with the remaining items (E/CR1, 2, and 3) revealed that the respondents responded more uniformly to the questions asking the level of complexity in customer requirements than on questions dealing with its mere number of criteria. The distinction made sense in that simply responding to multiple criteria on customer requirements is not a real challenge if the requirements are not complicated in nature. What is truly challenging to manufacturing firms is when customers' requirements are complicated and complex in that they seem to exhibit inherent trade-offs. It was decided that only the first three items (E/CR1, 2, and 3) would be retained for further analysis.

Overall, nine items were removed through the purification process. Apart from "Degree of Market Segmentation," all other sub-constructs resulted in higher than 0.79 alphas, indicating a high level of reliability. The number of items entering the exploratory factor analysis was 18.

An exploratory factor analysis was then conducted using principal components as means of extraction and varimax as method of rotation. Without specifying the number of factors, there were five factors with eigenvalues greater than 1. The single item for "Degree of Market Segmentation" scale (E/MS3) came up as a distinctive factor (factor loading: 0.85). The cumulative variance extracted by the five factors was 64%. The factor loadings of each item to respective factors are shown in Table 4.2.1.2. For simplicity, only loadings greater than 0.40 are shown in the factor pattern matrix.

Next, a correlation matrix (Table 4.2.1.3) of 17 items retained (E/MS3 not included) was examined for evidence of convergent and discriminant validity. E/MS3 was not included, for it was a single-item measure. The smallest within sub-construct (factor) correlations were: level of market internationalization = 0.328, length of product life cycle = 0.307, driving force for manufacturing technology = 0.337, and number of customer requirements = 0.481. All were significantly different from zero at p<0.01 level, providing evidence for convergent validity.

Table 4.2.1.2. Exploratory Factor Analysis for Retained External Environment Items

ITEM	F1-Product Life Cycle	F2-Mfl. Technology	F3-Market Internationalization	F4-Customer Requirements	F5-Market Segmentation	Alpha (α)
E/LC1	.74					
E/LC2	.83					
E/LC3	.66					α = .80
E/LC5	.70					
E/LC6	.79					
E/DT3		.68				
E/DT4		.74				
E/DT5		.81				α = .79
E/DT6		.71				
E/DT7		.71				
E/MH1			.80			
E/MH2			.85			α = .80
E/MH3			.73			
E/MH4			.74			
E/CR1				.78		
E/CR2				.79		α = .79
E/CR3				.87		
E/MS3					.85	-
Eigenvalue	2.83	2.79	2.55	2.29	1.10	
% of Variance	15.75	15.51	14.16	12.70	6.08	
Cumulative % of Variance	15.75	31.25	45.41	58.12	64.20	

Table 4.2.1.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for External Environment (Large Scale)

	E/MH1	E/MH2	E/MH3	E/MH4	E/LC1	E/LC2	E/LC3	E/LC5	E/LC6	E/DT3	E/DT4	E/DT5	E/DT6	E/DT7	E/CR1	E/CR2	E/CR3
E/MH1	1.000																
E/MH2	0.738	1.000															
E/MH3	0.339	0.432	1.000														
E/MH4	0.328	0.442	0.710	1.000													
E/LC1	-0.031	-0.012	0.018	-0.025	1.000												
E/LC2	-0.017	-0.056	-0.017	-0.073	0.579	1.000											
E/LC3	0.120	0.108	0.219	0.135	0.366	0.459	1.000										
E/LC5	-0.098	-0.005	0.102	0.030	0.307	0.492	0.374	1.000									
E/LC6	-0.118	-0.077	-0.029	-0.009	0.406	0.540	0.412	0.600	1.000								
E/DT3	-0.066	0.013	0.164	0.039	0.019	0.081	0.151	0.236	0.171	1.000							
E/DT4	-0.101	-0.082	0.050	-0.017	-0.092	0.032	0.082	0.071	0.062	0.450	1.000						
E/DT5	0.014	0.089	0.062	0.045	0.031	0.029	0.118	0.214	0.140	0.455	0.436	1.000					
E/DT6	0.092	0.150	0.068	0.034	0.016	0.081	0.188	0.242	0.110	0.357	0.337	0.653	1.000				
E/DT7	-0.012	0.008	0.051	-0.003	-0.022	0.073	0.069	0.179	0.137	0.352	0.451	0.433	0.419	1.000			
E/CR1	0.063	0.113	0.248	0.193	-0.021	0.078	0.219	0.166	0.026	0.206	0.171	0.097	0.179	0.140	1.000		
E/CR2	0.058	0.092	0.221	0.156	-0.011	0.109	0.114	0.226	0.073	0.143	0.098	0.100	0.211	0.076	0.481	1.000	
E/CR3	0.035	0.072	0.270	0.180	0.067	0.101	0.213	0.186	0.016	0.218	0.119	0.045	0.202	0.047	0.594	0.617	1.000
	E/MH1	E/MH2	E/MH3	E/MH4	E/LC1	E/LC2	E/LC3	E/LC5	E/LC6	E/DT3	E/DT4	E/DT5	E/DT6	E/DT7	E/CR1	E/CR2	E/CR3
Mean	2.37	2.51	3.84	3.69	2.00	1.97	2.54	2.11	2.05	3.42	3.37	2.82	3.08	3.29	3.51	3.00	3.63
S.D.	1.13	1.13	1.09	1.16	1.18	1.01	1.17	0.96	0.99	0.93	0.92	0.88	0.91	0.91	1.00	1.06	0.98
# of Violations	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: Total # of violations = 0

An examination of the correlation matrix to assess discriminant validity was carried out by counting the number of item to outer-scale item correlations greater than the minimum inner-scale item-to-item correlation. There were zero violations, indicating high level of discriminant validity. Overall, a total of 18 items for six scales are proposed for external environment (Appendix F).

4.2.2. Managerial Beliefs and Attitudes Instrument

The analysis began with purification using the corrected-item total correlation (CITC) analysis. The CITCs for each item are shown in Table 4.2.2.1.

One item (B/OW3) from "Organization of Work" sub-construct had a lower than 0.50 CITC. Examination of the wording revealed that the phrase "...concurrent manner" might not have been a familiar phrase to the respondents. The item was thus deleted from further analysis.

Also one item (B/MM4) from "Management Mechanism" sub-construct had a lower than 0.50 CITC. Examination of the wording showed that the phrase "...counseled rather than criticized" might have been too broad or generic to be included in measuring the sub-construct. Therefore, the item was excluded from further analysis.

Overall, the CITC level was high, after the purification; only three items in the "Management Mechanism" sub-construct (B/MM1, 3, and 8) had CITC lower than 0.60. As a result, level of Cronbach's alpha was also high, ranging from 0.85 to 0.93.

Table 4.2.2.1. Purification for Managerial Beliefs and Attitudes (Large Scale)

Coding	Items	CITC-1	CITC-2
	Goals for Investing in Facilities and Equipment: alpha = .93		
B/GI3	**Through investments in facilities and equipment, we want to encourage our workers to work in innovative ways.**	.84	
B/GI4	**Through investments in facilities and equipment, we want to increase intellectual work among our workers.**	.79	
B/GI5	**Through investments in facilities and equipment, we want to increase creativity among our workers.**	.85	
B/GI6	**Through investments in facilities and equipment, we want to support product improvement efforts among our workers.**	.84	
B/GI7	**Through investments in facilities and equipment, we want to support process improvement efforts among our workers.**	.81	
	Organization of Work: alpha = .86 (initial), .89 (final)		
B/OW3	We believe that jobs should be done in a concurrent manner.	.48	-
B/OW4	**We believe that functional departments should work together as a team.**	.82	.82
B/OW5	**We believe that employees from one department should work with employees from other departments.**	.76	.77
B/OW6	**We believe that employees should work together as a team.**	.75	.79
B/OW7	**We believe that workers should understand the nature of work in other departments.**	.65	.67
	Scope in Decision Making: alpha = .89		
B/DM1	**We believe that departments should discuss important decisions with other departments.**	.62	
B/DM2	**We believe that departmental managers should make decisions that benefit the whole company.**	.70	
B/DM3	**We believe that when making decisions, the overall effects of a decision should be considered.**	.76	
B/DM4	**We believe that decisions should be based on overall company objectives.**	.75	
B/DM5	**We believe that we should be willing to make sub-optimal decisions in local scale for maximum performance in global scale.**	.65	
B/DM6	**We believe that decision making should include input from many areas.**	.79	
B/DM7	**We believe that decision making should be a group process.**	.62	

Table 4.2.2.1. Purification for Managerial Beliefs and Attitudes (Large Scale) (continued)

Coding	Items	CITC-1	CITC-2
	Management Mechanism: alpha = .86 (initial), .85 (final)		
B/MM1	**We believe that managers should take tight control upon their subordinates. (reverse)**	**.53**	**.56**
B/MM2	**We believe that command and control is the best way to manage. (reverse)**	**.67**	**.68**
B/MM3	**We believe that workers should simply follow the directions given by their managers. (reverse)**	**.49**	**.52**
B/MM4	We believe that employees should be counseled rather than criticized.	.48	-
B/MM5	**We believe that managers should involve employees in decision making..**	**.70**	**.68**
B/MM6	**We believe that the best way to manage is to have employees "buy in."**	**.65**	**.62**
B/MM7	**We believe that managers should listen to employees' input.**	**.73**	**.70**
B/MM8	**We believe that employees should be led rather than controlled.**	**.57**	**.55**
	Focus of Managerial Tasks: alpha = .92		
B/FM3	**We believe that managers should focus on finding customer wants and needs.**	**.73**	
B/FM4	**We believe that managers should focus on finding ways to satisfy our customers.**	**.83**	
B/FM5	**We believe that managers should focus on providing value to customers.**	**.79**	
B/FM8	**We believe that managers should meet with customers or customer representatives regularly.**	**.78**	
B/FM9	**We believe that we should strive to get closer to our customers.**	**.81**	
B/FM10	**We believe that customer contact is important to our company.**	**.77**	
	Focus of Supplier Relationships Management: alpha = .91		
B/SM4	**We believe that our suppliers can be part of our success in our business.**	**.73**	
B/SM5	**We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.**	**.76**	
B/SM6	**We believe that our suppliers are strategic partners in building up our competitive capabilities.**	**.82**	
B/SM7	**We believe that the best suppliers are the ones who enables us to provide value to customers.**	**.78**	
B/SM8	**We believe that suppliers should be involved in decision making about product design.**	**.71**	
B/SM9	**We believe that suppliers should be involved in decision making about process design.**	**.70**	

Note: Items in bold were retained for further analysis.

An exploratory factor analysis was then conducted using principal components as the means of extraction and varimax as the method of rotation. Without specifying the number of factors, there were six factors with eigenvalues greater than 1. The exploratory factor analysis of the items is shown in Table 4.2.2.2. For simplicity, only factor loadings on or above 0.40 are shown in the table. The cumulative variance extracted by the six factors was 76%.

In the process of eliminating items that are not factorially pure, 7 items were deleted. First, four items from "Management Mechanism" sub-construct (B/MM5 to 8) had low factor loadings (below 0.40) as well as multiple cross-loadings (as high as 0.48) on different factors. Close examination of the wording of these items, along with the pattern of cross-loadings, revealed that the items were not clearly distinguished from "Scope in Decision Making" or "Focus of Managerial Tasks" sub-constructs. Thus the four items were eliminated from subsequent analysis. .

Second, two items from "Scope in Decision Making" sub-construct (B/DM1 and 7) had low factor loadings (below 0.50) as well as significant cross-loadings (as high as 0.47). Examining the wordings of these two items revealed that certain phrases in these items (e.g., "...should discuss... with other departments" or "... should be a group process") caused them to be interpreted quite close to the "Organization of Work" sub-construct. The two items were thus eliminated in the subsequent analysis.

Third, one item from "Focus of Supplier Relationships Management" sub-construct (B/SM4) had low factor loading (0.56). Looking into the wording of this

Table 4.2.2.2. Exploratory Factor Analysis for Retained Managerial Beliefs and Attitudes Items (Large Scale)

ITEM	F1-Focus of Managerial Tasks	F2-Goals for Investment	F3-Scope in Decision Making	F4-Focus of Supplier Mgmt.	F5-Organization of Work	F6-Mgmt Mechanism	Alpha (α)
B/FM3	.74						
B/FM4	.76		.41				
B/FM5	.68		.46				α = .92
B/FM8	.76						
B/FM9	.78						
B/FM10	.73						
B/GI3		.85					
B/GI4		.84					
B/GI5		.84					α = .93
B/GI6		.86					
B/GI7		.78					
B/DM2			.70				
B/DM3			.70				
B/DM4			.77				α = .89
B/DM5			.64				
B/DM6			.60				
B/SM5				.73			
B/SM6				.73			
B/SM7				.60			α = .89
B/SM8				.81			
B/SM9				.75			
B/OW4					.75		
B/OW5					.76		α = .89
B/OW6					.77		
B/OW7					.65		
B/MM1						.88	
B/MM2						.85	α = .84
B/MM3						.79	
Eigenvalue	4.29	4.20	3.71	3.47	3.11	2.40	
% of Variance	15.33	15.01	13.27	12.39	11.11	8.56	
Cumulative % of Variance	15.33	30.34	43.60	55.99	67.10	75.66	

item showed that the wording was less specific than the other items in describing the specific role suppliers can play as strategic partners for business success. The item was thus deleted from further analysis.

Finally, two items from "Focus of Managerial Tasks" sub-construct (B/FM4 and 5) had a cross-loading of 0.41 and 0.46, respectively, on "Scope in Decision Making" sub-construct, while loading 0.76 and 0.68, respectively, on its intended factor. The cross-loading was understandable when the wording was examined, for respondents seem to have interpreted the phrases "...focus on finding ways to satisfy our customers" and "...focus on providing value to customers" as being similar to "... considering overall effects of a decision." After careful examination of these two items, it was decided to keep the two items in spite of their cross-loadings. There were two reasons behind this decision: First, the factor loadings of 0.76 and 0.68 for B/FM4 and 5, respectively, can be regarded as being sufficient for an item to be part of a factor, for the items explain 58% and 46% of the variances extracted by the factor (calculated by squaring the factor loadings). Second, the items have an important bearing for the sub-construct in that they capture the core concept of the sub-construct. While items B/FM3, 8, 9, and 10 all focus on managers getting *closer* to their customers to *find* customer wants and needs, B/FM4 and 5 focus on managers finding *ways to satisfy* their customers. This aspect of "finding ways to satisfy" is an important element of the sub-construct, which needs to be preserved, if all possible.

Reliability was reexamined for "Scope in Decision Making," "Management Mechanism," and "Focus of Supplier Relationships Management." Cronbach's alphas for these three sub-constructs were calculated as 0.89, 0.84, and 0.89, respectively.

Next, a correlation matrix (Table 4.2.2.3) of the 28 items retained for further assessment was examined for evidence of convergent and discriminant validity. The smallest within sub-construct (factor) correlations were: goal for investments in facilities and equipment = 0.638, organization of work = 0.585, scope in decision making = 0.483, management mechanism = 0.575, focus of managerial tasks = 0.496, and focus of supplier relationships management = 0.500. All of them were significantly different from zero at $p<0.01$, indicating convergent validity.

An examination of the correlation matrix to assess discriminant validity revealed a total of 73 violations out of 648 total comparisons. None except one (B/SM7) of the items exceeded half of the potential comparisons, indicating high level of discriminant validity. Examination of the pattern of violations for B/SM7 indicated that the respondents perceived the item to be in somewhat similar term with the items in "Focus of Managerial Tasks," "Scope in Decision Making," and "Organization of Work" sub-constructs. The correlation was understandable from a theoretical view point, for the higher the emphasis on working in teams, decisions made more from an overall perspective, and management focuses more on finding ways to satisfy ones customers, the higher would be their regard of suppliers, who enables them to provide value to customers, as being their best suppliers. Since the number of violations (12) were slightly over half of the total possible comparisons (22), the item was retained for the sub-construct. Overall,

Table 4.2.2.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Managerial Beliefs and Attitudes (Large Scale)

	B/ GI3	B/ GI4	B/ GI5	B/ GI6	B/ GI7	B/ OW4	B/ OW5	B/ OW6	B/ OW7	B/ DM2	B/ DM3	B/ DM4	B/ DM5	B/ DM6	B/ MM1	B/ MM2	B/ MM3	B/ FM3	B/ FM4	B/ FM5	B/ FM8	B/ FM9	B/ FM10	B/ SM5	B/ SM6	B/ SM7	B/ SM8	B/ SM9
B/GI3	1.000																											
B/GI4	0.763	1.000																										
B/GI5	0.758	0.783	1.000																									
B/GI6	0.743	0.681	0.758	1.000																								
B/GI7	0.731	0.638	0.738	0.837	1.000																							
B/OW4	0.454	0.404	0.487	0.440	0.530	1.000																						
B/OW5	0.369	0.339	0.359	0.373	0.434	0.744	1.000																					
B/OW6	0.376	0.370	0.382	0.391	0.448	0.762	0.722	1.000																				
B/OW7	0.376	0.383	0.425	0.361	0.473	0.646	0.585	0.600	1.000																			
B/DM2	0.313	0.254	0.367	0.269	0.393	0.529	0.478	0.479	0.490	1.000																		
B/DM3	0.422	0.301	0.381	0.322	0.455	0.564	0.547	0.575	0.536	0.649	1.000																	
B/DM4	0.365	0.307	0.392	0.299	0.411	0.534	0.523	0.559	0.491	0.684	0.798	1.000																
B/DM5	0.349	0.283	0.396	0.297	0.403	0.474	0.461	0.455	0.465	0.483	0.546	0.576	1.000															
B/DM6	0.404	0.372	0.450	0.353	0.449	0.538	0.442	0.536	0.519	0.573	0.679	0.644	0.604	1.000														
B/MM1	0.203	0.147	0.123	0.145	0.210	0.194	0.191	0.205	0.165	0.068	0.187	0.124	0.167	0.209	1.000													
B/MM2	0.245	0.137	0.152	0.145	0.242	0.331	0.330	0.340	0.318	0.198	0.338	0.262	0.281	0.288	0.738	1.000												
B/MM3	0.189	0.180	0.132	0.110	0.142	0.245	0.229	0.219	0.192	0.135	0.252	0.215	0.258	0.302	0.575	0.599	1.000											
B/FM3	0.284	0.235	0.314	0.350	0.384	0.377	0.400	0.326	0.323	0.476	0.462	0.438	0.491	0.416	0.187	0.276	0.140	1.000										
B/FM4	0.320	0.275	0.360	0.355	0.444	0.455	0.463	0.401	0.416	0.533	0.563	0.556	0.483	0.545	0.179	0.316	0.145	0.771	1.000									
B/FM5	0.348	0.309	0.380	0.334	0.447	0.474	0.452	0.427	0.432	0.590	0.557	0.574	0.515	0.563	0.175	0.279	0.169	0.697	0.824	1.000								
B/FM8	0.357	0.319	0.391	0.387	0.434	0.405	0.400	0.374	0.443	0.426	0.456	0.380	0.406	0.482	0.274	0.295	0.238	0.644	0.630	0.631	1.000							
B/FM9	0.375	0.320	0.408	0.392	0.458	0.442	0.425	0.382	0.488	0.404	0.527	0.450	0.399	0.504	0.238	0.334	0.205	0.578	0.685	0.647	0.732	1.000						
B/FM10	0.333	0.308	0.409	0.385	0.489	0.477	0.442	0.418	0.512	0.413	0.491	0.437	0.350	0.561	0.169	0.279	0.166	0.496	0.644	0.612	0.704	0.843	1.000					
B/SM5	0.403	0.380	0.407	0.331	0.425	0.428	0.360	0.382	0.417	0.511	0.410	0.456	0.360	0.490	0.207	0.275	0.333	0.299	0.402	0.460	0.421	0.439	0.437	1.000				
B/SM6	0.388	0.334	0.421	0.336	0.450	0.505	0.416	0.467	0.492	0.549	0.486	0.508	0.446	0.566	0.262	0.311	0.325	0.349	0.448	0.491	0.456	0.469	0.487	0.859	1.000			
B/SM7	0.387	0.343	0.411	0.325	0.420	0.534	0.492	0.513	0.511	0.515	0.515	0.582	0.497	0.573	0.224	0.356	0.283	0.474	0.596	0.616	0.533	0.616	0.601	0.696	0.752	1.000		
B/SM8	0.254	0.238	0.324	0.275	0.333	0.357	0.309	0.373	0.380	0.320	0.317	0.371	0.314	0.406	0.221	0.234	0.257	0.313	0.400	0.405	0.403	0.418	0.383	0.500	0.574	0.565	1.000	
B/SM9	0.284	0.232	0.336	0.263	0.362	0.340	0.296	0.322	0.383	0.381	0.390	0.415	0.370	0.403	0.244	0.262	0.297	0.392	0.463	0.470	0.422	0.446	0.382	0.502	0.545	0.546	0.836	1.000
	B/ GI3	B/ GI4	B/ GI5	B/ GI6	B/ GI7	B/ OW4	B/ OW5	B/ OW6	B/ OW7	B/ DM2	B/ DM3	B/ DM4	B/ DM5	B/ DM6	B/ MM1	B/ MM2	B/ MM3	B/ FM3	B/ FM4	B/ FM5	B/ FM8	B/ FM9	B/ FM10	B/ SM5	B/ SM6	B/ SM7	B/ SM8	B/ SM9
Mean	3.74	3.46	3.54	3.77	3.93	4.31	4.32	4.47	3.81	4.28	4.30	4.38	3.65	4.01	3.51	3.83	3.91	3.78	4.02	4.11	3.46	3.93	4.17	3.98	3.91	4.11	3.26	3.05
S.D.	0.99	1.04	1.07	0.93	0.93	0.81	0.83	0.75	0.96	0.90	0.88	0.84	1.02	0.95	0.91	0.91	0.98	1.06	0.96	0.90	1.20	1.02	0.92	0.97	1.00	0.93	1.13	1.15
# of Violations	0	0	0	0	0	0	0	0	0	7	10	8	3	10	0	0	0	0	5	6	1	3	3	1	4	12	0	0

Note: The count of violations for 1 item (B/SM7) exceeded half of the potential comparisons, indicating low level of discriminant validity for this 1 item.
Total # of violations = 73

28 items and six scales are proposed for the managerial beliefs and attitudes construct (Appendix F).

4.2.3. Organizational Structure Instrument

The analysis for the organizational structure instrument begins with purification. The CITCs for each item are shown in Table 4.2.3.1. The process of purification, at this stage, resulted in only one item (O/LD1) having lower than 0.50 CITC. The negative wording of the item appears to have resulted in low CITC. The item was deleted from further analysis. After going through purification, all items had higher than 0.60 for CITC. Cronbach's alpha, after the purification, ranged from 0.86 to 0.93.

An exploratory factor analysis was then conducted using principal components as the means of extraction and varimax as the method of rotation. Without specifying the number of factors, there were five factors with eigenvalues greater than 1. Two items from the "Locus of Decision Making" sub-construct (O/LD8 and 9) were deleted because of their low factor loadings (below 0.60) These were among the items that had been modified and transferred from "Degree of Discretion in Rules and Regulations" sub-construct after pilot study (Page 85), to enhance discriminant validity between "Locus of Decision Making" and "Degree of Discretion in Rules and Regulations." The result of exploratory factor analysis showed that this did not work out as intended. The items had low factor loadings on "Locus of Decision Making" as well as some about of cross-loadings on "Degree of Discretion in Rules and Regulations." The two items

Table 4.2.3.1. Purification for Organizational Structure (Large Scale)

Coding	**Items**	**CITC-1**	**CITC-2**
	Locus of Decision Making: alpha = .88 (initial), .89 (final)		
O/LD1	Our work teams cannot take significant actions without supervisors or middle managers' approval. (reverse)	.40	-
O/LD2	**Our workers have the authority to correct problems when they occur.**	**.61**	**.62**
O/LD3	**Our workers handle job-related problems by themselves.**	**.63**	**.64**
O/LD4	**Our work teams have control over their job.**	**.68**	**.67**
O/LD5	**Our supervisors or middle managers are supportive of the decisions made by our work teams.**	**.68**	**.69**
O/LD6	**Our workers are encouraged to make suggestions to change current rules and procedures.**	**.63**	**.64**
O/LD7	**We encourage workers to be creative in dealing with problems at work.**	**.68**	**.69**
O/LD8	**Our workers are involved in writing policies and procedures.**	**.64**	**.63**
O/LD9	**Our workers are involved in developing standard methods.**	**.68**	**.67**
	Degree of Discretion in Rules and Regulations: alpha = .89		
O/NF4	**We have written rules and procedures that show how workers can make suggestions for changes.**	**.76**	
O/NF5	**We have written rules and procedures that describe how workers can make changes on their job.**	**.81**	
O/NF6	**We have written rules and procedures that show how workers can experiment with their job.**	**.70**	
O/NF10	**We have written rules and procedures that guide quality improvement efforts.**	**.69**	
O/NF11	**We have written rules and procedures that guide creative problem solving.**	**.72**	
	Number of Layers in Hierarchy: alpha = .86		
O/NL2	**There are many management layers between plant operators and the CEO (more than 6). (reverse)**	**.65**	
O/NL3	**There are few layers in our organizational hierarchy.**	**.72**	
O/NL4	**We are a lean organization.**	**.61**	
O/NL5	**There are only few management layers between plant operators and the CEO.**	**.83**	
	Level of Horizontal Integration: alpha = .93		
O/HI2	**Our tasks are done through cross-functional teams.**	**.77**	
O/HI3	**Our workers are assigned to work in cross-functional teams.**	**.86**	
O/HI4	**Our workers are trained to work in cross-functional teams.**	**.83**	
O/HI5	**Our workers are required to work in cross-functional teams.**	**.75**	
O/HI6	**Our managers are assigned to lead various cross-functional teams.**	**.75**	
O/HI8	**Our most important tasks are carried out by cross-functional teams.**	**.78**	
	Level of Communication: alpha = .87		
O/CO2	**Lots of communications are carried out among managers.**	**.63**	
O/CO3	**Communications are easily carried out among workers.**	**.69**	
O/CO4	**Strategic decisions are quickly passed on to relevant work groups.**	**.76**	
O/CO5	**Communication between different levels in hierarchy is easy.**	**.77**	
O/CO6	**Workers can easily meet and communicate with upper management.**	**.67**	

Note: Items in bold were retained for further analysis.

were thus eliminated from further analysis.

The exploratory factor analysis of the items is shown in Table 4.2.3.2. For simplicity, only factor loadings on or above 0.40 are shown in the table. The cumulative variance extracted by the six factors was 70%. Reliability was

Table 4.2.3.2. Exploratory Factor Analysis for Retained Organizational Structure Items (Large Scale)

ITEM	F1-Horizontal Integration	F2-Degree of Discretion in Rules	F3-Locus of Decision Making	F4-Level of Communication	F5-Layers in Hierarchy	Alpha (α)
O/HI2	.74					α = .93
O/HI3	.85					
O/HI4	.77					
O/HI5	.79					
O/HI6	.77					
O/HI8	.78					
O/NF4		.84				α = .89
O/NF5		.87				
O/NF6		.76				
O/NF10		.71				
O/NF11		.75				
O/LD2			.76			α = .86
O/LD3			.80			
O/LD4			.69			
O/LD5			.65			
O/LD6			.61			
O/LD7			.64			
O/CO2				.72		α = .87
O/CO3				.74		
O/CO4				.80		
O/CO5				.75		
O/CO6				.69		
O/NL2					.82	α = .86
O/NL3					.84	
O/NL4					.67	
O/NL5					.88	
Eigenvalue	4.37	3.74	3.51	3.48	2.97	
% of Variance	16.80	14.40	13.52	13.40	11.41	
Cumulative % of Variance	16.80	31.20	44.71	58.11	69.52	

reexamined for "Locus of Decision Making," which now has six items. Cronbach's alpha for the sub-construct came out as 0.86.

Next, a correlation matrix (Table 4.2.3.3) of the 26 items retained for further assessment was examined for evidence of convergent and discriminant validity. The smallest within sub-construct (factor) correlations were: locus of decision making = 0.382, degree of discretion in rules and regulations = 0.518, number of layers in hierarchy = 0.407, level of horizontal integration = 0.566, and level of communication = 0.473. All of them were significantly different from zero at $p<0.01$, indicating convergent validity.

An examination of the correlation matrix to assess discriminant validity revealed a total of 35 violations out of 538 total comparisons. None of the items exceeded half of the potential comparisons, indicating high level of discriminant validity. Thus, all 26 items and five scales are proposed for organizational structure construct (Appendix F).

4.2.4. Manufacturing Practices Instrument

The assessment of this instrument with seven sub-constructs and 33 items begins with purification. CITC level was generally high; the lowest CITC was 0.59 for M/CM5. Cronbach's alpha ranged from 0.85 to 0.92. The CITCs for each item are shown in Table 4.2.4.1.

Exploratory factor analysis was conducted using principal components as the means of extraction and varimax as method of rotation. Without specifying number of factors, there were six factors with eigenvalues greater than 1.

Table 4.2.3.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Organizational Structure (Large Scale)

	O/ LD2	O/ LD3	O/ LD4	O/ LD5	O/ LD6	O/ LD7	O/ NF4	O/ NF5	O/ NF6	O/ NF10	O/ NF11	O/ NL2	O/ NL3	O/ NL4	O/ NL5	O/ HI2	O/ HI3	O/ HI4	O/ HI5	O/ HI6	O/ HI8	O/ CO2	O/ CO3	O/ CO4	O/ CO5	O/ CO6
O/LD2	1.000																									
O/LD3	0.644	1.000																								
O/LD4	0.472	0.570	1.000																							
O/LD5	0.485	0.523	0.609	1.000																						
O/LD6	0.419	0.382	0.419	0.524	1.000																					
O/LD7	0.471	0.421	0.541	0.584	0.668	1.000																				
O/NF4	0.237	0.231	0.179	0.307	0.427	0.412	1.000																			
O/NF5	0.234	0.214	0.201	0.293	0.375	0.401	0.818	1.000																		
O/NF6	0.164	0.143	0.260	0.229	0.268	0.356	0.588	0.684	1.000																	
O/NF10	0.307	0.250	0.258	0.363	0.394	0.397	0.565	0.581	0.518	1.000																
O/NF11	0.212	0.168	0.268	0.258	0.316	0.388	0.571	0.618	0.599	0.676	1.000															
O/NL2	0.161	0.073	0.114	0.130	0.081	0.187	0.041	0.036	-0.013	0.172	0.068	1.000														
O/NL3	0.146	0.057	0.159	0.213	0.149	0.232	0.025	0.039	0.017	0.131	0.141	0.564	1.000													
O/NL4	0.253	0.154	0.200	0.332	0.229	0.316	0.097	0.068	0.046	0.237	0.196	0.407	0.573	1.000												
O/NL5	0.152	0.118	0.203	0.280	0.140	0.270	0.081	0.077	0.070	0.184	0.131	0.701	0.701	0.631	1.000											
O/HI2	0.289	0.329	0.497	0.545	0.437	0.441	0.318	0.308	0.304	0.327	0.396	0.083	0.190	0.255	0.181	1.000										
O/HI3	0.319	0.349	0.352	0.429	0.370	0.411	0.293	0.321	0.368	0.418	0.405	0.137	0.202	0.218	0.220	0.741	1.000									
O/HI4	0.389	0.361	0.438	0.486	0.437	0.482	0.368	0.389	0.412	0.442	0.482	0.168	0.235	0.283	0.262	0.684	0.830	1.000								
O/HI5	0.311	0.342	0.323	0.409	0.392	0.337	0.271	0.308	0.324	0.344	0.313	0.139	0.122	0.225	0.190	0.566	0.733	0.722	1.000							
O/HI6	0.256	0.301	0.329	0.409	0.317	0.316	0.350	0.352	0.348	0.382	0.377	0.056	0.165	0.170	0.157	0.618	0.644	0.663	0.642	1.000						
O/HI8	0.280	0.295	0.404	0.464	0.355	0.379	0.359	0.335	0.397	0.417	0.422	0.044	0.160	0.194	0.146	0.736	0.700	0.653	0.606	0.689	1.000					
O/CO2	0.184	0.104	0.262	0.364	0.250	0.310	0.278	0.315	0.249	0.402	0.344	0.182	0.168	0.349	0.292	0.394	0.307	0.396	0.293	0.401	0.381	1.000				
O/CO3	0.282	0.258	0.377	0.490	0.262	0.381	0.172	0.231	0.235	0.336	0.281	0.206	0.211	0.363	0.266	0.413	0.379	0.448	0.336	0.373	0.382	0.590	1.000			
O/CO4	0.318	0.306	0.397	0.473	0.342	0.416	0.241	0.243	0.228	0.322	0.289	0.138	0.210	0.410	0.304	0.465	0.344	0.407	0.272	0.341	0.341	0.563	0.648	1.000		
O/CO5	0.281	0.286	0.395	0.468	0.335	0.412	0.170	0.191	0.164	0.287	0.260	0.289	0.360	0.383	0.418	0.451	0.357	0.392	0.268	0.343	0.372	0.514	0.591	0.677	1.000	
O/CO6	0.281	0.165	0.312	0.368	0.302	0.393	0.185	0.203	0.180	0.299	0.252	0.321	0.344	0.422	0.468	0.287	0.268	0.334	0.237	0.250	0.264	0.473	0.476	0.589	0.701	1.000
	O/ LD2	O/ LD3	O/ LD4	O/ LD5	O/ LD6	O/ LD7	O/ NF4	O/ NF5	O/ NF6	O/ NF10	O/ NF11	O/ NL2	O/ NL3	O/ NL4	O/ NL5	O/ HI2	O/ HI3	O/ HI4	O/ HI5	O/ HI6	O/ HI8	O/ CO2	O/ CO3	O/ CO4	O/ CO5	O/ CO6
Mean	3.53	3.08	3.00	3.39	3.56	3.71	3.15	2.88	2.19	3.46	2.84	4.00	3.52	3.62	3.61	3.17	2.94	2.88	2.60	2.92	2.92	3.33	2.98	3.07	3.16	3.47
S.D.	0.97	0.94	0.94	0.87	1.00	0.93	1.25	1.26	1.12	1.21	1.29	1.30	1.27	1.13	1.28	0.99	1.03	1.09	1.10	1.04	1.10	0.90	0.89	0.95	0.99	1.08
# of Violations	1	0	5	9	5	10	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	1	0	0	0

Note: None of count of violations for each item exceeds half of potential comparisons.
Total # of violations = 35

Table 4.2.4.1. Purification for Manufacturing Practices (Large Scale)

Coding	Items	CITC
	Shop Floor Employee Involvement in Problem Solving: alpha = .90	
M/EI1	Shop-floor employees are involved in problem solving efforts.	.79
M/EI2	Shop-floor employees are involved in suggestion programs.	.64
M/EI3	Shop-floor employees are involved in designing processes and tools that focus on improvement.	.73
M/EI4	Shop-floor employees are involved in improvement efforts.	.83
M/EI5	Shop-floor employees are involved in problem solving teams.	.79
	Re-engineering Setup: alpha = .88	
M/RS1	Employees work on setup improvement.	.74
M/RS2	Employees redesign or reconfigure equipment to shorten setup time.	.78
M/RS3	Employees redesign jigs or fixtures to shorten setup time.	.75
M/RS4	We use special tools to shorten setup.	.63
M/RS5	Our employees are trained to reduce setup time.	.67
	Cellular Manufacturing: alpha = .88	
M/CM1	Products that share similar design or processing requirements are grouped into families of products.	.76
M/CM2	Products are classified into groups with similar processing requirements.	.79
M/CM3	Products are classified into groups with similar routing requirements.	.73
M/CM4	Equipment is grouped to produce families of products.	.68
M/CM5	Families of products determine our factory layout.	.59
	Quality Improvement Efforts: alpha = .85	
M/QM1	We use fishbone type diagrams to identify causes of quality problems.	.67
M/QM2	We use design of experiments (i.e., Taguchi methods).	.67
M/QM3	Our employees use quality control charts (e.g., SPC charts)	.72
M/QM4	We conduct process capability studies.	.72
	Preventive Maintenance: alpha = .92	
M/PM1	We emphasize good preventive maintenance.	.82
M/PM2	Records of routine maintenance are kept.	.74
M/PM3	We do preventive maintenance.	.88
M/PM4	We do preventive maintenance during non-productive time.	.66
M/PM5	We maintain our equipment regularly.	.82
	Dependable Suppliers: alpha = .91	
M/SR1	We receive parts from suppliers on time.	.72
M/SR2	We receive the correct number of parts from suppliers.	.78
M/SR3	We receive the correct type of parts from suppliers.	.73
M/SR4	We receive parts from suppliers that meet our specifications.	.77
M/SR5	Our suppliers accommodate our needs.	.75
M/SR6	We receive high quality parts from suppliers.	.71
	Pull Production: alpha = .88	
M/PP1	Production is "pulled" by the shipment of finished goods.	.71
M/PP2	Production at stations is "pulled" by the current demand of the next stations.	.78
M/PP3	We use a "pull" production system.	.82

Among the seven sub-constructs proposed by Koufteros et al. (1998), "Shop Floor Employee Involvement in Problem Solving" loaded together with "Re-engineering Setup" as a single factor, indicating that the respondents were not able to distinguish the questionnaire items for these two sub-constructs. Careful examination of the wordings in the measurement items revealed that the use of word "employees" as subject for each question could have caused the problem.

Previous studies by Koufteros (1995) and Koufteros et al. (1998) had analyzed the five items for "Shop Floor Employee Involvement in Problem Solving" separately from the rest of time-based manufacturing practices, theorizing that the sub-construct may be an antecedent to all other time-based efforts in manufacturing. However, the research framework proposed for this research in Figure 2.1 does not permit the incorporation of such antecedent relationship. Moreover, analyzing the measurement items for the sub-construct separately results in a deviation from the basic procedure for analysis for all other measurement items.

This research encompasses, to a certain extent, the notion that "Shop Floor Employee Involvement in Problem Solving" is an antecedent of all other time-based manufacturing practices by having "Locus of Decision Making" sub-construct included as one of the five dimensions of organizational structure. It was thus decided that the "Shop Floor Employee Involvement in Problem Solving" sub-construct be deleted from manufacturing practices construct in subsequent data analysis and structural modeling. The exploratory factor analysis of items for the remaining six sub-constructs and 28 items is shown in Table 4.2.4.2.

A correlation matrix (Table 4.2.4.3) of the 28 items was examined for evidence of convergent and discriminant validity. The smallest within sub-construct correlations were: re-engineering setup = 0.501, cellular manufacturing = 0.418, quality improvement efforts = 0.513, preventive maintenance = 535, dependable suppliers = 0.508, and pull production = 0.640. All of them were significantly different from zero at $p<0.01$.

An examination of the correlation matrix to assess discriminant validity resulted in only two violations out of 648 total comparisons, indicating high level of discriminant validity. Overall, 28 items and six scales were proposed for manufacturing practices construct (Appendix F).

4.3. SUMMARY OF MEASUREMENT ANALYSIS

Figure 4.3.1 illustrates a revised research framework as a result of having "Shop Floor Employee Involvement in Problem Solving" deleted as a sub-construct from manufacturing practices.

Table 4.3.1 contains the summary of measurement analysis carried out in this chapter. The final Cronbach's alpha value and the eigenvalue (rotation sums of squared loadings) for each of the scales are displayed. All scales have demonstrated sufficient level of reliability (Cronbach's alphas on or above 0.79), and convergent / discriminant validity.

The items are worded in manufacturing specific terms, making it easy for

Table 4.2.4.2. Exploratory Factor Analysis for the Retained Manufacturing Practices Items (Large Scale)

ITEM	F1-Depend. Suppliers	F2-Preventive Maintenance	F3-Cellular Mft.	F4-Reengineer Setups	F5-Quality Imp. Efforts	F6-Pull Production	Alpha (α)
M/SR1	.79						α = .91
M/SR2	.83						
M/SR3	.82						
M/SR4	.84						
M/SR5	.82						
M/SR6	.77						
M/PM1		.81					α = .92
M/PM2		.82					
M/PM3		.89					
M/PM4		.69					
M/PM5		.85					
M/CM1			.82				α = .88
M/CM2			.88				
M/CM3			.85				
M/CM4			.70				
M/CM5			.67				
M/RS1				.78			α = .88
M/RS2				.82			
M/RS3				.85			
M/RS4				.69			
M/RS5				.61			
M/QM1					.75		α = .85
M/QM2					.77		
M/QM3					.78		
M/QM4					.76		
M/PP1						.80	α = .88
M/PP2						.82	
M/PP3						.87	
Eigenvalue	4.20	3.81	3.44	3.39	2.87	2.57	
% of Variance	14.98	13.60	12.27	12.10	10.24	9.17	
Cumulative % of Variance	14.98	28.58	40.85	52.96	63.19	72.36	

Table 4.2.4.3. Item Correlation Matrix, Descriptive Statistics, and Discriminant Validity Tests for Manufacturing Practices (Large Scale)

	M/ RS1	M/ RS2	M/ RS3	M/ RS4	M/ RS5	M/ CM1	M/ CM2	M/ CM3	M/ CM4	M/ CM5	M/ QM1	M/ QM2	M/ QM3	M/ QM4	M/ PM1	M/ PM2	M/ PM3	M/ PM4	M/ PM5	M/ SR1	M/ SR2	M/ SR3	M/ SR4	M/ SR5	M/ SR6	M/ PP1	M/ PP2	M/ PP3
M/RS1	1.000																											
M/RS2	0.716	1.000																										
M/RS3	0.627	0.776	1.000																									
M/RS4	0.531	0.501	0.543	1.000																								
M/RS5	0.584	0.564	0.529	0.575	1.000																							
M/CM1	0.275	0.288	0.249	0.369	0.420	1.000																						
M/CM2	0.232	0.292	0.235	0.313	0.345	0.793	1.000																					
M/CM3	0.214	0.262	0.186	0.255	0.333	0.684	0.819	1.000																				
M/CM4	0.279	0.302	0.290	0.326	0.420	0.542	0.533	0.518	1.000																			
M/CM5	0.162	0.224	0.170	0.171	0.305	0.483	0.443	0.418	0.678	1.000																		
M/QM1	0.364	0.359	0.294	0.316	0.362	0.250	0.219	0.205	0.409	0.288	1.000																	
M/QM2	0.357	0.349	0.245	0.285	0.352	0.226	0.216	0.227	0.336	0.306	0.663	1.000																
M/QM3	0.347	0.305	0.261	0.231	0.403	0.309	0.236	0.203	0.242	0.202	0.556	0.516	1.000															
M/QM4	0.435	0.357	0.204	0.320	0.441	0.324	0.259	0.278	0.276	0.174	0.513	0.560	0.746	1.000														
M/PM1	0.327	0.301	0.222	0.320	0.368	0.295	0.243	0.226	0.299	0.224	0.365	0.405	0.415	0.480	1.000													
M/PM2	0.311	0.267	0.240	0.321	0.351	0.269	0.183	0.163	0.300	0.136	0.276	0.216	0.323	0.330	0.652	1.000												
M/PM3	0.260	0.265	0.212	0.271	0.340	0.247	0.191	0.172	0.281	0.191	0.341	0.359	0.377	0.411	0.797	0.791	1.000											
M/PM4	0.304	0.365	0.265	0.256	0.405	0.280	0.251	0.204	0.283	0.232	0.270	0.393	0.391	0.416	0.605	0.535	0.627	1.000										
M/PM5	0.227	0.267	0.171	0.285	0.337	0.241	0.236	0.233	0.233	0.178	0.274	0.307	0.341	0.397	0.780	0.648	0.801	0.621	1.000									
M/SR1	0.143	0.188	0.145	0.076	0.228	0.111	0.101	0.057	0.114	0.174	0.119	0.223	0.226	0.235	0.245	0.166	0.204	0.246	0.291	1.000								
M/SR2	0.115	0.177	0.159	0.127	0.219	0.109	0.105	0.047	0.051	0.146	0.047	0.137	0.150	0.182	0.324	0.212	0.262	0.238	0.317	0.752	1.000							
M/SR3	0.137	0.189	0.105	0.061	0.195	0.127	0.116	0.049	0.055	0.039	0.044	0.100	0.156	0.210	0.241	0.181	0.198	0.137	0.247	0.608	0.730	1.000						
M/SR4	0.247	0.242	0.253	0.185	0.221	0.134	0.121	0.035	0.076	0.055	0.054	0.119	0.131	0.165	0.205	0.234	0.211	0.118	0.202	0.559	0.612	0.641	1.000					
M/SR5	0.182	0.188	0.203	0.181	0.189	0.122	0.110	0.022	0.116	0.145	0.101	0.155	0.080	0.123	0.202	0.132	0.152	0.104	0.209	0.594	0.580	0.535	0.703	1.000				
M/SR6	0.257	0.262	0.268	0.189	0.264	0.189	0.113	0.021	0.149	0.145	0.151	0.208	0.178	0.238	0.291	0.264	0.300	0.165	0.272	0.508	0.534	0.532	0.716	0.719	1.000			
M/PP1	0.342	0.239	0.255	0.212	0.320	0.134	0.108	0.117	0.268	0.288	0.208	0.251	0.256	0.236	0.301	0.193	0.267	0.163	0.291	0.277	0.227	0.130	0.217	0.237	0.321	1.000		
M/PP2	0.362	0.308	0.313	0.336	0.380	0.254	0.193	0.093	0.311	0.293	0.267	0.235	0.305	0.233	0.308	0.227	0.285	0.253	0.279	0.234	0.233	0.089	0.204	0.198	0.191	0.640	1.000	
M/PP3	0.386	0.304	0.304	0.321	0.348	0.189	0.097	0.018	0.263	0.314	0.262	0.280	0.251	0.241	0.263	0.241	0.280	0.208	0.258	0.260	0.247	0.072	0.200	0.245	0.265	0.700	0.794	1.000
	M/ RS1	M/ RS2	M/ RS3	M/ RS4	M/ RS5	M/ CM1	M/ CM2	M/ CM3	M/ CM4	M/ CM5	M/ QM1	M/ QM2	M/ QM3	M/ QM4	M/ PM1	M/ PM2	M/ PM3	M/ PM4	M/ PM5	M/ SR1	M/ SR2	M/ SR3	M/ SR4	M/ SR5	M/ SR6	M/ PP1	M/ PP2	M/ PP3
Mean	3.24	2.78	2.75	3.23	2.78	3.63	3.59	3.45	3.57	3.43	2.73	2.34	3.00	3.09	3.40	3.82	3.73	3.32	3.67	3.35	3.50	3.76	3.84	3.74	3.72	3.15	2.96	2.92
S.D.	1.02	1.02	1.02	1.00	1.05	1.08	1.08	1.08	1.11	1.21	1.16	1.16	1.26	1.24	1.12	1.06	1.08	1.13	1.02	0.83	0.79	0.66	0.68	0.68	0.77	1.19	1.14	1.19
# of Violations	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Note: None of the count of violations for each item exceeds half of the potential comparisons.
Total # of violations = 2

Figure 4.3.1. Revised Research Framework

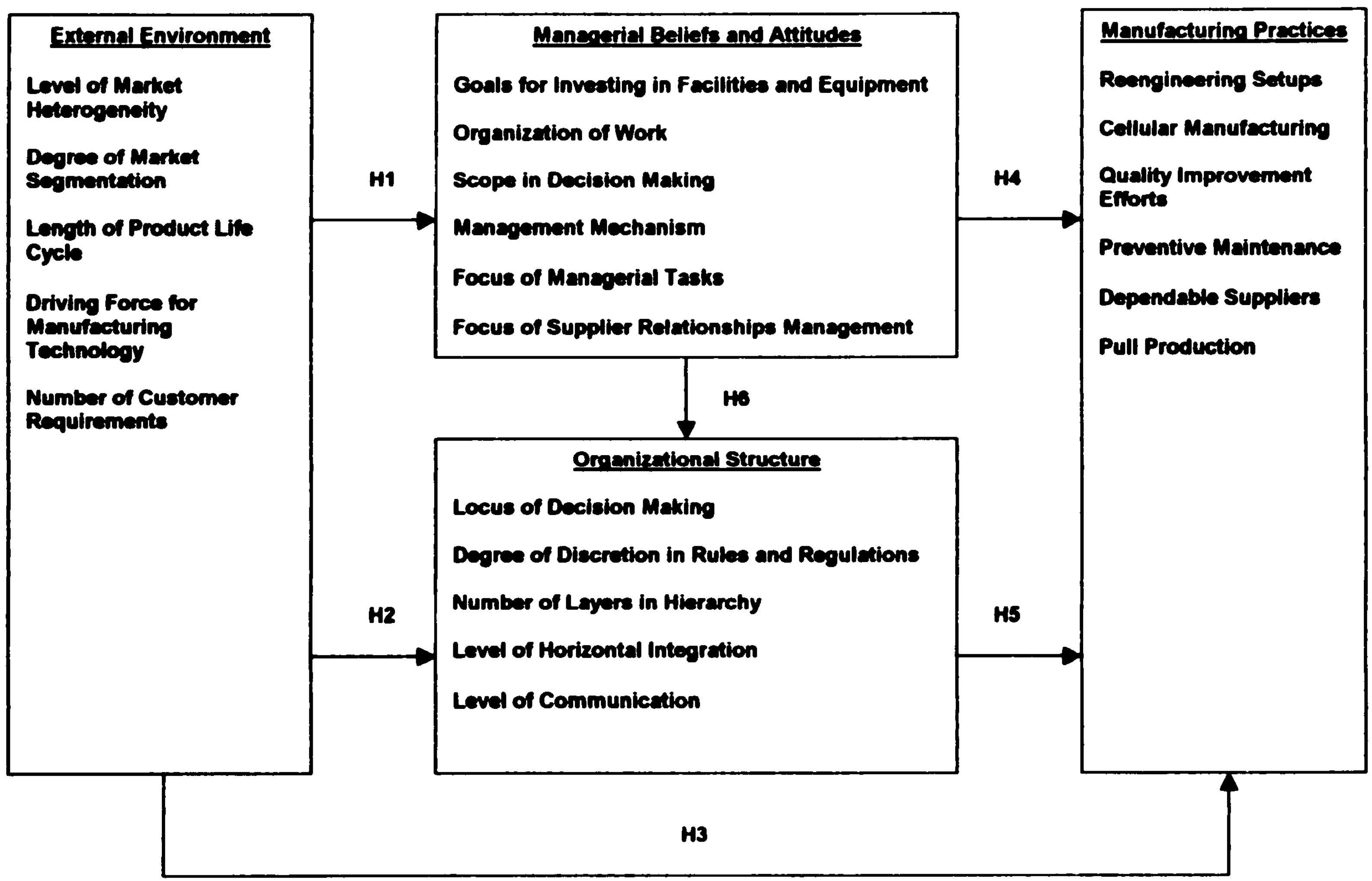


Table 4.3.1. Summary of Measurement Analysis

Constructs	Sub-Constructs	# of Items	Alpha	Eigen-value
External Environment (EXT ENV)	Level of Market Internationalization (E/MH)	4	0.80	2.55
	Degree of Market Segmentation (E/MS)	1	-	1.10
	Length of Product Life Cycle (E/LC)	5	0.80	2.83
	Driving Force for Manufacturing Technology (E/DT)	5	0.79	2.79
	Number of Customer Requirements (E/CR)	3	0.79	2.29
Managerial Beliefs and Attitudes (MGMT BA)	Goals for Investing in Facilities and Equipment (B/GI)	5	0.93	4.20
	Organization of Work (B/OW)	4	0.89	3.11
	Scope in Decision Making (B/DM)	5	0.89	3.71
	Management Mechanism (B/MM)	3	0.84	2.40
	Focus of Managerial Tasks (B/FM)	6	0.92	4.29
	Focus of Supplier Relationships Management (B/SM)	5	0.89	3.47
Organizational Structure (ORGL STR)	Locus of Decision Making (O/LD)	6	0.86	3.51
	Degree of Discretion in Rules and Regulations (O/NF)	5	0.89	3.74
	Number of Layers in Hierarchy (O/NL)	4	0.86	2.97
	Level of Horizontal Integration (O/HI)	6	0.93	4.37
	Level of Communication (O/CO)	5	0.87	3.48
Manufacturing Practices (MFT PRAC)	Re-engineering Setup (M/RS)	5	0.88	3.39
	Cellular Manufacturing (M/CM)	5	0.88	3.44
	Quality Improvement Efforts (M/QM)	4	0.85	2.87
	Preventive Maintenance (M/PM)	5	0.92	3.81
	Dependable Suppliers (M/SR)	6	0.91	4.20
	Pull Production (M/PP)	3	0.88	2.57

manufacturing managers / executives to answer to each item. Each scale had three to six measurement items, except for the "Degree of Market Segmentation" sub-construct, which ended up as a single item measure. Measurement items for each sub-construct are listed in Appendix F.

CHAPTER 5: CAUSAL MODEL AND HYPOTHESES TESTING

Having obtained valid and reliable scales that measure some critical dimensions of external environment, managerial beliefs and attitudes, organizational structure, and manufacturing practices, the relationship among these constructs were explored and hypotheses tested through structural equation modeling (LISREL) and analysis of variance (ANOVA).

5.1. THE CAUSAL MODEL

To explore the relationships between external environment, managerial beliefs and attitudes, organizational structure, and manufacturing practices, linear structural equations modeling (LISREL) was used. In structural equation modeling, it is preferable to have several indicators of a construct as opposed to a single indicator (Hair et al., 1995). In this research, composite measures were used as indicators for each construct.

First, composite measures were created by summing the individual scores for items in each sub-construct then dividing by the number of items. Taking the average of individual item scores for each sub-construct is justified by the fact that they came out as clean, separate factors, with demonstrated discriminant validity. Second, these composite measures were used as observable indicators of the exogenous latent construct (EXT ENV) and endogenous latent constructs (MGMT BA, ORGL STR, and MFT PRAC). Figure 5.1.1 illustrates the causal model, with composite measures as observable indicators of the exogenous and endogenous latent constructs.

5.2. RESULTS OF TESTING THE CAUSAL MODEL

Linear structural relations (LISREL) provides a vigorous method for testing causal models with both observable and latent variables as it is capable of simultaneously evaluating both the measurement and causal components of complex models (Dillion and Goldstein, 1984). Standardized coefficients and t-values of the causal relationships between exogenous and endogenous constructs were used to test the hypotheses stated in Chapter 2.

The goodness-of-fit index (GFI) and root mean square error of approximation (RMSEA) were used to evaluate the appropriateness of the overall causal model being tested. Goodness-of-fit index is a non-statistical measure ranging in value from 0 (poor fit) to 1.0 (perfect fit). Higher values indicate better fit, but no absolute threshold levels for acceptability have been established. The statistical distribution of the GFI measure is unknown, so there is no absolute standard with which to compare them (Jöreskog and Sörbom, 1989). RMSEA is an average of the residuals between observed and estimated input matrices. Values ranging from 0.05 to 0.08 are deemed acceptable (Hair et al., 1995).

All 224 responses were utilized in carrying out the LISREL analysis. The GFI was 0.86, while RMSEA being 0.067, indicating sufficient level of model-to-

Figure 5.1.1. Primary Causal Model

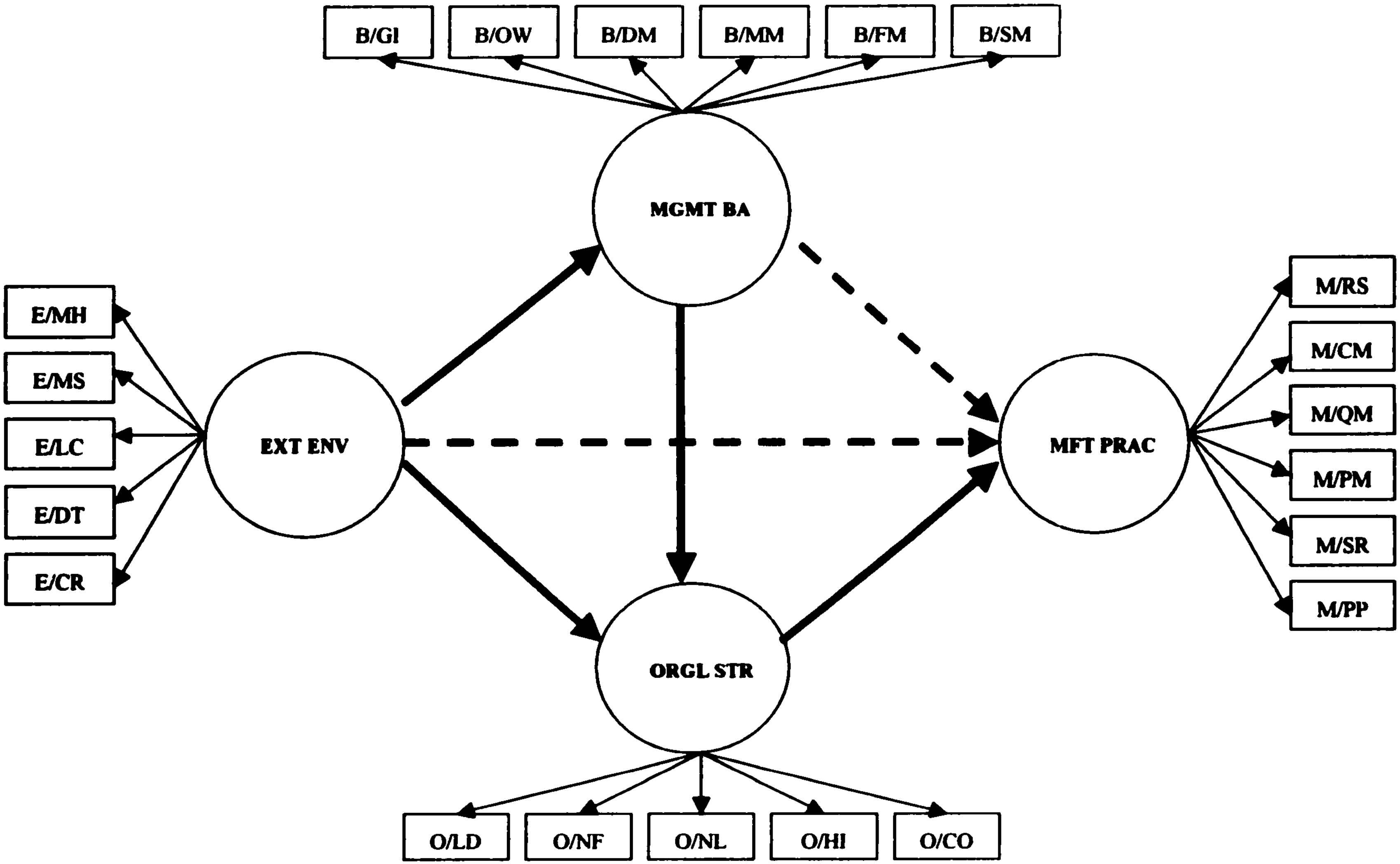


Table 5.2.1. Summary of LISREL Generated Data for Indicators

Exogenous Construct Indicators	Standardized Coefficients	*t*-values	Endogenous Construct Indicators	Standardized Coefficients	*t*-values
E/MH	0.23	-	B/GI	0.54	-
E/MS	0.20	1.72*	B/OW	0.57	9.25***
E/LC	0.22	2.09**	B/DM	0.64	9.67***
E/DT	0.37	2.51**	B/MM	0.34	5.57***
E/CR	0.38	2.45**	B/FM	0.68	9.27***
			B/SM	0.66	9.06***
			O/LD	0.55	-
			O/NF	0.59	8.40***
			O/NL	0.40	5.43***
			O/HI	0.65	10.46***
			O/CO	0.57	10.72***
			M/RS	0.63	-
			M/CM	0.47	7.17***
			M/QM	0.70	9.80***
			M/PM	0.55	8.23***
			M/SR	0.22	4.92***
			M/PP	0.59	7.85***

Note: * Significant at $\alpha < 0.10$, ** $\alpha < 0.05$, *** $\alpha < 0.01$ (Two-tailed *t*-test, $df = \infty$)

data fit. The standardized coefficients and *t*-values of the indicators are shown in Table 5.2.1. They are all above the minimum acceptable *t*-value of 1.645 (at $\alpha = 0.10$ for two-tailed *t*-test, $df = \infty$).

Figure 5.2.1 and Table 5.2.2 displays a summary of the data generated by LISREL related to the testing of the relationships between constructs. Among the six hypotheses proposed in Chapter 2, hypotheses 1, 2, 5, and 6 were supported by the data, while hypotheses 3 and 4 were not. The result indicates that there are no direct causal relationships from external environment to manufacturing practices, or from managerial beliefs and attitudes to manufacturing practices. The nature of these relationships appears to be indirect; the relationship between external environment and manufacturing

Figure 5.2.1. Result of LISREL Analysis

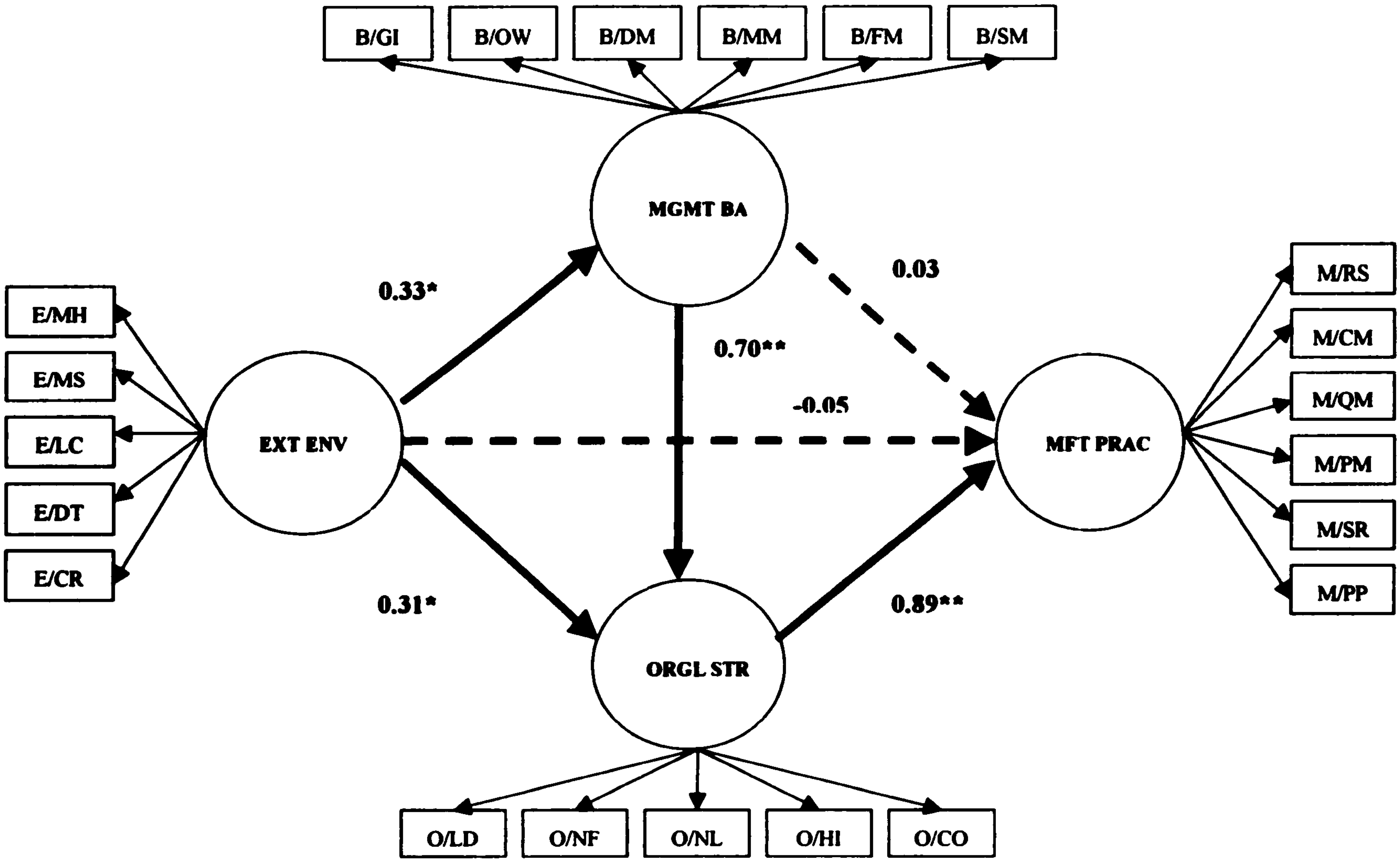


Table 5.2.2. Summary of LISREL Generated Data for Hypotheses Testing

Relationship	Standardized Coefficient	*t*-value	Significant?	Hypotheses Testing
EXT ENV → MGMT BA	0.33	2.09*	Yes ($\alpha < 0.05$)	H1: Supported
EXT ENV → ORGL STR	0.31	2.21*	Yes ($\alpha < 0.05$)	H2: Supported
EXT ENV → MFT PRAC	-0.05	-0.39	No	H3: Not supported
MGMT BA → MFT PRAC	0.03	0.23	No	H4: Not supported
ORGL STR → MFT PRAC	0.89	4.50**	Yes ($\alpha < 0.01$)	H5: Supported
MGMT BA → ORGL STR	0.70	7.17**	Yes ($\alpha < 0.01$)	H6: Supported

Note: * Significant at $\alpha < 0.05$, ** Significant at $\alpha < 0.01$ (one-tailed *t*-test, $df = \infty$)

practices is mediated through the internal environment (managerial beliefs and attitudes and organizational structure), and the organizational structure mediates the relationship between managerial beliefs and attitudes and manufacturing practices.

To further assess the various relationships between constructs, coefficients of direct, indirect and total effects were examined through LISREL. The coefficient of indirect effect is calculated by multiplying the coefficients of direct effects that lie along the indirect path. When multiple indirect paths exist between two constructs, the sum of all possible coefficients of indirect effects is calculated to represent the indirect effect between two constructs. The coefficient of total effects is the sum of coefficients of direct and indirect effects. The results are shown in Table 5.2.3.

As an example of how the coefficient of indirect effect is calculated, consider the two constructs, external environment (EXT ENV) and organizational structure (ORGL STR). Besides the direct path between the two, which has the

Table 5.2.3. Decomposition of Effects (Standardized Coefficients and t-values)

Relationship	Total Effects	Direct Effect	Indirect Effects
EXT ENV → MGMT BA	0.33 (2.09)*	0.33 (2.09)*	-
EXT ENV → ORGL STR	0.55 (2.47)*	0.31 (2.21)*	0.23 (2.17)*
EXT ENV → MFT PRAC	0.45 (2.33)*	-0.05 (-0.39)	0.50 (2.31)*
MGMT BA → MFT PRAC	0.66 (6.66)**	0.03 (0.23)	0.63 (4.02)**
ORGL STR → MFT PRAC	0.89 (4.50)**	0.89 (4.50)**	-
MGMT BA → ORGL STR	0.70 (7.17)**	0.70 (7.17)**	-

Note: * Significant at $\alpha < 0.05$, ** Significant at $\alpha < 0.01$ (one-tailed *t*-test, $df = \infty$)

coefficient of direct effect of 0.31, they also have an indirect path, which goes from EXT ENV to managerial beliefs and attitudes (MGMT BA), then from MGMT BA to ORGL STR (Figure 5.2.1). The coefficient of indirect effect is calculated by multiplying the coefficient of direct effect between EXT ENV and MGMT BA (0.33) to that between MGMT BA and ORGL STR (0.70), resulting in 0.23 (Table 5.2.3). In another example, the coefficient of indirect effect between EXT ENV and manufacturing practices (MFT PRAC) can be calculated by adding the coefficients of indirect effects along three indirect paths (EXT ENV → MGMT BA → MFT PRAC, EXT ENV → MGMT BA → ORGL STR → MFT PRAC, and EXT ENV → ORGL STR → MFT PRAC). The coefficients of these indirect paths are 0.0099 (0.33 * 0.03), 0.2056 (0.33 * 0.70 * 0.89), and 0.2759 (0.31 * 0.89), respectively, resulting in the coefficient of indirect effect of 0.50 between these two constructs (Table 5.2.3).

All relationships turned out to be significant in total effects, including those relationships that have not been significant when only direct effects were considered. This indicates that even though there may be no *direct* relationships from external environment to manufacturing practices or from managerial beliefs and attitudes to manufacturing practices, there are positive, significant *indirect* relationships between them, resulting in significant total effects in both relationships.

5.3. RESULTS OF ANALYSIS OF VARIANCE (ANOVA)

To further assess the research question "firms operating in a post-industrial environment would have different managerial beliefs and attitudes, organizational structure, and manufacturing practices than firms operating in an industrial environment," analysis of variance was performed. First, composite measures for external environment, managerial beliefs and attitudes, organizational structure, and manufacturing practices were created by adding the mean scores of each sub-construct and dividing them by the number of sub-constructs.

Second, the respondents were divided into two groups: respondents who scored below the mean on composite measure for external environment, and those who scored above the mean. The mean score of composite measure for external environment was 2.93, with a standard deviation of 0.46. Third, ANOVA was performed, using group one and two as an independent variable (factor), and managerial beliefs and attitudes, organizational structure, and manufacturing practices as dependent variables. The results of ANOVA are shown in Table

5.3.1. The mean scores, number of observations, and standard deviations of managerial beliefs and attitudes, organizational structure, and manufacturing practices for each group (group 1 - below the mean, group 2 - above the mean on external environment) are shown in Table 5.3.2.

The result of ANOVA indicates that there are significant differences in mean scores of managerial beliefs and attitudes, organizational structure, and manufacturing practices, respectively, between groups that scored high / low on external environment.

Table 5.3.1. Results of ANOVA on Managerial Beliefs and Attitudes, Organizational Structure, and Manufacturing Practices

		SS	df	MS	F	*p*-value
Managerial Beliefs and Attitudes	Between Groups	1.495	1	1.495	3.977*	.047
	Within Groups	83.480	222	.376		
	Total	84.975	223			
Organizational Structure	Between Groups	3.868	1	3.868	9.844**	.002
	Within Groups	87.242	222	.393		
	Total	91.110	223			
Manufacturing Practices	Between Groups	1.880	1	1.880	5.207*	.023
	Within Groups	80.133	222	.361		
	Total	82.012	223			

Note: * Significant at $\alpha < 0.05$, ** Significant at $\alpha < 0.01$

Table 5.3.2. Comparison of Group 1 and 2

		Group 1	Group 2	Difference
Managerial Beliefs and Attitudes	Mean	3.81	3.98	.17
	# of Observations	112	112	
	S.D.	.63	.59	
Organizational Structure	Mean	3.08	3.35	.27
	# of Observations	112	112	
	S.D.	.63	.62	
Manufacturing Practices	Mean	3.16	3.35	.19
	# of Observations	112	112	
	S.D.	.61	.59	

Note: Group 1 – below mean, Group 2 – above mean on external environment.

Some additional insights were gained through this analysis. The high level of mean scores for both groups on managerial beliefs and attitudes (3.81 and 3.98, respectively - Table 5.3.2) indicates that firms in both industrial and post-industrial environment are generally moving towards integrative managerial beliefs and attitudes, although firms operating in a post-industrial environment are higher in their level of integrative managerial beliefs and attitudes than firms operating in an industrial environment.

The mean scores of two groups in organizational structure (3.08 and 3.35, respectively) show the widest gap between the two (0.27 - Table 5.3.2) with the highest level of statistical significance (significant at $\alpha < 0.01$ - Table 5.3.1). Also, the mean scores for organizational structure on both groups (3.08 and 3.35) are on par or lower than the mean scores for manufacturing practices (3.16 and 3.35) and much lower than that for managerial beliefs and attitudes (3.81 and 3.98).

These results seem to indicate that organizational structure, more than any other internal variable, is defined by managers' perception on the nature of external environment. Even with a high level of integrative managerial beliefs and attitudes among managers operating in both industrial and post-industrial environment, firms do not seem to readily transform their organizational structure towards organic organizational structure. Among the three internal variables, organizational structure appears to exhibit the highest level of inertia against change.

Different dimensions of external environment may have different level of influence on various dimensions of managerial beliefs and attitudes, organizational structure, and manufacturing practices. To assess the nature of relationships on a sub-construct level, ANOVA was performed, using below / above mean on composite measures for each sub-construct in external environment as independent variables (factors), and composite measures for all other sub-constructs as dependent variables. The results are shown in Table 5.3.3.

The result verifies the notion that the level of influence of different dimensions of external environment on various dimensions of managerial beliefs and attitudes, organizational structure, and manufacturing practices would be different. Among the five dimensions of external environment, E/DT "Driving Force for Manufacturing Technology," E/MH "Level of Market Internationalization," and E/LC "Length of Product Life Cycle" appear to have greater amount of influence, in that order, on other sub-constructs. E/MS "Degree of Market Segmentation" and E/CR "Number of Customer Requirements" appear to have relatively less amount of influence.

Also revealing is how the sub-constructs in internal variables are affected by each sub-construct in external environment. For instance, M/CM "Cellular Manufacturing" showed no difference in the level of practice across all five dimensions of external environment. B/MM "Management Mechanism" was the sub-construct that had the second least amount of difference across different dimensions of external environment.

Table 5.3.3. Results of ANOVA on Sub-construct Level (Level of Significance)

	Independent Variables for ANOVA (Factors)					
	E/MH	E/MS	E/LC	E/DT	E/CR	E/MEAN
Managerial Beliefs and Attitudes						
B/GI Goals for Investing in Facilities and Equipment	0.426	0.111	**0.079***	**0.000*****	0.657	**0.020****
B/OW Organization of Work	**0.011****	0.860	0.465	**0.015****	0.994	0.148
B/DM Scope in Decision Making	0.913	0.809	0.629	**0.007*****	0.184	0.120
B/MM Management Mechanism	**0.064***	0.387	0.331	0.659	0.530	0.848
B/FM Focus of Managerial Tasks	**0.092***	0.109	0.772	**0.001*****	0.587	0.165
B/SM Focus of Supplier Relationships Management	0.120	0.442	0.191	**0.003*****	0.396	**0.022****
Organizational Structure						
O/LD Locus of Decision Making	**0.006*****	0.565	**0.097***	**0.016****	0.340	**0.013****
O/NF Degree of Discretion in Rules and Regulations	**0.011****	0.248	**0.011****	0.141	**0.041****	**0.000*****
O/NL Number of Layers in Hierarchy	**0.097***	0.670	0.613	**0.061***	0.762	0.512
O/HI Level of Horizontal Integration	**0.004*****	0.385	**0.000*****	**0.013****	0.113	**0.062***
O/CO Level of Communication	0.623	0.368	0.962	**0.000*****	0.600	**0.019****
Manufacturing Practices						
M/RS Reengineering Setups	0.995	0.461	0.715	**0.000*****	0.724	**0.033****
M/CM Cellular Manufacturing	0.766	0.940	0.752	0.131	0.143	0.988
M/QM Quality Improvement Efforts	**0.000*****	0.373	0.395	**0.010****	0.737	**0.012****
M/PM Preventive Maintenance	0.523	0.365	0.647	**0.019****	0.859	0.194
M/SR Dependable Suppliers	0.314	0.898	0.634	**0.025****	**0.068***	0.477
M/PP Pull Production	0.119	**0.025****	0.469	**0.000*****	0.193	**0.003*****

Note: * Significant at $\alpha < 0.10$, ** Significant at $\alpha < 0.05$, *** Significant at $\alpha < 0.01$

E/MH : Level of Market Internationalization
E/MS : Degree of Market Segmentation
E/LC : Length of Product Life Cycle
E/DT : Driving Force for Manufacturing Technology
E/CR : Number of Customer Requirements
E/MEAN : Composite Measure for External Environment

CHAPTER 6: SUMMARY AND RECOMMENDATIONS FOR FUTURE RESEARCH

This chapter provides (1) a summary of research findings and major contributions, (2) a discussion of limitations and recommendations for future research, and (3) implications for managers.

6.1. SUMMARY

Researchers in the field of post-industrial manufacturing literature argue that changing external environment (from industrial to post-industrial environment) would lead manufacturing managers to adopt new ways of managing their firms (Skinner, 1985; Doll and Vonderembse, 1991; Vonderembse et. al, 1997). This "new way" would appear in the form of "integrative managerial beliefs and attitudes" for organizational culture (Gerwin and Kolodony, 1992; Leonard-Barton, 1992; Nemetz and Fry, 1988; Walton, 1985), "organic structure" for organizational structure (Daft, 1995; Lawrence and Lorsch, 1967; Nahavandi, 1993; Nemetz and Fry, 1988; Parthasarthy and Sethi, 1992, 1993; Zammuto and O'Connor, 1992; Doll and Vonderembse, 1991), and "time-based manufacturing practices" for shop floor level practices (Blackburn, 1991; Koufteros et al., 1998).

This research intended to explore the relationships between (1) firms' external environment, (2) its internal environment (managerial beliefs and attitudes and organizational structure), and (3) its manufacturing practices through a large-scale survey. The research findings demonstrate that firms operating in a post-industrial environment have different managerial beliefs and attitudes, organizational structure, and manufacturing practices than firms operating in an industrial environment. A set of valid and reliable instruments were developed to measure the critical aspects of external environment, managerial beliefs and attitudes, and organizational structure in terms that are more manufacturing specific. The study contributes to our knowledge of post-industrial manufacturing in a number of ways.

First, a theoretical framework for post-industrial manufacturing is provided that identifies some of the most salient dimensions of external environment, managerial beliefs and attitudes, and organizational structure. This framework forms a foundation for future research. Numerous propositions can be tested using these constructs. Other constructs can be added in the future that might cover the unexplained variances.

Second, the study provides valid and reliable instruments to measure multiple dimensions of external environment, managerial beliefs and attitudes, and organizational structure. Although there were numerous measures provided in the literature for these constructs, their dimensions as well as specific terms used in their measurement items were not fit for use in the context of manufacturing. The measures developed through this study are concise and could be easily understood by manufacturing managers, for they are worded in terms that are manufacturing specific. Evidence of reliability and validity of these measures are reported, providing basis for use in future research.

Third, the study provides supporting evidence that external environment affects managerial beliefs and attitudes, organizational structure, and manufacturing practices, albeit the nature of influence from external environment to manufacturing practices is indirect rather than direct. The study also provides supporting evidence for the claim made by post-industrial manufacturing literature (Skinner, 1985; Doll and Vonderembse, 1991; Vonderembse et. al, 1997) that firms operating in a post-industrial environment would have different managerial beliefs and attitudes, organizational structure, and manufacturing practices than firms operating in an industrial environment. In doing so, this study extends the limitations of previous studies by providing the first broad-based empirical support for the theory of post-industrial manufacturing.

Fourth, the study provides important insights into the nature of relationships between external environment, managerial beliefs and attitudes, organizational structure, and manufacturing practices. The research findings support the notion that the manager's perception on the nature of external environment would directly affect his/her managerial beliefs and attitudes (Hypothesis 1), as well as the organizational structure (Hypothesis 2). It also supports the notion that managerial beliefs and attitudes would directly affect the organizational structure (Hypothesis 6), and that the organizational structure would directly affect manufacturing practices (Hypothesis 5). It did not support, however, the direct relationship between external environment and manufacturing practices (Hypothesis 3), or the direct relationship between managerial beliefs and attitudes and manufacturing practices (Hypothesis 4). The nature of these two relationships appears to be rather indirect than direct. The external environment still had an influence on the manufacturing practices, but only through the internal environment of the firm (managerial beliefs and attitudes and organizational structure), especially through organizational structure. Similarly, managerial beliefs and attitudes had an influence on manufacturing practices, but only through organizational structure.

Overall, this research indicates the significant role of internal environment of manufacturing firms for the adoption of time-based manufacturing practices, especially the strong influence of organizational structure. Among the three major variables (external environment, managerial beliefs and attitudes, and organizational structure), only organizational structure appears to have a strong direct relationship with manufacturing practices; the other two variables' relationship with manufacturing practices turned out to be indirect through organizational structure.

This seems to indicate that merely having the perception of post-industrial environment, or integrative managerial beliefs and attitudes, appears to be insufficient for firms to move into time-based manufacturing practices. Until the influence of external environment and managerial beliefs and attitudes is strong enough for firms to exhibit the characteristics of an organic structure, firms would be less inclined to adopt time-based manufacturing practices. Also, a group of firms already exhibiting the characteristics of an organic structure would more readily adopt time-based manufacturing practices, albeit their perceptions on external environment or their managerial beliefs and attitudes may vary.

6.2. RECOMMENDATIONS FOR FUTURE RESEARCH

In spite of the significant contributions mentioned above, this research has some important issues and limitations. By addressing these issues and limitations, possible directions for future research are derived. These can be largely categorized into measurement issues and structural issues.

6.2.1. Recommendations and Discussion of Measurement Issues

First, better construct definition and measurement items should be developed for the "Degree of Market Segmentation" sub-construct. Although single-item scales are not uncommon, it is difficult, if not impossible, to measure constructs accurately or completely with single-item scales (Spector, 1992; Hensley, 1999). Analyses of item-total correlation and factor structure of external environment scales seem to indicate that the notion of "market segment size" can be quite confusing to the respondents, especially when observed together with "market internationalization." The same analyses also seem to indicate that the notion of "growing number of market segments" might be a better way to measure this sub-construct. Future research should attempt to verify this understanding by developing better definitions and multi-item measurement scales for market segmentation, while carefully taking into consideration the two different aspects of the sub-construct (size and number).

Second, because of the limited number of observations (224), confirmatory factor analysis was not carried out in this research. Koufteros (1995) states that there is a lack of systematic confirmatory research in manufacturing, and that this lack of confirmatory studies impedes general agreement on the use of instrument. Since the usefulness of a measurement scale comes from its generalizability, future research should revalidate measurement scales developed through this research by the same referent population (respondents from the same four industries).

Third, future research should conduct factorial invariance tests. Generalizability of measurement scales can further be supported by factorial invariance tests. Using the instruments developed in this research, one may test for factorial invariance across different industries (through respondents from industries other than SIC 34, 35, 36, or 37), across different size firms, and across firms with different manufacturing strategies (make to stock versus make to order). Marsh and Hocevar (1985) have provided a detailed account to carry out factorial invariance tests using LISREL methodology.

Fourth, future research should apply multiple methods of obtaining data. The use of single respondents to represent what are supposed to be organization wide variables may generate some inaccuracy, more than the usual amount of random error (Koufteros, 1995). In this study, respondents were requested to respond to complex questionnaires dealing with organizational-level variables. It is suggested that multiple methods should be used to derive estimates of measures. Future research should seek to utilize multiple respondents from each participating organizations as an effort to enhance reliability of research findings.

Also this study has solely used subjective method of measurement. It may be appropriate to use both subjective and objective methods of measurement in future research. However, there are some difficult issues involved in measuring external environment and organizational structure both subjectively and objectively. Also, the lack of convergent validity among data gathered in both ways is well documented in the literature (For literature review in this subject, see Milliken, 1987; Jauch and Kraft, 1986; Ford and Slocum, 1977; Buchko, 1994; Matthews and Scott, 1995).

Once a construct is measured with multiple methods, random error and method variance may be assessed using multitrait-multimethod approach (Campbell and Fiske, 1959) or LISREL methodology. Bagozzi and Yi (1991) provide a comparison of three alternative procedures for analyzing multitrait-multimethod matrices.

6.2.2. Recommendations and Discussion of Structural Issues

First, future research should examine the hypothesized structural relationships in each industry. In this study, number of responses was heavily biased towards SIC 34 (49%), leaving not enough observations for SIC 35, 36, and 37 to perform this analysis (Table 4.1). Assuming an adequate sample in each industry, structural analyses may be done by industry. This would reveal either industry specific structural relationships or invariance of structural relationship across industries.

Second, future research should test hypothesized structural relationships with a different referent population. Respondents from industries other than SIC 34, 35, 36, or 37 should be utilized to test the generalizability of structural relationships. The relationships should also be tested in both consumer as well as non-consumer markets.

Third, future research should test hypothesized structural relationships at specific performance level. Several researchers have argued that if organizational theory and research are to be relevant to practitioners, emphasis must be placed on organizational effectiveness and its determinants (Cheng and McKinley, 1983; Hage, 1980; White and Hamermesh, 1981). Fry and Smith (1987) have also argued that the nature of relationship between congruence and effectiveness must be explored further. They state: "In the past, the relationship (between congruence and effectiveness) has been assumed to be a positive linear relation; the more congruent, the more effective. However, it could be that it is negative linear. Or it could be curvilinear, or some other form of relationship." Dividing the sample group into high and low performers, and testing for structural relationships within these two groups respectively, may provide important insights into determinants of high and low performance. The analysis can also uncover the relationship between level of performance and level of congruence among external environment, internal environment, and manufacturing practices.

Fourth, future research should incorporate contextual variables in the structural model. To uncover potentially useful role of contextual variables, this research has included 9 contextual variables. Firm size, measured in terms of number of employees or annual sales dollars, may have important bearings on organizational structure and its relationship with manufacturing practices. Intensity of competition may influence the relationships between external environment and internal environment (managerial beliefs and attitudes and organizational structure). Degrees of product and process complexity may have an effect on manufacturing practices and its relationship with other variables. Future research may incorporate such contextual variables as antecedents and moderators in the model.

Fifth, future research should investigate alternative hypothesized models of structural relationships. In this study, composite measures of items for each sub-construct were used as indicators for latent variables. And hypotheses were tested through assessing the relationships between latent variables only. However, the strength and nature of relationships among sub-constructs across variables may vary. By assessing these relationships at sub-construct level, one may explore numerous alternative models of structural relationships.

Sixth, future research should investigate more thoroughly how different dimensions of external environment affect various dimensions of managerial beliefs and attitudes, organizational structure, and manufacturing practices by performing multiple analysis of variance (MANOVA).

6.3. IMPLICATIONS FOR MANAGERS

The results of this study have several important implications for manufacturing managers. First, perceived changes in external environment (from industrial to post-industrial) are stimulating manufacturing managers to adopt integrative managerial beliefs and attitudes. The set of managerial beliefs and attitudes provided in this research is quite different and often times in direct contrary to industrial mindset. Post-industrial manufacturing literature (Skinner, 1985; Doll and Vonderembse, 1991; Vonderembse et al., 1997) has discussed this transition, and this study verifies its notion. Manufacturing managers should therefore assess the nature of their external environment and adapt to managerial beliefs and attitudes that is more fitting to their environment.

Second, perceived changes in external environment are also stimulating manufacturing managers to adapt to organic organizational structure. The research finding of this study indicates that the nature of influence from external environment to organizational structure is both direct (from external environment to organizational structure) and indirect (mediated by managerial beliefs and attitudes). This indicates that organic structure is more fitting for post-industrial environment and under integrative managerial beliefs and attitudes, whereas mechanistic structure is more fitting for industrial environment and managerial mindset. Manufacturing managers should carefully consider various aspects of organizational structure to enhance the fit between their external environment, managerial beliefs and attitudes, and organizational structure.

Third, manufacturing practices should be supported by appropriate organizational structure. The research finding of this study shows that there is a strong, direct relationship between organizational structure and manufacturing practices. This indicates that organic organizational structure is the single most important element that supports the adoption of time-based manufacturing practices. Therefore, it would be worthwhile for manufacturing managers who are contemplating on the adoption of time-based manufacturing practices to carefully consider the characteristics of their organizational structure and spend time and effort to build the appropriate infrastructure within their firm.

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APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT

EXTERNAL ENVIRONMENT

Level of Market Heterogeneity
Our competitors are U.S. companies (corporate headquarters located in U.S.).
Our competitors are foreign companies (corporate headquarters located in foreign countries).
Our competitors sell their products in the U.S. market.
Our competitors sell their products in a global market.
Our products are sold in the U.S. market.
Our products are sold in a global market.
Our customers get their supplies from all over the world.

Degree of Market Segmentation
Our market is divided into small market segments.
Our market segments are being divided into smaller ones over the years.
The number of market segments is increasing over the years.
We have different market segments to serve.
The boundary of our market segments is getting narrower over the years.
We serve many, small market segments.
Each of our market segments has distinctive characteristics.

Length of Product Life Cycle
A 'winning product' can last in the market quite a long time in our industry.
Products last in the market for a long time in our industry.
Products quickly become obsolete in our industry.
New products are introduced at a greater speed over the years.
Product life cycle is getting shorter in our industry over the years.
We need to develop next generation of products right after we introduce new products into the market.
We can clearly distinguish the period of product introduction, growth, maturity, and decline in our industry.
We plan ahead of time for phasing out old products when introducing new ones.

Driving Force for Manufacturing Technology
To gain economy of scale is the goal of adopting manufacturing technology in our industry.
To produce large amount of standardized products is the goal of adopting manufacturing technology in our industry.
To reduce unit cost is the goal of adopting manufacturing technology in our industry.
Firms with technology for economy of scale are leaders in our industry.
Firms with technology to produce multiple products efficiently are leaders in our industry.
To gain economy of scope is the goal of adopting manufacturing technology in our industry.
To make frequent changes in set-up is the goal of adopting manufacturing technology in our industry.
To produce variety of products is the goal of adopting manufacturing technology in our industry.
To respond quickly to design changes is the goal of adopting manufacturing technology in our industry.
To respond quickly to volume changes in demand is the goal of adopting manufacturing technology in our industry.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT (continued)

Number of Customer Requirements

Low price is the most important requirement from our customers.
Our customers' requirements are quite simple.
We can identify one 'order winning criterion' from our customers' expectations.
Our customers' requirements are always the same as before.
Our customers' requirements are becoming complicated over the years.
Our customers require satisfaction upon multiple criteria at the same time.
Our customers are asking us to do more then before.
We have to do well in all areas to satisfy our customers.
We cannot satisfy our customers anymore with only low cost and high quality.
Our customers are now requiring dependable delivery, service, and others, as well as low cost and high quality.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT (continued)

MANAGERIAL BELIEFS AND ATTITUDES

Goals for Investing in Facilities and Equipment

Through investments in facilities and equipment, we want to reduce direct labor costs.
Through investments in facilities and equipment, we want to reduce the number of workers.
Through investments in facilities and equipment, we want to encourage our workers to work in an innovative way.
Through investments in facilities and equipment, we want to increase intellectual work among our workers.
Through investments in facilities and equipment, we want to increase creativity among our workers.
Through investments in facilities and equipment, we want to support product improvement efforts among our workers.
Through investments in facilities and equipment, we want to support process improvement efforts among our workers.

Organization of Work

We believe that jobs should be done in sequences, being passed on from one person to another.
We believe that jobs should be done in time sequences, from one stage to another.
We believe that jobs should be done simultaneously, in a concurrent manner.
We believe that several functional departments should work together as a team.
We believe that workers should work together with workers from other functional departments.
We believe that workers should possess multiple skills, often beyond their functional boundaries.
We believe that workers should understand the nature of work in other departments.

Scope in Decision Making

We believe that by making decisions that optimize our performance in local scale, we can achieve maximum performance in global scale.
We believe that decisions made by each department have an effect on other departments.
We believe that decisions made by each department have an effect on the whole company.
We believe that in making certain decisions, each department should discuss with other departments.
We believe that decisions should be evaluated from an integrative perspective of the whole company.
We believe that overall effect should be considered and estimated before making certain decisions.
We believe that in making certain decisions, each department should be willing to yield for the benefit of the whole company.
We believe that we should be willing to make sub-optimal decisions in local scale for maximum performance in global scale.

Management Mechanism

We believe that managers should take tight control upon their subordinates.
We believe that command and control is the best way to manage.
We believe that workers should simply follow the directions given by their managers.
We believe that managers should use performance measures to control their subordinates.
We believe that managers should manage by means of collaboration and consensus.
We believe that collaboration and consensus is the best way to manage.
We believe that workers should be able to freely express their opinions.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT (continued)

Focus of Managerial Tasks

We believe that managers should focus on controlling costs.

We believe that once the internal tasks are optimized and production costs controlled, we would be providing value to customers.

We believe that managers should focus on monitoring market trends.

We believe that managers should focus on finding customer wants and needs.

We believe that managers should focus on finding ways to satisfy our customers.

We believe that managers should focus on providing value to customers.

We believe that optimizing our internal tasks is useless unless they provide value to customers.

We believe that controlling production costs is useless unless they provide value to customers.

Focus of Supplier Relationships Management

We believe that the goal of managing supplier relationships is to reduce purchasing costs.

We believe that we should maintain multiple suppliers to have them compete and supply us at minimum costs.

We believe that the best suppliers are low cost suppliers.

We believe that suppliers should be our strategic partners in improving quality.

We believe that suppliers should be our strategic partners in shortening manufacturing lead-time.

We believe that our suppliers can be part of our success in our business.

We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.

We believe that the goal of managing supplier relationships is to build up competitive capabilities.

We believe that our suppliers are strategic partners in building up our competitive capabilities.

We believe that the best suppliers are the ones who enable us to provide value to customers.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT (continued)

ORGANIZATIONAL STRUCTURE

Locus of Decision Making
Our cross-functional teams cannot do anything without senior executives' approval.
Our workers have a lot of control over their job.
Our workers have the authority to correct problems when they occur.
Our workers handle job-related problems by themselves.
Our workers do not need to get management's approval before they handle problems.
Our workers can make changes on their job whenever they see the need.
Our work teams have a lot of control over their job.
Our executives are supportive to the decisions made by cross-functional teams.
Our executives are supportive to the decisions made by our work teams.

Degree of Discretion in Rules and Regulations
Our workers are always expected to follow the existing rules and procedures.
Our rules and procedures point to the one-best-way of doing things.
Our workers are encouraged to make suggestions to change current rules and procedures.
Our rules and procedures allow workers to make adjustments on their job.
Our rules and procedures allow workers to experiment with their job.
Our rules and procedures show how workers can make suggestions to changes.
Our rules and procedures show how workers can make adjustments on their job.
Our rules and procedures show how workers can experiment with their job.
Our rules and procedures encourage workers to be creative in dealing with problems at work.

Number of Layers in Hierarchy
There are many layers in our organizational hierarchy.
Our company is a tall hierarchy.
Our managers have few subordinates (ten or less).
There are many management layers between plant operators and the CEO.
There are few layers in our organizational hierarchy.
We are a lean organization.
Our managers have many subordinates (twenty-five or more).
There are only few management layers between plant operators and the CEO.

Level of Horizontal Integration
Jobs are clearly distinguished according to each departmental boundary.
Our tasks are done through cross-functional teams.
Our workers are organized into work groups.
Our workers are cross-trained.
Our workers switch jobs with one another.
Our managers are rotated regularly to other departments.
Our workers have the opportunity to learn new skills.
Our workers are assigned to complete a task from beginning to end.
Our work teams are assigned to complete a task from beginning to end.
Our cross-functional teams are assigned to complete a task from beginning to end.
Our workers carry out their own support work rather than have specialized staffs for the work.

APPENDIX A: MEASUREMENT ITEMS ENTERING Q-SORT (continued)

Level of Communication
Boundaries between departments inhibit inter-departmental communications.
There are lots of communications going on between functional departments.
Workers can easily meet and communicate with workers from other departments.
Customer requirements are quickly transmitted to the appropriate department or work group.
Strategic decisions are quickly passed on to relevant work groups.
Communication between different levels in hierarchy is easy.
Workers can easily meet and communicate with upper management.
Lots of ideas are exchanged between our workers and top management.

APPENDIX B: COHEN'S KAPPA AND MOORE AND BENBASAT COEFFICIENT

The Q-sort method is an iterative process in which the degree of agreement between judges forms the basis of assessing construct validity and improving the reliability of the constructs. The method consists of two stages. In the first stage, two judges are requested to sort the questionnaire items according to different constructs, based on which the inter-judge agreement is measured. In the second stage, questionnaire items that were identified as being too ambiguous, as a result of the first stage, are reworded or deleted, in an effort to improve the agreement between the judges. The process is carried out repeatedly until a satisfactory level of agreement is reached.

The following example describes the theoretical basis for the Q-sort method and the two evaluation indices to measure inter-judge agreement level: Cohen's Kappa (Cohen, 1960) and Moore and Benbasat's "Hit Ratio" (Moore and Benbasat, 1991).

Let us assume that two judges independently classified a set of N components as either acceptable or rejectable. After the work was finished the following table was constructed:

		Judge 1		
		Acceptable	Rejectable	Total
Judge 2	Acceptable	X_{11}	X_{12}	X_{1+}
	Rejectable	X_{21}	X_{22}	X_{2+}
	Total	X_{+1}	X_{+2}	N

X_{ij} = the number of components in the i^{th} row and j^{th} column, for i,j = 1,2.

The above table can also be constructed using percentages by dividing each numerical entry by N. For the population of components, the table will look like:

		Judge 1		
Judge 2		Acceptable	Rejectable	Total
	Acceptable	P_{11}	P_{12}	P_{1+}
	Rejectable	P_{21}	P_{22}	P_{2+}
	Total	P_{+1}	P_{+2}	100

P_{ij} = the percentage of components in the i^{th} row and j^{th} column.

We will use this table of percentages to describe the Cohen's Kappa coefficient of agreement. The simplest measure of agreement is the proportion of components that were classified the same by both judges, i.e., $\Sigma_i P_{ii} = P_{11} + P_{22}$. However, Cohen suggested comparing the actual agreement, $\Sigma_i P_{ii}$, with the chance of agreement that would occur if the row and columns are independent, i.e., $\Sigma_i P_{i+}P_{+i}$. The difference between the actual and chance agreements, $\Sigma_i P_{ii} - \Sigma_i P_{i+}P_{+i}$, is the percent agreement above which is due to chance. This difference can be standardized by dividing it by its maximum possible value, i.e., $100\% - \Sigma_i P_{i+}P_{+i}$. The ratio of these is denoted by the Greek letter Kappa and is referred to as Cohen's Kappa.

Thus, Cohen's Kappa as a measure of agreement can be interpreted as the proportion of joint judgement in which there is agreement after chance agreement is excluded. The three basic assumptions for this agreement coefficient are: 1) the units are independent, 2) the categories of the nominal scale are independent and mutually exclusive, and 3) the judges operate independently.

For Kappa, no general agreement exists with respect to required scores. However, several studies have considered scores greater than 0.65 to be acceptable (e.g. Vessey, 1984; Jarvenpaa 1989; Solis-Galvan, 1998). Landis and Koch (1977) have provided a more detailed guideline to interpret Kappa by associating different values of this index to the degree of agreement beyond chance. The following guideline is suggested by them:

Value of Kappa	Degree of Agreement Beyond Chance
.76 - 1.00	Excellent
.40 - .75	Fair to Good (Moderate)
.39 or less	Poor

A second overall measure of both the reliability of the classification scheme and the validity of the items was developed by Moore and Benbasat (1991). The method required analysis of how many items were placed by the panel of judges for each round within the target construct. In other words, because each item was included in the pool explicitly to measure a particular underlying construct, a measurement was taken of the overall frequency with which the judges placed items within the intended theoretical construct. The higher the percentage of items placed in the target construct, the higher the degree of inter-judge agreement across the panel which must have occurred.

Scales based on categories which have a high degree of correct placement of items within them can be considered to have a high degree of construct validity, with a high potential for good reliability scores. It must be emphasized that this procedure is more a qualitative analysis than a rigorous quantitative procedure. There are no established guidelines for determining good levels of placement, but the matrix can be used to highlight any potential problem areas. The following exemplifies how this measure works.

Consider the simple case of four theoretical constructs with ten items developed for each construct. With a panel of three judges, a theoretical total of 30 placements could be made within each construct. Thereby, a theoretical versus actual matrix of item placements could be created as shown in the table below (including an ACTUAL "N/A: Not Applicable" column where judges could place items which they felt fit none of the categories).

		ACTUAL					Total	% Hits
		A	B	C	D	N/A		
THEORETICAL	A	26	2	1	0	1	30	87
	B	8	18	4	0	0	30	60
	C	0	0	30	0	0	30	100
	D	0	1	0	28	1	30	93

Item Placements: 120   Hits: 102   Overall "Hit Ratio": 85%

The item placement ratio (the "Hit Ratio") is an indicator of how many items were placed in the intended, or target, category by the judges. Examination of the diagonal of the matrix shows that with a theoretical maximum of 120 target placements (four constructs at 30 placements per construct), a total of 102 "hits" were achieved, for an overall "hit ratio" of 85%. More important, an examination of each row shows how the items created to tap the particular constructs are actually being classified. For example, row C shows that all 30-item placements were within the target construct, but that in row B, only 60% (18/30) were within the target. In the latter case, 8 of the placements were made in construct A, which might indicate the items underlying these placements are not differentiated enough from the items created for construct A. This finding would lead one to have confidence in a scale based on row C, but be hesitant about accepting any scale based on row B. An examination of off-diagonal entries indicates how complex any construct might be. Actual constructs based on columns with a high number of entries in the off-diagonal might be considered too ambiguous, so any consistent pattern of item misclassification should be examined.

APPENDIX C: LIST OF CONTEXTUAL AND PERFORMANCE VARIABLES

CONTEXTUAL VARIABLES

Please indicate which SIC group represents your PRIMARY industry.

- ☐ Fabricated Metal Products
- ☐ Industrial Machinery
- ☐ Electric and Electronic Equipment
- ☐ Transport Equipment

The NUMBER OF EMPLOYEES working in your plant.

☐ 100 – 249 ☐ 500 – 999 ☐ 2,500 and over
☐ 250 – 499 ☐ 1,000 – 2,499

The AVERAGE ANNUAL SALES $ (in millions) for your plant.

☐ Less than 10 ☐ 50 – 99.9 ☐ 500 – 1 billion
☐ 10 – 49.9 ☐ 100 – 499.9 ☐ Over 1 billion

What PERCENTAGE OF YOUR PRODUCTS (in volume) are:

Make to Stock? __________ % Make to Order? __________ %

What PERCENTAGE OF YOUR SALES (in $) are:

Industrial? __________ % Commercial? __________ %

How would you describe the main industry in which you compete?

☐ Little competition ☐ Quite competitive
☐ Moderately competitive ☐ Very competitive

Please select the TYPE OF OPERATION that best describes your plant:

☐ High volume, discrete part production
☐ Continuous flow process ☐ Flexible manufacturing
☐ Manufacturing cells ☐ Assembly line
☐ Job shop ☐ Projects ☐ Batch processing

What is the degree of product complexity in your dominant product line?

☐ Very low ☐ Low ☐ Moderate ☐ High ☐ Very high

What is the degree of process complexity in your dominant product line?

☐ Very low ☐ Low ☐ Moderate ☐ High ☐ Very high

What is your present job title?

☐ CEO/President ☐ Director ☐ Other
☐ Vice President ☐ Manager

APPENDIX C: LIST OF CONTEXTUAL AND PERFORMANCE VARIABLES (continued)

PERFORMANCE VARIABLES

Note: Please indicate HOW YOUR MANUFACTURING PLANT, over the PAST YEAR, has performed RELATIVE TO ALL OTHER COMPETITORS in your primary market segment.

1 = Unacceptable, 2 = Below satisfactory, 3 = Satisfactory, 4 = Above satisfactory, 5 = Superior

Manufacturing Performance

M/PER1 Our total cost per unit of product.
M/PER2 Our finished product defect rate.
M/PER3 Our new product introduction lead time.
M/PER4 Our number of end items.
M/PER5 Our order to delivery time.

Organizational Performance

O/PER1 Customers' perception on whether they are receiving their money's worth when purchasing our products.
O/PER2 Customer retention rate.
O/PER3 Generation of new business through customer referrals.
O/PER4 Sales growth.
O/PER5 Increased business from existing customers.
O/PER6 Return on investment.
O/PER7 Market share gain.
O/PER8 Overall competitive position.

APPENDIX D: ACRONYMS USED FOR CODING OF ITEMS IN EACH SUB-CONSTRUCT

EXTERNAL ENVIRONMENT

E/MH	Level of Market Heterogeneity (later, Level of Market Globalization)
E/MS	Degree of Market Segmentation
E/LC	Length of Product Life Cycle
E/DT	Driving Force for Manufacturing Technology
E/CR	Number of Customer Requirements

MANAGERIAL BELIEFS AND ATTITUDES

B/GI	Goals for Investing in Facilities and Equipment
B/OW	Organization of Work
B/DM	Scope in Decision Making
B/MM	Management Mechanism
B/FM	Focus of Managerial Tasks
B/SM	Focus of Supplier Relationships Management

ORGANIZATIONAL STRUCTURE

O/LD	Locus of Decision Making
O/NF	Degree of Discretion in Rules and Regulations
O/NL	Number of Layers in Hierarchy
O/HI	Level of Horizontal Integration
O/CO	Level of Communication

MANUFACTURING PRACTICES

M/EI	Shop-floor Employee Involvement in Problem Solving
M/RS	Reengineering Setups
M/CM	Cellular Manufacturing
M/QM	Quality Improvement Efforts
M/PM	Preventive Maintenance
M/SR	Dependable Suppliers
M/PP	Pull Production

APPENDIX E: MEASUREMENT ITEMS AFTER THE PILOT STUDY

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

EXTERNAL ENVIRONMENT

Level of Market Heterogeneity

E/MH1 Our competitors are primarily U.S. companies (corporate headquarters located in U.S.). (reverse)
E/MH2 Our competitors are primarily foreign companies (corporate headquarters located in foreign countries).
E/MH3 Our competitors sell their products in a global market.
E/MH4 Our products are sold in a global market.

Degree of Market Segmentation

E/MS1 Our market segments are narrow.
E/MS2 Our market segments' size are getting smaller.
E/MS3 The number of market segments is increasing over the years.
E/MS4 We have different market segments to serve.
E/MS5 We serve many, small market segments.

Length of Product Life Cycle

E/LC1 Products last in the market for a long time in our industry (more than 5 years). (reverse)
E/LC2 Products quickly become obsolete in our industry.
E/LC3 In our industry, product life cycles are getting shorter.
E/LC4 In our industry, we begin developing the next generation of products as soon as we introduce the current one.
E/LC5 In our industry, products rapidly go through market introduction, growth, maturity, and decline.
E/LC6 In our industry, product life cycles are short.
E/LC7 In our industry, product development is a continuing activity.

Driving Force for Manufacturing Technology

E/DT3 In our industry, firms have the technology to produce a variety of products efficiently.
E/DT4 In our industry, firms have the technology to make frequent set-up changes.
E/DT5 In our industry, firms have the technology to produce new products quickly.
E/DT6 In our industry, firms have the technology to make design changes quickly.
E/DT7 In our industry, firms have the technology to respond quickly to changes in volume demanded by customers.

Number of Customer Requirements

E/CR1 Our customers' requirements are complex.
E/CR2 Our customers' requirements are rarely the same as before.
E/CR3 Our customers' requirements are becoming more complicated.
E/CR4 Our customers require satisfaction on multiple criteria.
E/CR6 We have to do well in all areas to satisfy our customers.
E/CR7 Our customers require dependable delivery, flexibility, and service, as well as low cost and high quality.

APPENDIX E: MEASUREMENT ITEMS AFTER THE PILOT STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

MANAGERIAL BELIEFS AND ATTITUDES

Goals for Investing in Facilities and Equipment

B/GI3 Through investments in facilities and equipment, we want to encourage our workers to work in innovative ways.
B/GI4 Through investments in facilities and equipment, we want to increase intellectual work among our workers.
B/GI5 Through investments in facilities and equipment, we want to increase creativity among our workers.
B/GI6 Through investments in facilities and equipment, we want to support product improvement efforts among our workers.
B/GI7 Through investments in facilities and equipment, we want to support process improvement efforts among our workers.

Organization of Work

B/OW3 We believe that jobs should be done in a concurrent manner.
B/OW4 We believe that functional departments should work together as a team.
B/OW5 We believe that employees from one department should work with employees from other departments.
B/OW6 We believe that employees should work together as a team.
B/OW7 We believe that workers should understand the nature of work in other departments.

Scope in Decision Making

B/DM1 We believe that departments should discuss important decisions with other departments.
B/DM2 We believe that departmental managers should make decisions that benefit the whole company.
B/DM3 We believe that when making decisions, the overall effects of a decision should be considered.
B/DM4 We believe that decisions should be based on overall company objectives.
B/DM5 We believe that we should be willing to make sub-optimal decisions in local scale for maximum performance in global scale.
B/DM6 We believe that decision making should include input from many areas.
B/DM7 We believe that decision making should be a group process.

Management Mechanism

B/MM1 We believe that managers should take tight control upon their subordinates. (reverse)
B/MM2 We believe that command and control is the best way to manage. (reverse)
B/MM3 We believe that workers should simply follow the directions given by their managers. (reverse)
B/MM4 We believe that employees should be counseled rather than criticized.
B/MM5 We believe that managers should involve employees in decision making..
B/MM6 We believe that the best way to manage is to have employees "buy in."
B/MM7 We believe that managers should listen to employees' input.
B/MM8 We believe that employees should be led rather than controlled.

APPENDIX E: MEASUREMENT ITEMS AFTER THE PILOT STUDY (continued)

Focus of Managerial Tasks

B/FM3 We believe that managers should focus on finding customer wants and needs.
B/FM4 We believe that managers should focus on finding ways to satisfy our customers.
B/FM5 We believe that managers should focus on providing value to customers.
B/FM8 We believe that managers should meet with customers or customer representatives regularly.
B/FM9 We believe that we should strive to get closer to our customers.
B/FM10 We believe that customer contact is important to our company.

Focus of Supplier Relationships Management

B/SM4 We believe that our suppliers can be part of our success in our business.
B/SM5 We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.
B/SM6 We believe that our suppliers are strategic partners in building up our competitive capabilities.
B/SM7 We believe that the best suppliers are the ones who enables us to provide value to customers.
B/SM8 We believe that suppliers should be involved in decision making about product design.
B/SM9 We believe that suppliers should be involved in decision making about process design.

APPENDIX E: MEASUREMENT ITEMS AFTER THE PILOT STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

ORGANIZATIONAL STRUCTURE

Locus of Decision Making

O/LD1 Our work teams cannot take significant actions without supervisors or middle managers' approval. (reverse)
O/LD2 Our workers have the authority to correct problems when they occur.
O/LD3 Our workers handle job-related problems by themselves.
O/LD4 Our work teams have control over their job.
O/LD5 Our supervisors or middle managers are supportive of the decisions made by our work teams.
O/LD6 Our workers are encouraged to make suggestions to change current rules and procedures.
O/LD7 We encourage workers to be creative in dealing with problems at work.
O/LD8 Our workers are involved in writing policies and procedures.
O/LD9 Our workers are involved in developing standard methods.

Degree of Discretion in Rules and Regulations

O/NF4 We have written rules and procedures that show how workers can make suggestions for changes.
O/NF5 We have written rules and procedures that describe how workers can make changes on their job.
O/NF6 We have written rules and procedures that show how workers can experiment with their job.
O/NF10 We have written rules and procedures that guide quality improvement efforts.
O/NF11 We have written rules and procedures that guide creative problem solving.

Number of Layers in Hierarchy

O/NL2 There are many management layers between plant operators and the CEO (more than 6). (reverse)
O/NL3 There are few layers in our organizational hierarchy.
O/NL4 We are a lean organization.
O/NL5 There are only few management layers between plant operators and the CEO.

Level of Horizontal Integration

O/HI2 Our tasks are done through cross-functional teams.
O/HI3 Our workers are assigned to work in cross-functional teams.
O/HI4 Our workers are trained to work in cross-functional teams.
O/HI5 Our workers are required to work in cross-functional teams.
O/HI6 Our managers are assigned to lead various cross-functional teams.
O/HI8 Our most important tasks are carried out by cross-functional teams.

Level of Communication

O/CO2 Lots of communications are carried out among managers.
O/CO3 Communications are easily carried out among workers.
O/CO4 Strategic decisions are quickly passed on to relevant work groups.
O/CO5 Communication between different levels in hierarchy is easy.
O/CO6 Workers can easily meet and communicate with upper management.

APPENDIX E: MEASUREMENT ITEMS AFTER THE PILOT STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

MANUFACTURING PRACTICES

Shop Floor Employee Involvement in Problem Solving

M/EI1 Shop-floor employees are involved in problem solving efforts.
M/EI2 Shop-floor employees are involved in suggestion programs.
M/EI3 Shop-floor employees are involved in designing processes and tools that focus on improvement.
M/EI4 Shop-floor employees are involved in improvement efforts.
M/EI5 Shop-floor employees are involved in problem solving teams.

Re-engineering Setup

M/RS1 Employees work on setup improvement.
M/RS2 Employees redesign or reconfigure equipment to shorten setup time.
M/RS3 Employees redesign jigs or fixtures to shorten setup time.
M/RS4 We use special tools to shorten setup.
M/RS5 Our employees are trained to reduce setup time.

Cellular Manufacturing

M/CM1 Products that share similar design or processing requirements are grouped into families of products.
M/CM2 Products are classified into groups with similar processing requirements.
M/CM3 Products are classified into groups with similar routing requirements.
M/CM4 Equipment is grouped to produce families of products.
M/CM5 Families of products determine our factory layout.

Quality Improvement Efforts

M/QM1 We use fishbone type diagrams to identify causes of quality problems.
M/QM2 We use design of experiments (i.e., Taguchi methods).
M/QM3 Our employees use quality control charts (e.g., SPC charts)
M/QM4 We conduct process capability studies.

Preventive Maintenance

M/PM1 We emphasize good preventive maintenance.
M/PM2 Records of routine maintenance are kept.
M/PM3 We do preventive maintenance.
M/PM4 We do preventive maintenance during non-productive time.
M/PM5 We maintain our equipment regularly.

Dependable Suppliers

M/SR1 We receive parts from suppliers on time.
M/SR2 We receive the correct number of parts from suppliers.
M/SR3 We receive the correct type of parts from suppliers.
M/SR4 We receive parts from suppliers that meet our specifications.
M/SR5 Our suppliers accommodate our needs.
M/SR6 We receive high quality parts from suppliers.

Pull Production

M/PP1 Production is "pulled" by the shipment of finished goods.
M/PP2 Production at stations is "pulled" by the current demand of the next stations.
M/PP3 We use a "pull" production system.

APPENDIX F: MEASUREMENT ITEMS AFTER THE LARGE STUDY

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

EXTERNAL ENVIRONMENT

Level of Market Internationalization

E/MH1 Our competitors are primarily U.S. companies (corporate headquarters located in U.S.). (reverse)
E/MH2 Our competitors are primarily foreign companies (corporate headquarters located in foreign countries).
E/MH3 Our competitors sell their products in a global market.
E/MH4 Our products are sold in a global market.

Degree of Market Segmentation

E/MS3 The number of market segments is increasing over the years.

Length of Product Life Cycle

E/LC1 Products last in the market for a long time in our industry (more than 5 years). (reverse)
E/LC2 Products quickly become obsolete in our industry.
E/LC3 In our industry, product life cycles are getting shorter.
E/LC5 In our industry, products rapidly go through market introduction, growth, maturity, and decline.
E/LC6 In our industry, product life cycles are short.

Driving Force for Manufacturing Technology

E/DT3 In our industry, firms have the technology to produce a variety of products efficiently.
E/DT4 In our industry, firms have the technology to make frequent set-up changes.
E/DT5 In our industry, firms have the technology to produce new products quickly.
E/DT6 In our industry, firms have the technology to make design changes quickly.
E/DT7 In our industry, firms have the technology to respond quickly to changes in volume demanded by customers.

Number of Customer Requirements

E/CR1 Our customers' requirements are complex.
E/CR2 Our customers' requirements are rarely the same as before.
E/CR3 Our customers' requirements are becoming more complicated.

APPENDIX F: MEASUREMENT ITEMS AFTER THE LARGE STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

MANAGERIAL BELIEFS AND ATTITUDES

Goals for Investing in Facilities and Equipment

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B/GI6 Through investments in facilities and equipment, we want to support product improvement efforts among our workers.
B/GI7 Through investments in facilities and equipment, we want to support process improvement efforts among our workers.

Organization of Work

B/OW4 We believe that functional departments should work together as a team.
B/OW5 We believe that employees from one department should work with employees from other departments.
B/OW6 We believe that employees should work together as a team.
B/OW7 We believe that workers should understand the nature of work in other departments.

Scope in Decision Making

B/DM2 We believe that departmental managers should make decisions that benefit the whole company.
B/DM3 We believe that when making decisions, the overall effects of a decision should be considered.
B/DM4 We believe that decisions should be based on overall company objectives.
B/DM5 We believe that we should be willing to make sub-optimal decisions in local scale for maximum performance in global scale.
B/DM6 We believe that decision making should include input from many areas.

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B/MM1 We believe that managers should take tight control upon their subordinates. (reverse)
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B/FM3 We believe that managers should focus on finding customer wants and needs.
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B/FM10 We believe that customer contact is important to our company.

APPENDIX F: MEASUREMENT ITEMS AFTER THE LARGE STUDY (continued)

Focus of Supplier Relationships Management

B/SM5 We believe that through strategic partnership with our suppliers, our costs would reduce in the long run.

B/SM6 We believe that our suppliers are strategic partners in building up our competitive capabilities.

B/SM7 We believe that the best suppliers are the ones who enables us to provide value to customers.

B/SM8 We believe that suppliers should be involved in decision making about product design.

B/SM9 We believe that suppliers should be involved in decision making about process design.

APPENDIX F: MEASUREMENT ITEMS AFTER THE LARGE STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

ORGANIZATIONAL STRUCTURE

Locus of Decision Making

O/LD2 Our workers have the authority to correct problems when they occur.
O/LD3 Our workers handle job-related problems by themselves.
O/LD4 Our work teams have control over their job.
O/LD5 Our supervisors or middle managers are supportive of the decisions made by our work teams.
O/LD6 Our workers are encouraged to make suggestions to change current rules and procedures.
O/LD7 We encourage workers to be creative in dealing with problems at work.

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O/NF4 We have written rules and procedures that show how workers can make suggestions for changes.
O/NF5 We have written rules and procedures that describe how workers can make changes on their job.
O/NF6 We have written rules and procedures that show how workers can experiment with their job.
O/NF10 We have written rules and procedures that guide quality improvement efforts.
O/NF11 We have written rules and procedures that guide creative problem solving.

Number of Layers in Hierarchy

O/NL2 There are many management layers between plant operators and the CEO (more than 6). (reverse)
O/NL3 There are few layers in our organizational hierarchy.
O/NL4 We are a lean organization.
O/NL5 There are only few management layers between plant operators and the CEO.

Level of Horizontal Integration

O/HI2 Our tasks are done through cross-functional teams.
O/HI3 Our workers are assigned to work in cross-functional teams.
O/HI4 Our workers are trained to work in cross-functional teams.
O/HI5 Our workers are required to work in cross-functional teams.
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APPENDIX F: MEASUREMENT ITEMS AFTER THE LARGE STUDY (continued)

Note: Respondents were asked to response to the following questions, using the anchor 1=Not at all, 2=To a small extent, 3=To a moderate extent, 4=To a considerable extent, and 5=To a great extent.

MANUFACTURING PRACTICES

Re-engineering Setup

M/RS1 Employees work on setup improvement.
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Cellular Manufacturing

M/CM1 Products that share similar design or processing requirements are grouped into families of products.
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M/CM3 Products are classified into groups with similar routing requirements.
M/CM4 Equipment is grouped to produce families of products.
M/CM5 Families of products determine our factory layout.

Quality Improvement Efforts

M/QM1 We use fishbone type diagrams to identify causes of quality problems.
M/QM2 We use design of experiments (i.e., Taguchi methods).
M/QM3 Our employees use quality control charts (e.g., SPC charts)
M/QM4 We conduct process capability studies.

Preventive Maintenance

M/PM1 We emphasize good preventive maintenance.
M/PM2 Records of routine maintenance are kept.
M/PM3 We do preventive maintenance.
M/PM4 We do preventive maintenance during non-productive time.
M/PM5 We maintain our equipment regularly.

Dependable Suppliers

M/SR1 We receive parts from suppliers on time.
M/SR2 We receive the correct number of parts from suppliers.
M/SR3 We receive the correct type of parts from suppliers.
M/SR4 We receive parts from suppliers that meet our specifications.
M/SR5 Our suppliers accommodate our needs.
M/SR6 We receive high quality parts from suppliers.

Pull Production

M/PP1 Production is "pulled" by the shipment of finished goods.
M/PP2 Production at stations is "pulled" by the current demand of the next stations.
M/PP3 We use a "pull" production system.