The Level of Organizational Effectiveness of the (IC) Construction Firm: A Multivariate Model-Based Prediction Methodology

by

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A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Civil Engineering

Waterloo, Ontario, Canada, 1996

0-612-21408-7

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ABSTRACT

The Level of Organizational Effectiveness of The (ICI) Construction Firm:
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The assessment of organizational effectiveness represents a crucial step in the improvement process of the firm. Given the lack of consensus in its definitions and the various theoretical models and approaches that can be used to study and model organizational effectiveness, it is important for the validity of assessment that the methodology used to be linked to a suitable theoretical approach. The linkage must provide a theoretical basis for identifying the important organizational characteristics in the domain of effectiveness of the type of firm undergoing the assessment. This would ensure that the developed assessment methodology can be generalized to other similar firms of the same type, rather than being organization or firm-specific.

Most existing methods of assessing organizational effectiveness in the context of the construction firm tend to be organization-specific. Most utilize a project-dependent approach where assessment is typically performed after the completion of projects and effectiveness is assessed by the ability of the construction firm to achieve specific goal or goals that relate to time of execution, costs of completion, quality of finished work and/or a certain level of productivity. Project indicators, when used in the assessment of organizational effectiveness are crude at best. In certain instances, using these as indicators of effectiveness could be misguiding due to overlooking or not considering the particulars of each project performed by the construction firm.

Using the level of productivity by the construction firm as a common criteria of effectiveness suffers from many theoretical and methodological deficiencies. Both project indicators and productivity-based methods use indirect assessment. This yields very little information about the levels of important organizational characteristics that actually influence organizational effectiveness in the construction firm. An approach that incorporates the assessment of the important organizational attributes in the domain of effectiveness, based on and linked to an appropriate theoretical model, would give the construction firm a valuable and practical tool for monitoring its level of effectiveness.

A configurational perspective of organizational analysis and the competing values approach toward studying and modeling effectiveness criteria are identified in this research as most appropriate to be used to develop a valid assessment methodology for the construction firm, as it pursues suitable organizational configurations in its quest for effectiveness. The study of effectiveness' domains and dimensions, in the four ideal configurations of the competing values approach, helped in identifying criteria that are most relevant in examining the organizational effectiveness of the construction firm. These criteria are grouped into four general categories of organizational characteristics: structural context of the firm; organizational flexibility, rules and regulations; person-oriented processes in the firm; and organizational strategy means and ends used by the firm. Based on these categories, fourteen organizational variables are identified to form a basis on which a project-independent method of assessing effectiveness is developed. It is the hypothesis of this research that measurement of the level of these variables in the construction firm can yield a valid prediction of its level of organizational effectiveness.

To develop a yard stick against which the levels of the hypothesized variables can be measured, their ideal levels in an effective organizational configuration must be determined empirically. A field survey based on self-administered questionnaires was carried out to collect data from firms operating in the institutional, commercial, and industrial (ICI) construction sectors of the industry in Saudi Arabia. Data collection was based on measurement scales for the identified variables which were constructed and tested for reliability of use. Using the level of past project performance of the construction firm as a referent measure of organizational effectiveness and data pertaining to the fourteen variables, led to the development of a predictive multivariate linear model with five significant variables: organizational attitude toward change, level of multiple project handling ability, strength of organizational culture, level of workers' participation in decision making, and level of planning by the construction firm. The model is validated with a level of accuracy that makes it suitable for use by management of the construction firm to achieve a reliable prediction. Based on the findings of the study, a number of recommendations are made regarding assessment of organizational effectiveness and the natural shift in levels and types of effectiveness criteria that are possibly pursued by the firm during its life cycle as it changes from one configuration to another.

ACKNOWLEDGMENTS

(In The Name Of God, The Most Merciful, The Most Compassionate)

I wish to express my sincere gratitude to Prof. V.K. Handa my thesis advisor for guiding me through this research with his wisdom and deep insight. I have greatly benefited from his experience and advice on the analysis and presentation of data in this thesis, and his continuous constructive criticism. My sincere indebtedness goes out to both Prof. Cockfield and Dr. McKim for their help when presented with my questions during this study. I am also grateful to Prof. Matthews of the Statistics department for his generous help and valuable comments during data analysis.

My thesis would be meaningless if it wasn't for my wife, for her support and partnership in my endeavor has made me pull through the difficult times. I will never have enough words to express my appreciation and love for her. I am grateful to my children and family-at-large for their patience when I was busy at times and didn't have the time for them and for their prayers and best wishes for me.

I am greatly in debt to the Saudi Arabian Government who gave me all the financial support that I needed to pursue this study.

Finally, I thank the people of Canada and Ontario, and the University of Waterloo in particular for their friendship and understanding.

DEDICATION

I dedicate this thesis to my wife and children who gave me all the support I needed to accomplish this endeavor.

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CHAPTER (1)- INTRODUCTION

1.0. INTRODUCTION

There are many environmental and project factors that affect the performance of the construction firm and which, one could argue, fall outside the immediate control of the firm's management. However, organizational characteristics that fall under the control of management and which represent how the construction firm organizes itself in response to its environmental challenges, is most crucial in determining consistency of performance from project to project and ultimately survival.

The environment of the 1970s in Saudi Arabia and the early 1980s was characterised by high stable growth rates in construction output. This rapid growth stemmed from the level of public investment in infrastructure projects and house building. Construction firms used whatever experience they had to identify markets to which they were most suited. Market specialization occurred, not as any pre-meditated strategy, but rather through the firm's experience to identify projects which were successful for the firm. Organizational effectiveness was dictated by internal efficiency rather than the external environment because of the certainty that markets would not change dramatically. Little need for reference to the external environment. Most firms focused on cost as a prime indicator of effectiveness. Starting in the mid 1980s demands plummeted to a low level that was not anticipated- as the price of oil barrel sold for almost $ 40 US was selling for $ 9. In these conditions, construction firms struggled to cope with the new uncertainties and low demands. Many did not survive the acute drop in demand, while some changed and developed market strategies that were detrimental to their continued survival. Firms could not focus on costs alone any more. They had to compete within the context of a broad market base. So flexibility was in and focus was out. Decisions to vertically integrate in the 1970s were reversed and firms divested themselves from parts considered outside their core activity. The strategy of steady internal expansion was no longer an option. Many firms developed a wait- and- see- attitude.

In the first half of this decade, the Saudi construction industry witnessed a volatile market demand (acute drop in demand during 1990 and 1991, a recovery and a steady increase until 1994 then an abrupt decline in the last two years), ever increasing clients' demands for top quality of constructed product, increasing complexity of building projects, the move away from traditional forms of building contracts, lack of skilled labor, increasing international competition on the home front by overseas firms, and the advances in new technologies. Only those firms that pursue and maintain higher levels of organizational effectiveness will be able to address these challenges in the future and will be able to grow, and maintain effective performance to ensure continued survival well into the future.

The level of organizational effectiveness of the construction firm is mainly determined

The level of organizational effectiveness of the construction firm is mainly determined by organizational structure, strategy, and cultural factors. These factors influence the adaptation to the environment of the construction industry. In terms of organizational structure, a large percentage of construction firms are of the owner-manager type, highly hierarchical and functional in nature, and follow command and control type of structures. Coordination and control is based on a hierarchical sequence that supervises performance throughout the structure. However, some firms, in an effort to increase their organizational effectiveness, employ a matrix form of structure to accommodate the handling of multiple construction projects simultaneously. Communication in construction firms is frequent and informal and depends on the culture that exists in the firm, bureaucracy is not well established due to the small size of the average firm. To render their service successfully in project organizations, construction firms adopt structures that can be adjusted to suit the nature of their contractual relationship in construction projects with other construction firms. Contractual relationships influence the organizational effectiveness of construction firms when forming a project organization (i.e. general contracting, sub-contracting, joint-venturing, partnering, alliances, and consortiums). These relationships are dynamic and could last the whole project or part of it. These relationships result as a consequence of how the different types of firms in the industry organize to procure services and deliver the constructed product.

Construction firms structure, establish cultures, and strategize themselves to play a part in a complex process that involves a variety of steps and participants. This process has an enormous influence on how the construction firm organizes to deliver performance especially in today's environment where complex systems are being incorporated more and more into the construction process and construction risks are escalating to a higher level every day. Poor organizational effectiveness lead construction firms, unknowingly, to build inefficiency into their construction projects. These factors make construction firms face increasing uncertainty and ambiguity in their environment. To overcome these situations, the construction firm must control its risks by improving its organizational effectiveness. A fundamental task of control and improvement is measurement. This is advocated by most recently emerging management strategies such as Total Quality Management (TQM) , Rengineering, Partnering, and ISO 9000 principles.

Therefore, it is clearly becoming essential for construction firms to develop valid methods of assessing and predicting their level of organizational effectiveness. Utilizing a valid assessment method will enable construction firms to maintain their effectiveness and, hence, achieve projects' performance consistency.

1.1. THE RESEARCH PROBLEM

Organizational characteristics drive the internal and external interactions of the construction firm and are primary determinants of its performance. One of the prime reasons that a firm is able to maintain and improve its performance is its ability to measure, and adjust its organizational effectiveness, to suit its environment. However, in their quest for simplicity of use, management of most construction firms use only projects' outcome indicators as a measure for their organizational effectiveness. Projects' outcome indicators such as the level of achievement of specific goals that relate to projects' costs and duration and/or the achievement of certain levels of profit.

These indicators by themselves do not capture all the salient attributes of organizational effectiveness and only serve as crude predictors of the level of organizational effectiveness. Furthermore, in certain instances these indications are inaccurate and misleading. Just being within budget does not mean that the construction firm was effectively organized or determine whether it succeeds or fails.

The main purpose of this research is to develop a valid quantitative assessment methodology, that is based on appropriate theoretical and organizational analysis basis and that can be used to predict the level of organizational effectiveness in the construction firm in a simple and valid acceptable manner.

1.2. RESEARCH OBJECTIVES

Improvement of organizational effectiveness is not a cure-all sold to an organization or a firm to solve its many ills by supplying a magic pill. Improvement in effectiveness must be seen as an effort designed to assist the firm in planning to change for the better. Knox (1992) discussed major goals for objectives and motives for any pursuits of organizational effectiveness assessment activities. These fall in line with the objectives of this research in providing a valid assessment methodology and they are:

1. To ultimately aid in improving performance and productivity of construction firms and maintaining their consistency from project to project.

2. To initiate more participative management techniques by increasing management sensitivity to factors underlying the organizational attributes that influence effectiveness of workers and various groups to do the best work that they can for the firm.
3. To improve quality of feedback information concerning the important organizational attributes that would help management in troubleshooting and adjusting the important organizational attributes to achieve higher levels of effectiveness.

The achievement of these main objectives will lead to improved level of organizational effectiveness. To help in the achievement of these objectives, two strategies are considered while developing the proposed assessment;

1. That the assessment must be based on a simple quantitative model or models for prediction of organizational effectiveness. The model must be based on valid theoretical and organizational analysis basis in the context of the construction firm.
2. That the assessment must provide a prediction that is organizational process (organizational attributes) focused rather than construction product oriented (project-dependent approach).

Given the negative management attitudes towards using complex assessment schemes, developing a simple model will encourage its use and the regular assessment of effectiveness. Developing a model that focuses on the organizational attributes of the firm would make inroads into areas of improving the firm where, traditionally, suggestions to improve or increase effectiveness have been limited to general statements such as reduce costs, improve productivity, etc. By exposing potential sources of ineffectiveness with respect to the organizational attributes considered in the study, the proposed methodology will help the management of the construction firm to evaluate their organization in a better fashion and make appropriate plans and strategy.

1.3. RESEARCH METHODOLOGY

The methodology starts with a comprehensive research review of the current literature that includes the various theoretical perspective of organizational effectiveness; definitions, criteria of measurement, approaches, and models used to understand and study organizational effectiveness; issues relating to developing assessment of effectiveness in light of the available approaches; and review of existing methodologies. The extensive review leads to the identification of a suitable theoretical basis for the development of the methodology. The competing values approach and configurational perspective in organizational analysis are synthesized to formulate a basis on which to develop the desired prediction model. The competing values approach defines four ideal configurations, each with different effectiveness criteria that can be used to rate the effectiveness of the firm depending how close the firm's characteristics resemble those of the configuration that it attempts to pursue in its quest for effectiveness.

Effectiveness criteria is grouped in four general categories: structural context; flexibility, rules and regulations; person-oriented processes; and strategy means and ends. These categories are used to delineate fourteen variables that are hypothesized to predict organizational effectiveness of the construction firm. These include six variables in the category of structural context: level of subcontracting used by the firm, level of multiple projects handling ability, level of integration in services offered by the firm, level of coordination, level of information flow, and level of using contractual approaches such as joint-venturing, partnering, and alliances in project delivery. Four variables in the category of flexibility, rules and regulations that include: organizational attitude toward change; level of using rules and regulations; level of adherence to rules and regulations by management and workers, and level of organizational processes' control. Two variables are included in the third category of persons-oriented processes of the firm: strength of organizational culture, and level of workers' participation in decision making. Finally, in the fourth category of organizational strategy means and ends, two variables are included: level of planning by the firm and level of goal setting importance.

In order to develop the assessment method, the relationship (model) that relates specific levels of the identified effectiveness criteria and organizational effectiveness must be empirically determined. Therefore, a number of steps are performed. First, all of the hypothesized variables are to be operationalized and scales for their measurement constructed and tested for reliability of use. Second, a referent measure for organizational effectiveness must be constructed to be used in the analysis and model building. Third, cross-sectional survey of a homogenous group of construction firms will be carried out to collect necessary data. Due to the fact that construction firms pursue different levels of effectiveness criteria (variables) during the different stages in their life cycle, a study of effectiveness based on a snap shot (cross-sectional study) survey of construction firms can only considers a homogenous group of firms operating at approximately the same stage of life cycle in order to generalize its findings. In order to collect the cross-sectional data needed for model building and testing, data collection instruments in the form of self-administered questionnaires will be designed using the various constructed measurement scales that will be constructed. Fourth, a field survey of targeted construction firms must be planned and undertaken. In the survey, the constructed questionnaires will be used to collect relevant data from both management and workers' levels in the construction firm. Fifth, the collected data will be used in the analysis, development, testing, and validation of a multivariate prediction model. The model is based on linear modeling techniques of multiple regression using the various regression procedures to calculate a model which includes the most significant variables that are relatively easy to measure. Statistical data analysis and development of the multivariate regression model is handled through the use of a commercially available statistical analysis computer package called Statistical Analysis Systems (SAS). The package offers various regression procedures that will be used to fit and check the utility of developed model. Finally, the research will offer conclusions and recommendations relating to the developed model, its validity, and suitability for use as a practical tool by the construction firm to assess its level of organizational effectiveness.

1.4. SCOPE OF RESEARCH

The research considers three levels in the structural hierarchy of the construction firm: the strategic level, the organizational level, and the production level. In this research, the effectiveness of the construction firm at the organizational level is targeted for analysis. There are many factors that affect the overall effectiveness of the construction firm. These include project specific factors and organizational factors. This research will concern itself only with the organizational factors that influence the performance of the construction firm. In addition, the research will target only those firms that are operating mainly in the Institutional, Commercial, and Industrial (ICI) sectors of the construction industry. No particular type of firm is selected. The term "firm" in this research is applicable to all types of construction companies. Hence, a firm could be a general contractor (GC), or any type of subcontractors. It could be a very large firm that performs all A/E and construction work or it could be a firm that performs only the mechanical and electrical subcontracts. No limitation is put on size of work contract that are typically done by the firm or the size of the firm in this study or its volume of business. Finally and because of accessibility issues that relate to the nature of the group of firms that will be targeted by this study, data is collected from firms operating in the ICI sectors of the Saudi Arabian construction industry.

1.5. OUTLINE

The thesis is divided into an introduction, four major parts, and the appendices. The four major parts are arranged as follows:

Part1: Identification and Development of A Theoretical basis

Part2: Determination, Operationalization, and Measurement of Variables

Part3: Experimentation, Development, and Testing of Quantitative Models

Part4: Conclusions and Recommendations

The sequence in which the chapters are recommended to be read is given by Figure 1.1. The first part of the thesis that deals with identification and development of a theoretical basis for the proposed assessment is covered in Chapter (2) and the first section of Chapter (3). In Chapter (2), the following items are discussed and outlined in detail: the various theoretical perspectives on organizational effectiveness and their advantages and disadvantages; various criteria of effectiveness and issues of using multiple and conflicting criteria in the analysis and measurement of organizational effectiveness; the various organizational analysis methods and approaches and models used in the study of organizational effectiveness; issues in developing assessment methodologies; a detailed review of an existing methodology; and finally the chapter culminates with identification of an approach. Based on the review presented in Chapter (2), the theoretical basis and the various steps for the proposed methodology is discussed in the first section of Chapter (3).

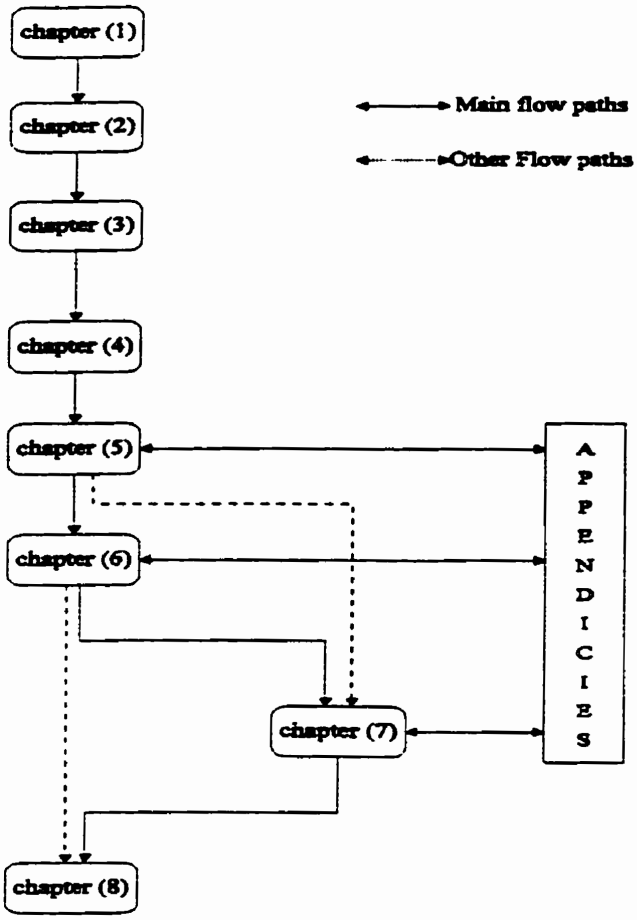

Figure 1.1: Flowchart of the Recommended Sequence for Reading Thesis

The second part of the thesis that deals with determination, operationalization, and measurement of variables, is covered in the reminder of Chapter (3) and all of Chapter (4) and the first section of Chapter (5). The remainder of Chapter (3) is devoted to the presentation of the first step of the proposed methodology. This step mainly deals with identifying the various effectiveness variables that are hypothesized to predict organizational effectiveness of the construction firm according to the selected approach. Chapter (4) covers operationalization and measurements for the independent variables and the dependent variable of the study. First, a referent measure for organizational effectiveness (dependent variable) to be used in the analysis, is constructed. Second, the independent variables are operationalized The first section of Chapter (5) covers the design and construction of the questionnaires and a discussion of the various steps of a field survey that is carried out to collect necessary data from a number of construction firms.

The third part of the thesis that deals with experimentation, data analysis, development, and testing of the prediction model, is covered in the remainder of Chapter (5), Chapter (6) and Chapter (7). In the second part of Chapter (5), the planning and selection of field survey is discussed along with procedures for the administration of questionnaires. Chapter (6) covers the discussion of methodology used in testing the reliability of measurement scales and data analysis. In Chapter (7) model selection, fitting, and validation, using multiple regression techniques, is detailed.

Finally, Chapter (8) gives the conclusions made from the findings of the study and discusses implications and recommendations for further research, to generalize the use of the developed methodology to include other types of construction firms.

CHAPTER (2)-LITERATURE REVIEW

2.0 INTRODUCTION

The first part of this chapter discusses the various perspectives of organizational effectiveness provided by the major theories of organization. The second part gives a comprehensive review of organizational effectiveness, criteria used for its measurement, approaches and models used by researchers to understand and examine effectiveness. The third part examines currently used and recently developed methodologies to assess organizational effectiveness of the construction firm.

2.1. THEORY AND EFFECTIVENESS

The study of organizational effectiveness represents an important part of organization theory. There are various views of organizations advanced by different theorists that compete for the attention of researchers, each has its strength and weakness. In general, the theoretical evolution of organizational effectiveness parallels that of the evolution of thought about organizations.

Several reviews of the history of general organizational theories serve as a backdrop for a discussion of the evolution of theory regarding organizational effectiveness. Perrow (1986), Scott (1992), Hall (1987), and Whetten and Cameron (1994) each discussed the "progression of thought in the field of organizational effectiveness. Perrow grounded his analysis in Weber's bureaucratic model-arguing that subsequent views of organizations were largely attempts to eliminate perceived weaknesses, or to accentuate the strengths, of this perspective. Scott organized his review around three perspectives of the organization: rational systems, natural systems, and open systems. He argued that the field has basically evolved through a series of stages, in which each of these systems' view dominated contemporary organizational theory. Hall organized his overview using a different set of organizational categories: structures, processes, and outcomes. Whetten's and Cameron's review of the history of theoretical thought on organizational effectiveness was organized along a time continuum of the different periods when the various organizational theories were emerging. This review of the history of theoretical thought, regarding organizational effectiveness, draws on these.

2.1.1 Classical Perspective

The earliest models of organizational effectiveness emphasized models of organization that focus attention on salient or distinctive attributes. Some theorists, also known as the classical school, developed universal principles, or models, that would apply in all situations and treated organizations as closed systems. Weber's (1947) characterization of bureaucracies is the most well known example. Weber's "rational-legal" form of organization was characterized by bureaucratic authority in the organization that control the organization through hierarchically structured positions in order to achieve effectiveness. Organizational effectiveness was related to decisions based on rules and regulations, equal treatment of all workers, separation of the position from its occupant, staffing and promotions based on skills and expertise, specific work standards, and documented work procedures, including formaliztion of procedures, specialization of work, and centralization of decision making (Hall, 1963; Price, 1968). Early applications of the bureaucratic model to the topic of effectiveness argued that efficiency was the appropriate measure of organizational performance. Given this performance criteria, the closer an organization was modeled after the typical bureaucratic characteristics (e.g., specialization, formalization, centralization), the more effective (i.e., efficient) it was.

One of the principal drawbacks of classical theorists is that they tend to treat all organizations as machine-like closed systems. Therefore organizational control and, hence, organizational effectiveness can be achieved by division of work and establishing lines of authority and discipline. Influence of the external environment is not recognized. As a result, subsequent models of organizations began to challenge these assumptions.

2.1.2. Human School Perspective

The classical view of organization was later challenged by some theorists who advanced the social nature of organizations that were, consequently, referred to as the 'human-relation' school. These theorists view organizations as made up of both tasks and people and represent a human counterpoint to the classical machine view of the organization. An example of this is the work by Barnard (1938) which challenged the classical theories' view that authority flowed from top down. Barnard proposed that management's role in achieving effectiveness was to facilitate communication and to stimulate subordinates to a high level of effort. An example of the human-relation school is participative decision making principles, which emerged from McGregor's (1960) Theory X- Theory Y and which promotes the creation of responsible jobs for workers and developing good group or team relations.

An effective organization from this perspective, therefore, needs to satisfy the needs of its workers by providing adequate inducements to sustain their required work contribution. It must also insure that the workers' actions are controlled by goals and decision making processes

2.1.3. Open-Systems Perspective

The problems associated with the closed system perspective of the organization led Ashby (1956) to view organizations as open systems that continuously exchange resources with their environments, importing various inputs that are then transformed with the aid of the organization subsystems and processes, into goods or services that are exported to the environment. Ashby formulated what he called the "law of requisite variety". It proposes that, in order for the system i.e., the organization or any of its subsystems to be effective, variety generated by the system or 'regulatory variety' as described by Beer (1974), has to equal or correspond to the variety generated in the internal and external environment of the system.

Katz and Kahn (1966) described the advantages of an open-system perspective in examining the relations of an organization with its environment, in order to be effective and survive. The open system perspective provides a general model of the organization that can guide the study of organizational effectiveness (Daft, 1983; Katz and Kahn, 1978; Nadler and Tushman, 1988). The main elements in the model are inputs, throughputs, and outputs. Inputs include all resources obtained from the external environments and used in the creation of outputs. Throughputs or transformations are activities that are performed on the inputs by social and technological components or subparts that include people and methods of production. Outputs include what the organization transfers back to the external environment. The environments includes all the external organizations and conditions that are directly related to an organization's main operation and its technologies. The systems perspective of effectiveness implies that if any one of the organization's subparts performs poorly, it will negatively affect the performance of the whole system. A systems view of organizations looks at factors such as relations with the environment. This is to ensure continued receipt of inputs and favorable acceptance of outputs, and the flexibility to respond to environmental changes.

Nadler *et al* (1992) advocated an emerging management tool which they called *Organizational Architecture*. They proposed an organizational model that underlines the importance of achieving two types of *fits* in order for the organization to achieve organizational effectiveness; an internal and an external fit. An adapted model for the construction firm is shown in Figure 2.1. According to the model, effectiveness is driven by three *fits* in the organization internal and external environment; the *internal fit* or congruence among the four components of work, people, informal structure and process, and formal organizational arrangements; the *strategic or internal-external fit* between strategy and work where organizations have to find the right combination of people, formal organization, and informal organization that meets the needs of the strategy; and a *strategy-organization or external fit* in order for the organization's business strategy to meet the demands of the external environment and achieve its purpose.

They concluded that there are very few universally good approaches to organizational architecture. Different ways of organizing will be more or less effective for different contexts, for different technologies and for different people.

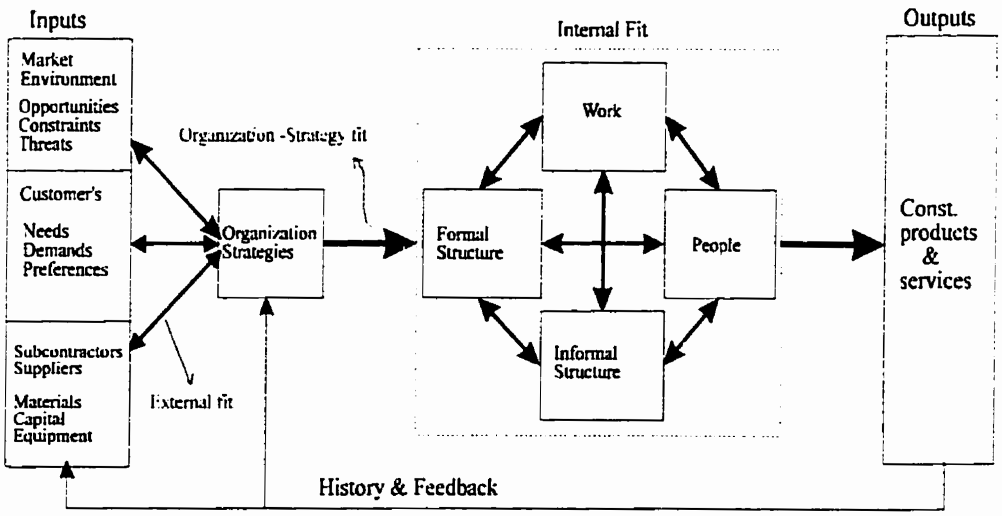

Figure 2.1: The Congruence Model[1]

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[1] adapted from Nadler *et al* (1992) *Organizational Architecture*, Jossey-Bass Publishers, pp. 54

2.1.4. Contingency Theory Perspective

This perspective argues that effectiveness is not a function of the extent to which an organization reflected the qualities of a specific ideal profile, such as Weber's bureaucracy, but, instead, it depends on the match between an organization's profile and environmental conditions. The challenge for contingency theorists was to identify the relevant environmental and organizational dimensions and to build theories of 'fit' between them.

Contingency theory started with Simon (1958) who argued that classical theories were just proverbs that contradicted themselves and that in order for organizations to achieve effectiveness, they should study the conditions, or the environment, under which the administrative principles proposed by the theories were applicable. Contingency perspective is embedded in open systems theory because it proposes that the effective design of organizational structural parameters (such as job specialization, unit size, centralization, etc.) are contingent upon, or influenced by, the various characteristics of its environment. These include complexity and stability; the age and size of the organization; the technical system (technology) used for production; and its power system, for example, who controls the organization.

Many contingency theorists have investigated environment-structure relationships and have identified many types of environments and effective organizational structures that best suit these types. Burns and Stalker (1961) defined organic and mechanistic types of organization and argued that mechanistic organizations (those that resemble Weber's bureaucracy) were best suited for highly stable and relatively simple environments. In contrast, organic organizations (those high on Bernard's characterization of the organization) were better suited for rapidly changing, highly complex environments. Woodward (1965) discussed the importance of technology in determining effective organizational structures. Lawrence and Lorsch (1969) and Pugh *et al* (1969) studied congruence between organizational and environmental dimensions.

The critical difference between bureaucracy and contingency theory thinking is that the former assumed that "one size fits all". That is, effective organizations were distinguished by their fit with a universal set of characteristics or one ideal type. In contrast, contingency theorists argued that effective organizations matched their profiles with prevailing environmental conditions

2.1.5. Institutional -Political Perspective

During the late 1970s, and early 1980s, thinking on organizational effectiveness entered another perspective. This perspective draws attention to the various stakeholders, or constituencies, in the internal and external environment around the organization (Pfeffer and Salanick, 1978; and Connally *et al*, 1980). Stakeholders are groups, or individuals, affected by the organization performance, who seek to influence the organization to satisfy their goals. This perspective proposes that an effective organization is the one that best satisfies the demands of those constituencies in its environment from whom it requires support for its continued existence. As a result of their divergent interests and goals, constituents advocate different ways of judging effectiveness.

This perspective is very similar to the systems view of the organization because both consider interdependence, but this perspective is not concerned with all of the organization's environment. It has a different emphasis. It seeks to consider only those in the environment who can threaten the organization's immediate survival.

There are a number of theoretical and methodological difficulties related to this perspective of effectiveness. The major difficulty is concerned with whose preferences should be weighted first or most heavily in reaching a judgment of organizational effectiveness. Other issues related to this topic are discussed in more detail in the coming section that deals with approaches modeled after this perspective.

2.1.6. Configurational Perspective

Another perspective that considers organization-environment relationships is the organizational configurational theory. This theory seeks to understand effective organizational forms over the life cycle of organizations (Hannan, 1991). This is similar to the population ecology theory of organizations. Unlike other theories where the unit of analysis ranged from the individual to the organization, this theory considers populations of organizations (Evan, 1993). Population ecology theory views the principal source of organizational change to achieve effectiveness is not adaptation or strategic choice by decision makers but rather by environmental selection. New organizational forms evolve and, if they fit a niche, are selected by the environment.

Traditional contingency theory, according to Miller and Freisen (1984), found that organizations must change their internal attributes, structures, strategies, and processes, to cope with changes in the environment. They argued the case for studying configurations, or forms, of organizations to determine effective ones, rather than linking individual attributes to effectiveness, by asking the question " what form does the internal change in these attributes take in response to particular changes in the environment?" They discussed two choices that the organization has: either the organization can try to keep up with changes in its environment by changing itself in piecemeal and perhaps incremental fashion and, by doing so, maintains an environmental fit at the expense of internal consistency or configuration; or it can delay transition until absolutely necessary, thereby, maintaining internal consistency and configuration, but at the price of worsening environmental fit.

Furthermore, they argued that organizations opt for internal consistency, or stable configurations, as long as possible for reasons that include: environmental change can sometimes prove to be temporary and, therefore, it is sensible to delay reaction to it; internal changes are costly and, therefore, it will be resisted, especially when a successful integration of structural and process attributes have been achieved; and, finally, that successful organizations are never sure of the attributes that lie at the roots of their success and, thus, would avoid tampering with their tried and successful configuration. Usually, adaptation is avoided until a major threat is perceived because change must eventually come. They concluded their argument by proposing that in the face of worsening environmental fit, organizations opt for totally new configurations, changing all their attributes drastically rather than piecemeal attributes' changes.

According to Miller and Freisen, a configuration refers to a multidimensional constellation of conceptually distinct characteristics that commonly occur together. Organizations have numerous dimensions of environments, processes, practices, beliefs, and outcomes, ideologies, groups, members, and gestalts. Configurations may be represented in typologies developed conceptually or captured in taxonomies that are derived empirically from these numerous dimensions.

Organizational approaches that are based on configurations, typically identify multiple ideal types of organization that can be pursued during the various life cycle stages of the organization to maximize organizational effectiveness. These approaches may be interpreted either as restricted to the initial ideal types posited by theory, or as allowing hybridization among these ideal types. A constraint on the set of effective organizational forms is the presence of contingency factors that determine the ideal types of organization that a real organization must resemble, to be maximally effective. When contingency factors are not identified, the organization may adopt any one of the ideal types defined by the particular theory and still remain effective. When the important contingency factors are identified, however, the form that an organization can adopt to be maximally effective may be restricted to a single ideal type. Thus, certain configurations of contextual factors may restrict the selection of structures, strategies, or both.

Miller and Freisen cited studies that uncovered effective configurations, or forms of organizations, such as: Burns and Stalker's (1961) that found "mechanistic" structures in firms dealing with stable environments and "organic" structures in firms found in dynamic environments; Lawrence's and Lorsch's (1969) that found similar structures in firms facing simple and stable environments, and firms facing complex and dynamic environments; Miles and Snow's (1978) which classified organizations into four types, the prospector, the analyzer, the defender, and the reactor, based on their strategies, structures, and managerial styles; and, finally, Mintzberg's (1979) which discussed the effective structuring of organizations into five configurations. These include: the simple structure where the force of direction that the various activities of an organization take to achieve a common goal and results in the entrepreneurial form when this force dominates an organization; the machine bureaucracy, where the force for efficiency becomes dominant and attempts to ensure a viable ratio of benefits gained to costs incurred; the professional bureaucracy, where the force of proficiency is dominant and makes organizations carry out tasks with high knowledge and skill; the divisionalized form, where the force for concentration helps concentrate efforts on serving particular markets; and the adhocracy form, that develops in response to an overriding need to innovate a new product.

The study of organizational effectiveness according to configurations, or forms, is justified in attempting to understand commonalties in organizational characteristics across organizations that make them effective. Dotty *et al* (1993) suggested that based on how close the characteristics of the organization are to that of an identified effective configuration or hybrids of identified configurations determines how effective it is. According to Meyer *et al* (1993), organizations are driven toward configurations in order to achieve consistency in their characteristics and, rather than trying to do well on everything, effective organizations concentrate on effective configurations and try to bring their elements into line with these configurations. They added that configurational inquiry represents a holistic stance, an assertion that the parts of a social entity take their meaning from the whole and can not be understood in isolation. Rather than trying to explain how order is designed into the parts of an organization, configurational inquiry tries to explain how effectiveness emerges from the interactions of those parts as a whole.

A configurational approach, that models organizational effectiveness criteria that could be pursued by organizations, has been proposed by Quinn and Rohrbaugh (1983). The approach is called the competing values approach. It identifies ideal configurations, or types, based on dominant values of structural context, focus, and strategic means and ends. An organization can pursue the values of these ideal configurations and, depending on how close it is to these values, determine its effectiveness. This approach represents the backbone of the methodology developed in this research and will be discussed in more detail later in this chapter.

2.1.7. Paradoxical Perspective

The view that organizations are simultaneously pulled in opposite directions by the preferences of multiple constituency led Quinn and Rohrbaugh (1981) and Quinn and

Cameron (1983) to introduce the Competing Values Model of Organizational Effectiveness. This model recognized the inherently paradoxical and, sometimes, conflicting nature of organizational life. Management must not only make tradeoffs between day-to-day competing demands on the organization resources, but, more importantly, it must balance competing characteristics regarding the core identity of the organization and how it functions.

From this perspective, effective organizations are both short-term and long-term focused, flexible and rigid, centralized and decentralized, goal and resource control oriented, concerned about the need of members and the demands of the customers. This view represents the natural, logical extension of earlier perspectives on organization. It borrows from contingency theory the emphasis on matching external and internal attributes. Like the multiple constituency perspective, it allows various conflicting or paradoxical criteria for measuring effectiveness. In a sense, the paradoxical perspective can be viewed as a more complex form of its predecessors. It allows for the likelihood of organizations operating simultaneously in different environmental domains, with each domain conveying different expectations. Whereas contingency theory assumed a single domain, for the sake of matching organizational and environmental characteristics, the extension provided by this perspective allows for multiple domains requiring multiple, simultaneous, and inherently contradictory matches.

The evidence supporting the paradoxical perspective of effectiveness is summarized by Cameron (1986a)[2] :

" It is not just the presence of mutually exclusive opposites that makes for effectiveness, but it is the creative leaps, the flexibility, and the unity made possible by them that leads to excellence. The presence of creative tension arising from paradoxical attributes helps foster organizational effectiveness"

Proponents of the paradoxical perspective use these conclusions to argue that effective organizations are not those that simply match a universalistic model, nor are they characterized by hyper-responsiveness in juggling competing constituency preferences and demands. Instead, effective organizations are characterized as hybrid forms or configurations, consisting of conflicting and uncomplimentary elements. They are both large and small, both growing and downsizing, and both tightly controlled and flexible.

2.2. DEFINITIONS AND CRITERIA OF EFFECTIVENESS

Hitt (1988) discussed the measurement of effectiveness and its importance in the creation and design of effective organizations. Steers (1975), described the measurement of effectiveness as one of the most problematic issues in the field of organization theory. Zummato (1982), also pointed out that assessment of effectiveness has proven to be one of

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[2] p. 549

the more intractable problems in study of organizations. Many researchers have offered a variety of models for examining effectiveness based on the various perspectives discussed, yet there is little consensus as to what constitutes a valid set of effectiveness criteria (Cameron, 1986b; Lewin and Minton, 1986). According to Das (1990), the definitions and, consequently the criteria and approaches employed in evaluating effectiveness, are various and, in some instances, paradoxical, as shown by the variability in the following definitions:

1. Georgopoulos (1957), referred to it " as the extent to which an organization as a social system, fulfills it's objectives without incapacitating it's means and resources and without placing a strain upon it's members"
2. Etzioni (1964), defined it as the degree to which an organization realizes its goals
3. Yuchtman and Seashore (1967), defined it as the ability of the organization, in absolute or relative terms, to exploit its environment in the acquisition of scarce and valued resources.
4. Goodman and Pennings (1977), suggested that organizations perform effectively if relevant constraints imposed by the constituency of the organization can be satisfied.
5. Hannan and Freeman (1977), defined it as the degree of congruence between organizational goals and observable outcomes
6. Price (1982), defined it as "the degree of achievement of goals and observable outcomes"

7. Miner (1988), defined effective organizations as those that receive inputs, transform them into outputs, export them to the environments, monitor the changes in the environments, and take corrective actions to ensure their survival.
8. Robbins (1990), defined organizational effectiveness as the degree to which an organization attains its short-term and long-term goals, the selection of which reflects strategic constituencies, the self interest of the evaluator, and the life stage of the organization.

Organizational effectiveness, as a construct, is conceptually very complex, and so must be its definitions. Closely related to the term effectiveness is the term efficiency. Efficiency is the amount of resources used to produce a unit of output. It refers to, and can be measured as, the ratio between an organization's resource inputs and its outputs. An organization that uses less resources to produce a unit output is deemed more efficient than one that uses a greater volume of resources for producing the same output. Some researchers use efficiency to measure effectiveness. Can an organization be effective without being efficient and vice versa? There are organizations that have inefficient systems, yet these organizations manage to achieve their goals. In the same way, it is possible for an organization to produce the wrong output efficiently. A good example is an organization which produces efficiently, but given market conditions and customer preferences, the wrong products are produced. It is possible to judge an organization as efficient when it is ineffective and vice versa. Therefore, effectiveness is distinguished from efficiency.

It is apparent that a variety of thoughts exist as to what constitutes organizational effectiveness. This is reflected by the number of variables that are being used as indicators of effectiveness. Campbell *et al* (1977) and Steers (1975), found many variables that can be categorized into four types. As shown in Table 2.1, these include: economic indicators such as profit, growth in sales or business volume; technical indicators such as productivity, quality of products and services; organizational indicators such as organizational flexibility and adaptation to changing environment, organizational control quality, stability; and finally, social indicators such as turnover rate, absenteeism rate, satisfaction levels, degree of conflicts between units in the organization, and workers' involvement, morale, and participation. No doubt, these various criteria are due to the diversity of organizations. All of these criteria cannot be relevant to every organization, and certainly some must be more important than others.

It is clear that all effectiveness criteria or domains are derived from different images of preferred organizational states and reflect divergent assumptions about the conditions that promotes these states. Harrison (1994) grouped and classified these domains or criteria used to measure effectiveness into three types. These are: output-goals, internal systems state, and adaptation and resource position (Table 2.2).

Table 2.1: Categories Of Indicators Of Effectiveness

Category	Examples of indicators
Economic	cost, profit, growth, efficiency, productivity
Technical	quality of product (number of defects), quality of service, number of accidents
Organizational	flexibility, adaptability, readiness, quality of control, stability, managerial task skills, managerial interpersonal skills, goal consensus communication
Social	satisfaction, conflict, cohesion, morale, motivation, involvement, participation, turnover, absenteeism, evaluation by external entities, value of human resources

The output-goal criteria as will be explained in the next section, correspond to many of the specific targets toward which the organization strives. They are sometimes expressed in terms of the success or failure to achieve a particular end, such as: the completion of a huge project contract within costs and on schedule; winning a certain percent of all bids entered; achieving 12 percent markup in all projects completed. Effectiveness criteria, dealing with output goals, are most useful when goals are defined in terms of clear, measurable objectives and members of the organization agree on the meaning and importance of these goals. Many of the criteria in the second type in Table 2.2 refer to organizational states and processes that can contribute to the achievement of output goals. Adaptiveness and resource-position criteria are especially relevant for organizations facing rapidly changing environments.

Table 2.2: Effectiveness Criteria

Group	Type	Criteria
Output Goals	Goal-attainment	success/failure
	Quantity of outputs	productivity (units produced); Profits
	Quality of outputs	# of rejects, complaints, customer satisfactions
Internal Systems State	Production/ Services Costs	Efficiency (ratio of outputs to costs), waste
	Human outcomes	worker satisfaction, motivation, work effort, safety
	Consensus/Conflict	agreement on goals, cohesion, cooperation within and among units, disputes
	Work and information flow	smooth flow of work processes & information
	Interperson relations/Culture	level of trust, openness of communication
	Participation	workers' participation in decisions affecting them
	Fit	compatibility of requirements with systems parts
Adaptation & Resource Position	Resource-quantity	size of organization (workers, cash, assets), resource flows (investments)
	Resource-quality	human capital (workers' experience and training)
	Legitimacy	compliance with standards of regulatory agencies
	Competitive/ Strategic Position	market share, size and volume of business rank among competitors, reputation in industry
	Impact on environment	ability to shape behavior of customers, suppliers and competitors
	Adaptiveness	flexibility
	innovativeness	quality of new products, services, procedures, incorporating new technologies & mgmt practices
	Fit	compatibility of internal system elements with reqmts and constraints of external environments

2.2.1. Conflicts Among Effectiveness Criteria

A close inspection of Table 2.1. and Table 2.2 reveals many contradictions, paradoxes, and tensions among the criteria listed. For example, growth is usually taken as an indicator of an organization's success in obtaining needed resources. However, growth can also lead to less participation in decision-making, reduced efficiency, and less ability to adjust to environmental changes (Hall, 1987). Management can hold conflicting priorities and evaluative criteria without being aware of the conflicts, because they do not evoke the criteria simultaneously or spell out their operational implications.

An additional problem is that few effectiveness criteria equally suit the interests and priorities of all organizational members, units, and the various levels inside the organization. For example: the owners of an organization probably assess effectiveness in terms of short-term profits; management looks for compliance and conformity to regulations, innovation and growth in the long run; workers press for better wages and working conditions. Hence, the effectiveness criteria that reflect the dominant group in the organization will probably conflict with that of workers.

Given that the various effectiveness criteria are not mutually compatible and applicable, how should one choose appropriate criteria in order to incorporate them into an assessment methodology? Many theorists discuss ways to utilize multiple conflicting criteria, Campbell *et al* (1977), Connolly *et al* (1980), Goodman and Pennings (1980), and Quinn and Rohorbaugh (1983), and Cameron (1984, 1986a). According to the competing values approach proposed by Quinn and Rohorbaugh, organizations can flourish while pursuing conflicting or paradoxical criteria of effectiveness. Instead of defining consensual criteria , organizations can adapt multiple criteria that define effectiveness in terms of the organization's ability to satisfy its diverse elements and constituents. According to this perspective, organizations must accept a certain a mount of trade-offs in treating the paradox in criteria. They also must attempt to balance these criteria against each other without going to one extreme or another which, in the long run tends to create imbalance.

2.3. APPROACHES AND MODELS OF EFFECTIVENESS

A review of general approaches, used by researchers in understanding organizational effectiveness would help in understanding the advantages and disadvantages associated with their use. Hannan and Freeman (1977), Zummato (1982), Cameron and Whetten (1983), and Miner (1988), outlined, in a comprehensive manner, the models and approaches that are used to understand organizational effectiveness. As seen in Table 2.3, these general approaches can be classified along four types of approaches, used to understand the concept of organizational effectiveness.

Table 2.3: Types of General Approaches to Effectiveness

Type	Example
Goal-attainment approaches	Goal model
Satisfaction of constituents	Multiple Constituency Approach
Systems approaches	Resource Model, Internal Process Model, Strategic Adaptation Model, Open-system
Qualities of Organization Approaches	Competing Values Approach

2.3.1. Goal-Attainment Approaches

An organization is, by definition, created deliberately to achieve one or more specified goals (Perrow, 1961). This is the main reason why goal is the most widely used criterion of effectiveness. Common goal-attainment criteria include profit maximization, beating out the competition, etc. Common among these goals is that they consider ends to which the organization was created to achieve. Does the organization achieve its various goals in terms of quality and quantity of outcomes? The degree, or level of attainment, of a certain output goal or goals is an indicator of organizational effectiveness. The approaches assume that organizations are rational, goal-seeking entities and successful goal accomplishment becomes an appropriate measure of effectiveness. However, the use of goals implies that other assumptions must also be valid if goal accomplishment is to be a viable measure. These include: the assumptions that the organization must have a few manageable goals that are identified and defined well; that there is an agreement on these goals and that progress toward these goals must be measurable. Only if these conditions hold, will goal accomplishment be deemed an appropriate criterion. While this is true of several goals (sales, production volume), the assumptions do not hold for other goals that may not be objectively measurable.

A long tradition in organization research defines effectiveness in terms of outputs and goal accomplishment (e.g., Simon, 1964; Price, 1968; and Campbell, 1977). But an almost equally long tradition criticizes the use of the goal model. Most recently, and perhaps most importantly, on the grounds that because organizations are complex entities, the specification of their goals are problematic. Yuchtman and Seashore (1977) listed methodological and theoretical reasons why the goal model should not be used in developing assessment of effectiveness. First, they argued, the assessment of organizational effectiveness, in terms of goal-attainment should be rejected because goals are ideal states that do not offer the possibility of realistic assessment. Second, they pointed out the difficulty in identifying the real goals of the organization. Organizations may have many goals; these goals can be inconsistent, contradictory, or incoherent. It is often unclear at what level, or with respect to what units, the attainment of goals should be measured The multiplicity of goals is fairly well recognized by the researchers in the field, who define effectiveness as the "balanced attainment of many goals" (Kirchoff, 1977). Some researchers, such as Goodman and Pennings (1977), and Campbell *et al* (1977), argued for measurement of effectiveness by getting the organization to specify (a) complete catalog of concrete and observable organizational objectives; (b) the conditions under which the organization should be able to achieve them; (c) the degree to which each objective should be satisfied. None, though, described or explained how goals are to be identified, nor they treat the complex issues that arise when there is more than a single ultimate criterion or goal.

It is clear that there are a number of problems when this approach is operationalized for use in developing an assessment of effectiveness. First is the question of what type of goals? Official or operative goals? Dependence on official goals does not always reflect the organization's actual goals. Official goals are formally defined outcomes that the organization states it is trying to achieve, and describe the organization's mission, what it should be doing, the reason it exists, and the values that underlie its existence. Official goals sound good but are vague and general in nature and not very specific or measurable, such as "to produce quality products at competitive prices". These goals can not be used as a criteria, given the likelihood that official and actual goals are different. Operative goals are intended to be the means through which official goals are accomplished. They describe desired operational activities and are often concerned with the short-term. Operational goals typically pertain to the primary tasks an organization must perform . Thus, different operational goals may exist at a variety of levels in the organization and may be differentially pursued by various parts of the organization.

Another issue in applying the approach is, because goals can be short and long term and are some times incompatible with each other and change over time, which ones should be used? Organizations have multiple goals that also create difficulties in operationalization of measurement because, multiple goals sometimes compete with each other. The achievement of "high product quality" and "low costs" are directly incompatible. Multiple goals must be prioritized: but how to allocate a relative importance to goals that may be incompatible and represent different interests? When short-term effectiveness measures set the standards or goals for an organization, the tendency can arise to favor the short-term over the long-term goals (Kanter and Brinkerhoff, 1981). According to Weick (1977), short-term efficiency and production-oriented measures tend to produce ritualistic behavior by the organization that is geared toward quantity rather than quality, and that behaviors, such as an organization's ability to adapt and be flexible in the long-term, may be lost.

Another problem with this approach is that it also assumes a consensus of goals inside the organization. Given that there are multiple goals and diverse interests within the organization, consensus may not be possible, unless goals are stated in such vague terms as to allow the various groups to interpret them favorably. This, according to Robbins (1990), may explain why most official goals in large organizations are traditionally broad and act to placate the different groups within the organization.

Another major problem with the goal attainment approach is one of substance, rather than measurement. Some researchers have argued that outcome measures of effectiveness are never pure indicators of performance quality because of a number of other factors enter in, most notably: the characteristics of the materials or objects on which the organization performs, the available technology (Mahoney and Frost, 1974); and a variety of environmental factors beyond the organization's control. These factors, affecting goal achievement, led Campbell *et al* (1977) to recommend that measurements of goal attainment should be confined to incidents of accomplishment directly under the organization's control.

Another limitation of the goal attainment approaches is the problem of interpreting the uses of goals in organizations. In some cases, goals are treated as window dressing, designed not to orient the behavior of organizational members, but rather, to provide only symbolic recognition to some constituency and in other cases, goals are seen not as actual targets to be aimed for, but rather, internal messages within the organization of what behavior is desired (Galbraith, 1973; and Hannan and Freeman, 1977). Weick (1979), noted that goals in organizations frequently are inventions to suit activity already performed. They are, or become, the organization's means of forming a rationale for past activity.

Finally, and most importantly, whatever the goal arrived at, an understanding of effectiveness must include not only the achievement of goals, but also an understanding of the factors that are associated with how these goals are achieved. According to Gaertner and

Ramnarayan (1983), in the absence of such an understanding, any goal achievement measure of effectiveness is simple but barren; clear in its measurement, but inadequate in utility. Unless the measurement reaches back into the processes, structures, and intentions that are associated with the goal achievement, little can be done to improve effectiveness.

As a result of these limitations, the theoretical focus has shifted to approaches that focus on organizational processes and structures which, either in the general case or in specific cases, are associated with how the organizational goals are achieved.

2.3.2. Systems Approaches

Systems Approaches represent the second type of approaches. Models that fall into this category are based on the systems view of the organization. They emphasize the organization as a system and attempt to assess the functioning of the system in terms of its inputs, transformation, and outputs. Examples here include the resource model, the internal process model, strategic adaptation model, and the open systems model.

2.3.2.1 Resource Model

The resource model views effectiveness as the ability of the organization, as a system, to exploit its environments. In other words an organization is most effective when it maximizes its position by optimizing its resource procurement. This approach has its limitations. It is known, that in certain instances, resource starved organizations outperform more resource-affluent ones.

2.3.2.2 Internal Process Model

In the internal process model, effectiveness is reflected in the efficiency of the processes inside the organizational systems. Theoretically, looking at the internal processes of the system seems to be more revealing of the effectiveness of the system than any other approach especially when the organization has little control over its environments. However, the approach has a narrow perspective of the functioning of the organization. It has no focus on the external interactions of the organization.

2.3.2.3 Strategic Adaptation Model

Strategic adaptation model suggests that effective organizations monitor their external environment constantly, receive feed back regularly, and take corrective actions to achieve their goals in the short term and ensure survival in the long term. This model recognizes the open-system nature of organizations, and their susceptibility to external forces. A limitation of this approach is that it pays little attention to what goes on inside the organization.

2.3.2.4 Open System Model

The open system approach stresses the view that the organization is a structured set of interconnected parts that communicate and interact together, and with the external environment, to accomplish its goals (Nadler *et al*, 1992). It considers the organization effective if it is successfully functioning as an open system, coping with problems that emanate from within the organization itself and from the external environment: that part of the world outside that has some relevance for the organization. Effectiveness is indicated by the organization's ability to meet internal and external challenges.

Robbins (1990), discussed two shortcomings of using systems approaches in the study of effectiveness. First, he alluded to the fact that measuring systems variables such as, adaptability to environmental changes or efficiency, may not be possible because one has to be able to develop valid and reliable measures that tap the quantity and intensity of these variables. Whatever measures that are in use, therefore, may be constantly open to question. In discussion of the second shortcoming, he used the argument that it's whether you win or you lose that counts, not how you play the game. If ends are achieved, are means important? The objective is to win, not to get out there and look good losing. The problems with systems approach, he added, emanate from its focus on the means necessary to achieve effectiveness. The problems in assessment of effectiveness arise because there are various interrelated means that are difficult to quantify in some cases, and which could be organized in more than one way in order to achieve effectiveness. This makes systems based assessment organization-specific, rather than generalized, an approach that could be applied to more than one organization.

Miner (1988), argued that systems approach may be distinguished from the goals approach, in that its emphasis on system maintenance and survival remain unchanged from one organization to another and from time to time within an organization. Goals, in contrast he argued, may differ and change. He added that the systems approach may be applied at any time, while it is unrealistic to evaluate goals achievement until the organization has had time to achieve them.

2.3.3. Multiple Constituency Approaches

The multiple constituency approaches have recently been proposed as a viable alternative to the goal and systems approaches for studying and measuring organizational effectiveness (Whetten, 1978; Connolly *et al*, 1980; Zammuto, 1982, 1984; Tusi, 1990). The multiple constituency approaches are based on the political view of the organization. They integrate the criterion of effectiveness for each group or constituency inside or outside the organization that has a stake in the organization's performance. A stakeholder is any group or individual who can affect, or is affected by, the organization's objectives. Stakeholders could include any number of the groups shown in Figure 2.2. These are the owners of the organization, government and regulating agencies, local community organizations, customers, competitors, workers, special interest groups, environmentalists, suppliers, and the media.

Connolly *et al* (1980)[3] argued that using this type of an approach in effectiveness assessment requires that organizations be viewed as

> " intersections of particular influence loops, each embracing a constituency biased toward assessment of the organization's activities in terms of its own exchange within the loop"

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[3] pp. 215

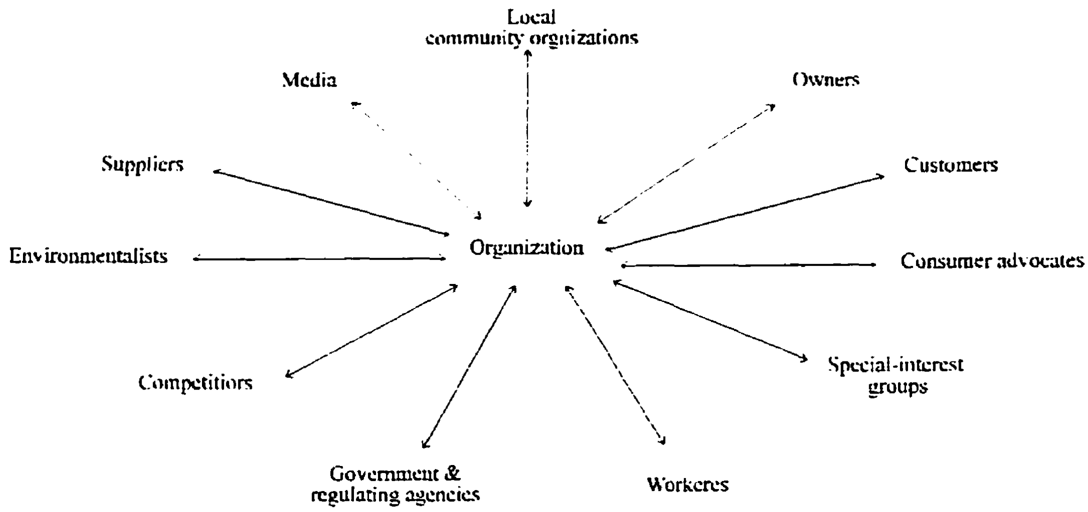


Figure 2.2: An Organization and Its Stakeholders

The multiple constituency approaches have been the underlying theme of many recent effectiveness studies (e.g. Cameron, 1978, 1984a; Jobson and Schneck, 1982; Zammuto, 1984; Wagner and Schneider, 1987; Tsui, 1990). Each of these studies points out that multiple constituency approaches, unlike the goal and system approaches, derive their criteria for assessing effectiveness from the preferences of multiple constituencies for the outcomes of organizational performance.

On this basis, the assessment of effectiveness, according to Daft (1983), provides a more accurate view of effectiveness than any single measure. To a degree, the multiple constituency approach represents an integration of the goal-based approaches. A major limitation is the assignment of proper weights to constituents to indicate the relative importance of satisfying their goals. Zammuto (1984), compared four multiple constituency models and their differences to address this issue of distribution of weights. Each of the models labeled the relativistic, power, social justice, and evolutionary perspectives provides different answers to the issue. Zammuto, discussed two specific areas of disagreements among the models that emanate from the central question: Whose preferences should be satisfied through the distribution of the outcomes of organizational performance? First, how are judgments of overall organizational effectiveness reached, given the divergent constituent preferences for performance. For each of the four models this becomes a question of whose preferences should be weighted most heavily in reaching a judgment about organizational effectiveness. Second, whose preference an organization should attempt to satisfy through the distribution of performance outcomes.

Whetten and Cameron (1994), listed four difficult theoretical and methodological challenges using these approaches in the assessment of organizational effectiveness: (a) individual stake holders when asked, have difficulty explicating their personal preferences and expectations for an organization; (b) a stake holder's preferences and expectations change, sometimes dramatically, over time; (c) a variety of contradictory preferences are almost always pursued simultaneously in an organization; (d) the expressed or known preferences of the strategic constituencies frequently are unrelated, or negatively related, to one another and to summary judgments made by stake holders about an organization's effectiveness.

According to Miner (1988), several answers have been proposed. One is that all constituents have an equal weight and the goals of every constituency deserve attention. Although this view offers a solution, the notion of equal consideration presents problems. The fact remains that the goals of certain constituencies may matter very little. For example, an organization can easily ignore the goals of its suppliers, if equal competing suppliers are available as is often the case in the construction industry.

An alternative solution is to consider only the strategic constituencies that immediately influence the organization. However, the problem, of satisfying their sometimes conflicting goals, still remains. In addition, if the assumption is made that the organization pursues and selects goals in response to these strategic constituencies, the favoring of some goals over others means that the other goals are ignored. For example, when the organization gives profits the highest priority, they meet the interests of the owners; however, that might conflict with customer satisfaction, and a supportive work climate, which favors the interests of the clients and workers respectively.

2.3.3. Qualities of Organization Approaches

The qualities of organization approaches relate effectiveness to organizational characteristics, such as degree of formalisation, communication, level of control, and/or other qualities related to structure, culture, and strategy. The competing values approach is an example here. The approach assumes that there is no "best" criterion for evaluating organizational effectiveness and that the concept of effectiveness is subjective. The approach assumes that these diverse criterion can be consolidated; that there are common elements underlying any comprehensive list of effectiveness criteria; and that these elements can be combined in such a way to create three basic sets of competing values. By classifying a wide variety of criteria of organizational effectiveness along these three sets, the approach creates four diverse models or basic configurations of effectiveness that represents the possible criteria used by organizations to model effectiveness.

2.3.3.1 Competing Values Approach

The competing values approach was first proposed by Quinn and Rohrbaugh (1983). The approach is also discussed by Lewin and Minton (1986), Cameron (1984a), Quinn (1988), Robbins (1990), and Maloney and Federle (1991). The approach is based on the premise that there is no one criterion for evaluating effectiveness. It organizes, consolidates, and integrates multiple criteria in the domains of effectiveness into three sets of incompatible dimensions. These are flexibility versus control, internal versus external focus, and means versus ends. The first set contrasts two dimensions of an organization's structure: flexibility values innovations, adaptation, and change while control favors stability, order, and predictability. The second set deals with whether focus and emphasis should be placed internally, on the well-being and development of the *people* in the organization or externally, on the well-being of the *organization* itself. The third set relates to organizational means versus ends; the former stressing internal processes and the long term, the latter emphasizing final outcomes and the short term.

These three sets are depicted in the four organizational models or configurations shown in Figure 2.3. The models are the open system model, the human-relations model, the rational goal model, and the internal process model. In the figure there are axes of contrasting values that define the four models. Each model represents a particular set of values and has a polar opposite with contrasting emphasis. The vertical axis pertains to organization structural context and it contrasts stability and control with flexibility. The horizontal axis pertains to focus: whether dominant values are internal or external to the organization. The two inner axes pertain to the organizational means and ends for each model and they contrast the processes or means (e.g. goal setting) to organizational outcomes and the outcomes or ends (e.g. productivity) themselves. In brief, each model has characteristics that differ from the other, and which influence the level of effectiveness in the organization differently. The rational goal model emphasizes control and organizational focus as dominant effectiveness values; planning and goal setting are means, and productivity and efficiency are ends.

The open system model emphasizes flexibility and an organizational focus as dominant effectiveness values; readiness and flexibility are means, growth and external support are ends. Dominant effectiveness values for the internal process model are control and internal focus, stressing communication processes as means and control as ends. The human-relations model emphasizes flexibility and internal focus, with cohesion and morale as means and skilled workers as ends.

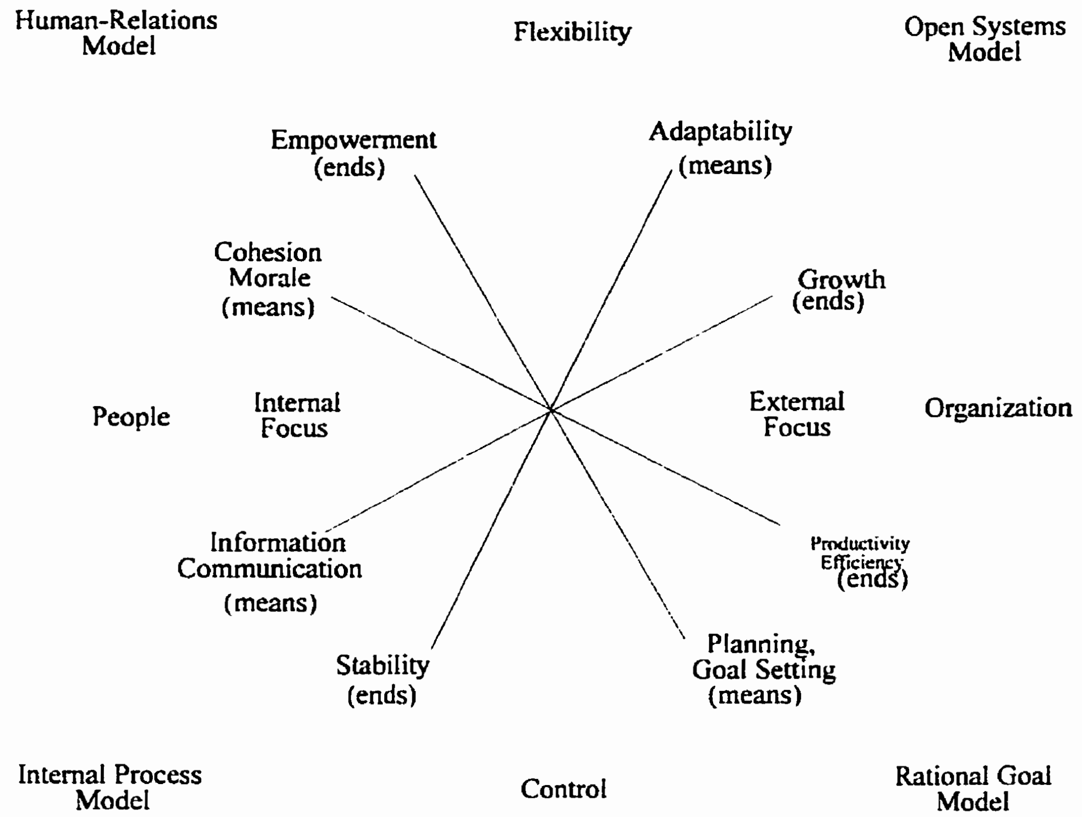


Figure 2.3: The Competing Values Approach's Four Ideal Models

2.5 SUMMARY OF CURRENT APPROACHES TO EFFECTIVENESS

The review of the current literature revealed that there are different definition and approaches to organizational effectiveness. Each has its advantages, but at the same time, each has distinctive disadvantages, partly inherent, and partly owing to limitation in the state of relevant theory and empirical results. These approaches can be characterized by two dimensions : (1) focus of the definition: some definitions focus on measures of terminal outcomes, such as profitability, survival, or goal attainment. Others tend to be more concerned with organizational processes and structures. (2) intended use of the concept of effectiveness: there are approaches that tend to be organization-specific while others are intended for a generality of organizations. The latter aim for general propositions about either outputs or organizational processes and structures. The former utilize the details available to explain events in a given organization, or class of organizations, in a less generalizable way. These two dimensions, when cross-classified, result in four distinct sets of approaches. The first set of approaches uses the traditional accounting measures, such as productivity, profit, or return on investment as criteria for effectiveness. This set of approaches also includes those that focus on organizational health and survival as the ultimate organizational outcome. These approaches are rooted in the theoretical perspective of population ecology. Problems with these approaches, stem form the fact that they rely solely on general quantitative measures of output, while organizations produce different things that, sometimes, are not easily quantifiable.

Approaches in the second set include all goal-centered approaches to organizational effectiveness. These were discussed extensively in the preceding sections. These approaches yield valuable insights about an organization's character and behavior, because serious goal setting represents an attempt at optimization of potentially conflicting organizational factors, in light of particular past and present circumstances, and desired future. Goal-centered approaches provide a useful degree of detail and context that are lacking in general output/outcome measures. However, in the preceding section, it was seen that goal-centered approaches have limitations. The major limitation is that goals are dynamic and likely to change over time, partly as reflections of changing external circumstances, and partly due to changes in the management of the organization.

In the third set, the approaches focus on generally effective or contingently effective system's components and processes of organizations. Systems approaches look at the basic processes in an open systems view of organizations (resource acquisition, transformation, output, and feedback) as interconnected, so that overall effectiveness may be assessed at any point in the system loop. Given the problems of defining and applying generally effective structures, system components, and processes, some of the approaches have attempted to develop models of process and structure that are organization-specific, mainly operating as guides to diagnosis and change in particular systems, their components and/or processes.

In the fourth set, the approaches focus mainly on qualitative processes. These approaches provide management with information about qualitative organizational attributes such as flexibility, openness of communication, adaptability, and management style, leadership, decision making, and culture. Although these approaches concern themselves with processes that lead to effectiveness, they also suffer from being too diffuse, not result-oriented, and have a narrow focus on contingently effective aspects of organizations.

2.6. ASSESSMENT OF ORGANIZATIONAL EFFECTIVENESS

In the literature, there are many techniques that were used in developing assessment. The first is traditional and is done by applying one of the common approaches, such as the goal model as the case in Kilmann and Herden (1976) model, Pennings and Goodman (1977) framework. Other techniques such as Keeley's (1978), and Hitt's (1988), also utilized a single approach; however, they relied on the more elaborate models, such as the resource model or strategic adaptation model.

Some methods synthesized a number of these approaches together such as Parsons' (1959), and Pickle's and Friedlandler's (1967). The Parsons' model synthesized parts of three models of effectiveness. It focuses measurement on four main tasks: adaptation (strategic adaptation model) and it includes such criteria as resource acquisition; development, growth, survival, flexibility, and control of environment; goal attainment (goal model) is measured by productivity and profitability; integration and it includes efficiency and openness of communication as criteria; employee satisfaction (constituency model) measured by employee retention.

The Pickle's and Friedander's model was developed specifically to study a group of small businesses. It synthesized the goal model with the multiple constituencies model. The model concerns itself with goals of seven parties that seek satisfaction from the organization and how to evaluate them. These parties are the owner; the employees; the customers; the suppliers; the creditors; the community in general; and the government. The empirical application for the approach is in the area of determining the distribution of satisfaction i.e. who gets satisfied first and how much? What may be viewed as an ineffective strategy regarding one constituency in the short term, may be viewed as highly effective for other constituencies over longer periods of time.

Some methods utilized the paradoxical perspective based models such as the competing values approach, as in the case of Ostroff and Schmitt (1993) and Maloney and Federle (1993). Maloney's study focused on organizations in the architectural, engineering, and construction industry. Their methodology identified the paradoxical culture types in these organizations and based their assessment on the consensus of four culture perceptions by management and workers. Their methodology is discussed in greater detail in later sections of this chapter.

2.6.1. Existing Methodologies

Most traditional assessment methodologies are based on the goal approach. They measure the level of achievement of a specific goal or goals. Three commonly used indicators ask if work was completed on time and/or within budget, and/or if it met certain quality standards. On-time completion means that the work finished within the scheduled duration of time. Within budget means no cost overruns. Meeting quality standards means that work output reached specific quality goals without significant level of rework. Typically, only under perfect project conditions do all three criteria are met by a construction firm. As a result, effectiveness of a construction firm is usually judged by meeting any one of these criteria.

Other indicators measure levels of achieved profits and/or levels of workers' productivity and compare these levels to specific levels that were established as goals. Profits indicate the difference between price and costs. Profit indicators by themselves are crude and shortsighted. Clearly, an organization can make a profit without being effective. Ineffective organizations make profits by cutting corners and improper practices; such organizations do not stay in business long.

Another goal-based indicator is productivity. It is the ratio that relates measurements of outputs to measurement of inputs. In construction, as in other industries, increased productivity is one of the traditionally sought after goals. If the organization is judged to have high productivity, it is considered effective. However, the concept of productivity seems to suffer as much debate regarding operationalization and measurement, as the construct of organizational effectiveness itself. Therefore, the questions are: what is productivity, how is it operationalized and measured, and what are the problems associated with measuring productivity, and using it as a measure to reflect organizational effectiveness? Productivity in construction can be defined in a variety of ways depending upon the work being performed, but is generally defined as output/input with output expressed in terms of physical units and input as man-hours required to produce the output. This is very close to the general definition of efficiency. The accurate determination of productivity rates is a problem in the construction industry according to Herbsman and Ellis (1990). They attributed this difficulty to the fact that productivity is influenced by many factors including: technological, such as design; material properties; equipment factors; location (site) factors; construction methods; and organizational factors such as labor factors and social factors. They added that the quantification of these factors in simple terms is too complex to allow a meaningful comparison between organizations or between projects, for a single organization.

The level of achievement of certain goals, in terms, of process time, production costs, profits, and desired levels of productivity, are considered as outcome measures. Outcome indicators, by themselves, simply do not give enough information about the organization. Organizations need evaluation that addresses not only the status of their internal processes, but also how they interact with the external environment.

Gameson (1992), found that one in five commercial construction clients were dissatisfied with the service they received. One of the factors, discussed by him, that leads to such low performance is the use of inappropriate measures to assess effectiveness. Improper assessment by organizations lead to inaccurate conclusions which, in turn, result in sub-standards performance. Although most managers use some indicators (mostly financial), these do not capture all of the salient elements of effectiveness and can not be relied upon as predictors of effectiveness. Measures used by management of construction firms are rarely justified or based on the theoretical approaches of understanding effectiveness. Development of better assessment methods is critical in order to achieve and maintain improved organizational performance. A recently developed assessment methodology (Maloney and Federle, 1993) is discussed in the next section.

2.6.1.1. Maloney's and Federle's Methodology

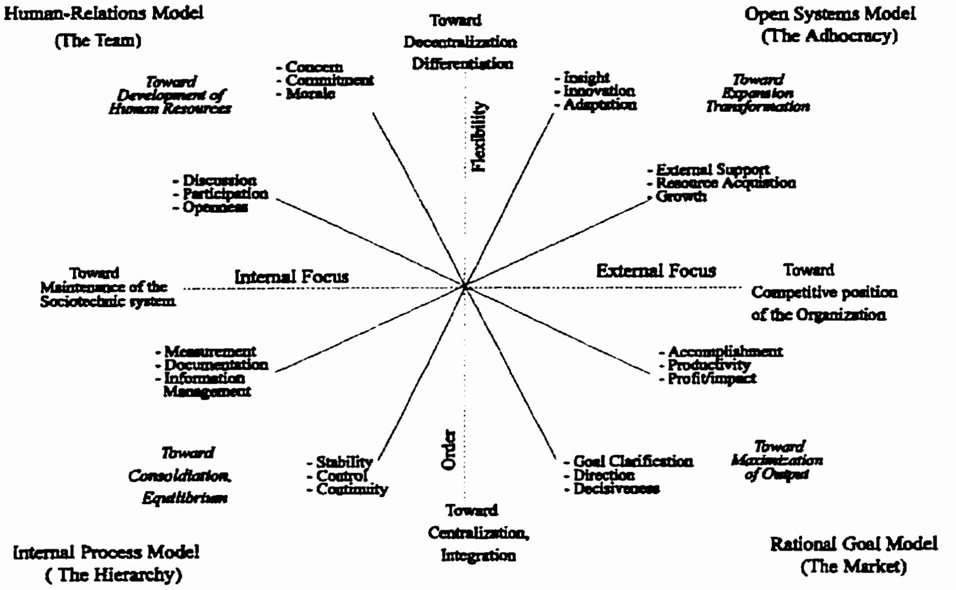
Maloney's and Federle's assessment methodology is focused on an organizational unit rather than the whole organization. It is based on the perceptions of the unit's manager, his superior, peers, and subordinates. Perceptions are formed of profiles relating to unit's culture, perceived organizational effectiveness criteria, leadership, and management skills. These profiles are based on typologies or configurations identified by the four models of the competing values approach. The perceptions of each profile are checked for congruence among them. The most important being the culture profile. The lack of agreements in perceptions of the culture of an organization especially that between the manager's and that of his subordinates, according to Maloney and Federle, creates the potential for significant organizational problems. Conversely, agreements in the perception. indicates a common understanding of the organization and the manager.

Profiles are then compared with each other to check for consistency of perceptions. Profiles of organizational effectiveness is compared to the culture profile to determine whether there is consistency between the perceived effectiveness criteria and the culture. Also leadership and management skills profiles are examined to determine consistency with the perceptions of the culture.

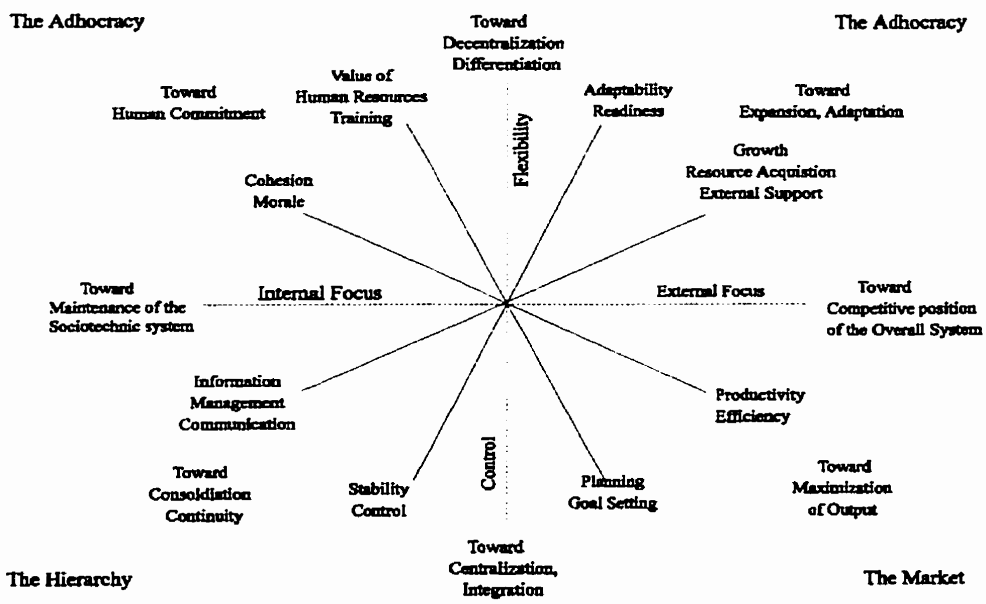
It is clear that the assessing organizational effectiveness according to this methodology is based primarily on evaluation of culture and the effectiveness criteria typologies identified from the four models in the competing values approach. These typologies or configurations are shown in Figure 2.4.(a) and (b) respectively. In (a), the four cultures configurations emphasize the values in the four ideal models. Under the rational goal model or firm-type organization, the term 'market culture' is used to describe the culture that has emphasis on order, maximization of output, rational production, values goal clarification, providing direction, and decisiveness about what is done. A firm that pursues this type of culture, prides itself on goal accomplishment, making profit, and its external interactions with suppliers, customers, and competitors. The open-systems model has an 'adhocracy culture' that is based upon expansion and transformation. This culture, according to Maloney (1991), prizes resource acquisition and growth. The emphasis of a firm that pursues this type of culture is on innovation, flexibility of structure in conjunction with a focus on external constituencies, and resource providers. This type of culture is at its best when the tasks are undefined. Organizations that pursue the human-relations model have cultures that are referred to as team or 'clan culture'. This culture is a direct opposite to the market culture and it values the human resource in the organization and promotes openness, participation, and involvement. This culture is characterized by team work, consensus decision making and information sharing.

In organizations that pursue the internal process model, the culture is referred to as the hierarchy or 'bureaucratic culture'. It is the opposite of the adhocracy culture and emphasizes stability, control through centralized decision making, and the maintenance and continuity of the organization, through rules and regulations that are used to control the internal systems.

In (b), effectiveness criteria used by organizations pursuing the various culture types are outlined. Organizations with an adhocracy culture use adaptability, readiness, growth, resource acquisition, and external support, Organizations with a clan culture use cohesion, morale, value of human resources, and level of training. Organizations with a market culture use productivity, efficiency, planning, and goal setting as criteria. Organizations with a hierarchy culture use stability, control, information flow, and communication



(a) Culture



(b) Effectiveness

Figure 2.4: Competing Values Framework by Maloney and Federle[4]

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[4] Source: Maloney and Federle (1993)

Assessment of organizational effectiveness is achieved in three steps. First, by classification of the unit's culture according to perceptions of the manager, superior, peers and subordinates, along the properties of four types of cultures identified in the competing values approach. Questionnaires are used to solicit perceptions on six main areas of organizational culture and ask the respondents to divide 100 points among four statements (each describes an aspect of the four culture typologies) in each of the six areas. These include dominant characteristics, organizational leader, organizational glue, organizational climate, and criteria of success. Second, by rating the respondents perceptions to an organizational effectiveness questionnaire on the existing and desired level of effectiveness criteria and the importance of the criteria. The questions included relate to the following criteria:

(1) participation, openness, commitment, morale for the clan culture.

(2) innovation, adaptation, external support, growth for the adhocracy culture.

(3) stability, control, documentation, and information management for the hierarchy culture.

(4) Productivity, accomplishment, direction, and goal clarity for the market culture

The questionnaires present the respondents with a series of statements (a total of sixteen) to which the respondents could rate his/her unit using a 5 or 7 point Likert scale. Third, unit's overall ratings or profiles of culture and organizational effectiveness are calculated by averaging the respective respondents' ratings. Fourth, the ratings of the respondents on unit's organizational effectiveness are analyzed and compared with respondents' overall culture ratings. Data is first presented in tabular format (Table 2.4) where the respondents' overall ratings are compared in tabular form with each other to check for consistency. As mentioned before, particular attention is paid to the comparison of the ratings of the manager and that of his subordinates. If there are significant differences between the perceptions of the manager and his subordinates, the potential exists for major problems. For organizational effectiveness, according to Maloney and Federle, a difference with a value of one between raters must be considered significant and is an indicator of potential problems for the organization.

The data is also presented in a graphical format by drawing pictograms to develop a better understanding of the results. Pictorial representation of all four perception profiles are drawn along the axes of the competing values approach. Maloney and Federle (1990) defined three zones that they used to examine the resulting plots of the data (Figure 2.5). An extremely negative zone in the center of the figure, an outermost negative zone, and an intermediate positive zone. Organizational units with culture plots falling in the extremely negative zone, they stated, have no well defined culture and organizations with a profile in this zone would be ineffective due to strong conflict between cultural values. In the outermost zone, cultures are carried to an extreme and organizations with profiles in this zone may suffer by being either too focused on one type and risk being oppressive if 'market culture', anarchy if 'adhocracy', irresponsible if 'team' and frozen if 'hierarchy', or focusing on all directions at the same time and becoming in Maloney's and Federle's words "a jack of the trades and a master of none". In the positive zone, trade-offs and balance among the values of the four cultures result in a strong effective culture.

By plotting the overall culture, and organizational effectiveness perceptions for each of the four types of raters, conclusions can be drawn regarding the culture and the unit's effectiveness in a manner consistent with the three identified zones in Figure 2.5.

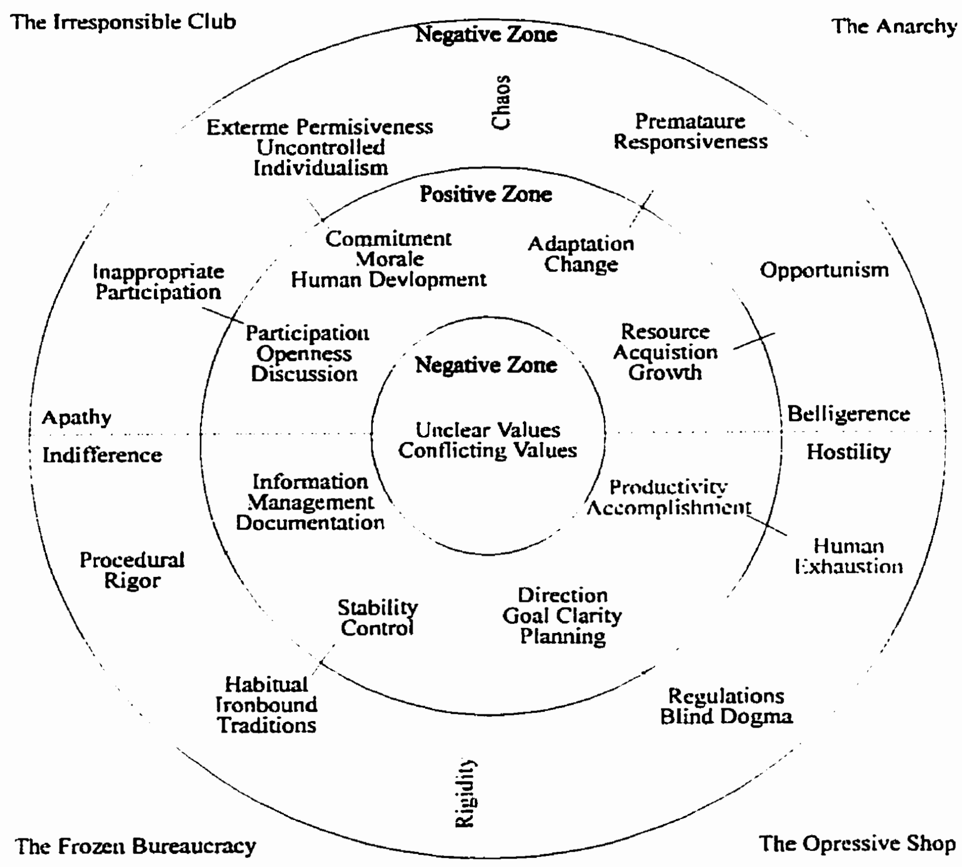

Figure 2.5: Positive and Negative Zones [5]

[5] Source: Maloney and Federle (1993)

An example of using the assessment methodology of a construction organization's unit that was surveyed and assessed by Maloney and Federle, is presented here for clarity.

The unit considered in the example is a field supervision unit of a general contractor organization (Maloney and Federle, 1990). Respondents included a manager, a supervisor, three peers, and nine subordinates. Table 2.4 tabulates data of four culture profiles according to respondents' perceptions of the culture existing in the unit. The unit is perceived to have a strong Market culture by the manager in five of the six areas as evidenced by the high total score of 72 out of 100. The superior's profile is similar to the manager's with the unit perceived as strong in Market culture with a total score of 45, except that the manager is perceived as strongly hierarchical as a leader. The peer's rating is similar for the Hierarchy culture with a score of 31 and a score of 29 for the Clan culture. The subordinates' profile gives an overall rating that is strongest in the Market culture with a score of 33 and in the Clan culture with a score of 28. As a result, it can be concluded that there is congruence among the manager's, superior's and subordinates' perceptions of the unit's culture. The manager, in particular, believes the unit to have a Market culture and gave it a score of 72. However, the other two raters, although agreeing that the unit has a Market culture, gave it lower scores than the manager does. The superior scored it 45 for the Market culture and assessed the unit in the Clan, Adhocracy, and Hierarchy cultures by scoring them 15, 8, 32 respectively. The subordinates scored it 33 for the Market culture and assessed the unit in the Clan, Adhocracy, and Hierarchy cultures by scoring them 28, 25, 14 respectively.

Table 2.4: Culture Profiles Ratings [6]

Culture Element	Raters			
	Manager	Superior	Peer	Subordinates
(1)Dominant Characteristics				
Personal Place	0	30	8	32
Dynamic/ Entrepreneurial	5	10	18	18
Formalized and Structured	5	0	28	9
Production Oriented	90	60	35	41
(2) Organizational Leader				
Mentor/ Father figure	0	0	10	5
Entrepreneur/ Risk taker	10	0	17	16
Coordinator, Organizer	10	70	47	43
Producer/ Competitor	80	30	27	36
(3) Organizational Glue				
Loyalty & Tradition	15	10	42	37
Innovation & Development	10	10	20	9
Rules & Policies	5	10	15	11
Production & Goal	70	70	23	43
(4)Organizational Climate				
Participative	0	20	45	44
Dynamism & Readiness	10	10	10	18
Stability	0	10	25	15
Competitive	90	60	20	23
(5) Criteria of Success				
Sensitivity to Customers	0	10	32	11
Product Leader & Innov.	0	10	3	3
Dependable delivery	90	80	53	67
Market Penetration	10	0	12	19
(6) Management of Worker				
Teamwork	0	20	27	37
Freedom & Uniqueness	10	10	42	20
Security/ Predictability	0	20	15	7
Production & Achievement	90	50	17	37
OVERALL CULTURE				
Team Culture	2.50	15.00	28.89	27.69
Market Culture	71.67	45.00	22.22	33.15
Hierarchy Culture	18.33	31.67	30.56	25.19
Adhocracy Culture	7.50	8.33	18.33	13.98

[6] Source: Maloney and Federle (1990)

Table 2.5 tabulates the organizational effectiveness profiles as a result of the perceptions of the respondents regarding the actual level of perceived criteria of effectiveness, the desired level, and its level of importance. The score range for the actual and desired level is measured on a 7 anchor points Likert scale. The score range for the level of importance is measured on a 5 anchor points likert scale.

Table 2.5: Organizational Effectiveness Profiles[7]

	Raters											
Effectiveness	Manager			Superior			Peer			Subordinates		
Criteria	actual	desired	imp.	actual	desired	imp.	actual	desired	imp.	actual	desired	imp.
Clan Culture												
participation,opennes	5.00	6.00	3.00	5.00	5.00	3.00	4.67	4.83	3.33	4.45	5.35	4.05
commitment, morale	6.00	6.50	4.50	4.50	5.00	3.00	5.00	5.83	3.83	5.15	6.05	4.65
Hierarchy culture												
stability, control	5.50	6.00	4.00	5.00	5.00	3.00	5.00	5.67	4.67	4.85	6.20	4.25
document, info mgt.	6.50	6.50	4.50	5.00	5.00	3.00	4.83	5.50	3.83	4.35	5.15	3.80
Market culture												
productivity, accomp	7.00	6.50	5.00	5.00	5.00	3.00	4.50	5.00	4.33	5.70	5.95	4.30
direction, goal clarity	6.50	6.50	5.00	5.00	5.00	3.00	5.33	5.50	4.17	4.80	6.00	4.45
Adhocracy culture												
innovation, adapt	5.00	6.00	3.50	5.00	5.00	3.00	4.00	4.83	3.50	4.15	5.40	4.05
ext. support, growth	6.50	7.00	4.00	5.00	5.00	3.00	4.17	4.67	3.17	4.75	6.15	4.40

As seen from Table 2.5, all four raters perceive this unit to be most effective in the market culture criteria. There is congruence with the perceptions of the raters of the unit's culture as a market culture from the data in Table 2.4. The manager perceived the unit to be

[7] In Maloney and Federle (1990) pp. 230

very effective in the effectiveness criteria of a market culture (a score of 7 out of 7) The superior, peer, and subordinates perceived the unit as most effectiveness in the same criteria but perceived it less effective as evident from their ratings of 5, 4.5 , and 5.7. Based on the difference of 1.3 (7 minus 5.7) between manager's and subordinates' rating of 7, potential problems can be anticipated. Graphical plots or pictograms of manager's and subordinates' ratings of overall culture and organizational effectiveness (Figure 2.6 (a), (b), (c), and (d)) can also be used to infer the same conclusions.

As described, this assessment methodology, considers the view that performance and effectiveness are primarily determined by the culture that exists inside the organization. However, Kotter and Heskett (1992), recommended that other organizational variables should be considered along with culture in the study of organizational effectiveness. Their study has shown that (according to their definition of culture) there is a positive relationship between strong cultures and organizational effectiveness (good performance). However, in some instances, organizations that were rated to have weak cultures performed just as good, or even better, than organizations with strong culture. Kotter and Heskett attributed these irregularities to the effects of other organizational characteristics, such as structural context, and strategy.

By delineating variables from the competing values' four models, Ostroff and Schmitt (1993), studied configurations of organizational effectiveness and efficiency by operationalization of effectiveness and the variables. Their findings indicated that effective and efficient organizations are influenced not only by strength of culture inside, but also by other

variables such as participation in decision making, goal emphasis, attitude toward change, and the level of structural contextual emphasis. Although both of the Kotter's and Heskett's, and Ostroff and Schmitt studies did not target construction organizations, their findings suggested the inclusion of other organizational characteristics or variables along with culture in the study of effectiveness seems to be appropriate.

In conclusion, Maloney's and Federle's methodology represents a crucial advance. Their assessment methodology identified and validated, for use by construction organizations, the four sets of culture and effectiveness criteria typologies found in the competing values approach.

2.7. SUMMARY

The review has provided a concise introduction into the relationships between the concept of organizational effectiveness and a number of theoretical perspectives of organization such as: the traditional theories of scientific management principles and Weber's bureaucracy; human-relations school; systems theory; contingency approach; political theory; and configurational approaches. The review also discussed the various criteria used in the assessment of organizational effectiveness and the conflicts that exist among them and recommendation to resolve these conflicts. The review also discussed the various definitions used to define effectiveness, and the approaches used for understanding and modeling organizational effectiveness: the goal model and the multiple constituencies model; systems models such as the internal process model, the strategic adaptation model, and the open systems model. The discussion also included the shortcomings of using such approaches in the operationalization and the measurement of effectiveness. In particular, the review has focused on the competing values model as a configurational approach and gave a detailed description of it. A review of existing methodologies was given, along with a detailed discussion of a recently developed methodology that uses the competing values approach's criteria to assess the effectiveness of organizational units in construction firms.

In summary, the review has shown that the competing values approach can be used as a conceptual model to categorize the characteristics of construction firms along its four ideal configurations. Its use, in studying organizational effectiveness in construction has been validated by the methodology developed by Maloney and Federle (1993). In the next chapter, the criteria of the competing values approach's four ideal configurations are used to conceptualize and identify four major categories of variables relevant in examining the organizational effectiveness of the construction firm.

CHAPTER (3)- METHODOLOGY

3.0. INTRODUCTION

First, in this chapter, issues in developing an assessment methodology are discussed and the logic of the proposed research methodology is presented. The methodology is broken down into three main stages. The first stage, which is covered in the second part of this chapter deals with identification of variables that are used to develop the prediction methodology. The second and third stages of the proposed methodology, that deals with development of measurement scales, construction of questionnaires, carrying out the field survey, and analyses and model fitting, will be covered in the following three chapters.

3.1. ISSUES RELATING TO DEVELOPMENT OF AN ASSESSMENT METHODOLOGY

The evolution of the methodologies used to study organizational effectiveness has progressed along roughly parallel lines with the development of the various theoretical models. Because no single methodology is suitable for the plethora of theoretical perspectives, the key to developing a valid assessment methodology rests with addressing the following seven questions:

1. What time frame is being employed? Short-term effects may differ from long-term effects, and different states in an organization's life cycle may produce different levels of performance.
2. What level of analysis is being used? Effectiveness at different levels of analysis in an organization (e.g. Subunit performance versus organizational adaptation) may be incompatible.
3. From whose perspective is effectiveness being judged? The criteria used by different constituencies to define effectiveness often differ markedly and often represent unique constituency interests.
4. On what domain of activity is the judgment focused? Achieving high levels of effectiveness in one domain of activity in an organization may mitigate against effectiveness in another domain.
5. What is the purpose for judging effectiveness? Changing the purposes of an evaluation may change the consequence and the criteria being evaluated.
6. What type of data are being used for judgment of effectiveness? Official documents, perceptions of members, participant observations, and symbolic or cultural artifacts all may produce different conclusion about the effectiveness of an organization.
7. What is the referent against which effectiveness is judged? No universal standard exists against which to evaluate performance, and different standards will produce different conclusions about effectiveness.

In developing this methodology, these seven questions are answered in a very detailed and sufficient manner in the following sections of this chapter and the chapters that deal with developing and testing the methodology. However, in brief, in developing the proposed assessment, this research focuses on a homogenous group of construction firms that operate in the same market and undergo the same forces in the environment.

The methodology is geared to assess organizational effectiveness at the firm level. The perspective of the assessment is from the management point-of-view, for the purposes of predicting the level of organizational effectiveness and uncovering the significant sources of ineffectiveness in the critical organizational attributes, in order to develop strategies to correct and adjust the organizational configuration. Workers' and management perceptions are the primary instrument upon which the assessment methodology is based.

Organizational effectiveness is judged in the analysis and development of the model, against a measure that consists of the three measures most commonly used to rate performance of a construction firm, namely, duration of execution of work, cost of completing the work, and finishing the work while conforming to quality specifications.

3.2. RATIONALE OF METHODOLOGY

Miller and Friesen (1984), in their analysis suggested that researchers should attempt to use an approach based on recurring patterns or configurations of attributes that relate to effectiveness empirically. According to Meyer *et al.* (1993) using configurational approaches in organizational assessment can be justified on grounds of attempting to understand commonalties across a homogenous group of organizations. This research is focused on developing an organizational effectiveness prediction methodology for construction firms that can be considered to form a homogeneous group. The construction firms targeted by this research have been selected from a group of construction firms serving the same construction market where they operate under the same conditions, and due to the relative young age of the Saudi ICI market, most of these firms operate within similar stage of life cycle.

After careful review of all the models and approaches, the competing values was chosen as the most valid configurational approach through which the proposed method of predicting effectiveness is developed. The reasons being: first it has been validated by Maloney and Federle (1993) in the assessment of construction organizations and their cultures; second, its four models or configurations, emphasize characteristics that represent the integration of most effectiveness criteria already used by researchers and managers.; and third, use of the multiple criteria represented by the four ideal models in the approach allow a more realistic depiction of the values and criteria of effectiveness that are typically pursued by a firm from one stage in its life cycle to another while changing its configuration.

The use of multiple criteria or characteristics is represented by the hybridization of values between the four models of the competing values approach. This hybridization results in certain tradeoffs between the different levels of conflicting or paradoxical values, based on the specific environmental situation faced by the organization. For example, stressing a moderate level of competitiveness and external focus by an organization does not exclude it from placing some emphasis on the development of its workers, and adopting strategies to enhance morale and cohesion among them. Cameron (1986a), supported the inclusion of paradoxical or conflicting criteria in assessments of organizational effectiveness in order to achieve a better assessment. Cameron (1983), suggested that in order to develop accurate measurement at the organizational level, variables and measures must be combined with some overall model that indicates performance in the multiple domains of effectiveness. He added that, although organizations could operate in multiple domains of effectiveness, they may also perform well only in a limited number of them. In other words, organizations can not satisfy all possible criteria of effectiveness. Tsui (1990), argued that, using a multidimensional view of effectiveness implies that different patterns of relationships between organizational effectiveness and its determinants will emerge, depending on the environment in which a particular organization functions.

Figure 3.1 (a), (b), (c), and (d) show pictograms of competing values criteria used in the assessment of effectiveness over the life cycle of the organization, as suggested by Quinn and Cameron (1983). It is clearly seen that organizations tend to pursue the values that belong to more than one model at the same time, regardless of the stage they are in. The only factor of difference from one stage to another is the differing levels of these values or criteria pursued by organizations, as seen in states (a), (b), (c), and (d). In state (b) the organization values flexibility but somewhat less than in (d), where more emphasis is put on flexibility. During stage (a), the organization places emphasis on flexibility just as much in (d) however, it places very little emphasis on control of its processes. In (c), the organization places less flexibility than in (a) and (d), but places more than in (b). This view represents a more realistic model of the nature of the firm, and how it organizes itself to achieve effectiveness. This is the view considered by this research.

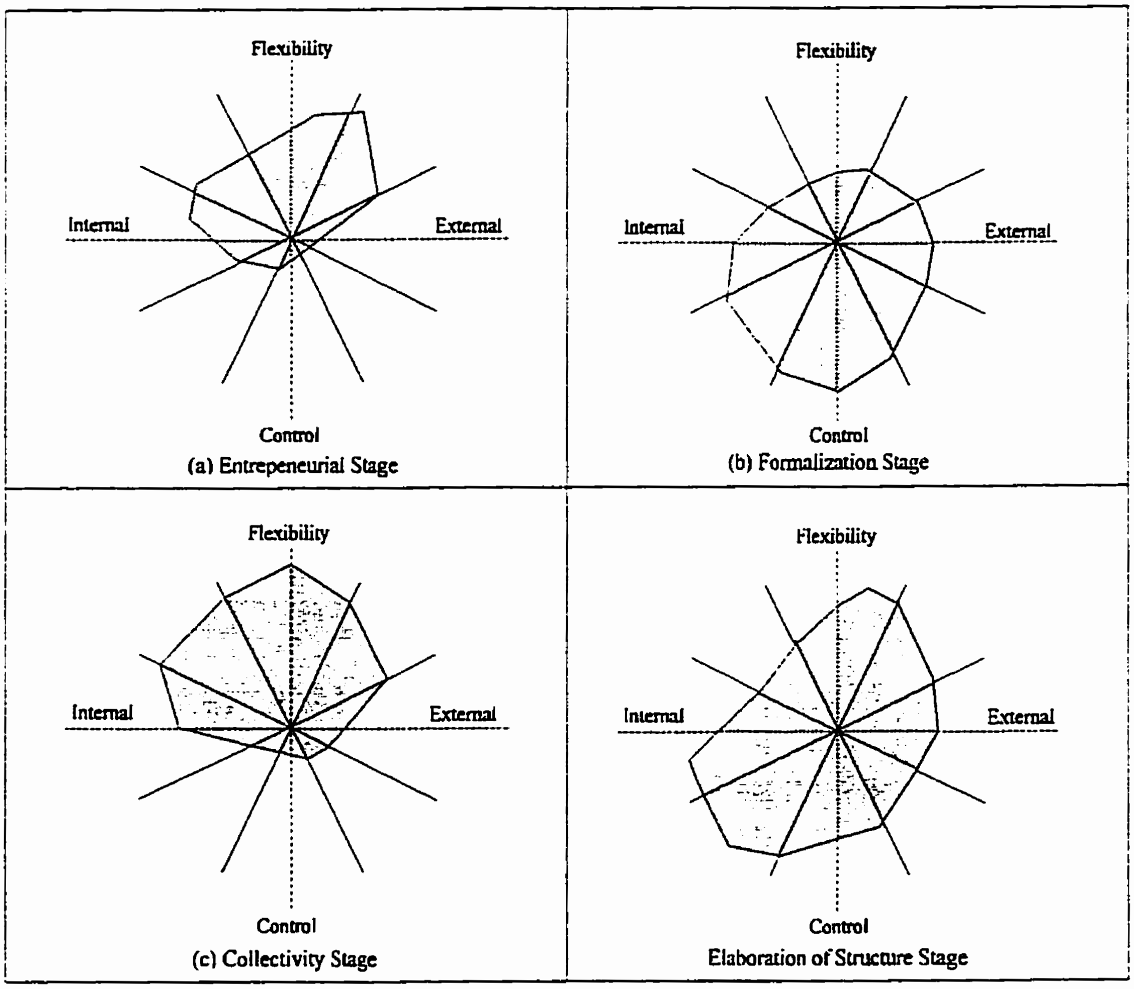

Figure 3.1: Organizational Life Cycle and Criteria of Effectiveness [1]

From this perspective, a homogenous group of firms that are within the same stage of their life cycle tend to pursue similar levels of criteria of effectiveness. These levels are

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[1] Source: Quinn and Cameron (1983)

determined as the result of hybridization of certain levels of values of the four models of the competing values approach to represent another configuration. Therefore, the levels of the hybridized criteria in this configuration/model can be used to predict the organizational effectiveness of firms. This is achieved by: gauging the levels of hybridized criteria in existing effective firms through empirical experimentation; and using the determined levels of these criteria as a gauge against which, levels of criteria in firms under question, can be compared.

Three main steps can be considered in order to develop valid quantitative models based on configurational inquiry (Dotty *et al*, 1993). First organizational configurations in an identified approach must be conceptualized and modeled as ideal types where effectiveness is highest because the fit, among the contextual, structural, and strategic factors is at a maximum in these configurations. In this research, the competing values approach was selected as a valid configurational approach that conceptualizes and identifies four ideal models of effectiveness criteria that can be pursued by construction firms to achieve effectiveness.

Second, organizational characteristics of the particular group of organizations or firms which represents the different effectiveness domains, in the ideal types, must be first integrated into an overall multivariate profile or model. The model must be fitted and tested empirically, using a valid referent measure of organizational effectiveness. This is done in order to identify those characteristics that are significant in the prediction of organizational effectiveness and their levels. Third, based on an assessment of the levels of these significant organizational characteristics, the overall model can then be used to predict the level of organizational effectiveness of the firm.

3.3. METHODOLOGY

A number of researchers have noted that when developing effectiveness measurement it is important to specify whether it is the variables that predict effectiveness, or the variables that indicate effectiveness, that are of interest (e.g. Cameron, 1986). This research focuses on developing a methodology to predict the organizational effectiveness of the construction firm. A multivariate model is developed and validated to achieve the best prediction. The model relates levels of identified organizational characteristics in a homogenous group of construction firms to an operational measure of their organizational effectiveness.

As seen in Fig 3.2, this was done in three main steps. First, organizational characteristics' categories and variables relevant for examining effectiveness of the construction firm were identified. Second, a field study was designed and carried out. In the study, a number of tasks as indicated, were accomplished:

- The identified variables were operationalized.
- A referent measure against which organizational effectiveness is judged, was constructed using the three common domains of effectiveness in construction: execution of work within scheduled duration, or completion of work within budgeted cost, and/or performance of work according to contractual standards and specifications.
- Scales of measurements were constructed for the variables and their reliability tested.

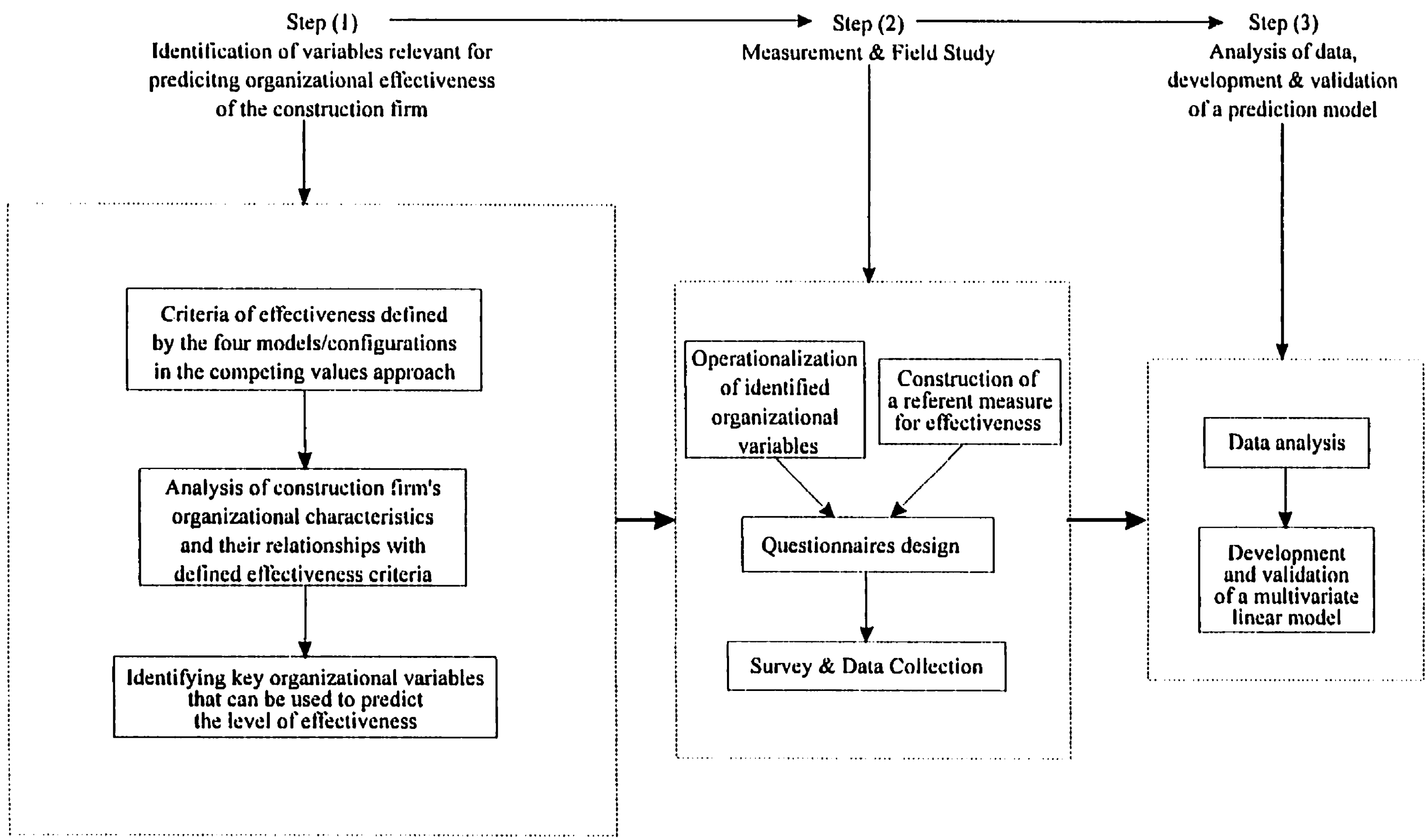

Figure 3.2: Three Main Steps of Methodology

- Self-administered questionnaires were constructed to collect data from management and workers in the construction firm.
- A field survey was carried out using the constructed questionnaires to collect cross-sectional data from a homogenous group of construction firms.

In the third step, the data collected from the field survey is used to test the hypothesis that organizational effectiveness, as operationalized, can be predicted using the developed measures of the identified variables. A multivariate linear regression model is developed and validated as a predictive model of the proposed assessment methodology. The rest of this chapter includes a discussion of the first step concerning the identification of variables, the following four chapters will discuss steps II and III of the methodology.

3.3.1. Identification of Variables

In order to have a comprehensive understanding of organizational effectiveness, the key variables in the domain of effectiveness of the construction firm, must be identified. The types of variables or criteria that can be used vary by domain and level of analysis. The target of this research is the construction firm and the level of analysis is at the organizational level. An analysis of the construction firm's characteristics that pertains to structural context: organizational flexibility, rules and regulations; organizational focus; and strategy (means vs. ends) along the dimensions of effectiveness as represented by values of the four models, helped to identify the important variables used to develop the methodology.

For analytical purposes, the construction firm can be viewed as having some form of vertical structure, or hierarchy, and operating within an environment (Figure 3.3). The external environment of a construction firm impact on it through different types of forces. The firm has a boundary. The firm's boundary is moveable because people from within it are in constant interaction with others from organizations outside the boundary. A construction firm's environment would comprise regulating agencies, competitors, suppliers, sub-contractors, consultants, etc. Inputs from the environment cross the firm's boundary and are transformed through the production process into outputs.

In the traditional sense, the primary role of the construction firm is the assembly of resources and transforming them into a product (a facility or part of it) using its skill in the techniques of construction and in the management of construction operations. It is becoming common for the construction firm to be involved in more than the construction phase of the building process. To accomplish its role, the construction firm usually: provides and direct its own workforce to do a portion of the actual work; supervises the work of subcontractors; plans, coordinates, and supervises parts or all of the construction process; and is responsible for completing the work on-time, on budget, and in accordance with specifications.

In considering the hierarchical structure of the typical construction firm, Langford and Male (1991), identified three different levels of management (Figure 3.3). The *institutional* or *strategic level* is concerned with adapting the firm to the external environment through planning and goal-setting, the *organizational level*, where the primary focus is on the lateral and vertical relationships within the firm's structure, and the *technical* or *production level*, concerned with transforming inputs from the environment into outputs to the environment. Each level has to accomplish their different tasks if the firm is to achieve organizational effectiveness in the face of uncertainty.

The production level is concerned very much with the present and getting the job done. The concern at the organizational level is one of mediation between the strategic level and the technical level as well as maintaining structural relationships between the various parts of the firm or with other external entities. There is less emphasis at this level on the technical skills and more on organizational skills such as the ability to handle people, organizational structure, systems, procedures and controls. Uncertainty of the construction environment requires that the firm operates in two time frames, the short term when dealing with the production level, and the longer term, when dealing with the strategic level. The question here is one of survival and adaptation to the forces of the construction industry. This research focuses on the organizational level of the construction firm.

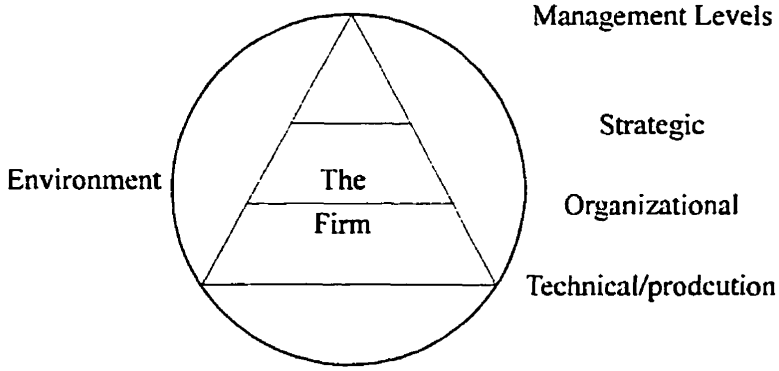

Figure 3.3 A Model of A Firm[2]

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[2] Source: Langford and Male (1991)

As stated before, a firm could pursue any of the criteria of four models in the competing values approach. Analysis along the values of the four configurations of the competing values approach helps in identifying the key variables to be included in the model. The analysis identifies fourteen variables that are deemed related to the construction firm's organizational effectiveness in four general categories (Table 3.1): structural; flexibility, rules, and regulation; person-oriented processes, and strategic means and goals.

Table 3.1 Dimensions, Categories, and Variables of Effectiveness

Competing Values Dimensions	Categories of variables	Variables
Structural	Structural context	1. Level of integration in services offered 2. Level of joint venturing, partnering, and alliances 3. Level of subcontracting 4. Level of multiple project handling ability 5. Level of coordination 6. Level of information flow
	Flexibility, rules, and regulations	1. Extent of rules and regulations 2. Level of adherence to rules and regulations 3. Level of control 4. Attitude toward change
Focus internal/external	Person-oriented processes	1. Strength of culture 2. Level of workers' participation in decision making
Means/ends	Strategic means and goals	1. Level of planning 2. Level of goal setting

3.3.1.1 Category (1): Structural

According to Daft (1983), firms can be defined as multi-dimensional social entities that are goal-directed, with a deliberately structured set of interconnected and mutually dependent parts that communicate and exist together to strive for a common purpose in a changing environment. The environment of a firm is the set of environmental elements with which the firm seek to interact, or has to interact, to accomplish its goals. Firms emphasize the need for fighting disorder in their environment and attempt to achieve order (i.e. effectiveness) by forming effective structures, promoting strong culture, controlling efficient internal processes, and devising new strategies to increase their competence.

What type of structure does a firm need in order to be effective? According to Ansoff (1988), the distinct types of responsiveness in which a firm seeks to engage can be used to identify the structure it needs. The types of responsiveness are: operating, competitive, innovative, entrepreneurial, and administrative. Ansoff classifies these responsiveness types into four basic forms or structures: the functional operating form which, minimizes the operating costs of the organization; the divisional-competitive form which, optimizes the organizations profits; the project matrix-innovative form that develops the organizations near-term profit potential; and the multistructure-responsiveness form which, addresses the different needs in different strategic business areas to develop the organization's long-term profit potential.

Mintzberg (1979), advanced that organizational structure of a firm is determined by interplay of seven forces; direction, efficiency, proficiency, concentration, innovation, cooperation, and competition. Based on the degree of interplay among these forces, he identified five types of structures or forms that include the simple or entrepreneurial structure, machine bureaucracy, professional bureaucracy, diversified structure, and adhocracy. The simple structure has direct supervision as its prime coordinating mechanism. The key part of the firm is at the strategic level and, as its name implies the structure is simple, uncluttered by rules and regulations, and has more participative decision-making. This type of organizational structure characterizes small construction firms such as a sub-contractor, employing a few workers.

Standardization of work processes is the prime coordinating mechanism in the machine bureaucracy structure. This type of structure typifies large sized general contractor firms which, use many rules and regulations, functional departments, and centralized decision - making that follows the chain of command. The professional bureaucracy structure has as its prime coordinating mechanism the standardization of skills. The production level is the key part of the firm. The majority of workers in this firm are highly skilled-professionals-with considerable work autonomy and decentralized decision-making. A typical example would be a turn-key construction firm with construction management services as its main core and which subcontracts the bulk of the construction work in its contracts to outside sub-contractors.

The divisional structure has as its prime coordinating mechanism the standardization of outputs. This type creates a series of relatively autonomous smaller divisions with functional structures. Grouping of divisions tends to be by markets. This structure is common in the very large general contractors firms with divisions serving in the various markets of the construction industry. The adhocracy structure is team based. The teams are highly flexible to achieve adaptation and decision-making within the team is decentralized with minimal supervision. The adhocracy structure is typified by the project structured construction firm.

Mintzberg argued that there is no one best structural form for effectiveness and in order for a firm to be effective, it has to model itself along one of forms he identified and manage its consistency of form. Tatum's (1990), conclusion, that there is no best organizational form that a construction firm can follow to achieve effective performance, is similar to Mintzberg's. Tatum asserted that what's really important is that the construction firm must attempt to maintain its effectiveness regardless of the form it takes. According to Pilcher (1990) a large percentage of construction firms are small, owner-style run business. The emphasis of firms in the construction industry is on producing a product while minimizing the risks associated with the effects of a very unstable and variable construction demand and still achieve an acceptable level of profits.

The organizational structure can be described by a number of dimensions that pertain to internal characteristics of the organization. These dimensions are: formalization, specialization, standardization, hierarchy of authority, complexity, and centralization. Formalization pertains to the degree of documentation of organizational procedures, regulations, and policy. Large organizations tend to be more formalized than small ones. Secondly, is specialization, which refers to the degree to which organizational tasks are subdivided into separate jobs. If specialization is extensive, each worker performs only a narrow range of tasks. If it is low, a worker performs a wide range of tasks in his job. Specialization is sometimes referred to as the division of labor.

The third structural dimension is standardization, which is the extent to which similar work activities are performed in a uniform manner. The fourth dimension is the hierarchy of authority and it describes who reports to whom, and the span of control in the firm. The fifth dimension is complexity, which refers to the number of activities or subsystems within the organization. Complexity reflects the number of vertical levels in the hierarchy, the number of departments existing horizontally across the organization, and the number of geographical locations where it exists. Centralization in an organization refers to the hierarchical level that has authority to make decisions. When decisions are delegated to lower levels, the organization is decentralized and vice-versa. The arrangement of tasks, roles, authority, and responsibility gives every organization its unique structure, through which it does its work. Throughout the history of organizations, structure evolved in response to the dual challenges of external diversity of the organizations strategic position, and their internal complexity.

According to the four models of the competing values approach, the structural criteria used to describe the four models are: flexibility, to describe the open system model; stability in the internal process model; planning and coordination in the rational goal model; and cohesion and culture in the human-relations model. In Table 3.1, two categories of variables that relate to the structural dimension of the construction firm are considered along the values of the four models in the competing values approach. These are: structural context; and flexibility, rules and regulations.

In the category of structural context, the study hypothesizes six variables as important attributes that can be used to indicate how effective the structural component of the construction firm is in dealing with its external and internal environment. This category of variables includes: level of integration in services offered by the construction firm; level of subcontracting used in majority of work projects; level of multiple project handling ability; level of using joint-venturing, partnering, and strategic alliances in project delivery; level of inter and intra-organization coordination; and level of information flow inside the firm. These are discussed in details as follows:

1. Level of Integration in Services Offered

Integration in services is defined as the degree to which a firm does things with in-house workers (Hansen, 1987). Porter (1980), defined integration as "the combination of technologically distinct production and/or other economic processes within the confines of a single firm". Porter discussed two types of integration, forward and backward integration. A firm integrates forward when it integrates toward the market it ultimately intends to serve .i.e. a construction firm building, owning, and leasing retail space to its clients. Backward integration occurs when the firm gains control over the supporting businesses in the overall process. An example is when a construction firm acquires the ownership of its suppliers, such as a concrete ready-mix company in order to supply its own concrete.

Hasegawa (1988), stressed the need for construction firms to formulate structures based on local market analysis and outlines three approaches; product differentiation, business diversification, and market segmentation. Hillebrandt and Cannon (1990), advocated four means of product differentiation for the construction firm. These are: offering a range of project management methods; extending into A/E design; extending into financial packaging; and extending into facilities management. They recommended the adoption of *Total Build Service* where the construction firm guarantees the final cost and completion date of a construction project and also gives a warranty on the quality and performance. The *Total Build Service* also offers facilities management and building management. According to Krippaehne *et al* (1992), a construction firm may integrate forward by performing land-development services, providing A/E design capability, owning and leasing facilities, and offering construction financing. It may also integrate backward by offering construction materials supply and other services.

When a firm integrates, it means that the firm is expanding a product or service position. As such, integration represents more administrative transactions within the firm's structure. Measuring the level of integration of services in the construction firm would gauge the effectiveness of the firms' structure in addressing the added structural complexity of organization as a result of the integration strategies by the construction firm in its attempt to control the quality and range of its construction product.

Therefore, it is important to evaluate the level of integration of services offered by the construction firm, for two reasons. First, because the level of integration influences the effectiveness and the strategic flexibility of the firm's structure, especially where firms, with integrated services, tend to develop defensive strategies and rigidity in their structures to compensate for increases in risks and potential increases in fixed costs. Second, because it underlies the effectiveness of the firm's structure to increase market share and exercise a greater degree of control over the quality of the construction product.

2. Level of Subcontracting

Construction work, in its conventional form, employs an intensive technology (Thompson, 1967) and requires the contribution of a variety of trades. Most construction firms obtain business by submitting competitive bids for projects with owner-determined specifications. Because of the custom-building nature of the construction process, it is difficult to predict the nature of future work and input requirements. The site-based nature of production also makes it highly prone to uncertainties in climate and site-conditions, and availability of resources in the local environment in which the work is carried out.

The use of subcontracting emerged in construction as a means of coping with these uncertainties. Subcontracting is a strategy that has long been used successfully in the construction industry. The nature of the industry, construction process, and the construction product, allow and encourage construction work to be at least partially performed by specialty subcontractors who specialize in a certain part or kind of construction process and work. As noted by Brensen *et al* (1984), by passing on some of the risks associated with the construction project to subcontractors, the general contractor retains flexibility. Subcontracting is used widely by General Contractors construction firms, to save money and time, and to gain strategic flexibility during times of change.

Construction subcontractors are usually more specialized and can do the work quicker and for less money than general contractor firms. Eccles (1981a), has shown the influence of subcontracting in increasing the complexity of structure in the general contractor construction firm. As the level of subcontracting used by the firm increases, the amount of coordination, information flow, and sub-contract management tasks increases. If the firm's structure is not able to address the increased complexity that results from utilizing subcontracting, the construction firm's ability to control its work will be lessened. Clarke (1980), argued that increased subcontracting has reduced the general contractor's control over the construction process, leading to cost and time overruns. Usdiken *et al*, (1988), argued that the extent of control over subcontractors emerge as a critical consideration in subcontracting strategy of the construction firm. The discussions in the literature suggest that certain organizational structural properties are linked to the level of subcontracting used by the particular construction firm. Eccles (1981a), for instance showed that construction firms carrying more complex projects, subcontract more. But Clarke (1980), observed that the construction firm faces a dilemma in regard to selecting a suitable level of subcontracting. On the one hand, the construction firms develop their competence in one or two trades, and limit their activities to, the winning of projects, and resort to extensive subcontracting. On the other hand, a strong commitment to in-house production and as, Harrigan (1985) noted, the need to safe guard production control, can be a strategy requirements making subcontracting less desirable.

The measurement of the level of subcontracting used by the construction firm underscores the firm's attitude towards structural flexibility, by risk sharing and enhancing its costs effectiveness. A construction firm that pursues strategic flexibility must have a structure that is better suited for contractual arrangements that provide the flexibility of subcontracting. Although subcontracting may provide costs effectiveness, it limits the degree of control the organization has over its processes. The result of this limitation will be more pronounced and negative when the firm's structure is not able to cope with the added complexity of subcontracting. However, when the firm's structure is suited for the proper use of subcontracting strategies, it can significantly enhance the construction firm's flexibility. If a general contractor manages a portfolio of subcontractors who have a broad cross section of abilities, the contractor should be able to successfully adapt to changes that may occur in the construction marketplace.

3. Level of Multiple Project Handling Ability

The typical construction firm is very project oriented and the majority of management's functions are thus directly related to individual projects (Rossow and Moavenzadeh, 1976). When the construction firm assumes the responsibility for handling more than one project at the same time, it increases the complexity of its structure. Thomas and Bluedorn (1986), discussed the factors that influence the choice of an authority structure by construction firms handling industrial construction projects and productivity. One of the influencing factors discussed is the number of projects, or the work load from other projects. The level of planning, organizing, control, and coordination, resulting from handling other simultaneous construction projects, affect the organizational structure effectiveness in delivering desired performance in these projects. The relationship between organizational structure of the construction firm and project characteristics and its influence on productivity and organizational effectiveness was also discussed by Thomas *et al* (1982, 1983).

This variable reflects the ability of the construction firm's structure to handle simultaneous work at different locations in order to increase its volume of business and its profits (Eccles, 1981b). The ability to handle multiple simultaneous projects is influenced by the organization's ability to deploy necessary resources in a manner that requires accurate planning and resource management. Deployment of resources, in different locations at the same time requires a suitable organizational structure to handle issues related to control, coordination, information flow, and communication. Multiple work projects affect the structure of the construction firm and tend to make it flatter, where project managers assume more control for their projects than the home-office manager. The measurement of the multiple project handling ability of a construction firm reflects the degree of success of the organizational structure in meeting the demands put on it, for more coordination among the various sites and home office, for more control of the resources, and for more information flow when multiple projects are handled.

4. Level of Joint-Venturing, Partnering and Alliances

This variable reflects the effectiveness of the firm's organizational structure in integrating with other construction companies' structures when the firm enters in such relationships. These relationships are usually entered into by the construction firm to access new technology, share risks, secure financing, enter new markets, improve competitive position, and meet project requirements. According to Badger and Mulligan (1995), construction firms tend to cooperate across local boundaries of their structures by forming joint ventures, consortia, and by pooling technical expertise, to reduce the level of exposure to risk. This is done mainly by establishing collaborative relationships with manufacturers, financiers, and other suppliers. The relationships could be called upon when needed.

Partnering is an emerging tool that influences how the firm links its structure with that of other organizations to enhance performance. Partnering represents a long-term commitment between two or more firms for the purpose of achieving specific business objectives by maximizing the effectiveness of each participant's resources. A partnering relationship has a long-term perspective, builds trust and openness between the partners, encourages innovation, and increases awareness of needs, and objectives of all partners. Partnering forms when a set of independent firms work together to manage the flow of goods and services along the entire value-added chain in order to improve competitiveness and performance. Firms that partner have the coordination and scale associated with large firms and the flexibility, and low overhead usually found in smaller firms.

Partnering is being advocated for construction firms as means of enhancing their effectiveness. In construction, the partnering chain could start from collection of raw material to the ready-to-manufacture material phase, to components' production stage, to assembly, installation, and site construction, to the final delivered product. Construction is cited as a good example where value added partnerships (VAPs) can work very well since, it has been using subcontracting for a long time (Cook and Hancher, 1990). Subcontracting, however in its present form, can not be qualified as a partnering relationship because, as Gardiner and Simmons (1992) outlined, general contractors usually hold the subcontractors at arm's length and attempt to keep any economic gains to themselves. Cook and Hancher concluded that construction firms can use effective partnering as a contracting strategy to replace the potentially adversarial atmosphere of the traditional bidding methodology.

5. Level of Organizational Coordination

Coordination is defined by Petit (1975), as the fitting together of the subtasks needed to accomplish an overall objective, i.e., the proper functioning of the organization. The purpose of coordination is to once again integrate the parts of a task that are separated, due to division of work. Coordination occurs in an action and time dimension. The division of work breaks up the actions required to perform the total tasks into a series of linked actions. It does so in a time dimension, so certain types of actions precede others. Coordination reunites the separate activities, with emphasis on synchronization of effort, which is required for effective production.

Without coordination, the firm's tasks would not be realized in an effective manner. This is so because workers do not understand how their activities are related to others in the firm. They do not see the "big picture" of how things are done clearly enough to know how best to integrate their work with other members work and attain the best overall results. Coordination is directed by the firm's management. This directed coordination leads to the hierarchical structure of the firm. Activities are linked by putting the workers, who perform these activities, under the authority of a supervisor who coordinates the various tasks. When the number of workers exceeds the upper limit of the number of subordinates that a supervisor can coordinate, the task of coordinating is subdivided among two supervisors. This leads to a new need for coordination, called second order coordination of the two supervisors from still a higher level in the firm. As the size of the firm grows, additional layers of coordination must be added, and the hierarchical structure of the firm is developed. Thus, coordination has a vertical as well as a horizontal dimensions in firms (Figure 3.4). In the structural hierarchy, coordination becomes complex and more difficult. It is impossible for management at the top to cope with all the coordination problems that come up through the hierarchy. Therefore, various formal procedures are used to enhance routine coordinative work (Litterer, 1965).

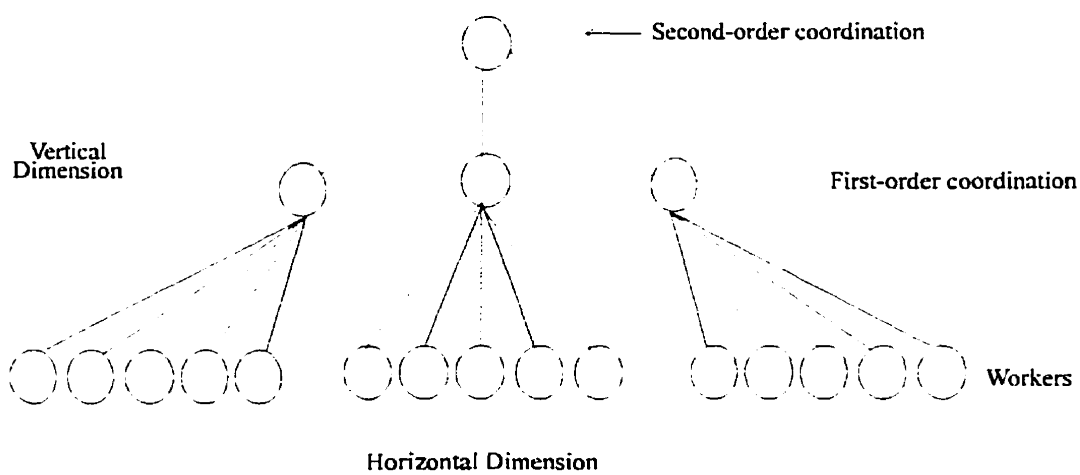

Figure 3.4: Horizontal and Vertical Dimensions of Coordination[3]

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[3] Source: Petit (1975)

In brief, coordination is a necessary process that must be performed by the various management levels in the firm to ensure that basic functions such as decision making, planning, organizing, and control are carried out in a manner that ensures organizational effectiveness.

The measurement of this variable reflects how effective the organizational structure is in coordinating its internal and external relationships. It is crucial for the construction firm, especially the one which emphasizes planning in its structure to coordinate its activities and its relationships in the context of the construction process, especially since construction project organizations usually include multiple organizations. Coordination, as a criteria for effectiveness would underscore the organization's attempt to utilize necessary means to ensure cooperation and proper information flow, both internally and externally, respond to internal conflicts and possible problems arising in contractual relationships.

6. Level of Information Flow

Nearly every management textbook stresses the need for effective communication inside the firm in order to achieve organizational effectiveness. Managers and researchers agree that information flow processes underlie most aspects of organization functioning and are critical to organizational effectiveness. Snyder and Morris (1984), studied organizational-level performance measures and the relationship between four aspects of information flow (adequacy of information about organization policies and procedures, information exchange within the work group, management-subordinates information exchange, and feedback information). Their study provided empirical evidence that supported the existence of a relationship between a high level of information flow and overall organizational performance.

According to Furnham and Gunter (1993), communication of information is a vital process in every organization. They added that when the communication of information is accurate and effective, an organization can function smoothly, but when there is a failure or breakdown in communication, or when information is distorted, there can be serious repercussions for the performance of any firm. Information flows in and around the firm and in different directions. Information also flows into and out of the firm. Within the firm, information flows up from lower to higher levels or down from higher to lower levels, and across levels in the organization. As well as formalized channels of communication, most firms contain informal channels where information flows between individuals with no restrictions. Information flows through informal channels, are sometimes more important and quicker than formal information flow (Baskin and Aronoff, 1989)

Dawson (1989), identified five important characteristics of an ideal information flow:

1. Accuracy: Message clearly reflects intention and truth as seen by sender and is received as such.
2. Reliability: diverse observers would receive message in the same way.
3. Validity: messages are consistent, allows prediction and incorporates knowledge.
4. Adequacy: Message is of sufficient quantity (detail) and appropriate timing.
5. Effectiveness: message achieves the intended result from sender's point of view.

The measurement of this variable will indicate the degree of openness and quality of information being communicated formally and informally within the organizational structure of the construction firm.

3.3.1.2 Category (2): Flexibility, Control, and Rules and Regulations

In the second category, of flexibility, control, and rules and regulations, the study hypothesizes four variables that influence how effective the organizational structure is in mediating between the flexibility-control points in the flexibility-control dimension of the competing values approach. These include:

1. Extent of Using Rules and Regulations

Rules and regulation are a set of guidelines established by the management of the firm in an effort to regulate its internal processes and interactions, and its relationships with the external environment. Fink, *et al* (1983) pointed out that all firms establish rules, procedures, and policies that govern members' behavior in ways that are not covered by other methods of control in the organization. In general, a firm aims to have rules and policies that are broad, flexible, and subject to change, in order to provide management with the freedom to involve workers (where appropriate) in the process of establishing rules that are functional to their jobs and to the overall work effort. Flexible, broad and general rules also allow management to modify and update rules in response to changing demands both inside and outside the organization. The extent of using rules and regulations underscores the firm's effort to exert more control on its processes. Measurement of this variable underscores the extent to which regulations are being used by the construction firm. in work procedures and evaluation

2. Level of Adherence to Rules and Regulations

An important element that affects the effectiveness of established rules and regulation is influenced by the level of adherence by workers and management in an organization. Rules are no more effective than the willingness of the management and workers to abide by them. This is the prime reason why rules are established to be flexible so as to allow management to modify, update and bend rules when necessary, to suit both the internal and external environments. This variable measures how the construction firm (management and workers) adheres and complies to rules and regulations established to govern tasks and work processes.

3. Level of Control

Internally focused organizations that value control emphasize stability and control as criteria for effectiveness. Control underscores the firm's attempts to exert its influence over its processes to achieve stability. Control is a way of making sure that things happen the way they are supposed to happen. Control, in an organization is gained through mechanism and procedures. A budget is a control device and or how it is used is a control method. Flow of activities inside organizations are managed through control systems. A control system is a combination of control devices and procedures established and organized to make sure that the activities of the organization achieve the intended results.

Control systems serve a variety of purposes that include maintaining required task roles, maintaining organizational character, and minimizing and/or correcting deviations from established standards relative to quantity, quality, flow of work, costs, and safety.

The sources of control in firms stem from different levels that include: supervisory control; self-control; social control (culture); and system control. In assessing the level of control, factors that must be considered include degree of control and its affordability (effects on the organization costs and profits); sources of control given the nature of the firm and people employed by it; the impact of the control system on other organizational activities; congruence between control system and organizational goals and values.

The measurement of the level of control reflects the degree of control that the construction firm tries to exert over its processes in an attempt to ensure stability and quality of operations and, hence, organizational effectiveness.

4. Organizational Attitude Toward Change

Some firms treat change as an accidental occurrence, while others plan change. Firms that persist in resisting change eventually fail. Management in firms, or those who have sufficient influence on the firm itself, take actions to institute change because they feel a need for change. The objective of planned change is to keep the firm viable. Firms, in certain times, seek to bring about changes that would: align its structure, improve human resource practices, use of new construction processes, enter into new construction markets, or expanding into other sectors of the industry. According to Cummings and Worley (1993), effectiveness depends, in part, on how well the firm manages these changes, especially in the face of the resistance to change that sometimes occurs without proper management of the change. Robbins (1989), discussed the organizational change process in the model (Figure 3.5). He described three actions for successful change: the unfreeze of the old state; change into the new state; and refreezing the new state. Unfreezing is necessary to overcome the pressures of both individuals and group conformity or resistance to change from the status quo. Resistance can be reduced by communication of the logic of change to workers; increased involvement of workers in the process of change, to obtain commitment; and giving support during change, through new training. After change takes place, refreezing represents the smooth incorporation of changes into the organization's system, making it more permanent.

There are a host of factors which stimulate change in firms. These include: strategic, structural, cultural, new technology, and management succession. Most of the major organizational changes originate from external events. Organizational attitude toward change, given the characteristics of the environment, plays a major role in how successful the firm is in changing and adapting to challenges in the environment. The change process can be considered a success only if the future state desired is achieved; the functioning of the firm works as planned; and the transition occurs without undue cost to the firm.

The measurement of organizational attitude toward change underscores flexibility of management and workers in the construction firm, toward instituting change in organizational processes, tasks, and work methods in order to bring about improvements to deal with the challenges facing them.

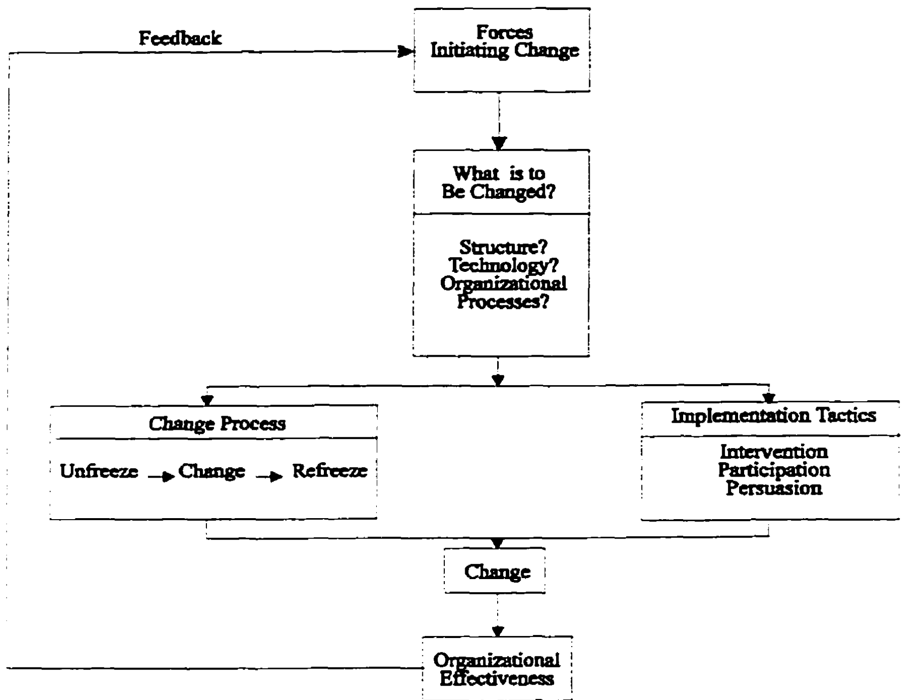

Figure 3.5 : A Model For Organizational Change[4]

3.3.1.3 Category (3): Persons-Oriented Processes

Evans (1986), listed the focus of attention on human resource management, as one of the most important factors that influence organizational effectiveness. Sophisticated human relations and human resource policies, have been found to be a common denominator in successful firms (Foulkes, 1980).

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[4] Source: Adapted from Robbins (1990)

The third category of variables in the methodology is based on the dimension of focus in the competing values approach and it is represented by how much emphasis the construction firm puts on its internal organization and persons-oriented processes. All firms must manage their internal environments through processes that target their workers. In brief, firms have to motivate their workers and create the appropriate environments to maintain their motivation. This must be done by complementing the traditional authority inside the hierarchical structure with procedures and processes to establish and pay attention to human relations in order to improve the quality of working life. Two variables are identified from this category that could describe the persons-oriented processes: strength of organizational culture existing in the firm and level of workers' participation in decision making.

1. Strength of Organizational Culture

The aims of any firm should be to create an environment in which the objectives of the organization, can be most economically and satisfactorily achieved, while at the same time providing satisfactory working conditions for the human resources (people) involved. Job satisfaction is: the extent to which workers feel satisfied or dissatisfied with work, with their place in the organization in relation to colleagues with whom they work and with the environment in which they work.

The relationship between firms that promote cultures with strong emphasis on the persons-oriented processes and performance is well established (Kotter and Heskett, 1992). Gordon and DiTomaso (1992), investigated the relationships between culture strength and performance. Their findings supported those of Dension's (1990); that a strong culture is predictive of short-term future performance. Maloney (1989), stated that "managing culture is the key to organizational effectiveness" [5]. Taylor and Bowers (1972), determined that relationships exist between employee perceptions and attitudes, and firm success. Hansen and Wernerfelt (1989), found that a strong emphasis on human resources, and having a strong culture are significant predictors of profitability. Therefore, this variable is considered because it reflects the internal climate of the firm and its strength or weaknesses, which are directly tied to performance.

A review of the literature revealed many definitions of organizational culture. It is been defined as that sum of shared values, behavior patterns, symbols, attitudes, and normative ways of conducting work that differentiates one organization from all others. It is also defined as the shared beliefs, ideologies, and norms that influence organizational actions Deal and Kennedy (1982), identified key elements that influence organizational culture: business environment; values or norms of behavior shared by members of the organization; the rites and rituals to reinforce the values or norms of behavior, and communication and management of the cultural network that sustains the culture.

Every firm exists within a particular type of business environment and must adapt to that environment. The organization must develop expertise within that environment to perform effectively. Maloney and Federle (1990), argued that the business environment has

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[5] In Maloney. W. (1989) Organizational Culture: Implications for Management. *ASCE Journal of Management in engineering*. Vol. 5. (2). pp. 137

perhaps the largest influence on an organization's culture because it determines what is important to the organization.

Values and norms that are shared by the members of the organization represent an important element of culture. Allen and Kraft (1982), stated that norms are needed in an organization to guide interpersonal relationships. Deal and Kennedy (1982), asserted that workers who upheld good values, make success attainable, provide role models, symbolize the organization to the external environment, preserve and set standards of performance, and motivate other workers. Rites and rituals are needed to reinforce the values and norms. Several types of rituals are important; communication and social rituals; work rituals; management rituals; and recognition rituals. Communication rituals and social rituals concern issues such as how people should be addressed in the organization, how people are cultured into the organization, and how conflict is settled. Work rituals are the procedures that are utilized by members to perform the work. Management rituals govern the conduct of manager and how and by whom decisions are made or coordinated. Recognition rituals are used to illustrate the values the organization seeks to uphold.

Communication, as an element of culture, not only involves the actual information being communicated, but also the interpretation of that knowledge. Maloney and Federle (1990), argued that effective communication depends upon what they termed as the cultural network more than on the formal structure because, they reasoned, that most of the communication takes place within the cultural network. They added that managing the cultural network is the key to organizational effectiveness. Organizations must learn to identify characters in the network, the rules that govern the network, and how to manage communication through the network. Organizations should promote strong cultures in order to reach higher level of effectiveness.

Hendrickson and Tung (1989), argued that in construction, creating a culture that promotes a workers' job satisfaction is a very complex issue. They added that construction firms must adopt strategies to lessen the effects of market demand fluctuation and their practice of firing and laying off workers as their volumes of work decline. In addition, they listed two factors that negatively, influence the strength of cultures in construction firms: the method of grouping workers into crews that are supervised in a hierarchical fashion (scientifc management philosophy); and limitations put on workers' participation in decision making due to the low level of training offered by the average construction organization and low skill level among construction workers entering the job market.

2. Level of Workers' Participation in Decision Making

Decision making, from an organizational perspective, is part of a large process (Figure 3.6). Information must be gathered, and this establishes the parameters of what can be done. Once the information is gathered, it must be interpreted. This interpretation is transmitted as advice to the decision maker as to what should be done. The decision must be authorized and conveyed before it is executed. Referring to the figure, it can be said that decisions are most centralized when the decision maker controls all the steps. As others gain control over these steps, the process becomes more decentralized.

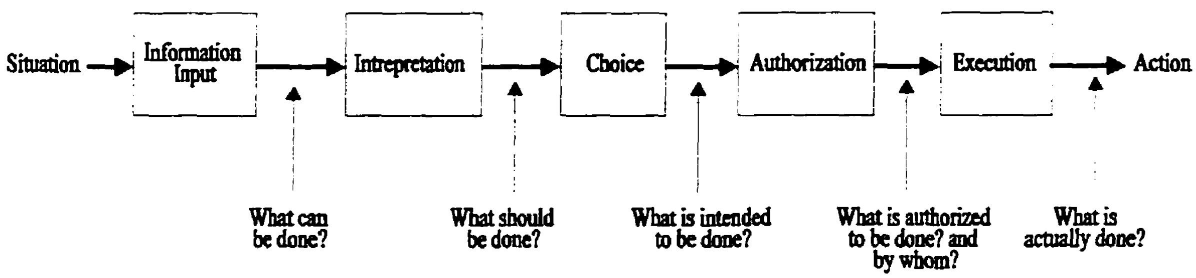

Figure 3.6: Organization Decision making Process

It is often difficult, in a firm, to identify who made a particular decision. At first glance it would appear that management, who has the final responsibility for taking a particular action makes the decision. However, according to Petit (1975), if the formal and informal channels of communication that contribute information to the decision making process are studied, it becomes clear that many individuals participate in the process upon which the decision is based.

Why is participation in decision making by workers important to the organizational effectiveness of the firm? In addition to speed, which is needed to respond rapidly to changing conditions at the point at which the change is taking place (avoiding the need to process information through a vertical hierarchy), sharing in the decision making process, can provide more detailed input into the decision. If those most familiar with an issue make the decision, more of the specific facts relevant to that issue would be available. Another important reason for an organization to incorporate participation in decision making is the increased motivation to workers, by allowing them to make decisions that will affect how they do their jobs.

A long trail of motivational theories, beginning with McClelland (1953), and including McGregor (1960), Maslow (1970), and numerous other researchers, leads one to the conclusion that workers' participation in decision making contributes directly, and indirectly to desired organizational outcomes through three important factors affecting the workers. These are shown in Figure 3.7 and include job satisfaction, personal growth and development, and a willingness to change. For instance, high job satisfaction results in lower turnover, fewer absences, and slightly lower accident rates. It also leads to a better quality of output and to a healthier workforce (Kearney and Hays, 1994). Other research has correlated high levels of job satisfaction with reduction in lax behavior to "good citizenship" among workers (Bateman and Organ, 1983).

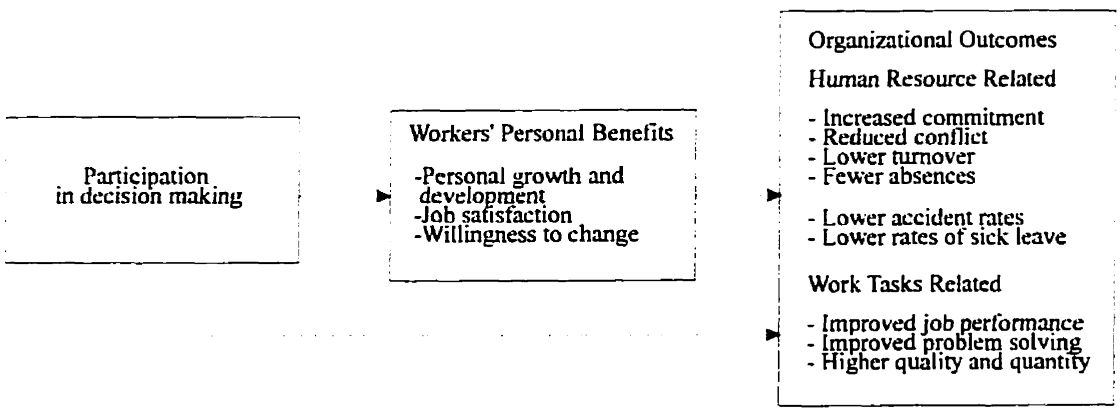

Figure 3.7: Participative Decision-Making and Workers and Organizational Benefits

The job satisfaction that results from participative decision making has been also associated with stronger organizational commitment which, Kearney and Hays (1994) held consists of (a) a willingness of workers to exert high levels of effort on behalf of the firm, (b) a strong desire to remain in the firm, and (c) an acceptance of the firm's goals and values. Using these and other definitions, researchers have linked organizational commitment resulting from participative decision-making, to high performance levels, low turnover, and other measures of organizational effectiveness (Angle and Perry, 1983).

Borcherding (1977), explored the relationship between participative approaches to decision making and their effects on job satisfaction and productivity. On the one hand, he concluded that participative decision making is common among construction firms, especially those dealing with small size projects, and usually leads to higher productivity. On the other hand, he argued that because participative decision making no longer takes place on large industrial projects, supervisors, and especially workers in firms handling such projects, lose their enthusiasm toward construction work, and frequently, work productivity is reduced.

Maloney (1993, 1994), discussed the fact that construction firms in the U.S. suffer declining performance because worker involvement is minimal due to workers management practices in most US construction firms are mainly characterized by the scientific management philosophy. Furthermore, he argued that, it is important that worker involvement must become a way of life and that the greater the worker involvement, the greater the benefits to the firm.

Schrader (1972), reported that a workers' participation in decision-making leads to increased effectiveness and productivity in construction firms. He based his conclusions on a study in which the productivity of a work group that participated in changing work methods increased 14 %, as compared to another group that did not participate in the decision-making process. In construction firms, he concluded that a high level of participation by the workers in the decision-making process would eventually result in improved construction production methods, lower resistance to change, and more enthusiastic commitment.

Schrader also discussed two reasons used by management of construction firms to explain their failure to use participative decision-making in a regular fashion: the long period of time required for participative decision-making to become effective; and the short length of time the average worker is employed in construction. He discussed a practical approach to participative decision making in construction work crews such as crew performance analysis by members of the crew, the use of workers of long standing, plus a crew elected representative to help plan methods. This, he argued, would create a sense of involvement in the group that would be carried to the crew. He also argued that very little time is required for studies of daily construction operations of the crew which are characterized by a low need for expertise and coordination beyond the crew. Furthermore, he concluded that construction employment is reasonably stable, even though many workers can still be labeled temporary. He argued that these workers are, nevertheless, a good source of new ideas and practical know-how.

Measurement of the level of participation in decision-making by workers reflects the style of how the construction firm manages its workers and their involvement in decision - making to promote commitment. Internally focused construction firms that value flexibility in the assessment of effectiveness, are more sensitive to their workers. They allow a higher of degree of participation in decision making through a strong culture of team work. Internally focused construction firms that value control in the assessment of effectiveness, stress adequate communication and information management through a strong culture of hierarchy, with clear rules and regulations for performance.

Drucker (1988), in his information-based organizations approach that enhances organizational effectiveness, advocated that workers must be organized as teams. The members of teams must do different tasks, participate in decision making and direct themselves. In these teams the culture is strong because the workers are empowered to do their work. The key to effectiveness is that everyone in these task focused teams constantly thinks through what information he/she needs or can give to maintain and improve organizational effectiveness.

3.3.1.4 Category (4): Strategy (Means and Ends)

The fourth category reflects what strategic means and ends is used by the construction firm to achieve organizational effectiveness. This category of variables underlie a firm's attempts to adopt effective strategies in an effort to increase its competitiveness and adapt to its environment. There are common themes in the definition of strategy. Strategy is concerned with the means to meet ends. According to Ansoff (1988), a strategy is also a set of rules for guiding decisions about organizational behavior. Strategy can be thought of as the firm's intent, that is often expressed in a plan. The plan states the mission, objectives, goals, and the actions required to fulfill them, in the context of the firm's internal and external environments. In business terms, strategy is fundamentally how to position a firm in its competitive environment in a way that allows continuous superior performance to that of others. Strategy could be explicit as a part of a formal strategic planning process or an implicit intent across the organizational functional dimensions and structures.

Organizational strategy is typically formulated for three levels: technical/production level; business level; and corporate level. A technical/production strategy determines how the firm's internal operation deals with the transforming of inputs into outputs and is mainly concerned with the present and getting the job done. Business strategies are formulated in order to position the firm competitively in markets. Corporate strategy identifies the firm's missions and main objectives. The firm's mission is its *raison d'être*. A mission may be narrowly or broadly defined and probably has emanated from the founding entrepreneur's vision of what the firm should be and it is normally expressed in qualitative terms. A firm's objectives stem from the mission and is expressed normally in quantifiable terms.

Two views have emerged on the nature of strategy. The first perspective views strategy as a planning mode. A strategy is worked out in advance, is explicit and firms develop a systematic and structured plan to meet objectives. The second perspective sees strategy as an evolutionary mode. Strategy evolves over time, it is not thought out and planned but it is a stream of significant decisions. This is the evolutionary mode, or logical incrementalism as called by Ansoff (1988). Planned strategy is worked out in such detail that it becomes difficult to alter once implemented. An evolutionary strategy, on the other hand, requires the selection of the best strategy under a given set of circumstances. It advocates flexibility to be able to adapt. This requires careful environmental scanning, monitoring, and evaluation. Typically, a firm's overall strategic posture is determined by a mixture of both.

According to the competing values approach, externally focused firms that value control in the assessment of effectiveness, emphasize planning and goal setting that promotes productivity and accomplishment. Therefore, in this category, the methodology hypothesizes two variables: the level of planning carried out by the construction firm; and its level of goal-setting.

1. Level of Planning

Planning, as a strategy, is described by Hunger and Wheelen (1993), and shown in Figure 3.8. The process includes four main phases. In the first phase, the firm carries out an environmental scan where the firm analyzes its strength (S), weakness (W), opportunities (O), and threat (T). This is commonly referred to as 'SWOT' analysis. In the second phase, firm's mission, objectives and strategies to achieve them, and policies of strategies are formulated. Programs, budgets, and procedures are carried out in the third phase to implement the formulated strategies. The last phase includes evaluation and control of strategies.

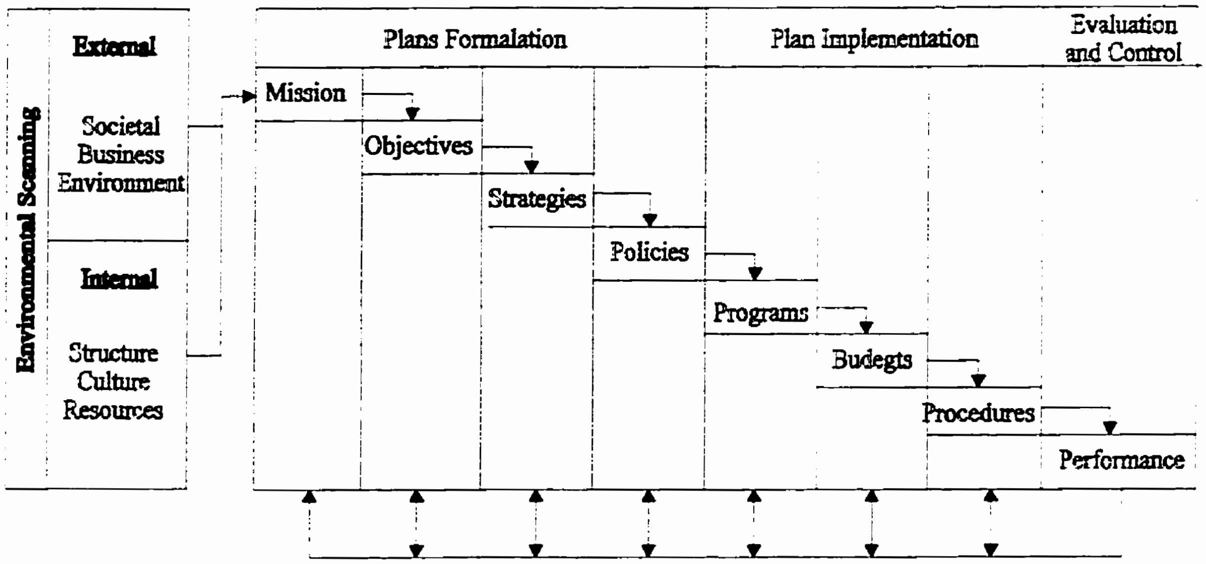

Figure 3.8: Planning Process Model[6]

Many researchers discussed the importance of strategic planning to the effectiveness of construction organizations, large and small, regardless of the aspect of construction in which they are involved. Furthermore, these researchers stress that strategic planning should be recognized as an important aspect of the organization's overall activity and requires as much attention as routine operations, Warszawski (1994). Betts and Ofori (1992), Langford and Male (1991), advocated the use of strategic planning and management techniques for the construction firm to gain organizational effectiveness and hence a competitive advantage.

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[6] Source: Adapted from Hunger and Wheelen (1993)

The measurement of the level of planning by the construction firm underscores the firm's attitude toward utilizing planning in routine operations and in adapting to its internal and external demands in its environment in achieving organizational effectiveness.

2. Level of Goal Setting

Bengtsson (1984), reported that goals are indispensable to the effective management of construction firms. Naylor and Ilgen (1984), observed that over 90% of the reviewed studies, that deal with goal setting, reported at least some beneficial effects on performance. They concluded that goals can strongly influence performance, and that the process of setting goals is an important aspect with respect to work motivation.

Whatever the firm's ultimate goals, there are a number of means of pursuing each of them. A goal of profit can be served by an efficient production activity and a creative marketing and bidding program. A goal of safe working conditions can be promoted through procuring equipment with built-in safety features, good maintenance and training of workers, all of which encourage the workers to follow safe operating practices.

There are a number of descriptive ways of categorizing goals, Dawson (1992) gave the following categories that are typical for a business firm: financial goals, marketing goals, production goals, quality goals, technological goals, growth goals, and social goals. Scott[7] identifies three models: rational, natural, and open system as sources of any organizational

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[7] In P.S. Goodman and J. K. Pennings, eds., New Perspectives on Organizational Effectiveness (San Francisco: Jossey-Bass, 1977), Chap. 4

goal. The rational model, in which goals are specified from goods, services, activities, and productivity levels; the natural model, in which goals emerge reflecting human needs of the organization at the different levels; and the open system model, which recognizes organizational goals such as adaptability, flexibility in the exchange of resources between the organization and its environment.

Goals are established as necessary consequence of the firm's self definition, its purpose of existence, and managing them involves dealing with goal conflicts. These conflicts stem from inherent differences in the nature of goals, due to the competition of resources associated with having different goals at the different levels of the firm. Firms are normally faced with an enormous number and variety of goals to manage. General goals versus specific goals; long- term versus short- term goals; organization level goals versus sub-organization goals; and high priority versus low priority goals. The ideal situation for a firm is when there is congruence among the different types of goals and the firm can cope with situations where congruence is not possible and manage the conflict in order to minimize its negative effect on the rational goals.

Two characteristics of such means to a final goal are noteworthy. The means themselves constitute ends (goals). First, efficient production does not just happen, rather, it is a goal that firms strive to obtain. It is a sub-goal that itself can be pursued through variety of means, and these means constitute sub-sub-goals. Each major goal of a firm is the beginning of a chain of goals and sub-goals, in which each sub-goal is a means to a larger goal. Second, each sub-goal tends to be more concrete and more of a tangible objective than the related goal. The goal of efficient production activity is more concrete, in the sense that it is a more definitive guide for decision making, than is the goal of high profit. According to Fink *et al* (1983), as one moves along the means-ends chain, the sub-goals tend to become ever more "operational". Thus, one can visualize firm's goals as a tree shaped structure of goals, with a mean-ends chain fanning out from each major goal to more operational goals. In Figure 3.9, section of a possible means-ends chain of goals for a construction firm is shown.

Various perspectives have been given for goal setting strategy in the context of the construction firm. Channon (1978), alluded to goal setting strategy in terms of the extent of diversification. Newcombe (1990), also discussed the extent of market diversification, by the type of the constructed product, and geographical expansion (i.e., spread of activities). Newcombe considered four markets: single market, dominant market, related market and unrelated market; local, regional, national, and international. He concluded that construction firms start as small, local and single market and gradually grow, mainly through goals deliberately set by the firm.

The measurement of the level of goal setting by the construction firm underscores its strategy to motivate workers toward effective performance by the achievement of organizational-level goals such as increasing profits levels, increasing costs effectiveness, growth into other construction sectors, improving level of process quality, improving client satisfaction, and increasing workers' involvement. Most of the current literature recommends that management strategize to find ways of incorporating these goals into their construction firms to increase performance. Bengtsson (1984), found that the goal of profit within the construction firm headed the aggregate reply at all hierarchical levels in the firm.

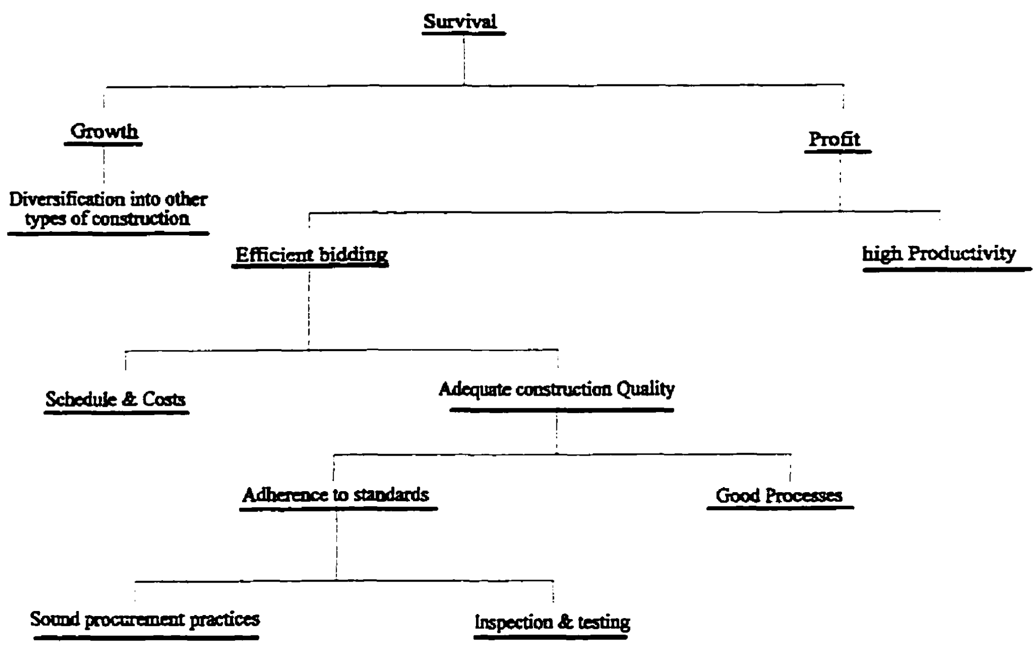

Figure 3.9: Example of A Goal-Chain For A Construction Firm

Maloney (1994), discussed the strategic planning for human resource management and stated that the typical construction firm pursues a strict hierarchical method of workers management which leads to decreased workers involvement. Therefore, when a construction firm sets a goal of increased workers involvement, this indicates the level of importance that the firm attaches to changing its traditional hierarchical process of workers management to practices that have the potential of worker satisfaction and higher performance.

3.4. SUMMARY

In this chapter, the logic of the proposed methodology was first discussed. The competing values approach is selected as valid approach. The proposed methodology uses the effectiveness criteria in the approach's four ideal models, to hypothesize four categories of fourteen variables deemed relevant for examining organizational effectiveness of the construction firm. The ideal levels of these variables, represent the levels that a homogenous group of construction firms attempts to pursue at a certain stage in their life cycle in order maximize their organizational effectiveness. The levels of these variables are used to predict the organizational effectiveness of firms depending how close the levels of these variables in the firm to the ideal levels.

Secondly, because the ideal levels of the hypothesized variables are not known, three main steps were outlined to determine, empirically, a quantitative model. This model relates the ideal levels of these variables to a referent measure of organizational effectiveness. The process of model development outlined, includes (a) the identification of variables that will be used to predict effectiveness according to the criteria of the four ideal models in the competing values approach; (b) a field study in which the identified variables are operationalized, measures constructed, and data collected; and (c) data analysis, model selection and validation.

The rest of the chapter was devoted to discussing the identification of variables. This section dealt primarily with how the fourteen variables were identified from four categories of criteria relevant for examining effectiveness along the three dimensions of the competing values approach of structure, focus and strategy means and ends. These variables are hypothesized to influence the organizational effectiveness of the construction firm, and hence, can be used to predict it. In the first category of structural context, six variables were identified that include the level of integration of services offered by the construction firm; level of using joint-venturing, partnering, and alliances; level of subcontracting; level of multiple project-handling ability; level of coordination; and level of information flow.

In the second category of flexibility, rules and regulations, four variables were identified that include the level of rules and regulations used by the firm; level of adherence to rules and regulations by management and workers; level of process control; and organizational (management and workers) attitude toward change. In the third category of persons-oriented processes in the firm, the methodology identified two variables. These include the strength of organizational culture and the level of workers' participation in decision making. Finally, in the category of strategic means and ends, two variables were identified: the level of planning; and level of strategic goal-setting by the firm.

Measurement scales for the identified variables must be constructed in order to test the usefulness of these fourteen variables in predicting the level of organizational effectiveness of the construction firm. In the following chapter, measurement of the variables is discussed.

CHAPTER (4)-OPERATIONALIZATION OF VARIABLES

4.0. INTRODUCTION

In order to perform analysis, to test the study's hypothesis and develop a model of prediction, a valid referent measure of organizational effectiveness must be constructed and the fourteen hypothesized variables operationalized. In the first section of this chapter, a description of how organizational effectiveness of the construction firm is operationalized into a measure that can be used as a referent in data analysis and model building. In the second part, measurement of the fourteen hypothesized variables is described.

4.1. ORGANIZATIONAL EFFECTIVENESS: A REFERENT MEASURE FOR ANALYSIS

This research uses the synthesis of the goal model and multiple constituencies approach to operationalize a measure for organizational effectiveness of the construction firm to be used in the analysis and model building. This is achieved by incorporating into the measure, the three performance domains or goals that are most commonly used to rate the achievements of the construction firms, by management and the constituents of the construction project. These three domains relate to the firm's level of performance in construction projects. These are: duration of execution, and whether or not the firm accomplishes its work tasks without any delays according to the stipulated time schedule in the work contract; costs of performance, and whether or not the firm accomplishes its work tasks within budgeted costs; and, finally, quality of execution, and whether or not the firm's work is within specifications. Table 4.1 shows the effectiveness criteria that the four main parties, typically involved in the construction project use in their evaluation of the construction firm, and possible satisfaction indicators that are used to measure these criteria.

Table 4.1: Constituents' Effectiveness Criteria

Constituents	Effectiveness Criteria	Satisfaction Indicator
Customer	Work quality, price, and duration	Satisfactory costs and quality level, no delays
Firm's Owner	Project's performance	Within budget, schedule, and contractual specs High profits
Subcontractors	Contractual relationships	Satisfactory transactions
Public agencies	Compliance to Codes	No codes violation.

The most common criteria used by constituents of construction firms to evaluate the satisfactions of their goals can be linked to the level of performance in completed construction work. Past performance achievement in the three domains can be shown to influence the concerns of the constituents as shown in Figure 4.1. The percentage of construction work projects that were completed within scheduled time (p_1), percentage of construction work completed within budgeted costs (p_2), and percentage of construction work finished within contractual quality specifications (p_3) can be used to indicate how effective the firm was for the period considered in satisfying its goals and those of its constituents.

Completion within scheduled time, would not only satisfy the goals of the customer, but also that of the firm itself, especially if there is an incentive for more profits with timely completion. The suppliers and workers of the firm would also stand to gain from timely completion because of the increased probability that payments and salaries will be made on time. In addition, timely completion means that the firm could free its resources and make itself available for more work which could bring in more profit and at the same time secure longer employment for the workers and give its suppliers an opportunity for more work.

Completion of the work tasks within the scheduled duration or less, also implies that no gross code violations occurred. Delays usually result from work failing inspections and firms having to perform considerable rework to satisfy clients' specifications and public codes.

Completion of the work tasks within budgeted costs or less means that there were no cost overruns that the customer or the firm itself had to incur, through claims or work stoppage. This implies that the firm would realize planned profits. It also, implies that estimates used by the firm in procuring subcontractors and suppliers for part of the work were accurate, which means that the transactions with these suppliers were completed satisfactorily. Completion of the work with quality, in a manner as specified by the contract,

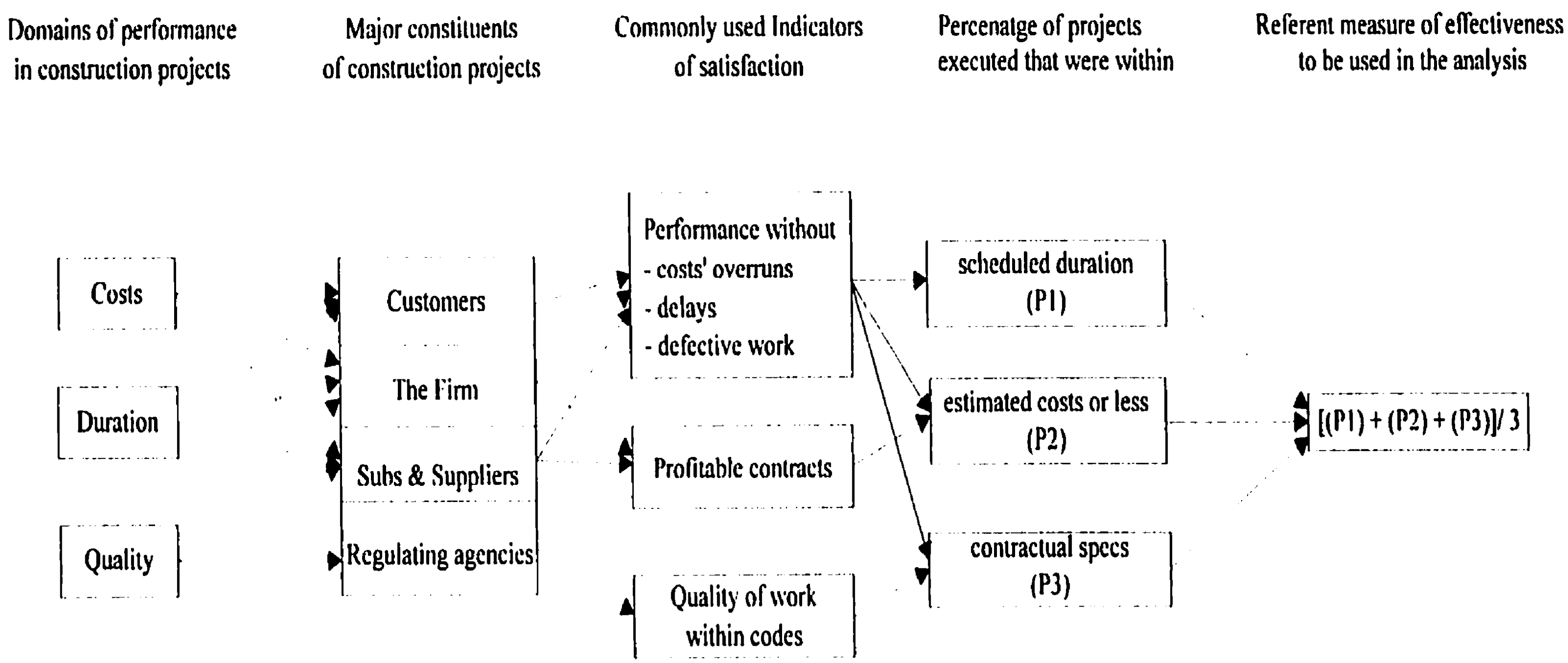

Figure 4.1: Synthesis of A Referent Measure For Organizational Effectiveness of the Construction Firm

would not only satisfy the customer, but also public agencies who monitor the work's compliance to governing codes and regulations. In these three domains, past projects performance could provide a snap shot of how effective the firm has been in satisfying its major constituents. The methodology uses the level of past project performance as a referent measure of organizational effectiveness to be used in the analysis.

As shown in Equation 4.1, the measure is calculated as the average of three percentages: percentage of projects that were completed within scheduled duration (p_1); percentage of projects that were completed within budgeted costs or less (p_2); and percentage of projects that were completed without any claims by customers for defective work or excessive rework as a result of bad work quality (p_3). Equal weights are assigned to each component of the measure, since it is the assumption taken here that they are equally important in determining how effective the level of performance is.

$$\textit{Level of performance } (Y) = \frac{(p_1 + p_2 + p_3)}{3} \qquad \textbf{Eq (4.1)}$$

where:

p_1 = percentage of projects that were completed within scheduled duration.
p_2 = percentage of projects that were completed within budgeted costs or less.
p_3 = percentage of projects that were completed without any claims by customers for defective work or excessive rework as a result of bad work quality.

4.2. OPERATIONALIZATION OF THE FOURTEEN VARIABLES

Since all the identified fourteen variables can not be directly observable through hard quantitative measures, ratings are used to measure management and workers perceptions of variables' characteristics, aspects, and magnitudes in the firm. According to Furnham and Gunter (1993), although perceptions-based measurement are essentially subjective in nature, using such measures is just as systematic as using hard measures, and can yield valuable organizational data in a quantifiable form that can be treated as hard measures, if proper research techniques are used. According to Babbie (1992), rating can be used to ask the respondents to estimate the magnitude (level) of a characteristic or quality that an object possesses. Quantitative scores, along a continuum, such as shown by Figure 4.2, have been supplied to respondents and are used to estimate the strength of the attitude, perception, or belief. In other words, the respondents indicate on a scale, the position where they would rate the level or quality of the object under question. The ordinal scale arranges objects or alternatives, according to their magnitude, in an ordered relationship. The Likert scale is such a scale, where respondents indicate their ratings of the attribute under question by checking the appropriate number on the scale.

In the 7 anchor-points ordinal Likert scale, shown in the figure, the anchor value 7 indicates a very high level, the anchor value 6 indicates a high level, the anchor value 5 indicates an above average level, the anchor value 4 indicates an average level, the anchor value 3 indicates a below average level, the anchor value 2 indicates a low level, and the anchor value 1 indicates a very low level.

7 6 5 4 3 2 1

Figure 4.2: 7-Anchor Points Ordinal Scale

Typically, there are multiple items (statements) according to which the respondents rate the attributes of the variable under question. To measure the level of the variable under question, rating for each attribute is assigned a weight, then the ratings are added to determine the overall rating. Usually the weights are assumed to be uniform across the various items because the priori contribution of each item to the overall level of the variable is not known. An example illustrates the above. Suppose there are four items used to measure the various attributes of the variable, then the ratings for all items are added up and divided by the number of items (equal weights are assigned) which is four in this case, to determine the overall average rating of the variable.

All variables are measured using summated rating method (Likert method) using a 7 anchor-points scales that are constructed similar to the one described above. The reason that a 7 anchor-points scale is chosen rather than one with five or three anchor points, is that a better and more accurate rating will result from using such a scale. The strength of culture variable is measured using the constant sum scale discussed by Zikmund (1994) and used by Maloney and Federle (1993) in their methodology to assess organizational culture. Constant-sum scales are typically used to measure attitudes and they approximate an interval type measure, however it is still considered an ordinal scale.

In order to overcome response bias, measurement of variables is based on multiple ratings and two different levels of workers within the construction firm. Multiple ratings are solicited from the managerial level and from the workers' level. Ratings obtained from the two different levels in the firms are first aggregated and then averaged within each firm in order to create organization-level scores.

For each variable, the research generated a number of items that reflect the various aspects of the variable without emphasis on any one. Multiple items are used for each variable because they constitute a more reliable measure than individual items. Each item can be thought of as a "measure" in its own right, of the strength of the variable in that aspect. Theoretically, according to Devellis (1991), the universe of items is assumed to be infinitely large, and that precludes any hope of identifying it when items are developed to measure constructs or variables. This research attempted to identify multiple items for each variable or construct that exhaust the possibilities for types of items that capture the essence of the variable. Items that are used to operationalize and the measurement of the fourteen variables are as follows:

4.2.1. Level of Subcontracting

The level of subcontracting used by the construction firm is assessed in thirteen areas that rate the extent to which in a typical construction project, architectural and construction activities are entrusted out to other firms. The scale used to measure the level of subcontracting by the firm asks the respondent to rate the extent to which, in an average size project, the following activities are entrusted out to other firms:

1. Design and planning.
2. Site work.

3. Substructure.

4. Superstructure (skeleton).

5. Floor systems.

6. Interior wall system.

7. Exterior wall system.

8. Roof systems.

9. Masonry work.

10. Metal work.

11. Electrical system.

12. Mechanical systems.

13. Finish work.

4.2.2. Attitude Toward Change

Organizational attitudes toward change is assessed using a 7 anchor-points Likert scale that ranges from strongly agree '7' to strongly disagree '1'. Eight areas are addressed that deal with the following:

1. Level of accepting changes by the workers and their ease in accepting changes in organizational processes.

2. Level of viewing changes as an effort to improve processes by the workers in the construction firm.

3. Level of eagerness exhibited by workers to understand changes in processes.

4. Level of eagerness exhibited by workers to adopt alternative work methods in case of adopting new work processes.
5. Level of encouragement exhibited by management for needed organizational change.
6. Level of changes based on regular processes reviews by management.
7. Rate of introducing changes to improve processes that keeps pace with improvements by other organizations in related fields.
8. Level of achieving the resumption of smooth operations in a reasonable time period once changes are introduced in the firm.

4.2.3. Extent of Rules and Regulations

The extent of rules and regulations variable is assessed using a 7 anchor-points Likert scale that ranges from very extensive regulation '7' to very little regulation '1'. Four areas that relate to the extent of using regulation in work procedures, instruction, and evaluation by the construction firm are addressed and they are as follows:

1. Extent of using rules and regulations in management of all work processes.
2. Extent of using rules and regulations in instructions and procedures for performing work tasks.
3. Extent of using rules and regulations in work evaluation.
4. Extent of using rules and regulations to control management and workers' actions.

4.2.4. Level of Adherence to Rules and Regulations

The level of adherence to rules and regulations variable is assessed using a 7-point Likert scale that ranges from very strict adherence '7' to very little adherence '1'. Assessment is performed in three areas that relate to the level of adherence to rules and regulation by management and workers of the firm and they are as follows:

1. Level of adherence by management of the construction firm to established rules, regulations, and procedures.
2. Level of adherence by workers to established rules, regulations, and procedures.
3. Level of adherence by the firm to established rules, regulations, and procedures that govern relationships with external entities such as suppliers, subcontractors, other partners and allies.

4.2.5. Level of Control

This variable is measured using a 7 anchor-points Likert scale, that ranges from very high '7' to very low '1'. Level of organizational control is assessed in the following areas:

1. Level of using documentation and formalized rules, jobs descriptions, and work procedures in all organizational processes.
2. Level of using control systems to standardize outputs.
3. Level of controlling all organizational processes to meet quality standards.
4. Level of using control tools and methods by management in monitoring processes' quality.

5. Level of using various methods to check, monitor, and update progress of all work activities to ensure that production is within target schedule and budgeted costs.
6. Level of maintaining smooth operations in all organizational processes.

4.2.6. Level of Integration In Services Offered

Measurement of this variable is performed by using a 7 anchor points scale that asks the respondent from the management level to rate the firm according to very high level '7' to very low '1'. The level of integration in services offered by the construction firm is assessed in five areas that measure the level of integration up-stream or downstream of the construction phase in the construction process as described by Sanvido (1988). These five areas are assumed to have equal weights in determining the overall level of integration in the firm and they are as follows:

1. Extent of services offered by the organization in the A/E design field.
2. Level of self owned construction materials supply.
3. Level of construction financing services offered to clients.
4. Operating and maintenance services offered by organization to its clients.
5. Extent of providing construction management services.

4.2.7. Level of Joint-venturing, Partnering, and Alliances

The level of joint venturing, partnering, and alliances is assessed in four areas that measure the degree of utilizing such contractual methods by the construction firm in project delivery and the quality of entering such relationships. These are as follows:

1. Level of developing these relationships with other organizations, i.e. suppliers, subcontractors, general contractors, A/E consultants or any other related fields.
2. Level of improvement in quality and cost of performance when these relationships are used.
3. Level of accepting contracts that requires joint venturing agreements.
4. Level of maintaining the quality of these relationships with other firms if any in a positive manner.

4.2.8. Level of Multiple Projects Handling Ability

The level of multiple project handling ability is measured in five areas that assess the construction firm's ability to perform satisfactorily when assuming multiple projects responsibilities. The 7 anchor-points scale, from strongly agree '7' to strongly disagree '1' is used to measure this variable by asking the respondent to rate the statements regarding the following aspects of multiple project handling:

1. Absence of any noticeable negative changes in quality of organizational processes when the organization assumes the handling of multiple projects. This is emphasized because any negative changes would indicate poor handling by the organization.

2. Organizational structure suitability for handling simultaneous projects' responsibilities.
3. Acquisition of needed resources (labor, equipment, material, capital) for handling multiple projects in a reasonable and timely manner. This is an important consideration in rating this variable because it shows whether the firm can acquire the necessary resources to carry out its responsibilities in a satisfactory fashion, or not.
4. Frequency and size of multiple projects handled simultaneously by the firm. Regularity indicates, to some degree, that the firm has the capabilities to deal with complex organizational issues involving multiple projects handling.
5. Level of satisfaction of the various projects' constituents when the construction firm is handling multiple projects simultaneously.

4.2.9. Strength of Organizational Culture

Culture has been defined as coherence (Deal and Kenndey, 1982; Weick, 1985); as homogeneity (Ouchi and Price, 1978); as stability and intensity (Schein, 1985); as congruence (Schall, 1983); as internalized control (DiTomaso, 1987). While there are many definitions of culture, very few researchers tried to operationalize it. These various researchers seem to consider cultural strength a function of some combination of the following: who and how many accept the dominant values in the firm; how strongly, deeply or intensely the values are held; and how long the values have been dominant. Gordon and DiTomaso (1992), operationalized the strength of culture by the consistency of survey responses, across work groups within the firms, to questions that dealt with eight cultural factors. These were: clarity of strategy/shared goals, systematic decision-making, integration and communication, innovation/risk-taking, accountability, action orientation, fairness of rewards, and development and promotion from within. They defined consistency as the inverse of the variance in questionnaire responses (the degree of gap between the different perceptions). Based on this method, the degree of agreement on cultural characteristics across respondents is related directly to performance. As mentioned in chapter 2, Maloney and Federle (1993), discussed the degree of gap between perceptions of cultures by managers and their subordinates in construction and engineering organizations, as an indicator of the state of effectiveness in the units studied. This study adopted the questionnaire developed by Maloney and Federle to rate the strength of overall culture in the firm. The main reason for using Maloney's and Federle's questionnaire is because the way it is constructed. In line with the competing values approach, Maloney's and Federle's ratings method considered that different types of cultures can be equally effective while other methods did not allude to this factor.

The strength of organizational culture variable is thus measured using the constant method scale developed and used by Maloney and Federle. The scale contains statements about culture's six major aspects of dominant organizational characteristics: organizational climate, success factors, organizational glue, leadership style, and management style. In each area, four statements are given, with each describing one of the four types of cultures in the ideal configurations as identified by the competing values approach. The respondent is asked to rate the firm according to how similar the situation is inside the firm to that description, by dividing 100 points among the four statements. The division is accomplished by distributing more points to the statements that describe very closely the situations inside the firm. If the situation inside the firm resembles only one of the statements, then all 100 points are assigned to that statement, if two statements describe the situation equally, then 50 points are given to each statement. If all four statements describe the situation equally, then 25 points are given to each, etc. Ratings are added for each of the four types across the six areas and averaged.

Scoring the strength of culture is done then by identifying the minimum deviation in perceptions between management average total and the workers' average total across the four types of culture. The degree of deviation in perceptions of culture across the four types is converted to a measure of cultural strength on an ordinal scale with 7 "very strong" to 1 "very weak" using the expression in Equation. 4.2 below. Maximum possible deviation is 100 points. A deviation in perception of this magnitude corresponds to a very low rating of 1 on the 7 anchor-points Likert scale, indicating a very weak culture. Therefore, it follows that when the deviation is approximately zero, the corresponding rating on the Likert scale should be very high or very strong '7'. Therefore each, 100/7 or approximately 14 points of deviation in perception, equal one point reduction on the 7 anchor-points Likert scale .

$$\text{Rating using a 7 anchor points Likert scale} = \left(7 - \frac{|\textbf{\textit{Total Dev}}|}{\textbf{14}}\right) \qquad \text{(Eq.) 4.2}$$

where

$|\textbf{\textit{Total Dev}}|$ = absolute value of total deviation between workers' and management's overall culture perceptions

4.2.10. Level of Workers' Participation In Decision Making

The level of workers' participation in decision-making in the construction firm is assessed in seven areas that measure the degree and quality of participation in decision-making by workers. These relate to the following:

1. the degree that decision making responsibilities is based on sharing and participating among all workers in each organizational unit and across all units.
2. the level that management encourages workers to initiate and take decisions concerning work processes.
3. the level that management encourages workers to participate in decisions making by soliciting their input and ideas regarding all organizational processes.
4. the level that management consults with workers before making decisions concerning work processes.
5. the level that decisions making within organizational units is actually based on consensus of almost all workers or their teams.
6. the level that workers in the organizations are not penalized for wrong decisions but are encouraged to take responsibilities for their actions in a constructive manner.
7. the level that positive workers' attitude exist in the organization towards participation in decisions making responsibilities as evident by their volunteering of opinions in decisions making.

4.2.11. Level of Coordination

The level of inter- and intra-organizational coordination activities is assessed using a scale that ranges from very highly coordinated '7' to very little coordination '1'. The firm's level of coordination is assessed in five areas that measure the following :

1. Level of coordination in activities that govern work flow in all organizational processes.
2. Level of coordination of work relationships inside the various organizational units.
3. Level of coordination of work relationships among the various organizational units.
4. Level of coordination in activities concerning problem and conflict resolution in and among organizational units.
5. Level of coordination in activities concerning work relationships between the construction firm and its subcontractors, suppliers, allies, and partners.

4.2.12. Information Flow

Information flow (openness and quality of communication) is assessed in six areas that was addressed by Guevara and Boyer (1981), to test problems in quality and openness of flow of information within construction firms both vertically within the organizational hierarchy and laterally across organizational units. 7 anchor-points scale of strongly agree '7' to strongly disagree '1' is used to rate the following:

1. Level of noticeable interruptions in flow of information, both vertically within the organizational hierarchy and laterally across the organizational units.

2. Level of accuracy of information being communicated across all levels of the firm and associated level of distortion in communicated information.
3. Level of regularity and sufficiency in information quality and quantity, communicated inside the firm.
4. Level of accessibility and availability of information when needed by workers.
5. Level of regularity and timeliness of feed-back information about organizational processes and work tasks.
6. Level of quality and quantity of information flow with external entities sharing in work relationships. i.e., other firms, suppliers, subcontractors, and partners.

4.2.13. Level of Planning

Level of planning by the construction firm is assessed in four areas that relate to the following:

1. Level of planning used by management to develop strategies to achieve stated general business goals and process quality goals.
2. Level of regularity of the planning process.
3. Level and frequency of scanning the internal environment (internal organizational audits) of the firm in development of planning strategies for improvement of internal organizational processes.
4. Level of using strength, weakness, opportunities, and threats (SWOT) analysis in development of planning business strategies for the firm.

4.2.14. Level of Goal Setting

The level of goal setting is assessed by the level of importance the construction firm attaches to goal setting in six major areas that deal with the following goals:

1. Increasing profit levels.
2. Increasing costs effectiveness.
3. Growth into other construction sectors.
4. Improving level of process quality.
5. Improving client satisfaction.
6. Increasing workers' empowerment.

4.3. SUMMARY

A measure of organizational effectiveness of the construction firm is developed to act as a referent, against which organizational effectíveness is judged in the analysis and the development of the methodology. It is determined by the average level of performance over the last five years of operation and is calculated as the average percentage of percent of projects completed within scheduled time or less, percent of projects that were completed within budgeted costs or less, and percent projects that were completed without claims and within acceptable levels of compliance to clients specifications.

The fourteen variabies were operationalized and scales for their measurement were developed. Likert scales were constructed for measurement of all the identified variables except for the strength of culture, which was measured using an existing scale. All other variables were measured by multiple items scales that rate the magnitude of the important attributes for each variable.

CHAPTER (5)- FIELD SURVEY: QUESTIONNAIRE DESIGN, ADMINISTRATION, AND DATA COLLECTION PROCEDURES

5.0. INTRODUCTION

The first part of the chapter covers the design of the questionnaires used to collect data needed for model development. In the second part, survey and data collection procedures are discussed.

5.1. QUESTIONNAIRE DESIGN

Two types of self administered questionnaires were used in this research (appendix A). A questionnaire that targeted management of the construction firm and a second one that consists of only parts of the first one and is targeted at the workers level in the firm. The reason that a single questionnaire was not used in this survey was because a number of questions regarding data concerning the firm could not be answered at the workers' level. For example the scales that measured the level of subcontracting, level of integration in services offered, level of planning, and level of goal-setting were omitted form the workers' level questionnaire. This is also the case concerning values that had to be extracted from firm's records by management concerning performance relating to time of execution, costs, and quality levels of projects handled in the past by the construction firm.

In designing these questionnaires to collect the necessary data for the variables of the study, as discussed in the last chapter, Likert scales were mostly used. Each scale is composed of various items that attempts to measure the underlying attributes of the particular variable. The number of items in each scale is given in Table 5.1 Each item is represented by a statement to which the rater could indicate his rating according the scale associated with the variable. Statements of items in all the scales were made as clear as possible to facilitate response by rater in indicating his attitude about the items in his respective firm. Open ended questions were strictly avoided which eliminated the need for coding of answers by respondents and raw data collected were transferred directly into a computer format. In the interest of being unambiguous and precise, items were made as short as possible so the rater could understand without any misinterpretation and respond quickly without any difficulty.

5.1.1. Questionnaire Construction

Babbie (1992) discussed the importance of the formatting and arrangements of items in self administered questionnaires and points out that the format of the questionnaire is just as important as the nature and wording of the statements used in acquiring the ratings. Based on his recommendations, the questionnaire used by this research in the data collection were constructed to be uncluttered, spread out, and of reasonable length.

Table 5.1: Types of Measurement scales and Number of Items

	variable	type of scale used	No. of items
1	level of subcontracting	Likert scale with 7 anchor points	13
2	attitude toward change	same	8
3	extent of rules and regulations	same	4
4	adherence to rules and regulations	same	3
5	level of control	same	6
6	level of integration in services offered	same	5
7	level of joint-venturing, partnering, and alliances	same	4
8	multiple project handling ability	same	5
9	strength of organizational culture	Constant-sum scale (divide 100 points among four statements per item)	6
10	workers' participation in decision making	Likert scale with 7 anchor points	7
11	level of coordination	same	5
12	level of information flow	same	6
13	level of planning	same	4
14	level of goal setting	same	6

Items in each scale were ordered to begin with the simplest and most interesting statements to motivate the respondent to give viable answers and avoid response-set among the respondents where answers are patterned after each other. This could happen especially if the set of statements began with several that indicated a particular orientation.

Scales were ordered by arranging the items relevant to each variable together. Variables were not given names in order not to bias responses. Each variable was assigned a code number. Clear basic instructions are given using phrases as to exactly how to use the scales in indicating the appropriate rating of the items under question. An example is the instruction used in scale used for measuring the level of goal setting variable where the respondents were first told exactly what is the intention of the scale i.e. to rate the importance of setting the specific goals listed, then they are informed how the scale works in assigning the appropriate rating i.e. that each described goal should be assigned a rating from highly important (7) to highly not important (1).

Since the firms considered in this study are comprised from ICI firms operating in the Saudi Arabian construction industry, the questionnaire was constructed using Arabic and English languages (appendix A shows English version). This is so because of the nature of firms operating in the Saudi theater. Although all firms surveyed are Saudi owned, it became apparent that provision of questionnaires in both languages is a must because there are some managers and workers that are non-Arabic speaking. In the survey, in some cases, both management and workers of a number of firms surveyed used the questionnaires which were written in Arabic and in other firms, only management used the questionnaires written in Arabic and workers used the version written in English. In a small number of firms surveyed, both management and workers used the questionnaire written in English.

5.1.2. Questionnaires Administration

5.1.2.1. Number and Levels of Respondents

The questionnaires are designed as self-administered. In each organization, three workers' level questionnaire and two management's level questionnaire are distributed to be filled out. As seen in Figure 5.1 the management level questionnaire is used to collect ratings from two different people. The first must be from a higher management position in home-office i.e. manager of operations, and the second is from the management ranks in the field operations i.e. field project manager. In the second type that targets the workers' level in surveyed firms, three field workers' responses are solicited. These three workers are to be chosen randomly and must be at the skilled worker level.

There are two main reasons for seeking responses from two levels in the firm. The first and most apparent is to avoid response bias in measurement of organizational attributes. This is achieved by averaging and aggregating the ratings from the two levels when calculating variables' scores. The second reason pertains to the measurement of certain variables such as strength of culture where the gap in perceptions of the two levels was used to arrive at an aggregate score of the variable for the firm. In order to measure response consistency, Denison (1990) used the inverse of the variance (gap) in questionnaire responses across work groups within firms. Gordon and DiTomaso (1992) used the deviations in perceptions of different levels of work groups within firms to measure adaptability and stability.

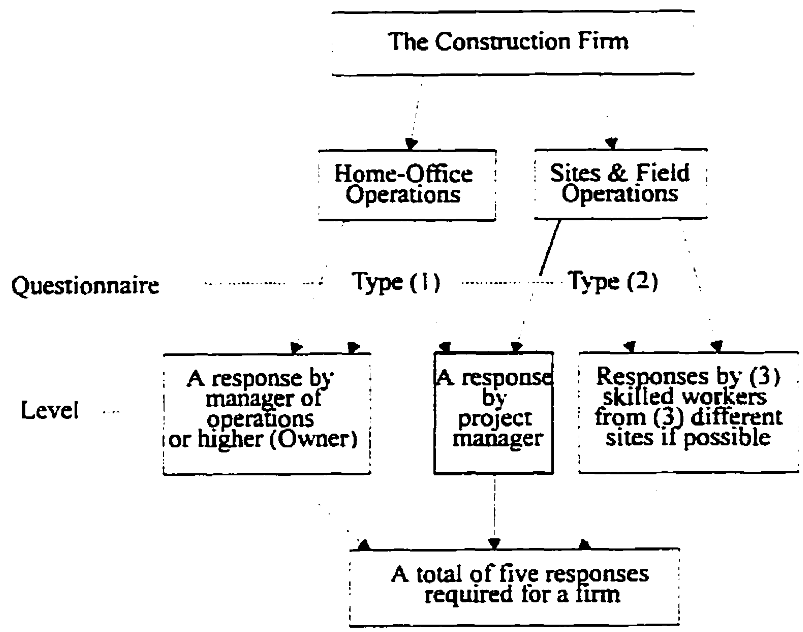

Figure 5.1: Level and Number of Questionnaires' Respondents

5.2. SURVEY

5.2.1. Design

Zikmund (1994) described five stages in selection of a sample for field studies which include defining the target population, selecting a sampling frame, determine if a probability or non probability sampling will be used, determine sample size, and select actual sampling units. As mentioned before, the target population of this study is all construction firms operating primarily in the institutional, commercial, and industrial sectors of the construction industry limited to the Saudi Arabian markets and been licensed to operate in these sectors for the last ten years. This may represent a limitation to generalize the research results to other firms that have just started operating in ICI construction and for other ICI firms operating in different regions of the world. However, regardless of the regional differences between industries between the different countries in the free world, due to its nature, construction firms operating in these industries still share many characteristics which lessen the impact of focusing the study only on one market.

As a sampling frame, the Saudi Ministry of Commerce's official commercial register[1] was used to identify construction firms that are classified as ICI firms operating in Saudi Arabia. Therefore, this study only considered those firms that are officially registered as such and have the appropriate licenses to operate in such capacities and been licensed for the last 10 years to handle contracts in ICI construction. The sampling frame contains many types of construction firms: general contractors (GC) type firms; specialty subcontractors type firms in all types of electrical, mechanical, petro-chemical, and industrial installations, and turn-key constructors.

The sampling frame contained more than 500 firms. This number represents the firms that define themselves publicly as exclusively operating in one type or a combination of the three types this research is focused on. A number of these firms have regional offices in large cities of the country and had local branches in smaller ones. The actual number of firms who are performing ICI work might be higher, however the bulk of their activities are focused on other types of construction such as residential, building, and heavy construction.

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[1] See the Saudi Exclusive Companies Directory 1994. Shrooq Publications. Jeddah. Saudi Arabia

A sample size of approximately 30 percent or 150 firms was chosen from the total number of firms in the sampling frame. It was felt that this sample is sufficient to represents the various characteristics and environments existing in the industry. More than 200 construction firms operating in the ICI sectors of the Saudi construction industry were initially contacted to seek agreement to participate in the study and to ensure sufficient number of responses. However only 120 firms or approximately sixty percent of those firms contacted agreed to participate in the survey.

The firms were selected randomly from the sampling frame. This was done by arranging a list of all names in the sampling frame in a random manner based on the first and last letter of the name of the organization. Then the names were selected based on the position of the name on the list where every third name was chosen. This last step was repeated until the desired number was chosen. Once the firms in the survey were identified, management in each firm was contacted personally in order to explain the purpose of the research and its goals. Forms of the questionnaires were given manually to the management and passed to three field workers at work sites, randomly identified by the management.

5.2.2 Procedures

The first thirty cases were administered personally by the author over a period of three months to firms selected randomly from the list of chosen ICI construction firms. During this period extensive preparation were taken, where in each case, multiple visits were necessary to allow management the opportunity to review their records and to arrange for a final meeting with all respondents in some cases to discuss the language used in the questionnaires and any misinterpretations that may be encountered. This was primarily done to eliminate problems concerning language used and misinterpretations by prospective respondents. As a result, minor adjustments were made in the format and language used.

The distribution of questionnaires to the rest of the cases chosen was performed manually where the questionnaires were delivered to management with a cover letter explaining the administration procedures. Follow-ups through Facsimile and telephone conversations ensured the collection of remainder of questionnaires distributed.

5.3 DATA COLLECTION

As stated before the first thirty records were collected manually in person by the author. Due to time constraints, all possible number of remaining records were collected within two months period through facsimile and regular mail after telephone follow-up.

Upon checking and decoding the questionnaires with the marked scales, the results were tabulated using a commercially available spreadsheet software. Firms' records with any missing data were deleted. Only complete records are considered by this study. Although, some researchers are of the view point that records with missing data, still could be used by substituting average values in place of missing values, in this study, it was decided to reject any record with missing data because of the difficulty of determining how much missing data warrants acceptance or rejection. As a result, only the complete records of seventy one percent of those agreed to participate in the survey or eighty six records were deemed satisfactory to use to develop and test the desired prediction model.

5.4. SUMMARY

Based on the operationalization of variables in the last chapter, scales for their measurement with various number of items are constructed in two types of questionnaires These two types solicit perceptions from management and workers levels in the construction firm in order to collect necessary data to perform analysis and model building, testing and validation. Requirement of five responses from each firm is necessary to avoid bias in perceptions and improve reliability of data collected.

Survey design and procedures are discussed. ICI firms surveyed by the study were firms licensed for operating in the Saudi Arabian construction market for the last ten years and maintaining operations for the last five years. A total of eighty six data records were deemed complete and satisfactory for use in data analysis and developing and validating the desired prediction model that is discussed in the next chapter.

CHAPTER (6)- MEASUREMENT AND DATA ANALYSIS

6.0. INTRODUCTION

In this chapter analysis of collected data and results are presented. In the first part reliability of scales used in measurement is discussed. In the second part, descriptive statistics and intercorrelation analysis of the fourteen independent variables and the dependent variables are presented.

6.1. MEASUREMENT

6.1.1. Reliability of Measurement Scales

Ghiselli *et al* (1981), considered reliability the fundamental issue in measurement. Devellis (1991), defined scale reliability as the proportion of variance attributable to the true score of the variable to be measured by the scale. An assessment to test the reliability of using the constructed scales in measurement of the variables was performed. This was accomplished in two steps. First, the scales were used in measurement during data collection. Second, the data collected by each scale were checked for reliability using the widely used measure of reliability called the internal consistency method (Carmines and Zeller, 1979).

6.1.1.1 The Internal Consistency Method

Internal consistency is typically equated with Cronbach's (1951) coefficient alpha (α). This method gives a value similar to Cronbach's alpha measure. Alpha measure is examined in some detail for several reasons. First , it is widely used as a measure of reliability. Second, an exploration of the logic underlying the computation of alpha provides a sound basis for showing how it measures reliability.

Variability in a set of scale's items scores can be attributed to two sources. Either as the result of actual variation that the scale measures (i.e. true variation in the variable), or the result of error in the scale. Another way to think about this is to regard total variation as having two components: "signal" (i.e., true differences) and "noise" (i.e., score differences caused by everything else) . Computing alpha measures as explained in next sections partitions the total variance among the set of items in a scale into signal and noise components. The proportion of total variance that is signal equals alpha. Thus, another way to think about alpha is that it equals 1-error variance.

To understand internal consistency more fully, it helps to examine the covariance matrix for a multi-items scale. A typical covariance matrix for three items scale that measures a variable (X) is shown in Table 6.1. A covariance matrix is a more general form of a correlation matrix. The diagonal elements of the covariance matrix are variances (i.e., covariances of items with themselves-just as the unities along the main diagonal of a correlation matrix are variables' correlations with themselves. The off-diagonal values are covariances, expressing relationships between pairs of items scores. Using the customary symbols, the covariance matrix of three items that, when added together, make up a scale that measures a variable (X) is shown in Equation. 6.1.

Table 6.1: Typical Covariance Matrix

	Item (1)	Item (2)	Item (3)
Item (1)	Var_1	Cov_{12}	Cov_{13}
Item (2)	Cov_{12}	Var_2	Cov_{23}
Item (3)	Cov_{13}	Cov_{23}	Var_3

$$X = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{13} \\ \sigma_{12} & \sigma_2^2 & \sigma_{23} \\ \sigma_{13} & \sigma_{23} & \sigma_3^2 \end{bmatrix} \qquad \textbf{(Eq.) 6.1}$$

What can this matrix tell us about the relationship of the individual items to the scale as a whole? The covariance matrix has a number of useful properties. Among these, is the fact that adding all of the elements in the matrix together (i.e., summing the variance, which are along the diagonal and the covariances off the diagonal), gives a value that is equal to the variance of the scale as a whole (assuming that the items are equally weighted). So, if the terms are all added up, the resulting sum would be the variance of scale (X) or (σ_x^2).

Alpha (α), is defined as the proportion of a scale's total variance that is attributable to a common source, presumably the true score of the variable underlying the items. Thus, to compute alpha (α), it would be useful to calculate a value for the scale's total variance and a value for the proportion that is "common variance".

All variation in items that is due to the variable, *X*, is shared or common. The term "joint" is used to describe this variation. When *X* varies, as it would, for example, across firms having different levels of the variable *X*, scores on all the items will vary with it because it is a cause of those scores. Thus, if *X* is high, all the items scores will tend to be high; if *X* is low, they will tend to be low. This means that the items will tend to vary jointly. So, the underlying variable affects all of the items and, thus, they are correlated. The error terms, in contrast, are the source of the unique variation that each item possesses. Whereas all items share variability due to *X*, no two share any variation from the same error source under measurement assumption.

Each item's score in a scale varies as a function of the shared variation with other items due to variation of the underlying variable and the unshared variation as result of error. It follows that the total variation of a scale measuring a variable (*X*) as a whole must be a combination of these two sources. According to definition of reliability (Devellis, 1991), alpha (α) equals the ratio of common-shared variation to total variation.

Now, consider a n-item scale that measures a variable (*X*) whose covariance matrix is as follows:

$$\begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{13} & \cdot & \cdot & \cdot & \sigma_{1n} \\ \sigma_{12} & \sigma_2^2 & \sigma_{23} & \cdot & \cdot & \cdot & \sigma_{2n} \\ \sigma_{13} & \sigma_{23} & \sigma_3^3 & \cdot & \cdot & \cdot & \sigma_{3n} \\ \cdot & \cdot & \cdot & & & & \cdot \\ \cdot & \cdot & \cdot & & & & \cdot \\ \cdot & \cdot & \cdot & & & & \cdot \\ \sigma_{1n} & \sigma_{2n} & \sigma_{3n} & \cdot & \cdot & \cdot & \sigma_n^2 \end{bmatrix}$$

The variance (σ_x^2) of the n-item scale equals the sum of all matrix elements. The entries along the main diagonal are the variances of the individual items represented in the matrix (the variance of the *i* th item is signified as (σ_i^2) with itself as a result from computing the sampled scores from the sample. Each represents variation that is unique to that single item. Therefore, the sum of the elements along the main diagonal, $\sum\sigma_i^2$, is the sum of variances of the individual items with themselves. The covariance elements between the variables represents joint variation. Thus we can express the ratio of unique or non-joint variation to total variation in *X* as:

$$\sum\sigma_i^2 / \sigma_x^2$$

It follows that alpha as the proportion of shared or joint variation, is the complement of the ratio above which equals as follows :

$$\alpha = 1 - (\sum\sigma_i^2 / \sigma_x^2)$$

To adjust for the number of items (n) in the scale and limit the range of possible values for alpha (α) to between 0.0 and 1.0, theoretically, the expression above is multiplied by (n/n-1) which results in Equation (6.2). It is clear that the number of items (n) in a scale, that attempt to measure the various attributes of the underlying variable, affect the reliability of the scale. This expression for alpha measures was used in this research to calculate reliability of scales used to measure all the variables, except for the strength of culture.

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_{xi}^2}\right) \qquad \text{Eq. (6.2)}$$

As an example of using the method described above to compute an alpha value for a scale used by this methodology, the covariance matrix computed from collected data is shown below of the eight items in the scale that was used to measure the attitude toward change variable.

$$X_{11} = \begin{bmatrix} 0.45 & 0.26 & 0.28 & 0.29 & 0.07 & 0.11 & 0.01 & 0.14 \\ 0.26 & 0.35 & 0.23 & 0.21 & 0.07 & 0.07 & 0 & 0.13 \\ 0.28 & 0.23 & 0.34 & 0.23 & 0.08 & 0.12 & 0.02 & 0.17 \\ 0.29 & 0.21 & 0.23 & 0.53 & 0.24 & 0.22 & 0.16 & 0.23 \\ 0.07 & 0.07 & 0.08 & 0.24 & 0.49 & 0.33 & 0.22 & 0.31 \\ 0.11 & 0.07 & 0.12 & 0.22 & 0.33 & 0.45 & 0.18 & 0.16 \\ 0.01 & 0 & 0.02 & 0.16 & 0.22 & 0.18 & 0.26 & 0.16 \\ 0.14 & 0.13 & 0.17 & 0.23 & 0.31 & 0.16 & 0.16 & 0.42 \end{bmatrix}$$

All variances values were calculated using the responses to each item that were collected from the seventy six surveyed construction firms. For each item, there was a total of 380 different scores (5 respondents per firm times 76 firms). The sum of variances along the diagonal that represents ($\sum \sigma_i^2$) is equal to 3.28 and the sum of all elements in the matrix, which represents the total variance of the scale (σ_x^2), equals 12.9. In order to calculate an alpha value (α) for the scale that was used to measure the attitude toward change variable, we substitute in Equation (6.2). The value is calculated to be 0.85 which, indicates that the scale has a very good reliability. According to Devellis (1991), scales with Cronbach's alpha values above 0.60 have a fair degree of reliability. $\sum(\sigma_i^2)$ and (σ_x^2) values, for all scales, indicate alpha (α) measures between the values of 0.62 and 0.88 (Table 6.2). These results indicate a fair degree of reliability for some measures and good reliability for others. As mentioned previously, all Cronbach's alpha values were based on 380 responses.

6.2. DATA ANALYSIS

The data were analyzed using the commercial Statistical Analysis Systems (SAS) computer software package provided by SAS Institute Inc. The SAS is an integrated system of software products that enables to perform statistical and mathematical analysis among other things. Various SAS language and procedures were used in calculating the descriptive statistics, intercorrelations analysis, and multiple regression analysis used in model fitting and checking model adequacy.

Table 6.2: Scales' Cronbach's Alpha (α) Values

Scale	Variances				
	$\sum(\sigma_i^2)$ [a]	(σ_x^2) [b]	n [c]	n/(n-1)	alpha (α)
X_1	4.62	25.10	13	1.083	0.88
X_2	3.28	12.89	8	1.143	0.85
X_3	1.32	2.86	4	1.333	0.72
X_4	1.21	1.90	3	1.67	0.62
X_5	2.63	7.20	6	1.20	0.76
X_6	1.82	4.27	5	1.25	0.71
X_7	1.77	3.64	4	1.33	0.66
X_8	1.48	3.95	5	1.25	0.78
X_9	.	.	.	.	.
X_{10}	2.45	8.55	7	1.167	0.83
X_{11}	2.12	5.10	5	1.25	0.75
X_{12}	3.24	7.83	6	1.20	0.70
X_{13}	1.55	4.16	4	1.33	0.83
X_{14}	1.66	5.17	6	1.20	0.81

[a] the sum of variances of the individual items with themselves
[b] the sum of covariances of all items and variances of the individual items with themselves
[c] number of items in the scale

SAS procedures were used and yielded an output that helps in interpreting the results of the analysis performed. Explanation of the various SAS procedures that were used, and meaning of their outputs are covered in SAS user's guides.[1]

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[1] See SAS language and Procedures and SAS User's Guides. Version (6) fourth edition. 1990. SAS institute Inc.

6.2.1. Descriptive Statistics

X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, and X_{14} represent the fourteen hypothesized variables, where:

X_1 = *Level of subcontracting*
X_2 = *Attitude toward change*
X_3 = *Extent of rules and regulations*
X_4 = *Level of Adherence to rules and regulations*
X_5 = *Level of control*
X_6 = *level of integration in services offered*
X_7 = *Level of joint venturing, partnering, and alliances*
X_8 = *Level of multiple project handling ability*
X_9 = *Strength of organizational culture*
X_{10} = *Level of workers' participation in decision making*
X_{11} = *Level of coordination*
X_{12} = *Level of information flow*
X_{13} = *Level of planning*
X_{14} = *Level of goal setting*

Based on the aggregated organizational level scores for the seventy six construction firms (appendix B), Table 6.3 shows the values calculated for the mean, standard deviation, and aggregated minimum and maximum scores for each of the fourteen variables and (Y), the referent measure of organizational effectiveness. The values are based on data from the seventy six records used in model fitting and selection. Level of subcontracting (X_1) has a mean score of 4.79, standard deviation of 0.32 with a minimum score of 3.92 and a maximum score of 5.62 on the Likert scale. The mean score indicates that, on average, the firm within the surveyed group, perform the majority of its work contracts with a slightly above average level of subcontracting in the thirteen specialty areas considered by the study.

Table 6.3: Descriptive Statistics

	Descriptive statistics				
Variable	N	Mean	Std Dev	Minimum	Maximum
X_1	76	4.79	0.32	3.92	5.62
X_2	76	4.47	0.44	3.72	5.34
X_3	76	4.96	0.19	4.5	5.25
X_4	76	4.70	0.35	3.88	5.25
X_5	76	5.93	0.27	5.00	6.33
X_6	76	4.36	0.44	3.58	5.25
X_7	76	5.14	0.42	4.25	5.93
X_8	76	3.87	0.36	3.00	4.66
X_9	76	5.00	0.59	3.81	6.54
X_{10}	76	4.81	0.34	4.00	5.50
X_{11}	76	4.49	0.22	4.06	5.18
X_{12}	76	3.05	0.39	2.00	4.00
X_{13}	76	4.79	0.23	4.25	5.25
X_{14}	76	5.05	0.15	4.50	5.30
Y	76	0.68	0.14	0.40	0.90

The variable attitude toward change (X_2) has a mean score of 4.47, a standard deviation of 0.44, and a minimum and maximum scores of 3.72 and 5.34 respectively. This points out that on average, the (ICI) construction firm from the surveyed group, accepts and views organizational change positively as a way to remain flexible and adaptable to its environment.

For the extent of rules and regulations variable (X_3), the mean score is 4.96, the standard deviation is 0.19, and the minimum and maximum scores are 4.50 and 5.25. The mean score indicates an above average use of rules and regulations by the firms surveyed, as a prime method of organizational control. The level of adherence to rules and regulations (X_4) has a mean score of 4.70, a standard deviation of 0.35, and a minimum and maximum scores of 3.88 and 5.25. These results indicate that the workers and management of the firms surveyed, have an above average level in using and adhering to the rules and regulations as means of organizational control. This is emphasized by the mean score of 5.93 for the level of control variable (X_5), which indicates that the firms surveyed have a high level of control inside their organizations. It is interesting to note that both the mean scores for the control and the attitude toward change variables among the surveyed group are above average level, which might be understood as that this group of firms value both control and flexibility in their pursuit of organizational effectiveness. This is in line with Cameron's (1986a) suggestion that firms pursue paradoxical criteria of effectiveness

The nature of markets in ICI construction tends to lead the average firm operating in such markets, especially GC type firms, to offer more services in order to be competitive. This is confirmed by the mean score of 4.36 for the level of integration in services offered variable (X_6). Results show that the surveyed firms have a slightly above average level of integration in offering the services evaluated by this study which include in-house A/E, material supply, financing, operating and maintenance, and construction management.

Regarding use of joint-venturing, partnering, and alliances (X_7) in project delivery by the surveyed firms, the results show an above average level with a mean score of 5.14, a standard deviation of 0.42, and a minimum and maximum scores of 4.25 and 5.93. This level can be attributed to the nature of ICI construction contracts especially in the industrial sector, where joint-venturing and alliances are usually requested and promoted by the owners.

Results show the multiple project handling ability variable (X_8) with a mean score of 3.87, a standard deviation of 0.36, and a minimum and maximum scores of 3.0 and 4.66. The surveyed firms have a slightly below average level. This could be explained by the nature of work contracts in ICI construction, which, because of their size, tend to limit most firms operating in such sectors to one job at a time. One could argue that this indicates a better competitive position for firms that can operate with a high level of multiple project handling ability.

The variable strength of organizational culture (X_9) has a mean score of 5.0, a standard deviation of 0.59, and a minimum and maximum scores of 3.81, and 6.54 which indicates that most firms surveyed, have an above average cultural strength. This could be explained by the fact that in order for firms operating in ICI construction to be competitive, they need to be managed in a way that foster a better internal climate, strong leadership, strong organizational glue, clearly defined success criteria, and conducive management style. This is emphasized by the mean score of 4.81 for the level of workers' participation in decision making (X_{10}), which shows an above average level for the firms surveyed.

A mean score of 4.49 for the level of coordination (X_{11}), shows that the firms surveyed have an average level of coordination in their intra- and inter-organizational activities. The level of information flow (X_{12}) has a mean score of 3.05, standard deviation of 0.39, and a minimum and maximum scores of 2.00 and 4.00. This indicates that on average, the ICI firm among the surveyed group has a below average level of quality and openness of information as defined in this study.

The mean score for the level of planning (X_{13}) is 4.79, which indicates that this groups of firms pursue an above average level of using activities' planning as an organizational strategy. For the level of goal setting (X_{14}), the mean score is 5.05, which indicates that among the group, there is an above average level of importance of setting goals such as increasing profit levels, increasing costs effectiveness, growth into other sectors, improving quality, improving clients' service, and increasing workers' participation in decision making.

Finally, the surveyed group has a mean score of 0.68 for the referent measure of organizational effectiveness (Y) with a standard deviation of 0.15 and a minimum score of 0.40 and a maximum score of 0.90. The mean score indicates that on average, a firm from the surveyed group, performed effectively in 68 percent of its past projects, within budgeted costs and/or within scheduled duration, and/or according to contractual specifications. In the group, the lowest score is for a firm that only performed in 40 percent of its past projects, within budgeted costs and/or within scheduled duration, and/or according to contractual specifications. The highest rating was achieved by a firm that performed 90 percent of its past projects within budgeted costs and/or within scheduled duration, and/or according to contractual specifications.

6.2.2. Intercorrelations

The SAS procedure "PROC CORR" was used on the aggregated organizational scores to calculate Kendall (τ) Tau intercorrelations coefficients scores for all fourteen variables (X_i's) and (Y) the referent measure of organizational effectiveness. Table 6.4 summarizes the SAS output that gives intercorrelations values and the corresponding (p) values for each correlation below it. The (p) values are considered at the 0.05 level for significance testing. Use of Kendall (τ) Tau correlation coefficient in the analysis rather than using Pearson's (ρ) rho correlation coefficient, is chosen due to the ordinal nature of scales used in scoring and measuring the variables of the study. Kendall (τ) values give a better estimate of the covariance relationship when the variables under questions are rank or ordinal in nature.

As shown, *level of subcontracting* (X_1) has very low correlation with organizational effectiveness ((τ)= 0.0256) with no statistical significance which could be interpreted as no relationship. *Level of integration in services offered* (X_6), and *level of goal setting* (X_{14}), *level of using joint venturing, partnering, and alliances* (X_7) show low correlations with (τ) values of 0.2896, 0.2643, and 0.2648. However, their level of statistical significance is moderately

Table 6.4: Kendall Tau Correlation Coefficients (τ)

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	(Y)
1	level of subcontracting	1.0000 0.0000														
2	attitude toward change	-0.068 0.4037	1.0000 0.0000													
3	extent of rules and regulations	0.0045 0.5564	0.3219 0.0001	1.0000 0.0000												
4	level of adherence to rules and regulations	-0.147 0.0861	0.3105 0.0002	0.1309 0.1324	1.0000 0.0000											
5	level of control	0.0323 0.7158	0.3570 0.0001	0.1118 0.2156	0.2555 0.0046	1.0000 0.0000										
6	level of integration in services offered	0.1870 0.0267	0.1094 0.1833	0.2524 0.0033	-0.1590 0.0637	0.0251 0.7788	1.0000 0.0000									
7	level of joint-venturing partnering, alliances	-0.0560 0.5390	0.2770 0.0018	0.0662 0.4754	0.3669 0.0347	0.3734 0.0001	0.0420 0.6510	1.0000 0.0000								
8	level of multiple project handling ability	0.0778 0.3868	0.5409 0.0001	0.3098 0.0008	0.1945 0.0347	0.3657 0.0001	0.2913 0.0014	0.2362 0.0162	1.0000 0.0000							
9	strength of culture	0.0300 0.7202	0.7057 0.0001	0.4932 0.0001	0.2678 0.0017	0.2952 0.0008	0.3025 0.0003	0.2271 0.0125	0.5579 0.0001	1.0000 0.0000						
10	participation in decision-making	0.0705 0.3909	0.5005 0.0001	0.5485 0.0001	0.1934 0.0207	0.1943 0.0251	0.4616 0.0001	0.1755 0.0490	0.4688 0.0001	0.7076 0.0001	1.0000 0.0000					
11	level of coordination	0.0130 0.8743	0.1692 0.0350	0.3774 0.0001	0.2248 0.0074	0.0894 0.3040	0.0793 0.3390	0.0402 0.6531	0.1010 0.2553	0.2285 0.0004	0.3074 0.0001	1.0000 0.0000				
12	level of information flow	-0.0090 0.9174	0.2264 0.0099	0.2553 0.0054	0.2103 0.0220	0.1209 0.0257	0.2483 0.0062	0.1489 0.1285	0.2546 0.0088	0.3053 0.0007	0.3263 0.0002	0.2104 0.0175	1.0000 0.0000			
13	level of planning	0.0273 0.7414	0.5028 0.0001	0.3202 0.0001	0.1947 0.0206	0.3250 0.0077	0.2118 0.0109	0.1308 0.1446	0.3685 0.0001	0.6186 0.0001	0.5236 0.0001	0.3559 0.0001	0.2963 0.0001	1.0000 0.0000		
14	level of goal-setting	0.1510 0.0769	0.1251 0.1323	0.1202 0.1668	0.0608 0.4845	0.2331 0.0104	0.0516 0.5483	-0.0060 0.9460	0.1126 0.2211	0.2758 0.0012	0.2392 0.0042	0.3296 0.0001	0.1934 0.0346	0.2741 0.0011	1.0000 0.0000	
(Y)	organizational effectiveness	0.0256 0.7551	0.7332 0.0001	0.5002 0.0001	0.3445 0.0001	0.3345 0.0001	0.2896 0.0005	0.2648 0.0032	0.6076 0.0001	0.8223 0.0001	0.6921 0.0001	0.3630 0.0001	0.3350 0.0002	0.5542 0.0001	0.2643 0.0032	1.0000 0.0000

P values are listed under (τ) values. All $P < 0.05$ are significant high with (p) values of 0.0005, 0.0017 and 0.0032. This indicates a very weak, significant relationship between these variables and level of performance in firms studied.

The *level of adherence to rules and regulations* (X_4), *level of coordination* (X_{11}), *information flow* (X_{12}), and *level of control* (X_5) have somewhat higher coefficients that range from 0.3345 to 0.3630. and a high level of statistical significance (all (p) values are less than 0.0002). This is an indication that these variables have a weak but significant relationship with the level of effectiveness (Y). Variables that include the *level of planning* (X_{13}) and *extent of rules and regulations* (X_3) have moderately strong and highly significant relationships with (Y) shown by (τ) values of 0.5542 and 0.5002 respectively (both (p) values <0.0001).

Values of (τ) of 0.7332, 0.6076, 0.8223, and 0.6921 and their respective (p) values (all p's < 0.0001) for the variables that include *attitude towards change* (X_2), *level of multiple project handling ability* (X_8), strength of organizational culture (X_9), and *level of workers' participation in decision making* (X_2), indicate that there are strong and highly significant relationships between these variables and the referent measure of effectiveness (Y).

Based on these findings, it is seen that in firms that were studied a high level of organizational effectiveness indicated by a high level of performance in past projects is associated with strong culture that promotes a high level of participation in decision-making processes by its workers, a high level of positive attitude toward change by management and workers, a high level of planning as a strategy to adapt to environmental risks, a high level of multiple projects handling ability, and a moderate level of using rules and regulations by the firm. These variables account for much of the variability in organizational effectiveness of the firms studied. However the other variables that have weak but significant associations also contribute to high levels of effectiveness in the firms studied.

6.3. SUMMARY

The consistency method was used to test the reliability of the constructed scales in measuring the underlying variables. The results showed that the constructed scales were valid in measurement of those variables. Intercorrelations analysis showed that the level of subcontracting that the firm uses in delivering its projects has weak correlation with effectiveness as measured in this study. However, other variables that have weak correlations with effectiveness such as the level of integration in services offered, level of using joint venturing, partnering, and alliances, the relationships proved more significant.

Variables that include the level of adherence to rules and regulations, level of coordination, level of information flow, and level of control, have significant and somewhat higher correlations with effectiveness. Level of planning and extent of rules and regulations in the construction firm proved to have a moderately strong and highly significant relationship with effectiveness.

The results also showed very strong and highly significant correlations between effectiveness and variables that include the level of multiple project handling ability by the firm, the strength of organizational culture existing inside the firm, and the level of workers' participation in decision making allowed by the management of the construction firm.

It is concluded from the results seen in this chapter that in firms that were studied, a high level of organizational effectiveness is associated with the following: a strong organizational culture that promotes a high level of participation in decision-making processes by workers in the firm; a high level of positive attitude toward change by management and workers of the firm; a high level of planning used by the firm as a strategy to adapt to environmental risks; a high level of multiple project handling ability; a moderate level of using rules and regulations by the firm; a moderate level of coordination and information flow within the structural dimensions of the firm. These variables account for much of the variability in organizational effectiveness of the firms studied, as evident from the correlation analysis. However, in order to use these variables in the prediction of organizational effectiveness, multiple linear regression modeling techniques with least square-estimation method are used to fit and select a model that incorporate the most significant variables. This is the topic covered in the next chapter.

CHAPTER (7)- MODEL FITTING AND VALIDATION

7.0 INTRODUCTION

This chapter presents the process of fitting a multivariate linear model on the data collected, using statistical multiple regression methods available on the SAS computer package. In the first part, preliminary steps are presented regarding model fitting using dummy regression techniques. The second part deals with model fitting and selection using the various regression procedures. The third part deals with checking the adequacy and validation of the fitted model.

7.1. MODELING

Multiple regression procedures using least squares estimation of model's parameters are used to test the relationships between the fourteen hypothesized predictors and the constructed referent measure of organizational effectiveness of the construction firm (Y). An expose of the basics of model fitting and testing using multiple regression and least square estimation is given in appendix (C).

The general additive multiple regression model, which relates a dependent variable (Y) to k predictors variables $X_1, X_2, \ldots\ldots\ldots X_k$, is given by

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots + \beta_k X_k + e \qquad \text{Eq. (7.1)}$$

where

α= vertical intercept
$\beta_1, \beta_2, \ldots, \beta_k$ = partial slopes of regression line (regression coefficients)
e= random error

The principle of least squares is used in simple linear regression to estimate the coefficients. According to the principles of least squares, the fit of a particular estimated regression function ($a + b_1x_1 + \ldots\ldots + b_kx_k$) to the observed data is measured by the sum of squared deviations between the observed y values and the y values predicted by the estimated function or model:

$$\sum\left[y - (a + b_1x_1 + \cdots\cdots + b_kx_k)\right]^2$$

The least squares estimates of $\alpha, \beta_1, \beta_2, \cdots\cdots, \beta_k$ are those of $a, b_1, b_2, \ldots\ldots, b_k$ that make this sum of squared deviations as small as possible. The utility of an estimated model can be assessed by examining the extent to which predicted y values based on the estimated regression function (model) are close to the y values actually observed. The first predicted value of (y) or ($\hat{y}_1$) is obtained by taking the values of the predictor variables $x_1, x_2, \ldots, x_k$ for the first observation or data record and substituting these values into the estimated regression model. Doing this successively for the remaining observations yields the predicted values $\hat{y}_2$ $\hat{y}_3, \ldots, \hat{y}_k$.

In developing the desired model, the eighty six data records were split randomly into two sets. The first set contained only seventy six records and was used in model development. The second set which contains the remaining ten records was reserved for model validation purposes.

7.1.1. Preliminary Steps

Typically, there are two goals of mathematical modeling. One is to obtain a valid estimate of a causal relationship and the other is to obtain a good predictive model. According to Retherford and Choe (1993) when the goal is "prediction" it is appropriate to develop linear models because of their simplicity of use. As the goal of this study was to obtain a prediction model based on the linear combination of the hypothesized variables, procedures of a statistical computer program (SAS) was used in developing, fitting, diagnosing, and checking the adequacy of the multivariate linear model. Various multiple regression procedures based on least square estimation of regression parameters are used to estimate model parameters. For further details on issues relating to the fundamentals of fitting the model using multiple regression and checking its adequacy, refer to appendix (C). It gives an exposé of fitting a multiple regression model using least squares estimation method, model selection criteria, and the various selection procedures used by this research in fitting the desired model.

Suppose that a response variable Y can be predicted by a linear combination of a number of regressor variables X_1, X_2,........, X_k, you can fit the regression parameters as shown in Equation (7.1). A number of regression methods are used to select the best model with the highest R-square value based on analysis of variance and parameter estimates. These include all possible regression procedure, the maximum R^2 method, and the three sequential selection methods of forward, stepwise, and backward elimination. The criteria for inclusion of predictor variables in a model and selecting an appropriate model based on the output of the various multiple regression procedures used in the analysis are discussed in more details in appendix (C)

7.1.2 Dummy Regression

In developing the desired model, dummy variables were used to code the variables because of the ordinal nature of scales used in scoring the firms in the sample. Dummy variables or contrast variables' use is proposed as outlined by Retherford and Choe (1993). The prime function of dummy variables is to represent categorical and ordinal variables to gain a better realistic model than by modeling the ordinal variables as ratio or interval variables. According to Judd and McClelland (1989) m-1 contrast codes must be employed to code a categorical or ordinal variable with m levels.

Therefore, in coding the seven levels (7= very high to 1= very low) scales used in measurement, six dummy variables must be employed to represent each of the original variables. This would have resulted in dealing with a large number of variables in the model which would render it impractical. A solution was to crash down the 7 anchor-points ordinal scale to a three levels scale of high, moderate, and low for each of the variables. Two contrast codes were employed for each variable which made the possible total number of variables in the model more manageable. The three levels in the crashed scales were assumed between the values that mark the 33rd and 67th percentiles of the cumulative distribution for each variable obtained from scores on the 7 anchor-points Likert scales. Table 7.1 shows the 33rd and the 67th percentiles values for the fourteen variables. Scores below the value that marks the 33rd percentile on the cumulative distribution were classified as low scores, all scores that fall between the 33rd and 67th percentiles' values were classified as moderate and all scores above the 67th percentile were classified as high.

To illustrate the use of Table 7.1, an example is discussed. A firm was scored by its management and workers and an average aggregated score was calculated to equal 4.5 relating to the attitude toward change variable (X_2). To convert this score to a high, moderate, or low level rating, the table is used. A moderate level rating is indicated because the score falls between the 33rd percentile value of 4.3 and the 67th percentile value of 4.7. If the score is above 4.7, a high level rating is indicated, and if it is below 4.3 a low level rating is indicated.

Each X_i of the fourteen hypothesized variables is coded by two dummy variables (D_{i1}) and (D_{i2}.). As shown in Table 7.2, the two dummy variables can represent the three levels for each variable. When the level of X_i is determined to be high, the variable is represented by the situation D_{i1} = (0) and D_{i2} = (1). When the level of X_i is judged to be medium, X_i is represented by D_{i1} = (1) and D_{i2} = (0). Where the level is low, the variable is represented by D_{i1} = (0) and D_{i2} = (0).

Table 7.1: Percentiles of Variables' Scores

No.	variable	Value at the 33rd percentile	Value at the 67th percentile
1	level of subcontracting	4.7	4.9
2	attitude toward change	4.3	4.7
3	extent of rules and regulations	4.9	5.0
4	level of adherence to rules and regulations	4.5	4.9
5	level of control	5.8	6.0
6	level of integration in services offered	4.6	5.0
7	level of joint-venturing, partnering, and alliances	4.5	4.8
8	level of multiple projects handling ability	3.7	4.0
9	strength of culture	4.4	5.0
10	level of workers'participation in decision making	4.7	5.0
11	level of coordination	4.4	4.5
12	level of information flow	2.7	3.0
13	level of planning	4.5	4.8
14	level of goal setting	5.0	5.1

It should be noted that substitution for dummy variables should always be considered in pairs to indicate the proper level of the variable. For a low level rating, both dummy variables that represent that variable should be given the value of zero. For a moderate or high level rating, the value of one is assigned to the dummy variable that represents that proper level and the value of zero is given to the other dummy variable.

Table 7.2: Coding of Dummy Variables

Case	Variable's Level	Dummy variables Values
1	High	[$D_{i1} = 0$, $D_{i2} = 1$]
2	Moderate	[$D_{i1} = 1$, $D_{i2} = 0$]
3	Low	[$D_{i1} = 0$, $D_{i2} = 0$]

As shown in Equation (7.2), the regression model considers twenty eight dummy variables to represent the original fourteen variables. The intercept a is the low level or the reference level for construction organizations studied ($D_{i1} = 0$, $D_{i2} = 0$). The b coefficient is the effect of each variable on the level of organizational effectiveness.

$$Y = a + b_{11}D_{11} + b_{12}D_{12} + b_{21}D_{21} + b_{22}D_{22} + b_{31}D_{31} + b_{32}D_{32} + \ldots + b_{14,1}D_{14,1} + b_{14,2}D_{14,2} \qquad \text{Eq. (7.2)}$$

7.1.3. Model Fitting and Selection Methods

The methodology followed in fitting and checking the adequacy of a multiple regression model using the collected data records is shown in Figure 7.1. SAS was to fit various regression models based on the seventy six data records shown in appendix (B). Five multiple regression selection procedures or methods were used in model fitting. All possible regression models procedure or RSQUARE, the MAXR forward regression method, and the three sequential selection procedures of FORWARD, BACKWARD, and STEPWISE.

All possible regression procedure or RSQUARE finds a specified number of models with the highest adjusted R^2 and the lowest Mallows' (C_P)[1] statistic in a range of model sizes (see part (I) of appendix (D) for the results of the regression procedure RSQUARE as the selection method). The RSQUARE method is a useful tool for exploratory model building.

The MAXR procedure uses forward selection to fit the best one-variable model, the best two-variable model, the best three-variable model, and so on until it exhausts all possibilities. (see part (II) of appendix (D) which shows the results of SAS's MAXR regression procedure.

The sequential method of FORWARD selection starts with no variables in the model and adds variables until no significant improvement, in regard to a model Statistic, can be detected based on the assigned level of significance for inclusion of variables.

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[1] Mallows, C.L. (1973) Some comments on Cp. Technometrics. 15, pp. 661-675. Also see appendix (C) for explanation

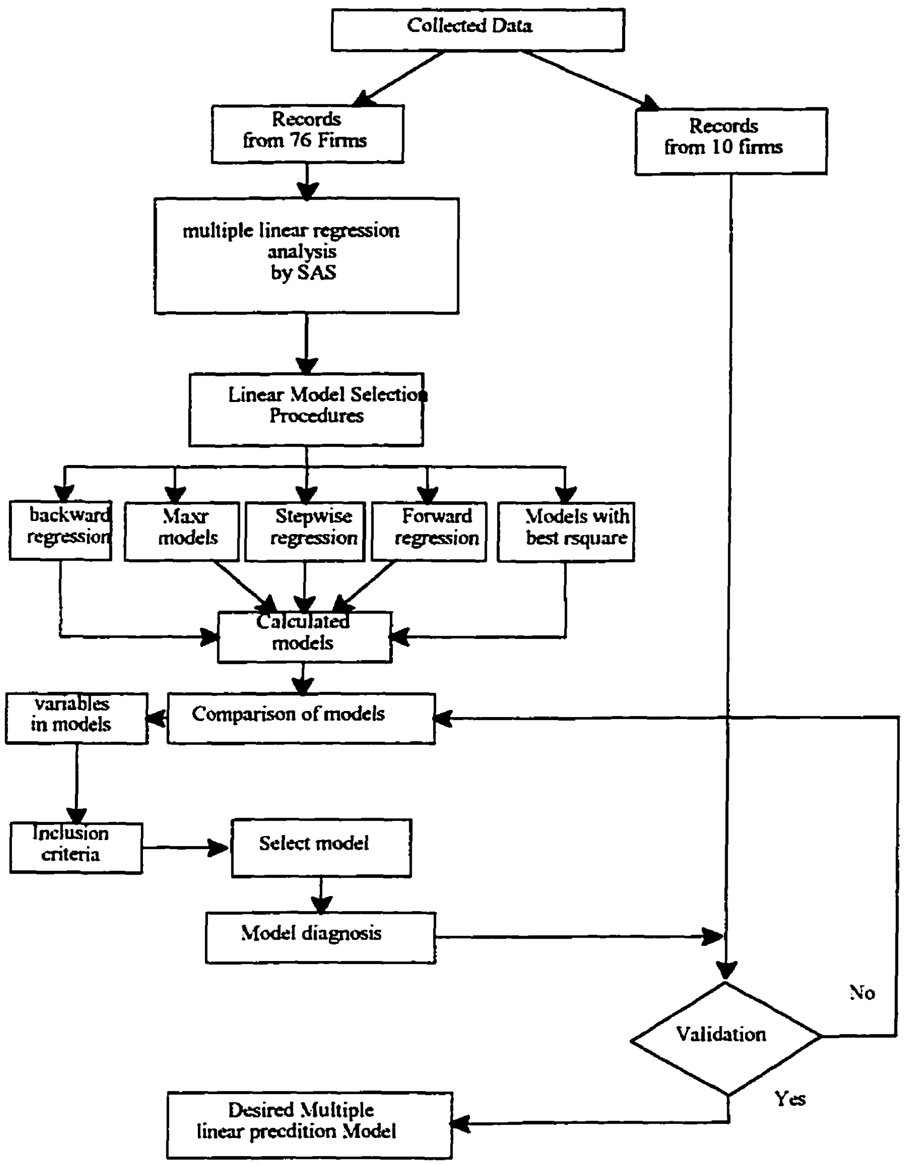

Figure 7.1: Model Fitting and Selection Methodology

Sequential STEPWISE regression method is a modification of the FORWARD procedure and differs in that variables already in the model do not necessarily stay there. BACKWARD sequential procedure starts with all the variables in the model and then go through a backward elimination process of variables in order to improve a model's statistic. Sequential procedures are discussed in more detail later in this chapter and in appendix (C). Parts (III), (IV), and (V) of appendix (D) give the results of SAS's regression procedure PROC REG with model selection FORWARD, STEPWISE, and BACKWARD respectively.

While, all these model selection methods are useful tools for model building, no statistical method can be relied on to identify the "true" model. Effective model building requires substantive theory to suggest relevant predictors and plausible functional forms for the model. However, the various selection procedures, still can be used as useful approaches to selecting a model with a subset of predictor variables. Stevens (1992) state the following two rules of thumb for the selection of predictor variables in models.

1. Choose variables that correlate highly with the criterion but that have low intercorrelations.
2. To these variables add other variables that have low correlations with the criterion but that have high correlations with the other predictors.

In addition, Cody and Smith (1991) recommended that it is best to be guided by the following two principles when choosing which predictors to include in a regression model:

1. Parismony-less is more in terms of regressors. Adding another regressor to the model will always explain a little bit more, but it often confuses our understanding of the issue and complicates measurement and use of the model.
2. Common Sense- the regressors must bear a logical relationship to the dependent variable in addition to a statistical one.

The different models resulting from the various model selection procedures will be compared, analyzed, and a model with an appropriate number of predictors, considering these criteria, will be selected as the model to be considered for diagnosis and validation.

7.1.3.1. Fitted Model Using SAS's RSQUARE Procedure

The procedure of all possible regression, as its name suggests, fits all possible regression of a given size. With m explanatory variables there are 2^m possible regression models, ranging from the simplest form, where only one of the predictors is included, to the most complex, in which all predictors are included. This approach generally relies on R^2 as the assessment criterion, and the process starts by computing the R^2 values for all the combinations of predictors of a give size, that is, ranging from 1 to m. For each subset of a given size the combination of predictors that yields the largest R^2 value is selected out and then compared, again in terms of R^2 , with the others "winners" from the other subsets of different size. The more recent algorithms such as the one used by SAS, employ the model's adjusted R^2 and Mallows' C_p statistic values as the selection criteria.

A good model, according to this, is the one that has a high adjusted R^2 value and a small C_p value (for accurate prediction) that converges with a value that approximates the value of $(k+1)$ where k is the number of predictors in the model ($C_p \cong k+1$, for unbiasedness in estimating model coefficients). Applying this criteria to the set of multiple regression models that resulted from using the all possible regression procedure, it is seen that the C_p values and the expression $(k+1)$ converge three times. The first occurs when there are nine dummy predictor variables in the model (which represent five of the original variables), and the second convergence occurs when the model includes as predictors, twenty six dummy variables (which represent thirteen of the original variables). In the third occurrence, the C_p value is exactly equal to $(k+1)$. This takes place when there are twenty seven dummy variables in the model (which represent all the original fourteen variables).

Regarding the first occurrence, there are six models that fulfill the $C_p \cong (k+1)$ condition, each with 9 dummy variables. However, each containing a different set of variables. These are as follow:

(1) A model with C_p =10.11, adjusted R^2 of 0.92, and includes the following dummy variables as predictors: D_{12}, D_{21}, D_{22}, D_{81}, D_{82}, D_{101}, D_{102}, D_{112}, D_{131}.

(2) A model with C_p = 10.20, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{21}, D_{22}, D_{81}, D_{82}, D_{101}, D_{102}, D_{112}, D_{131}, D_{142}.

(3) A model with C_p = 10.28, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{21}, D_{22}, D_{81}, D_{82}, D_{92}, D_{101}, D_{102}, D_{131}, D_{142}.

(4) A model with C_p = 10.28, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}

(5) A model with C_p = 10.29, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{21}, D_{22}, D_{71}, D_{72}, D_{81}, D_{82}, D_{92}, D_{101}, D_{102}.

(6) A 9-variable model with C_p = 10.47, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{21}, D_{22}, D_{81}, D_{82}, D_{101}, D_{102}, D_{121}, D_{131}, D_{132}.

In the second convergence, there are three models that fulfill the $C_p \cong (k+1)$ condition, each with 26 dummy variables. However, each containing a different set of variables. These are as follow:

(1) A model with C_p = 26.9, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{11}, D_{12}, D_{21}, D_{22}, D_{31}, D_{32}, D_{41}, D_{42}, D_{51}, D_{61}, D_{62}, D_{71}, D_{72}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{111}, D_{112}, D_{121}, D_{131}, D_{132}, D_{141}, D_{142}.

(2) A model with C_p = 27.22, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{11}, D_{12}, D_{21}, D_{22}, D_{31}, D_{32}, D_{41}, D_{42}, D_{51}, D_{52}, D_{61}, D_{62}, D_{72}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{111}, D_{112}, D_{121}, D_{131}, D_{132}, D_{141}, D_{142}.

(3) A model with C_p = 27.40, adjusted R^2 of 0.92 and includes the following dummy variables as predictors: D_{11}, D_{12}, D_{21}, D_{22}, D_{31}, D_{32}, D_{41}, D_{42}, D_{51}, D_{52}, D_{61}, D_{62}, D_{71}, D_{72}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{111}, D_{112}, D_{121}, D_{131}, D_{132}, D_{141}.

The last convergence occurs when $C_p \cong (k+1)= 28$. Only one model fulfills the condition with twenty seven dummy variables. (1) A model with $C_p = 28$, adj. R^2 of 0.92 and includes the following 27 variables as predictors: D_{11}, D_{12}, D_{21}, D_{22}, D_{31}, D_{32}, D_{42}, D_{42}, D_{51}, D_{52}, D_{61}, D_{62}, D_{71}, D_{72}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{111}, D_{112}, D_{121}, D_{131}, D_{132}, D_{141}, D_{142}.

SAS's RSQUARE method selected one of the 26 variable models as the model of choice (see Table 7.3 for ANOVA and parameter estimates). The overall model has a root mean square error (RMSE) of 3.9%, F value of 35.538 and Prob> F = 0.0001 which indicates that the overall model is statistically significant.

By checking the null hypothesis T= H0: Parameter= 0, (the t test that the parameter is zero, this is computed as the Parameter Estimate divided by the Standard Error for each variable) concerning the parameter estimates, (Prob>$|T|$) of each variable included in the model and whether it true or not, many included predictors could be eliminated from the model. The (Prob>$|T|$) is the two-tailed significance probability that a t statistic would obtain a greater absolute value than that observed, given that the true parameter is zero. Thus, in the case the null hypothesis is true, based on the assigned level of significance of 95 % (this occur when Prob>$|T|$ = 0.05), the Parameter estimate (partial coefficient) for the variable equals to zero. This is the case for sixteen dummy variables included in the original model: D_{11}, D_{12}, D_{31}, D_{32}, D_{41}, D_{42}, D_{51}, D_{52}, D_{61}, D_{62}, D_{71}, D_{72}, D_{111}, D_{112}, D_{121}, and D_{141}. This leaves ten dummy variables in the model that include D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}, D_{132}.

Table 7.3: ANOVA and Parameter Estimates For RSQUARE's Model

All Possible Regression Procedure's 26 variable model:
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	1.41632	0.05447	33.538	0.0001
Error	49	0.07511	0.00153		
C Total	75	1.49142			

Root MSE	0.03915	R-square	0.9496
Dep Mean	0.67899	Adj R-sq	0.9229
C.V.	5.76618		

Parameter Estimates

Var	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INT	1	0.397729	0.02389	16.944	0.0001
D_{11}	1	0.000093	0.01431	0.007	0.9948
D_{12}	1	0.011893	0.01361	0.874	0.3866
D_{21}	1	0.079782	0.02236	3.569	0.0008
D_{22}	1	0.080523	0.02685	2.999	0.0042
D_{31}	1	0.003185	0.01759	0.181	0.8571
D_{32}	1	-0.001317	0.01795	-0.073	0.9418
D_{41}	1	0.021504	0.01794	1.199	0.2365
D_{42}	1	0.019342	0.02169	0.892	0.3768
D_{51}	1	0.002989	0.01571	0.190	0.8499
D_{52}	1	0.015533	0.01588	0.978	0.3328
D_{61}	1	0.005938	0.02327	0.255	0.7996
D_{62}	1	-0.006416	0.02320	-0.277	0.7833
D_{71}	1	0.028977	0.02574	1.126	0.2657
D_{72}	1	0.021664	0.02522	0.859	0.3945
D_{81}	1	0.038300	0.01666	2.300	0.0258
D_{82}	1	0.075767	0.01985	3.816	0.0004
D_{91}	1	0.053599	0.02986	1.795	0.0488
D_{92}	1	0.108707	0.04302	2.527	0.0148
D_{101}	1	0.054594	0.02594	2.065	0.0405
D_{102}	1	0.080440	0.03284	2.450	0.0179
D_{111}	1	-0.001673	0.01248	-0.134	0.8939
D_{112}	1	0.011062	0.01332	0.831	0.4101
D_{121}	1	-0.005618	0.01326	-0.424	0.6736
D_{131}	1	0.045057	0.01667	2.703	0.0094
D_{132}	1	0.030383	0.01764	1.723	0.0091
D_{141}	1	-0.003112	0.01188	- 0.262	0.7945

These ten dummy variables represent five of the original variables which include the attitude toward change (X_2) represented by D_{21} and D_{22}; level of multiple projects handling ability (X_8) represented by D_{81}, and D_{82},; strength of organizational culture (X_9) represented by D_{91} and D_{92}; level of workers' participation in decision making (X_{10}) represented by D_{101} and D_{102}; and level of planning (X_{13}) represented by D_{131} and D_{132}. The choice of including or excluding a predictor, based on the (Prob> | T |) criterion, is viable, however the original model with twenty six dummy predictors still can be used.

This finding suggests the suitability of inclusion of the 10 remaining variables in the desired prediction model. However, in order to make a final judgment, as to whether to retain these variables or not, it is determined that a sound decision can be made only after inspecting all the different variables which are retained in models fitted using the other selection procedures.

7.2.3.2 Fitted Model Using SAS's MAXR Method

The maximum R^2 improvement technique does not settle on a single model. Instead, it tries to find the "best one variable model, the "best" two variable model, and so forth. The MAXR method begins by finding the one-variable model producing the highest R^2. Then another variable, the one that yields the greatest increase in R^2, is added. Once the two-variable model is obtained, each of the variables in the model is compared to each variable not in the model. For each comparison, MAXR determines if removing one variable and replacing it with the other variable increases R^2. After comparing all possible switches, MAXR makes the switch that produces the largest increase in R^2. Thus, the two-variable model achieved is considered the "best" two-variable model the technique can find. The process is repeated with adding a third variable to find the "best" three-variable model, and so forth[2].

Referring to part (II) appendix (D), the MAXR method yielded twenty eight models. The best-one variable model, the best-two variable model, the best-three variable model and so on. The maximum R^2 criteria is used by the procedure in selecting the best models. In similar fashion to the all possible procedure, the MAXR procedure selected the same model with twenty seven variables as the model of choice. This makes sense, since inclusion of a large number of predictors in the model gives a better prediction. However, the inclusion of a large number of variables in a model influence the ease and simplicity of using such a model. Again, checking the null hypothesis of the partial coefficients of the variables in the selected model leads to the same results of leaving only ten dummy variables in the model with Prob < 0.05. The variables left in the model are: D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}, D_{132}. It is interesting to note that these ten variables, left in the model, are the same variables selected for inclusion by the MAXR procedure in the best ten-variable model and they are also the same set of ten variables which resulted from the RSQUARE procedure.

Analysis of variance (ANOVA) for the best 10-variable model (Table 7.4), gives a large F value of 100.97 with Prob>F equals to 0.001 which indicates that the model is highly significant. Notice that the (Prob > | T |) values for the ten variables in the model are much

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[2] See SAS/STAT User's Guide, Volume 2, GLM-VARCOMP, SAS, Inc., Version 6, Fourth Edition, pp. 1398

lower (more significant) than the values when the variables were included in models with a larger number of variables. This indicates that the ten variables together give a more statistically significant prediction and explain variation in the dependent variable more reliably.

Table 7.4: ANOVA and Parameter Estimates of MAXR's Best-10 Variable Model

MAXR Procedure's Best 10-variable Model

(R-square = 0.939)
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F	Prob>F
Model	10	1.40122183	0.14012218	100.97	0.0001
Error	65	0.09020316	0.00138774		
Total	75	1.49142499			

Parameter Estimates

Var	DF	Parameter Estimate	Standard Error	T for H0: parameter=0	Prob> |T|
INT	1	0.430833	0.01241292	34.708	0.0001
D_{21}	1	0.082006	0.01558782	5.261	0.0001
D_{22}	1	0.087827	0.01742064	5.042	0.0001
D_{81}	1	0.046882	0.01292925	3.626	0.0006
D_{82}	1	0.086633	0.01718308	5.042	0.0001
D_{91}	1	0.050298	0.01896751	2.652	0.0100
D_{92}	1	0.092391	0.02651142	3.485	0.0009
D_{101}	1	0.064817	0.02014799	3.217	0.0020
D_{102}	1	0.099860	0.02413474	4.138	0.0001
D_{131}	1	0.050969	0.01245903	4.091	0.0001
D_{132}	1	0.043357	0.01390434	3.118	0.0027

7.1.3.3 Fitted Models Using SAS's Sequential Procedures

The sequential procedures can be viewed as a compromise with all possible regression approach. Three types of sequential methods are mainly utilized, namely, *forward selection*, *stepwise selection, and backward elimination*. Essentially, these approaches differ with respect to the direction taken in model selection and the reversibility of a decision as to the worthiness of a candidate predictor.

Forward selection process begins with no variables having been included in the regression equation. The correlations of all the predictor variables with the dependent variable are calculated, and that predictor with the largest correlation is selected if its corresponding partial F-value is statistically significant at some predetermined level. The independent variable with the largest correlation is entered, and the regression equation is calculated. At each successive stage the independent variable with the largest *partial* correlation coefficient is selected. Based on the comparison of the corresponding partial F test value for the variable with a predetermined critical tabulated F-value, the process either, includes the variable which gave the highest partial corresponding coefficient, recalculate the regression equation, and return to select another variable, or the process adopts the regression equation as calculated.

The results of using the FORWARD procedure in fitting a model by SAS, is shown in part (III) of appendix (D). A summary is given in Table (7.5). The procedure went through a number of iterations to arrive at a model with seventeen dummy variables. The analysis of variance indicates a highly significant model with F value of 63.3 with Prob>F of 0.0001 Upon examining the (Prob > | T |) values for the partial coefficients of the seventeen dummy variables in the model, it is noticed that the values for partial coefficients of seven dummy variables exceeds the (α) level of 0.05. Therefore, the null hypothesis that the partial coefficient equals zero can be accepted and these variables can be excluded from the model.

This leaves D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}, and D_{132}, which are the same ones included in the MAXR's best-10 variable model. They are also the same variables that were retained in the RSQUARE 26-variable model, after the exclusion of insignificant variables.

Table 7.5: ANOVA and Parameter Estimates of Model By FORWARD Selection

Forward Selection Procedure Model
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F value	Prob>F
Model	17	1.41517	0.08325	63.314	0.0001
Error	58	0.07626	0.00131		
C Total	75	1.49142			

Root MSE	0.03626	R-square	0.9489
Dep Mean	0.67899	Adj R-sq	0.9339
C.V	5.34033		

Parameter Estimates

Var	DF	Prameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INT	1	0.393893	0.018418	21.386	0.0001
D_{12}	1	0.011602	0.009956	1.165	0.2487
D_{21}	1	0.077908	0.019098	4.079	0.0001
D_{22}	1	0.080794	0.022739	3.553	0.0008
D_{41}	1	0.023836	0.014106	1.690	0.0964
D_{42}	1	0.022038	0.015765	1.398	0.1675
D_{52}	1	0.013368	0.011079	1.207	0.2325
D_{71}	1	0.032116	0.022569	1.423	0.1601
D_{72}	1	0.021540	0.022087	0.975	0.3335
D_{81}	1	0.041766	0.013524	3.088	0.0031
D_{82}	1	0.079304	0.017127	4.630	0.0001
D_{91}	1	0.057326	0.024733	2.318	0.0240
D_{92}	1	0.107718	0.033752	3.191	0.0023
D_{101}	1	0.053830	0.021512	2.502	0.0152
D_{102}	1	0.079160	0.026067	3.037	0.0036
D_{112}	1	0.011115	0.009681	1.148	0.2557
D_{131}	1	0.043529	0.013195	3.299	0.0017
D_{132}	1	0.031780	0.014573	2.181	0.0333

Stepwise selection procedure works by calculating the correlations of all the predictor variables with the dependent variable. The method selects the first variable that is most highly correlated and enters it into the regression model. This variable is retained in the fitted model if the overall F-test shows that the regression equation is statistically significant. The partial correlation coefficients is calculated for all the variables not in the regression equation. The method selects the next variable with the highest partial correlation coefficient and enters it into the model. With both variables in the model, the method computes the regression equation and retains the new variable if its partial F-value is statistically significant as compared to critical tabulated $(1-\alpha)$-values under the F-distribution with 1 and n-2-1 degrees of freedom. The process then, selects the next variable with the highest correlation with the dependent variable and enters into the regression, given that the first two variables are already in the regression equation. The decision as to whether any of the three variables should be included in the regression given that the first two are already in is made on the basis of the partial F-values of the three variables. The stepwise procedure continues in similar fashion. Termination of the process occurs when no variable can be either entered or removed from the regression equation.

The results of using SAS's STEPWISE selection procedures in fitting a model is shown in part (IV) of appendix (D), a summary is given in Table 7.6. The procedure went through many iterations to arrive at a model with eleven dummy variables. The analysis of variance gives an F value of 93.7 with Prob>F of 0.0001 and root MSE of 3.7% and an adjusted R-square of 0.93. The model is highly significant and has a very good r-square value.

Looking at the (p) values for the partial coefficients, we notice, that D_{52} has a (p) value that exceeds the (α) of 0.05. Therefore, the dummy variable D_{52} can be excluded from the model, which leaves the same ten dummy variables that was retained in MAXR's best-10 variable model, the same ten variables that were retained after the exclusion of insignificant variables in RSQUARE and FORWARD selection models.

Table 7.6: ANOVA and Parameter Estimates of Model By STEPWISE Selection

STEPWISE Procedure Model
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	1.40423	0.12766	93.700	0.0001
Error	64	0.08719	0.00136		
C Total	75	1.49142			

Root MSE	0.03691	R-square	0.9415
Dep Mean	0.67899	Adj R-sq	0.9315
C.V.	5.43617		

Parameter Estimates

Var	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INT	1	0.427441	0.01250907	34.170	0.0001
D_{21}	1	0.080744	0.01546821	5.220	0.0001
D_{22}	1	0.084998	0.01736555	4.895	0.0001
D_{52}	1	0.015628	0.01051630	1.486	0.1422
D_{81}	1	0.048599	0.01286275	3.778	0.0003
D_{82}	1	0.081482	0.01737478	4.690	0.0001
D_{91}	1	0.050460	0.01879393	2.685	0.0092
D_{92}	1	0.097762	0.02651581	3.687	0.0005
D_{101}	1	0.059906	0.02023499	2.960	0.0043
D_{102}	1	0.092327	0.02444487	3.777	0.0004
D_{131}	1	0.052891	0.01241237	4.261	0.0001
D_{132}	1	0.043364	0.01377686	3.148	0.0025

BACKWARD elimination procedure works by starting with a regression model that includes all of the variables. The R^2 induced from deleting each variable, or equivalently the partial F test value for each predictor variable treated as though it were the last variable to enter the regression equation, is calculated. Based on the comparison of the lowest partial F test value with a predetermined critical tabulated F-value, the procedure either, removes that variable associated with the calculated R^2, recompute the regression with the remaining predictor variables and recompute a new R^2, and go through the cycle again by removing another variable, or adopt the regression equation as calculated.

Table 7.7: ANOVA and Parameter Estimates of Model By BACKWARD Selection

Backward Elimination Model
Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	1.40122	0.14012	100.971	0.0001
Error	65	0.09020	0.00139		
C Total	75	1.49142			

Root MSE	0.03725	R-square	0.9395
Dep Mean	0.67899	Adj R-sq	0.9302
C.V.	5.48647		

Parameter Estimates

Var	DF	Parameter Estimate	Standard Error	T for H0 Parameter=0	Prob > |T|
INT	1	0.430833	0.01241292	34.708	0.0001
D_{21}	1	0.075606	0.01558782	5.261	0.0001
D_{22}	1	0.080827	0.01742064	5.042	0.0001
D_{81}	1	0.047882	0.01292925	3.626	0.0006
D_{82}	1	0.096633	0.01718308	5.042	0.0001
D_{91}	1	0.057698	0.01896751	2.652	0.0100
D_{92}	1	0.105391	0.02651142	3.485	0.0009
D_{101}	1	0.061817	0.02014799	3.217	0.0020
D_{102}	1	0.102060	0.02413474	4.138	0.0001
D_{131}	1	0.047969	0.01245903	4.091	0.0001
D_{132}	1	0.048357	0.01390434	3.118	0.0027

The results of using SAS's BACKWARD procedure in fitting a model is shown in part (V) of appendix (D), a summary is given in Table 7.7. The procedure retained ten dummy variables in its model of choice, D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}, and D_{132}. These are the same ten variables that were identified earlier. ANOVA gives an F value of 100.971 with Prob>F of 0.0001 and RMSE of 3.7% and an adjusted R-square of 0.93. The model is highly significant and has a very good r-square value.

7.2. FITTED MODEL

It is seen that one model stands out clearly as the best model based on multiple criteria of selection and all factors considered and discussed previously. A model with 10 dummy variables (D_{21}, D_{22}, D_{81}, D_{82}, D_{91}, D_{92}, D_{101}, D_{102}, D_{131}, D_{132}) that represent the medium and high levels of five original variables that include the *attitude toward change* (X_2), *level of multiple projects handling ability* (X_8), *strength of organizational culture* (X_9), *level of workers' participation in decision making* (X_{10}), and *level of planning* (X_{13}).

7.2.1. Model Diagnostic

Part (VI) of appendix (D) shows the fitted model with the ten dummy variables. The model is the same shown by Table 7.4 for MAXR's "best" 10-variable model, and Table 7.7 for model selected by the BACKWARD method. Model adequacy is checked by residual analysis, detecting influential outliers observation, and checking for multicollinearity.

7.2.1.1 Residual Analysis

Part (VI) of appendix (D) shows the plot of residuals versus the predicted value of $(\hat{Y})$ which helps in diagnosing the level of variance for the residuals. It shows that the residual variances fall within a horizontal band around the mean line of 0.0. The points exhibit no particular pattern around the 0.0-line such as curvature or much greater spread in one part of the plot than in another, vertically or horizontally. This shows that the residuals have equal variance. Furthermore, the normal probability plot of the residuals shown in appendix (D), exhibits a linear pattern with minimal snaking at the ends. Both these findings indicate that the residuals have equal variance and are normally distributed which leads to the conclusion that linearity assumptions are upheld by the model.

7.2.1.2 Outliers

In order to detect any outliers, SAS provides a diagnostic statistic called Cook's distance which is a measure of the influence of deleting the specific observation on the estimated parameters. The plot of Cook's distance statistics against the observation number shows no influential outliers in the data observation (part (VI) appendix (D). This is evident by the range of values on the plot (< 0.3) which is well below the value of one that would require the investigation as recommended in appendix (C).

7.2.1.3 Multicollinearity

According to Schroeder *et al* (1986), multicollinearity is probably present in all regression models, since the predictor variables are unlikely to be totally uncorrelated. Thus whether or not multicollinearity is a problem depends on the degree of collinearity. They added that although there are many indicators of multicollinearity, the difficulty is that there is no statistical test that can determine whether or not it is a problem. They recommended to search for "high" correlation coefficients between variables included in the fitted model.

Multicollinearity among the predictor variables was assessed by examining the tolerance values among the predictors variables which is an indication of the degree of correlation between each variable in the model and the other variables included in the regression. The range for tolerance values is between 0 and 1, and high tolerance values for the variables (> 0.20) are preferred since they indicate low multicollinearity (see appendix (C)).

The range of values for the variables in the fitted model is between 0.10 to 0.5, which shows low tolerance values for the variables D_{92}, D_{101}, and D_{102} that might result in interpretation problems. However, the (τ) intercorrelations coefficients of the original variables, represented by the three dummy variables, with the original variables represented by the other dummy variables in the model, show no "high" correlation coefficients (Table 6.4). This indicates that including these variables in the fitted model, does not provide the model with redundant information.

7.2.2. Inferences Based on Parameters of Fitted Model

The fitted model is shown in Equation (7.3). The model is highly significant at α =0.05 and $P<$ =0.0001. Analysis of variance shows that the model has a root mean square error of 0.043 which means that the model has 4.3 % error in prediction. The model's R-square and adjusted R-square are 0.93 and 0.91 respectively.

The intercept (INT) and the dummy variables that represent the high and moderate levels of only five of the original fourteen hypothesized predictors were determined to be significant in predicting the level of effectiveness (Y) based on their (Prob > | T |) values. Most probability values for the parameter estimates in the model equal 0.0001, which indicates very high significance, except for D_{81}= 0.0006, D_{91}= 0.0100, D_{92}= 0.0009, D_{101}= 0.0020, and D_{132}= 0.0027. These values are still well below the (α) of 0.05.

The dummy variables are D_{21} and D_{22}, representing the levels of the variable, attitude toward change by management and workers of the construction firm (X_2); D_{71} and D_{72}, representing the levels of the variable, level of multiple projects handling ability (X_8); D_{91} and D_{92}, representing the levels of the variable, strength of organizational culture (X_9); D_{101} and D_{102}, representing the levels of the variable, level of workers' participation in decision making (X_{10}); and D_{131} and D_{122}, representing the levels of the variable, level of planning (X_{13}).

$$\boldsymbol{Y} = (0.431) + (0.082)\,\boldsymbol{D_{21}} + (0.088)\,\boldsymbol{D_{22}} + (0.047)\,\boldsymbol{D_{81}} + (0.087)\,\boldsymbol{D_{82}} + (0.050)\,\boldsymbol{D_{91}} + (0.092)\,\boldsymbol{D_{92}} + (0.065)\,\boldsymbol{D_{101}} + (0.100)\,\boldsymbol{D_{102}} + (0.051)\,\boldsymbol{D_{131}} + (0.043)\,\boldsymbol{D_{132}} \qquad \text{Eq. (7.3)}$$

The partial coefficients in the model, for any two dummy variables, represent the effect of being moderate or high level in any of the five variables. A value of 0.431 is shown as the intercept in the model above. This value represents the low level or the reference level for construction firms studied. It also represents the predicted level of organizational effectiveness in a firm with low ratings in all of the five variables. It is worth noting here that the actual level of effectiveness for such a firm may fall anywhere between 0.431 and zero. Similarly, because, the maximum predicted level of effectiveness that can be calculated by the model for a firm equals 0.869, the actual level of effectiveness for such a firm may fall anywhere between this value and 1.00.

It is noted that the value of (Y) is influenced very little by whether a firm is rated as having a moderate *level of attitude toward change* or having a high level as represented by the two coefficients of 0.082 and 0.087 for D_{21} and D_{22} respectively. This means that there is a slight gain in effectiveness associated with an increase from a moderate level to a high level of attitude toward change by the group of firms studied.

Rating the construction firm as having a high level of multiple projects handling ability contributes 0.087 (coefficient for D_{82}). While rating it as having a moderate ability, contributes only 0.047 (coefficient for D_{81}). This seems to indicate that a high level of multiple projects handling ability contributes about double that of a moderate level to an increase in the predicted level of organizational effectiveness.

There is also a difference in contribution to predicted level of effectiveness of a construction firm (Y) between a moderate strength of organizational culture (D_{91} coefficient = 0.050) and a high strength of culture (D_{92} coefficient = 0.92). This is in line with the expectation that a stronger culture leads to a higher level of organizational effectiveness.

A high level of *workers' participaticn in decision-making* in the construction firms studied, impacts the value of (Y) by 0.100 (coefficient for D_{102}) for a high level rating, and 0.065 (coefficient for D_{101}) for a moderate level rating. This indicates that an increase in the level of organizational effectiveness is associated with an increase in *the level of workers' participation in decision-making* in the firms studied.

For the variable, *level of planning*, the coefficient for a moderate level of planning (D_{131}) is 0.050, and 0.043 for a high level of planning (D_{122}.). This means that there is a slight decline in effectiveness with an increase from a moderate to a high level of planning in the group of firms studied. This could be explained by the limitation in organizational flexibility caused by the inherent rigidity of planning (Cummings and Worley, 1993).

7.2.3. Validation of Fitted Model

Predicting the level of organizational effectiveness by the model is based on the possible combination of high, moderate, and low ratings of the five variables for any firm. Table 7.8 shows the ratings of the ten firms whose records were not used in model development, the predicted level of effectiveness and the actual level calculated from management response. The first record belongs to a firm with the following ratings of the five variables: highly favorable attitude toward change (D_{21}= 0, D_{22}= 1), a moderate level of multiple project-handling ability (D_{71}=1, D_{72}= 0), performs planning very regularly (D_{131}= 0, D_{122}= 1), has a strong culture (D_{91}= 0, D_{92}= 1), and a moderate level of participation in decision making by workers (D_{101}= 1, D_{102}= 0). The level of organizational effectiveness predicted by the model for the firm is equal to 0.76. Based on this value, the prediction can be made that this construction firm has a level of organizational effectiveness that would cause it to perform in 76 percent of its work projects on time and/or within budget and/or according to specifications and unsuccessfully in the rest 24 percent. The actual level for this firm is calculated by substituting into Eq. (4.1) the values given by firm's management for p_1= 80%, p_2= 80%, and p_3=75% which results in a level of approximately 78 percent.

The second record belongs to a firm that was rated as having an unfavorable (low) attitude toward change(D_{21}= 0, D_{22}= 0), a low level of multiple project handling ability (D_{71}= 0, D_{72} = 0), a moderate level of planning (D_{131}= 1, D_{122}= 0), a moderate strength of culture (D_{91}= 1, D_{92}= 0), and a low level of workers' participation in decision-making (D_{101}= 0, D_{102}= 0). The level of organizational effectiveness predicted, is approximately 53 percent. Whereas the actual level is 0.56, calculated from the three percentages of 60%, 60%, and 50% for percent of projects completed within scheduled duration (p_1), and percent of projects finished within budgeted costs (p_2), and percent of projects performed according to contractual specifications (p_3), respectively.

Comparing the predicted level with that of the actual level for the other firms listed in the table, leads to the conclusion that model's prediction is very reliable and valid. As seen in the table, predicted levels of effectiveness are very comparable with the actual levels of effectiveness calculated from data records, for the remaining eight firms. This indicates the robustness of the fitted model.

Table 7.8: Predicted and Actual Levels of Organizational Effectiveness

	Levels of variables					Level of organizational effectiveness	
No.	attitude toward change (1)	multiple projects handling (2)	strength of culture (3)	decision making participation (4)	level of Planning (5)	predicted	actual
1	H	M	H	M	H	0.76	0.78
2	L	L	M	L	M	0.53	0.55
3	H	H	H	M	M	0.80	0.80
4	M	H	M	M	L	0.71	0.70
5	L	M	L	L	L	0.48	0.50
6	M	M	M	L	M	0.66	0.67
7	H	H	H	M	H	0.81	0.80
8	M	H	L	M	M	0.62	0.60
9	M	M	M	L	M	0.65	0.67
10	M	M	M	H	L	0.71	0.70

* levels is shown by L, M, and H to indicate low, moderate, and high level.

It should be noted that the model is intended as a tool that gives management an idea about how organizational characteristics measured by the variables in the model influence the overall performance and not specifically rate performance on a project by project basis.

According to the (*Y*) value predicted, the conclusion could be made that a firm would perform within scheduled time, and/or within costs, and/or according to specs in some projects and that it would fail to achieve performance in all other cases (1-*Y*).

7.3. SUMMARY

Analysis of data using dummy regression techniques, the various multiple regression procedures of the SAS computer package yielded a model with ten dummy variables that represent only five of the original fourteen variables. These variables are proven significant in predicting the level of organizational effectiveness of the construction firm as operationalized by this research. These variables include firms' attitude toward change, its level of multiple project-handling ability, its level of planning, its strength of culture, and the level of workers' participation in decision-making in the firm.

The developed model is a practical tool. By rating the five variables in the model using the scales developed by this methodology, it is very simple to calculate the level of organizational effectiveness of the ICI construction firm.

CHAPTER (8)-CONCLUSIONS AND RECOMMENDATIONS

8.0 INTRODUCTION

In the first part of the chapter, conclusions are given regarding the use of the fitted model as the backbone of the assessment methodology. In the second part, implications of the findings of the research are discussed and a number of recommendations are outlined regarding the application and improvement of the assessment methodology.

8.1. CONCLUSIONS

The model developed by the research methodology is quantitative and identify "good" and "bad" states for certain variables or criteria identified by the research. However the model does not tell us what types of organizational dynamics are needed to create these "good" or "bad" states. ICI construction firms can deduce from the model the type of dynamics or changes that might lead toward or away from these states. By simply following the checklist shown in Figure 8.1, a firm can achieve a prediction of its level of organizational effectiveness.

-Checklist-

1. Randomly, select five raters from the firms' workforce: two management-level workers (preferably from two different locations, i.e. one from office and one from site; and three site level workers from different units or trades.

2. Distribute questionnaires forms that, only include measurement scales that relate to the five variables included in the model: attitude toward change, multiple projects handling ability, strength of organizational culture, level of workers' participation in decision making, and level of planning .

3. Collect Variables' responses, aggregate and average them to arrive at variables' scores (assume equal weight for each response) for the firm.

4. By using Table 6.3, convert aggregated firm-level scores for the five variables, from scores on 7 anchor-points Likert scales' to ratings on a three levels scale of low, medium, and high.

5. Depending on the achieved variables' levels, assign values of 0 or 1 in pairs, to the ten dummy variables representing the five original variables.

6. Use Table 7.2 and the assigned values of dummy variables to substitute in pairs for each of the five original variables in the model.

7. Calculate the firm's predicted level of organizational effectiveness.

Figure 8.1: Management Checklist For Calculating A Prediction

ICI construction firms that are operating at that particular stage of life cycle as the surveyed group of firms (at least more than 10 years of operation in the ICI sector), can use the model to assess their organizational effectiveness and calculate a predicted level. Based on the predictive model, two of the five variables with the largest partial coefficients: the level of workers' participation in decision making and the strength of organizational culture, are most significant in predicting the level of organizational effectiveness in the construction firm. This highlights the importance of human resources and workers-oriented processes in explaining and promoting effectiveness.

Although these findings support previous organizational effectiveness models and research, the precise explanation for the present results is unknown. Organizational theorists have proposed that the effort workers are willing to put forth on behalf of an organization (firm) depends largely on the way the workers feel about the job, co-workers, and supervisors. A positive internal environment, participation, and mutual trust are likely to promote worker satisfaction and positive attitudes, which may result in workers producing up to potential, thereby increasing organizational effectiveness.

The inclusion of the variables attitude toward change and the level of multiple projects handling ability in the model underscores the importance of these significant structural attributes in achieving flexibility and adaptability and hence promoting and achieving organizational effectiveness. A high level of attitude toward change is deemed necessary for the firm, in order to be flexible and adaptable to the unstable environment of the construction market. A high level of multiple project handling ability implies that the construction firm structure is suitable to handle the added requirements brought on by operating in multiple sites. This, in turn, would lead to an increase in the firm's volume of business and more profits, which keeps all constituents of the firm satisfied.

Although the impact of the other variable in the model, the level of planning, is lower than that of the other variables, and the difference in contribution between having a low and high level of planning is minimal, its inclusion alludes to the importance of using planning as an important strategic factor in achieving effectiveness.

Finally, it can be concluded that this research has contributed to the on-going efforts to improve the existing methodology of assessing organizational effectiveness of the construction firm.

8.2. IMPLICATIONS AND RECOMMENDATIONS

In order to discuss the implications of the findings of the study for future research and make meaningful recommendations on that basis, an important issue must be first addressed. This issue relates to the other hypothesized variables not included in the prediction model. As seen from the correlation analysis, except for the level of subcontracting, the remaining variables not included in the model, correlated with the level of effectiveness in a highly significant manner, which proved that these variables are related to effectiveness in some significant way. For the variables: extent of rules and regulations; level of adherence to rules and regulations; and level of control variables, the correlations are moderate. The correlations are low for the variables: level of integration in services offered; level of using joint-venturing, partnering, and alliances; and level of coordination, and level of information flow. Their exclusion from the model could be explained from a statistical point of view as having strong relationships with variables already in the model. However the low and moderate correlations of these variables could be explained by the influence of the particular life cycle's stage in which the group of firms surveyed are operating which makes them pursue the criteria that proved to be highly correlated and are included in the model.

The influence of the particular stage of life cycle on the types and levels of criteria that are pursued by the firm is well explained by the fact, and as proposed by the competing values approach, that firms pursue different levels of criteria or even different criteria altogether at the different stages of their life cycle. For the majority of firms studied in this research, the stage of life cycle in which they are operating, determined the type of criteria (the five variables with high correlations with (Y) and their levels (partial coefficients) to be most important in prediction of organizational effectiveness. The correlations of the variables not include in the model could be higher if firms surveyed were selected from a group in which the majority prove to be operating at a different stage of life cycle, and that which deems the pursuit of variables, not include in the model, as more relevant for examining and predicting effectiveness than the ones included in the developed model.

A simple plan of action then would be, using the four main stages of life cycle alluded to in chapter (2) of entrepreneurial, formalization, collectivity, and elaboration of structure stage, classify the construction firm according to the stage of life cycle in which it operates, identify the effectiveness criteria and levels that are pursued for each particular stage through empirical research, and finally, compare the levels of these criteria in the firm to the levels that should be present at that particular stage of life cycle. However a major difficulty faced, is the classification of the firm according to the stage of life cycle in which it operates. Although the research alluded to four main stages (there could be more), there is no concrete method to classify the firm into one of them. One recommendation to resolve this problem is to use the firm's age measured by years of operations as a variable in determining the particular stage of life cycle. However this criteria can not be used in classification as different firms take different time periods to span the same stages. What is needed to be done? In light of the preceding, the following recommendations are given to make the developed methodology apply in a more generalized manner:

1. In order make the methodology sensitive to the stage in which the construction firm operates, a classification scheme according the stage of life cycle must be devised and levels of the various criteria, that possibly could be pursued by firms during each of the four main stages (or a determined number of stages), must be identified empirically. One way that future research can handle this issue is to concentrate on the identification of easily recognized organizational markers, signals, and characteristics that accompany each of the four main stages or the determined number of stages.
2. Given that the impact of the levels and type of criteria used to assess effectiveness change with a change in the stage of firm's life cycle and since the methodology

developed, only considered a particular group of construction firms, future research should also consider different types of construction firms. Different types of firms must be considered in order to make the methodology more generalized and sensitive to the various types and to identify the proper levels for effectiveness criteria for each stage and for each type of firm. Although all construction firms share many characteristics, there are differences. Therefore, for other types of construction firms, different levels of different groups of variables may become more significant as discussed earlier. The four main stages could represent an initial starting point. These stages could be broken down into mini stages depending on the level of accuracy desired.

3. Given the importance of human resources, internal processes, and organizational culture, future research should focus more directly on the assessment of these linkages. For example, an area that can be considered is the types of scales used to assess the linkages of the underlying attributes of variables in these crucial areas. In this study, scales used in the measurement of the variables relating to these areas are very reliable, however, the type of scales that are needed are of a different nature and detail. Development of such scales needs to focus on linkages of persons-oriented processes' variables to organizational effectiveness in such a way that would give more insight of the influence of their underlying attributes on organizational effectiveness.

APPENDIX (A)
QUESTIONNAIRES

ORGANIZATIONAL EFFECTIVENESS QUESTIONNAIRE
TYPE (1)

PART (a)

Please note when providing information in this part of the questionnaire the term "average" should be related to the all the work performed during the last five years of operations in your firm.

1.Age in years of operation ____

2.Average number of annual work contracts. ________________________________

3.Percentage of work contracts (projects) that were finished on or before scheduled time in the last five years to the nearest 5 percent) __________________________________

4.Percentage of work contracts (projects) that were finished with no costs overruns in the last five years to the nearest 5 percent. ____________________________________

5.Percentage of work contracts (projects) that were finished without litigation or clients' claims or major rework due to inferior quality of performance in the last five years to the nearest 5 percent.

____

Part 2

Please respond by rating your organization according to Likert scale (very high (7), high (6), above average (5), average (4), below average (3), low (2) , and very low (1))

1. Level of profits made by your organization in the last five years?

   7 6 5 4 3 2 1

2. Percentage of projects that were finished within schedule in the last five years.

   7 6 5 4 3 2 1

3. Percentage of projects that were finished with no cost overruns in the last five years.

   7 6 5 4 3 2 1

4. Percentage of projects that were finished with no clients complaints or claims filed because of quality problems in the last five years.

   7 6 5 4 3 2 1

5. Level of goals achievement in terms of market share and growth in the last five years.

7 6 5 4 3 2 1

6. Level of goals achievement in terms of quality of output and productivity levels in the last five years.

7 6 5 4 3 2 1

7. Level of meeting and satisfying specified clients' goals in terms of products' quality achieved in the last five years.

7 6 5 4 3 2 1

8. Level of meeting and satisfying specified clients' goals in terms of products' price and execution time, achieved in the last five years.

7 6 5 4 3 2 1

9. Level of meeting and satisfying contractual obligations and expectations of suppliers and subcontractors in the last five years.

7 6 5 4 3 2 1

10. Level of satisfying workers' goals in terms of wages' increases, job security, and other benefits in the last five years.

7 6 5 4 3 2 1

11. Level of satisfying workers' goals in terms of training and enhancing of skills in the last five years.

7 6 5 4 3 2 1

12. Level of adherence to public codes and regulations, achieved in the last five years.

7 6 5 4 3 2 1

ORGANIZATIONAL EFFECTIVENESS QUESTIONNAIRE TYPE (1)

PART -3

Rate the extent to which the following activities in an average project are entrusted out to other organizations by the firm on a scale that ranges from "almost always" (7), to "almost never" (1).

	7	6	5	4	3	2	1
a.Design & Planning	7	6	5	4	3	2	1
b.Site work	7	6	5	4	3	2	1
c.Substructure	7	6	5	4	3	2	1
d.Superstructure (Skeleton)	7	6	5	4	3	2	1
e.Floor systems	7	6	5	4	3	2	1
f.Exterior wall systems	7	6	5	4	3	2	1
g.Interior wall systems	7	6	5	4	3	2	1
h.Roof systems	7	6	5	4	3	2	1
i.Masonry work	7	6	5	4	3	2	1
j.Metal work	7	6	5	4	3	2	1
kMechanical systems	7	6	5	4	3	2	1
l.Electrical systems	7	6	5	4	3	2	1
m.Finish work							

(Rate the following statements as they relate to the firm according to the scale that ranges from "strongly agree" 7 to "strongly disagree" 1).

(2)

a.Workers accept changes in organizational processes readily and their resistance to it is very minimal

7 6 5 4 3 2 1

b. Workers view changes in organization's processes as an effort to improve operation.

7 6 5 4 3 2 1

c. Workers are eager to volunteer time to understand changes in organizational processes.

7 6 5 4 3 2 1

d. Workers are always critical of processes in use and look for other alternatives.

7 6 5 4 3 2 1

e. Management views changes in organizational processes favorably and actually encourages it when it is needed.

7 6 5 4 3 2 1

f. Management always reviews organizational processes so it could introduce change wherever it is needed.

7 6 5 4 3 2 1

g. Rate at which changes are introduced into organizational processes tries to keeps pace with improvements in the field.

7 6 5 4 3 2 1

h. Once changes are introduced in organizational processes, smooth operations are usually resumed in a very quick period.

7 6 5 4 3 2 1

Please rate the extent of rules and regulation used in the firm to regulate activities described below on the scale that ranges from "very extensive regulation" (7) to "very little regulation" (1)

---

(3)

a. All organizational work processes.

7 6 5 4 3 2 1

b. Instructions & procedures to perform work tasks.

7 6 5 4 3 2 1

c. Approaches to evaluate work tasks.

7 6 5 4 3 2 1

d. Management and workers actions

7 6 5 4 3 2 1

Please rate the following activities in the firm according to the statements below on the scale that ranges from "very strict adherence" (7) to "very little adherence" (1)

(4)

a. Adherence of management to established work rules, regulations, and procedures.

7 6 5 4 3 2 1

b. Workers' adherence to established work rules, regulation, and procedures.

7 6 5 4 3 2 1

c. Adherence by the firm to established rules, regulations, and procedures that govern relationships with external entities such as suppliers, subcontractors, other partners or allies.

7 6 5 4 3 2 1

Please rate the level of activities in the firm described in the following statements according to scale ranging from " very high" (7) to " very low" (1))

(5)

a.Documented and formalized rules, job description and procedures are used in the firm.

7 6 5 4 3 2 1

b.Control systems are used to standardize outputs

7 6 5 4 3 2 1

c.All work processes used by the firm are reviewed, controlled to meet quality standards.

7 6 5 4 3 2 1

d. Process control tools & methods (i.e. Pareto charts, benchmarking, statistical process control (SPC), concurrent engineering) are used in monitoring processes' quality.

7 6 5 4 3 2 1

e. Various methods are used to check, monitor, and update progress all work activities to ensure that production is within target schedule and budgeted costs.

7 6 5 4 3 2 1

f. A sense of order, continuity, and smooth operations is maintained in all organizational processes.

7 6 5 4 3 2 1

Rate the level of activities in the firm according to the scale that ranges from "very high" (7) to "very low" (1).

(6)

a. The level that the firmprovides an in -house A/E consultants service to clients.

7 6 5 4 3 2 1

b. The level that the firm provides its own materials supply.

7 6 5 4 3 2 1

c. The level that the firm provides financing services to clients.

7 6 5 4 3 2 1

d. The level that the firm provides operating and maintenance services to its clients.

7 6 5 4 3 2 1

e. The extent of providing construction management services by the firm

7 6 5 4 3 2 1

Rate the level of activities in the firm according to the scale below that ranges from "very high" (7) to "very low" (1).

((7)

a. The level that the firm partners with other organizations i.e. suppliers, subcontractors, general contractors, A/E consultants or other related fields.

7 6 5 4 3 2 1

b. The level that the firm joint venture with other organizations.

7 6 5 4 3 2 1

c. The level that the firm develop alliances to handle specific types of work.

7 6 5 4 3 2 1

d. Level of developing and maintaining the quality of these types of contractual relationships with other organizations if any in a positive manner.

7 6 5 4 3 2 1

Rate activities of the firm described in the following statements according to the scale below that ranges from "strongly agree" (7) to "strongly disagree" (1).

---

(8)

a. No noticeable negative change is detected in quality output of organizational processes when the firm is handling multiple projects.

7 6 5 4 3 2 1

b. The firm's structure is suited to handle simultaneous projects at different sites.

7 6 5 4 3 2 1

c. In general, the firm can in a reasonable time acquire all the resources it needs for handling multiple projects.

7 6 5 4 3 2 1

d.Handling multiple average size construction projects is the norm for the firm.

7 6 5 4 3 2 1

e. More often than not, when the firm is handling multiple projects at different sites, the level of satisfaction of the various projects' constituents is acceptable.

7 6 5 4 3 2 1

Please distribute 100 points among the four statements in each of the six parts depending on how similar the situation in the firm to that described in each statement. For example in part (A) , if the situation in your organization seems similar to that described in statement (I) and somewhat to that in (II), then you could give 75 points to (I) and 25 points to (II).

(9)

(A)

I. The organization can be characterized as a place of high morale, cohesion, and sharing among its workers. __________

II. The organization can be characterized as a dynamic place where emphasis is on acquiring new processes, innovating, and taking risks. __________

III. The organization can be characterized as a formalized and structured place where bureaucratic procedures control all processes. __________

IV. The organization can be characterized as a place where workers are goal oriented and emphasis is put on efficient production. __________

(B)

I. The climate inside the organization is comfortable. High trust and openness prevails. __________

II. The climate inside the organization encourages dynamism, learning, and readiness to adapt to the new. __________

III. The climate inside the organization emphasizes stability. Work procedures are clear and enforced. __________

IV. The climate inside the organization is competitive and emphasis is on beating the competition. __________

(C)

I. Success is defined on the basis of sensitivity to clients, suppliers, the public, and concern for workers. __________

II. Success is defined on the basis of being the first in having or using newest processes and innovating . __________

III. Success is defined on the basis of having a smooth operation Within schedule execution, low costs production. __________

IV. Success is defined on the basis of achieving maximum production while offering the most competitive pricing. __________

(D)

I The glue that holds the organization together is loyalty and tradition. Commitment to the organization runs high. ____________

II.The glue that holds the organization together is a commitment to innovation and development. ____________

III.The glue that holds the organization together is formalized policies. ____________

IV.The glue that holds the organization together is emphasis on market success and increased production. ____________

(E)

I.The head of the organization is generally considered to be a mentor, a sage, or a parent figure. ____________

II.The head of the organization is generally considered to be an innovator, or a risk taker. ____________

III.The head of the organization is generally considered to be a coordinator, an organizer, or an efficiency expert. ____________

IV.The head of the organization is generally considered to be a hard-driver, a producer, or a competitor. ____________

(F)

I.The management style is characterized by team work , consensus, and participation. ____________

II.The management style is characterized by individual initiative, innovation, freedom, and uniqueness. ____________

III.The management style is characterized by security of employment, longevity in position, and predictability. ____________

IV.The management style is characterized by competitiveness, production, and achievement. ____________

Please rate activities in the firm described by the following statements according to the scale below ranging from " Strongly agree" (7) to " Strongly disagree" (1))

(10)

a. In general, decision making responsibilities is based on sharing and participating among all workers in each organizational unit and across all units.

7 6 5 4 3 2 1

b. In general, management encourages workers to initiate and take decisions concerning work processes.

7 6 5 4 3 2 1

c. Management encourages workers to participate in decisions making by soliciting their input and ideas regarding all organizational processes.

7 6 5 4 3 2 1

d. Management consults with workers before making decisions concerning work processes.

7 6 5 4 3 2 1

e. Decisions making within organizational units is actually based on consensus of almost all workers or their teams.

7 6 5 4 3 2 1

f. Workers in the firm are not penalized for wrong decisions but are encouraged to take responsibilities for their actions in a constructive manner.

7 6 5 4 3 2 1

g. A positive workers' attitude exist in the firm towards participation in decisions making responsibilities as evident by their volunteering of opinions in decisions making.

7 6 5 4 3 2 1

Please rate level of coordination in organizational activities described in the following statements according to the scale below that ranges from "very highly coordinated" (7) to " very little coordination" (1).

(11)

a. Activities that govern work flow and progress among organizational units.

7 6 5 4 3 2 1

b. Problems resolution activities among organizational units.

7 6 5 4 3 2 1

c. Work relationships between organization and its subcontractors, suppliers, and partners.

7 6 5 4 3 2 1

d. Activities concerning problem and conflict resolution in and among organizational units

7 6 5 4 3 2 1

e. Work relationships' activities between the construction firm and its subcontractors, suppliers, allies, and partners.

7 6 5 4 3 2 1

Please rate the activities in the firm described in the following statements according to the scale below ranging from " Strongly agree" (7) to " Strongly disagree" (1))

(12)

a. The flow of information, both vertically within the organizational hierarchy and laterally across the organizational units is uninterrupted.

7 6 5 4 3 2 1

b. Communication flow inside the organization could be best described as very accurate with very little distortion in information communicated.

7 6 5 4 3 2 1

c. Information communicated inside the organization is almost always sufficient in quality and quantity.

7 6 5 4 3 2 1

d. Access to information by workers when desired is almost always available in the organization.

7 6 5 4 3 2 1

e. Feed back about organizational processes & work tasks is communicated regularly and timely.

7 6 5 4 3 2 1

f. Quality & quantity of information flow is acceptable with external entities sharing in work relationships. i.e. , other firms, suppliers, subcontractors, and partners.

7 6 5 4 3 2 1

Please rate the level of activities in the firm described in the following statements according to the scale below ranging from " very high" (7) to " very low" (1))

---

(13)

a.The level that planning is used to develop strategies to achieve organizational goals and objectives.

7 6 5 4 3 2 1

b.The level that operational planning is used in identification of problems in quality of operations, implementation of necessary changes, and their assessment.

7 6 5 4 3 2 1

c.The level that frequent and multiple environmental scanning functions is used by the organization to monitor markets trends and other competitors in the industry.

7 6 5 4 3 2 1

d.The level that strength, weakness, opportunities and threats (SWOT) analysis is used in strategic planning, changing, and adapting organization to its environment.

7 6 5 4 3 2 1

Rate the level of importance in the firm for setting goals described in the statements below according to the scale that ranges from " of primary importance" (7), to "of no importance" (1).

(14)

a. Increasing profits levels.

7 6 5 4 3 2 1

b. Increasing costs effectiveness.

7 6 5 4 3 2 1

c. Growth into other sectors.

7 6 5 4 3 2 1

d. Improving quality.

7 6 5 4 3 2 1

e. Improving clients' service and relationships.

7 6 5 4 3 2 1

. Increasing workers' participation in descision making

7 6 5 4 3 2 1

ORGANIZATIONAL EFFECTIVENESS QUESTIONNAIRE TYPE (2)

(Rate the following statements as they relate to the firm according to the scale that ranges from "strongly agree" 7 to "strongly disagree" 1).

(1)

a. Workers accept changes in organizational processes readily and their resistance to it is very minimal.

7 6 5 4 3 2 1

b. Workers view changes in organization's processes as an effort to improve operation.

7 6 5 4 3 2 1

c. Workers are eager to volunteer time to understand changes in organizational processes.

7 6 5 4 3 2 1

d. Workers are always critical of processes in use and look for other alternatives.

7 6 5 4 3 2 1

e. Management views changes in organizational processes favorably and actually encourages it when it is needed.

7 6 5 4 3 2 1

f. Management always reviews organizational processes so it could introduce change wherever it is needed.

7 6 5 4 3 2 1

g. Rate at which changes are introduced into organizational processes tries to keeps pace with improvements in the field.

7 6 5 4 3 2 1

h. Once changes are introduced in organizational processes, smooth operations are usually resumed in a very quick period.

7 6 5 4 3 2 1

Please rate the extent of rules and regulation used in the firm to regulate activities described below on the scale that ranges from "very extensive regulation" (7) to "very little regulation" (1)

(2)

a. All organizational work processes.

7 6 5 4 3 2 1

b. Instructions & procedures to perform work tasks.

7 6 5 4 3 2 1

c. Approaches to evaluate work tasks.

7 6 5 4 3 2 1

d. Management and workers actions

7 6 5 4 3 2 1

Please rate the following activities in the firm according to the statements below on the scale that ranges from "very strict adherence" (7) to "very little adherence" (1)

(3)

a. Adherence of management to established work rules, regulations, and procedures.

7 6 5 4 3 2 1

b. Workers' adherence to established work rules, regulation, and procedures.

7 6 5 4 3 2 1

c. Adherence by the firm to established rules, regulations, and procedures that govern relationships with external entities such as suppliers, subcontractors, other partners or allies.

7 6 5 4 3 2 1

Please rate the level of activities in the firm described in the following statements according to scale ranging from " very high" (7) to " very low" (1))

(4)

a.Documented and formalized rules, job description and procedures are used in the organization.

7 6 5 4 3 2 1

b.Control systems are used to standardize outputs

7 6 5 4 3 2 1

c.All work processes used by the organization are reviewed, controlled to meet quality standards.

7 6 5 4 3 2 1

d. Process control tools & methods (i.e. Pareto charts, benchmarking, statistical process control (SPC), concurrent engineering) are used in monitoring processes' quality.

7 6 5 4 3 2 1

e. Various methods are used to check, monitor, and update progress all work activities to ensure that production is within target schedule and budgeted costs.

7 6 5 4 3 2 1

f. A sense of order, continuity, and smooth operations is maintained in all organizational processes.

7 6 5 4 3 2 1

Rate activities of the firm described in the following statements according to the scale below that ranges from "strongly agree" (7) to "strongly disagree" (1).

(5)

a. No noticeable negative change is detected in quality output of organizational processes when the organization is handling multiple projects.

7 6 5 4 3 2 1

b. The organization structure is suited to handle simultaneous projects at different sites.

7 6 5 4 3 2 1

c. In general, the organization can in a reasonable time acquire all the resources it needs for handling multiple projects contract.

7 6 5 4 3 2 1

d.Handling multiple average size construction projects is the norm for the organization.

7 6 5 4 3 2 1

e. More often than not, when the firm is handling multiple projects at different sites, the level of satisfaction of the various projects' constituents is acceptable.

7 6 5 4 3 2 1

Please distribute 100 points among the four statements in each of the six parts depending on how similar the situation in your organization to that described in each statement. For example in part (A) , if the situation in your organization seems similar to that described in statement (I) and somewhat to that in (II), then you could give 75 points to (I) and 25 points to (II).

---

(6)

(A)

I.The organization can be characterized as a place of high morale, cohesion, and sharing among its workers. ____________

II.The organization can be characterized as a dynamic place where emphasis is on acquiring new processes, innovating, and taking risks. ____________

III.The organization can be characterized as a formalized and structured place where bureaucratic procedures control all processes. ____________

IV.The organization can be characterized as a place where workers are goal oriented and emphasis is put on efficient production. ____________

(B)

I.The climate inside the organization is comfortable. High trust and openness prevails. ____________

II.The climate inside the organization encourages dynamism, learning, and readiness to adapt to the new. ___________

III.The climate inside the organization emphasizes stability. Work procedures are clear and enforced. ___________

IV.The climate inside the organization is competitive and emphasis is on beating the competition. ___________

(C)

I.Success is defined on the basis of sensitivity to clients, suppliers, the public, and concern for workers. ___________

II.Success is defined on the basis of being the first in having or using newest processes and innovating . ___________

III.Success is defined on the basis of having a smooth operation Within schedule execution, low costs production. ___________

IV.Success is defined on the basis of achieving maximum production while offering the most competitive pricing. ___________

(D)

I The glue that holds the organization together is loyalty and tradition. Commitment to the organization runs high. ___________

II.The glue that holds the organization together is a commitment to innovation and development. ___________

III.The glue that holds the organization together is formalized policies. ___________

IV.The glue that holds the organization together is emphasis on market success and increased production. ___________

(E)

I.The head of the organization is generally considered to be a mentor, a sage, or a parent figure. ___________

II.The head of the organization is generally considered to be an innovator, or a risk taker. ___________

III.The head of the organization is generally considered to be a coordinator, an organizer, or an efficiency expert. __________

IV.The head of the organization is generally considered to be a hard-driver, a producer, or a competitor. __________

(F)

I.The management style is characterized by team work , consensus, and participation. __________

II.The management style is characterized by individual initiative, innovation, freedom, and uniqueness. __________

III.The management style is characterized by security of employment, longevity in position, and predictability. __________

IV.The management style is characterized by competitiveness, production, and achievement. __________

Please rate activities in the firm described by the following statements according to the scale below ranging from " Strongly agree" (7) to " Strongly disagree" (1))

---

(7)

a. In general, decision making responsibilities is based on sharing and participating among all workers in each organizational unit and across all units.

7 6 5 4 3 2 1

b. In general, management encourages workers to initiate and take decisions concerning work processes.

7 6 5 4 3 2 1

c. Management encourages workers to participate in decisions making by soliciting their input and ideas regarding all organizational processes.

7 6 5 4 3 2 1

d. Management consults with workers before making decisions concerning work processes.

7 6 5 4 3 2 1

e. Decisions making within organizational units is actually based on consensus of almost all workers or their teams.

7 6 5 4 3 2 1

f. Workers in the firm are not penalized for wrong decisions but are encouraged to take responsibilities for their actions in a constructive manner.

7 6 5 4 3 2 1

g. A positive workers' attitude exist in the firm towards participation in decisions making responsibilities as evident by their volunteering of opinions in decisions making.

7 6 5 4 3 2 1

Please rate level of coordination in organizational activities described in the following statements according to the scale below that ranges from "very highly coordinated" (7) to " very little coordination" (1).

---

(8)

a. Activities that govern work flow and progress among organizational units.

7 6 5 4 3 2 1

b. Problems resolution activities among organizational units.

7 6 5 4 3 2 1

c. Work relationships between organization and its subcontractors, suppliers, and partners.

7 6 5 4 3 2 1

d. Activities concerning problem and conflict resolution in and among organizational units

7 6 5 4 3 2 1

e. Work relationships' activities between the construction firm and its subcontractors, suppliers, allies, and partners.

7 6 5 4 3 2 1

Please rate the activities in the firm described in the following statements according to the scale below ranging from " Strongly agree" (7) to " Strongly disagree" (1))

(9)

a. The flow of information, both vertically within the organizational hierarchy and laterally across the organizational units is uninterrupted.

7 6 5 4 3 2 1

b. Communication flow inside the organization could be best described as very accurate with very little distortion in information communicated.

7 6 5 4 3 2 1

c. Information communicated inside the organization is almost always sufficient in quality and quantity.

7 6 5 4 3 2 1

d. Access to information by workers when desired is almost always available in the organization.

7 6 5 4 3 2 1

e. Feed back about organizational processes & work tasks is communicated regularly and timely.

7 6 5 4 3 2 1

f. Quality & quantity of information flow is acceptable with external entities sharing in work relationships. i.e. , other firms, suppliers, subcontractors, and partners.

7 6 5 4 3 2 1

APPENDIX (B)

Averaged Aggregated
variables' scores for the 76 ICI construction firms

obs	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	Y
1	5.077	5.344	4.917	5.125	6.167	4.250	5.875	4.667	6.548	5.071	4.771	3.333	5.00	5.15	0.900
2	4.846	5.125	5.083	4.875	6.167	4.250	5.813	4.333	6.190	5.179	4.542	3.333	4.75	5.10	0.867
3	5.077	5.063	5.083	5.000	6.167	4.167	5.688	4.333	5.952	5.107	4.438	3.000	4.75	5.15	0.833
4	4.077	5.031	5.167	5.125	6.000	4.250	5.313	4.000	5.833	5.071	4.396	3.000	4.75	5.00	0.800
5	4.308	4.813	5.250	4.875	6.000	4.167	5.250	4.000	5.714	5.000	4.354	3.333	4.75	4.95	0.750
6	4.154	5.125	4.917	5.000	6.167	4.250	5.938	4.333	5.833	5.071	4.542	3.667	5.00	5.20	0.867
7	4.769	5.031	5.000	5.000	6.167	4.167	5.813	4.000	5.833	4.964	4.479	3.000	5.00	5.15	0.800
8	5.077	4.938	5.083	4.750	6.000	4.250	5.375	4.000	5.476	5.036	4.417	2.667	5.25	5.05	0.733
9	3.923	4.844	5.167	5.000	6.000	4.000	5.688	4.000	5.238	5.143	4.354	3.333	5.00	4.95	0.717
10	4.154	5.031	5.000	5.000	6.000	4.083	5.750	4.000	5.833	5.179	4.396	3.333	5.00	5.15	0.800
11	4.615	5.063	4.917	4.750	6.167	4.083	5.188	3.667	5.476	5.143	4.375	2.000	4.75	5.25	0.783
12	5.077	4.969	5.000	5.000	6.000	4.167	5.563	4.000	5.833	5.107	4.396	4.000	5.00	5.10	0.800
13	4.462	5.000	5.167	5.250	6.000	4.250	5.625	4.667	5.714	5.179	4.979	4.000	4.75	5.10	0.867
14	4.462	4.969	5.167	5.125	6.167	4.250	5.563	4.333	5.714	5.143	4.896	3.000	5.25	5.15	0.850
15	4.692	5.000	5.083	5.125	6.333	4.167	5.438	4.333	5.714	5.107	4.875	3.333	5.00	5.10	0.817
16	4.462	4.688	5.250	5.000	6.000	4.083	5.313	4.000	5.595	5.071	4.729	3.667	5.00	5.15	0.817
17	4.923	4.969	5.167	5.000	5.833	4.167	5.250	4.000	5.595	5.036	4.625	3.333	4.75	5.05	0.800
18	4.615	4.781	5.000	5.000	6.333	4.250	5.313	4.000	5.357	5.000	4.729	3.333	5.00	5.10	0.800
19	4.769	4.875	5.167	5.000	6.167	4.000	5.125	4.000	5.357	5.000	4.667	2.667	5.00	5.05	0.800
20	5.000	4.719	5.167	4.875	6.000	4.083	5.125	4.000	5.119	4.964	4.563	3.667	4.75	5.10	0.783
21	4.923	4.813	5.083	4.875	6.000	4.083	5.063	4.000	5.119	4.929	4.542	2.667	4.75	5.05	0.783
22	5.000	4.750	5.000	4.750	6.000	4.167	5.000	4.000	5.357	4.893	4.521	2.667	5.00	5.15	0.783
23	4.615	5.188	4.917	4.875	5.833	4.083	5.000	4.000	5.119	4.857	4.500	2.000	4.75	5.05	0.767
24	4.538	4.594	5.000	4.875	6.000	4.167	4.938	4.333	5.119	4.821	4.375	2.667	5.00	4.95	0.767
25	4.692	4.406	4.917	4.750	6.167	4.167	4.938	4.667	5.000	4.786	4.396	3.000	5.00	4.90	0.750
26	4.846	4.625	4.917	4.875	6.167	4.250	4.938	4.333	4.762	4.714	4.271	3.333	5.00	4.95	0.733
27	5.000	4.469	4.833	5.000	6.167	4.083	4.813	4.000	4.762	4.714	4.292	3.000	4.75	5.15	0.717
28	4.846	4.781	5.000	4.875	6.000	4.000	4.938	4.000	4.762	4.750	4.271	3.000	4.75	5.00	0.717

obs	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	Y
29	4.692	4.813	4.917	4.750	5.833	4.167	5.000	4.000	4.524	4.679	4.250	3.333	4.75	4.95	0.700
30	4.692	4.875	4.750	4.500	6.167	4.167	5.125	3.667	4.524	4.750	4.292	3.333	5.00	5.00	0.700
31	5.077	4.531	4.833	4.750	6.167	4.167	5.000	4.000	4.405	4.607	4.271	2.667	5.00	4.85	0.683
32	4.769	4.594	4.667	4.750	5.833	4.083	4.875	3.667	4.405	4.607	4.417	2.667	4.75	4.90	0.667
33	5.615	4.563	5.250	5.125	6.000	4.250	5.750	4.000	5.476	5.250	5.188	3.333	4.75	5.30	0.833
34	5.462	4.500	5.167	4.875	6.000	5.167	5.563	4.000	5.476	5.500	5.042	3.333	4.75	5.25	0.833
35	5.000	4.438	5.083	5.000	5.667	5.083	5.250	4.000	5.357	5.393	4.958	3.333	4.75	5.20	0.800
36	4.846	4.500	5.250	4.625	6.000	5.167	5.063	4.000	5.238	5.357	4.938	3.333	5.00	5.15	0.800
37	4.923	4.688	5.167	4.250	6.167	5.250	5.125	4.000	5.119	5.286	4.917	3.667	4.75	5.15	0.767
38	4.923	4.250	5.167	4.125	5.500	5.083	5.313	4.000	5.119	5.179	4.813	3.333	4.75	5.20	0.767
39	5.000	4.469	5.083	4.375	6.167	5.083	5.688	3.667	5.119	5.107	4.688	3.000	4.75	5.05	0.750
40	4.615	4.531	5.083	4.375	6.000	5.167	5.313	3.667	5.119	5.036	4.438	3.333	4.75	5.15	0.750
41	4.846	4.500	5.000	4.750	5.833	5.083	5.250	4.000	5.238	5.107	4.375	3.333	4.50	5.10	0.733
42	5.154	4.531	5.000	5.000	6.167	4.917	5.688	4.000	5.119	5.071	4.479	3.333	4.50	5.20	0.733
43	4.615	4.563	5.167	4.375	6.167	5.083	5.688	4.000	5.357	5.071	4.604	3.333	4.50	5.10	0.733
44	5.308	4.469	5.083	4.375	5.833	5.000	5.250	4.000	5.119	4.857	4.479	3.000	4.50	5.00	0.717
45	4.692	4.406	5.083	4.250	5.167	5.083	5.375	4.000	5.119	4.821	4.604	3.333	4.75	5.05	0.717
46	5.077	4.375	5.000	4.000	6.000	5.000	5.313	4.000	5.357	4.929	4.271	2.667	4.75	5.10	0.717
47	5.000	4.375	5.000	3.875	5.667	5.000	5.438	4.000	5.119	4.964	4.479	2.000	4.50	5.00	0.717
48	4.846	4.344	4.917	4.750	6.000	5.083	5.188	3.667	5.000	4.857	4.396	3.333	5.00	4.95	0.700
49	4.923	4.344	5.000	4.875	5.000	5.000	5.313	3.667	5.119	5.179	4.458	3.000	5.25	4.85	0.700
50	4.923	4.313	4.917	4.500	5.667	4.917	5.250	4.000	5.000	4.786	4.354	3.000	4.50	5.00	0.683
51	4.923	4.281	5.083	4.500	6.167	4.833	5.063	3.667	5.000	4.750	4.479	3.000	4.75	5.05	0.667
52	4.692	4.281	4.833	4.125	5.667	4.750	4.938	3.333	5.000	4.714	4.271	3.000	4.75	5.05	0.667
53	4.923	4.250	4.750	4.250	5.833	4.750	4.563	4.000	5.000	4.786	4.250	2.667	4.75	5.15	0.650
54	4.923	4.156	4.833	4.375	6.167	4.667	4.875	4.333	5.000	4.857	4.229	3.333	5.00	5.20	0.650
55	5.308	4.156	4.583	4.250	6.167	4.667	4.750	4.000	4.762	4.750	4.271	2.667	4.50	5.15	0.633
56	5.385	4.094	4.833	4.250	5.833	4.583	4.875	4.000	4.643	4.679	4.292	3.000	4.75	5.10	0.600

obs	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	Y
57	4.692	4.125	4.667	4.375	5.833	4.583	4.625	4.000	4.524	4.643	4.292	3.333	4.25	5.10	0.567
58	4.769	4.781	4.750	4.250	6.000	3.917	5.750	4.000	4.524	4.500	4.479	2.667	4.75	5.15	0.517
59	5.231	3.938	4.667	4.125	5.667	3.917	5.188	3.333	4.524	4.607	4.417	3.333	4.50	5.10	0.500
60	4.692	3.938	5.000	4.000	5.667	4.000	5.000	3.333	4.524	4.429	4.458	2.667	4.25	5.15	0.500
61	4.769	3.969	5.167	4.250	6.167	3.917	4.813	3.667	4.524	4.179	4.604	2.667	4.25	5.25	0.500
62	4.923	3.938	5.083	4.875	5.667	3.917	4.625	3.000	4.405	4.464	4.625	3.000	4.75	5.20	0.500
63	4.846	3.875	4.583	5.000	6.167	3.833	5.688	3.667	4.405	4.036	4.708	3.000	4.75	5.15	0.483
64	4.462	4.000	4.500	5.000	5.667	3.583	5.313	3.333	4.405	4.143	4.542	3.000	4.75	5.15	0.483
65	4.769	3.875	4.583	4.500	5.833	3.750	5.250	3.333	4.405	4.036	4.667	3.000	4.75	5.15	0.467
66	4.846	3.844	4.833	4.750	6.000	3.667	4.625	3.000	4.405	4.000	4.396	3.333	5.00	5.20	0.467
67	4.846	3.844	4.583	5.125	6.167	4.000	4.750	3.333	4.405	4.179	4.375	2.667	5.00	5.15	0.467
68	4.000	3.875	4.750	5.000	5.833	4.000	4.438	3.333	4.286	4.321	4.500	3.000	4.75	5.10	0.467
69	5.077	3.844	4.750	5.125	6.000	4.167	4.500	3.667	4.286	4.393	4.375	3.333	5.25	4.95	0.467
70	4.846	3.844	4.833	4.375	6.000	3.917	4.625	3.667	4.048	4.464	4.438	2.667	5.00	4.90	0.450
71	4.077	3.813	4.750	4.500	5.667	4.167	4.500	3.667	4.048	4.286	4.396	3.000	4.50	4.60	0.433
72	4.538	3.813	5.000	5.000	6.000	4.000	4.375	3.667	4.048	4.429	4.271	2.667	5.00	4.75	0.433
73	4.846	3.813	4.833	4.500	5.500	4.083	4.250	3.333	4.048	4.429	4.063	3.000	4.50	4.85	0.417
74	4.692	3.781	4.750	5.000	5.333	4.167	4.313	3.000	4.048	4.500	4.583	2.667	4.25	4.80	0.417
75	4.846	3.781	5.083	4.000	5.333	3.917	4.313	3.667	3.929	4.429	4.292	2.667	4.50	4.55	0.400
76	4.462	3.719	4.750	4.750	5.333	4.167	4.813	3.333	3.810	4.500	4.292	2.667	4.50	4.50	0.400

APPENDIX (C)

AN EXPOSÉ ON MULTIPLE REGRESSION

C.0. INTRODUCTION

The general additive multiple regression model, which relates a dependent variable y to k predictors variables $x_1, x_2, ..., x_k$, is given by the model equation

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k + e$$

The model assumes that there is a line with a vertical intercept α and partial slopes of β_1 , β_2 ,....,β_k called the true or population regression line. The random deviation e is assumed to be normally distributed with mean value 0 ($\mu_e = 0$) and variance σ^2 for any values of x_1, ...x_k. This implies that for fixed x_1, x_2, ..., x_k values, y has a normal distribution with variance σ^2 and mean y value that equals the expression

$$\begin{pmatrix}\text{mean y value for fixed} \\ x_1,\cdots,x_k \text{ values}\end{pmatrix} = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k$$

The β_i's are called population regression coefficients and $\alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k$ is referred to as the population regression function.

C.1. FITTING A MODEL AND ASSESSING ITS UTILITY

The principle of least squares is used in simple linear regression to estimate the coefficients. According to the principles of least squares, the fit of a particular estimated regression function $a + b_1 x_1 + \ldots\ldots + b_k x_k$ to the observed data is measured by the sum of squared deviations between the observed y values and the y values predicted by the estimated function or model:

$$\sum [y - (a + b_1 x_1 + \cdots\cdots + b_k x_k)]^2$$

The least squares estimates of α, β_1, β_2,......, β_k are those of a, b_1, b_2, ..., b_k that make this sum of squared deviations as small as possible. The utility of an estimated model can be assessed by examining the extent to which predicted y values based on the estimated regression function (model) are close to the y values actually observed. The first predicted value of y or $\hat{y}_1$ is obtained by taking the values of the predictor variables x_1, x_2, ..., x_k for the first observation or data record and substituting these values into the estimated regression model. Doing this successively for the remaining observations yields the predicted values $\hat{y}_2$ $\hat{y}_3$, ... , $\hat{y}_k$.

The residuals are then the differences y_1 - $\hat{y}_1$, y_2 - $\hat{y}_2$, . . . y_k - $\hat{y}_k$ between the observed and predicted values. The residual (or error) sum of squares, SSResid, and the total sum of squares, SSTo, are given by

$$\text{SSResid} = \sum\left(y - \hat{y}\right)^2 \qquad \text{SSTo} = \sum(y - \bar{y})^2$$

where $\bar{y}$ is the mean of the y observations in the sample. SSResid measures the amount of total variation that has not been explained by the fitted model. SSTo is a measure of total variation in the sample data

The number of degrees of freedom associated with SSResid is n-(k+1). An estimate of the random deviation variance σ^2 is given by:

$$S_e^2 = \frac{\text{SSResid}}{\text{n - (k + 1)}}$$

and S_e^2 is the estimate of σ. The coefficient of multiple determination, R^2, interpreted as the proportion of variation in observed y values that is explained by the fitted model, is given by:

$$R^2 = 1 - \frac{\text{SSResid}}{\text{SSTo}}$$

Generally, a desirable model is one that results in both a large R^2 value and a small S_e value. However, there is a catch: These two conditions can be achieved by fitting a model that contains a large number of predictors. Such a model may be successful in explaining all the dependent variable y variation, but it almost always specifies a relationship that is unrealistic and difficult to interpret. What is wanted really is a simple model, one with relatively few predictors whose roles are easily interpreted, which also does a good job of explaining variation in y.

The SAS procedures used in the analysis to calculate a multiple regression linear model using the fourteen hypothesized predictors includes R^2 and S_e values in its output, and give SSResid. In addition it computes a quantity called adjusted R^2, which involves a downward adjustment of R^2. If a large R^2 has been achieved through using just a few predictors in the model, adjusted R^2 will differ little from R^2. However, the adjustment can be substantial when either a great many predictors (relative to the number of observations) have been used or when R^2 itself is small to moderate.

C.1.1. The F Test for Model Utility

In the simple linear model with regression function $\alpha + \beta x$, if $\beta = 0$, there is no useful linear relationship between y and the single predictor variable x. Similarly, if all k coefficients β_1, β_2, ...,β_k are zero in the general k- predictor multiple regression model, there is no useful linear relationship between y and any of the predictor variables x_1, x_2, ..., x_k included in the model. Before using an estimated model in further inferences (for example prediction), it is desirable to confirm the model's utility through formal ,test procedure. This test is called the F test. From the preceding section, we know that SSTo is a measure of total variation in the sample data and that SSResid measures the amount of total variation that has not been explained by the fitted model. The difference between total and error sums of squares is itself a sum of squares, called regression model sum of squares (SSRegr) and equals SSTo - SSResid.

SSRegr is interpreted as the amount of total variation that has been explained by the model. The model should be judged useful if SSRegr is large relative to SSResid, and this achieved by using small number of predictors relative to sample size. The number of degrees of freedom associated with SSRegr is k, the number of model predictors, and df for SSResid is n - (k+1). The model utility F test is based on the following distributional result. When all the k β_i's are zero in the model $Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k + e$, the statistic $F = \dfrac{\text{SSRegr}/\text{k}}{\text{SSResid}/[n-(k+1)]}$ has an F probability distribution based on k numerator df and n-(k+1) denominator df. The value of F tends to be larger when at least one β_i is not zero than when all the β_i's are zero, since more variation is typically explained by the model in the former case than in the latter. An F statistic value far out in the upper tail of the associated F distribution can be more attributed to at least one nonzero β_i rather than when all β_i's are zero. This is why the model utility F test is upper tailed.

Therefore the F test for utility of the multiple regression linear model

$$Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k + e$$

Null hypothesis:

$H_o: \beta_1 = \beta_2 = \beta_3 = \cdots\cdots = \beta_k = 0$ (There is no linear relationship between y and any of the hypothesized predictors $x_1, x_2, \ldots\ldots, x_k$)

Alternative hypothesis:

H_a: At least one among β_i's is not zero. (there is a useful linear relationship between y and at least one of the predictors)

$$\text{Test Statistic: } F = \frac{\text{SSRegr}/\text{k}}{\text{SSResid}/[n-(k+1)]}$$

where SSRegr = SSTo - SSResid. An equivalent formula is

$$\frac{R^2/k}{(1-R^2)/[n-(k+1)]}$$

Rejection region:

The null hypothesis is rejected when $F > F$ critical value. The F critical value (level of significance)

C.2. VARIABLE SELECTION (HOW MANY PREDICTORS TO RETAIN IN THE MODEL)

By checking the null hypothesis T= H0: Parameter= 0, (the *t* test that the parameter is zero, this is computed as the Parameter Estimate divided by the Standard Error for each variable) concerning the parameter estimates, (Prob>|T|) of each variable included in the model and whether it true or not, the decision can be made as to how many variables to retain in the model. The (Prob>|T|) is the two-tailed significance probability that a *t* statistic would obtain a greater absolute value than that observed, given that the true parameter is zero.

Assessing the statistical significance of sets of the coefficients β_i's by model comparison tests provides a useful and flexible way for guiding the variable selection process. The *t* test values and their probabilities (T:H0=0, Prob> |T|) that are calculated or given by SAS computer package for the "significance" of the parameter estimate of the intercept and each predictor included the model is generally used as the test for including the predictor or excluding it from the model. The (Prob> |T|) value represents the probability of rejecting the null hypothesis that the particular coefficient equals to zero. Depending on the chosen level of significance for including variables in the model, the lower the (Prob> |T|) value, the better chance for including the variable in the model. The resulting (Prob> |T|) values for the hypothesized variables depends on the model selection procedures used in model building. The (T:H0=0, Prob> |T|) values given by the various model selection procedures should be treated carefully especially for stepwise and forward selection procedures, especially if the initial pool of predictors is moderate (15) or large (30) (Stevens, 1992).

C.2.1. Model Selection Procedures

Model selection methods can be divided into two types. There are those based on fitting every possible model, computing one or more summary quantities from each fit, and computing these quantities to identify the most satisfactory models. Several of the most powerful statistical computer packages have an all-subsets option such as SAS and SPSS. Methods of the second type are often referred to as automatic selection, or stepwise, procedures. The general idea is to either begin with m predictor model and delete variables one by one until all remaining predictors are judged important, or begin with no predictors and add predictors until no predictor not in the model seems important.

What characteristic(s) of the estimated models should be examined in the search for a best model? Devore and Peck (1993) discussed the use of R^2 which measures the proportion of observed y variation explained by the model. A model with a large R^2 value is preferable to another model containing the same number of predictors but which has a much smaller R^2 value. However they argued that using R^2 to choose between models containing different numbers of predictors is not so straightforward because adding a predictor to a model can never decrease the value of R^2. In particular, the model containing all candidate predictors is guaranteed to have R^2 value at least as large as for any model that includes some but not all of these predictors. A small increase R^2 in resulting from the addition of a predictor to a model may be offset by the increased complexity of the new model and the reduction of degrees of freedom associated with SSResid. This is why adjusted R^2 was introduced. Adjusted R^2 formalizes the notion of diminishing returns as more predictors are added-small increases in are outweighed by corresponding decreases in degrees of freedom associated with SSResid. Therefore a reasonable strategy in model selection is to identify the model with the largest value of adjusted R^2 (the corresponding number of predictors k is often much smaller than their total number) and then consider only the model and any others whose adjusted R^2 values are nearly as large.

In the following section several sequential selection procedures that have been used in regression analysis (Dillon and Goldstein, 1984) are presented.

C.2.1.1. All Possible Regression Subsets

This procedure, as its name suggests, fits all possible regression of a given size. With (m) explanatory variables there (2^m) possible regression models, ranging from the simplest form, where only one of the predictors is included, to the most complex, in which all predictors are included (see later in the appendix the results yielded by all possible regression procedure performed by SAS computer on data used by this study). This approach generally relies on R^2 as the assessment criterion, and the process starts by computing the R^2 values for all the combinations of predictors of a give size, that is, ranging from 1 to m. For each subset of a given size the combination of predictors that yields the largest R^2 value is selected out and then compared, again in terms of R^2, with the others "winners" from the other subsets of different size. The more recent algorithms allow different selection criteria to be used such as adjusted R^2 which is discussed in the preceding paragraph and C_p. statistic. C_p was proposed by Mallows (1973) as a criterion for selecting a model. It is a measure of total squared error. The value for the C_p statistic is defined by:

$$C_p = (SSE_p/S^2) - (N\text{-}2{*}p)$$

where SSE_p is the error sum of squares for a model with p parameters including the intercept, if any, and S^2 is the mean square error (MSE) for the model. A good model according to this criterion is one that has small C_p (for accurate prediction) and $C_p \cong k + 1$ (for unbiasedness in estimating model coefficients) where k is the number of predictors in the model.

C.2.1.2. Sequential Selection

The sequential procedures can be viewed as a compromise with all possible regression approach. Three types of sequential methods are mainly utilized. Namely, *backward selection, forward selection, and stepwise selection*. Essentially, these approaches differ with respect to the direction taken in model selection and the reversibility of a decision as to the worthiness of a candidate predictor.

backward selection works in the following way:

1. A regression equation (model) that includes all of the p independent variables is obtained.
2. The R^2 induced from deleting each independent variable, or equivalently the partial F test value for each independent variable treated as though it were the last variable to enter the regression equation, is calculated

3. The lowest partial F test value, denoted by F_L , is compared with a predetermined critical tabulated F -value denoted by F_C.. If

   a. $F_L < F_C$ remove that variable associated with this , recompute the regression equation in the remaining independent variables and return to stage 2;

   b. $F_L > F_C$ adopt the regression equation as calculated

Forward selection works in the following way:

1. The process begins with no variables having been included in the regression equation.
2. The correlations of all the predictor variables with the dependent variable are calculated, and that predictor with the largest correlation is selected if its corresponding partial F-value is statistically significant at some predetermined level.
3. The independent variable selected at stage 2 is entered, and the regression equation is calculated.
4. At each successive stage the independent variable with the largest *partial* correlation coefficient is selected.
5. The corresponding partial F test value for this variable, denoted by F_H , is compared with a predetermined critical tabulated F-value, denoted by F_C. If:

   a. $F_H < F_C$, include that variable which gave the highest partial corresponding coefficient, recalculate the regression equation, and return to stage 4;

b. $F_H > F_C$ adopt the regression equation as calculated.

Stepwise selection works in the following way:

1. Calculate the correlations of all the predictor variables with the dependent variable. As the first variable to enter the regression, select the one most highly correlated with the criterion. Let X_i denote the selected predictor variable.
2. Regress Y on X_i. Retain in the fitted model if the overall F-test shows that the regression equation is statistically significant.
3. Calculate the partial correlation coefficients of all the variables not in the regression equation with the criterion. Select as the next variable to enter the one with the highest partial correlation coefficient. Denote the selected variable by X_j.
4. With both X_i and X_j in the model, compute the regression equation. Retain the new variable X_j in the regression equation if its partial F-value is statistically significant as compared to critical tabulated $(1-\alpha)$-values under the F-distribution with 1 and n-2-1 df.
5. Select as the next variable to enter the one most highly correlated with the dependent variable, given that the variables X_i and X_j are already in the regression equation. Denote this variable by X_k.
6. Enter the new variable X_k into the model, and compute the regression equation including X_i, X_j, and X_k. The decision as to whether (1) X_k should be included in the regression given that X_i and X_j are already in, (2) X_i warrants retention in the model given that X_j and X_k have been already included, and (3) X_j warrants retention in the model given that X_i and

X_k have been already included can be made on the basis of the partial F-values of the three variables.

7. The stepwise procedure continues in similar fashion. Termination occurs when no variable can be either entered or removed from the regression equation.

The various selection procedures can be viewed as useful approaches to selecting "good" subsets of predictor variables. Stevens (1992) state the following two rules of thumb for the selection of predictor variables in models.

1. Choose variables that correlate highly with the criterion but that have low intercorrelations.
2. To these variables add other variables that have low correlations with the criterion but that have high correlations with the other predictors.

C.3. DIAGNOSIS AND CHECKING MODEL ADEQUACY

In order to make reliable inferences from the chosen regression model the key assumptions that (1) the error (e) has a normal distribution, (2) the standard deviation of (e) is σ, which does not depend on observation x, have to hold. Inferences based on the regression model continue to be reliable when model assumptions are slightly violated (mild nonnormality of the random deviation distribution). However, use of an estimated model in the face of grossly violated assumptions can result in very misleading conclusions being drawn. Therefore it is desirable to check for model adequacy by inspecting that the model holds these assumptions. This is done by a number of steps which include residual analysis, and mutlicollinearity analysis.

C.3.1. Residual Analysis

Residual analysis is handled by plotting the computed standardized residuals resulting from the fit of the chosen model. Plots of the standardized residuals against each predictor variable in the model called standardized residual plots, are helpful in identifying unusual or highly influential observations and in checking for violations of model assumptions. That is, a plot of (X_1, standardized residual) pairs, another of (X_2, standardized residual) pairs, and so on. A desirable plot is one that exhibits no particular pattern (such as curvature or much greater spread in one part of the plot than in another), and one that has no point that is far removed from all the others. A point falling far above or below the horizontal line at height zero (an outlier) corresponds to a large standardized residual, which may indicate some kind of unusual behavior, such as recording error, a non standard experimental condition, or an atypical experimental subject. A point that has an x value that differs greatly from others in the data set could have exerted excessive influence in determining the fitted line (an influential). In case an observation is suspected, deleting the observation and refitting the model will reveal the extent of actual influence.

A good check that is performed in residual analysis is the normal probability plot of the standardized residuals. A normal probability plot of the standardized residuals that departs too much from a straight line casts doubt on the assumption that the random deviation (e) has a normal distribution.

C.3.1.1. Outliers

An outlier among a set of residuals is one that is much larger than the rest in absolute value, perhaps lying as many as three or more standard deviations from the mean of the residuals. Clearly, the presence of such an extreme value can significantly affect the least-squares fitting of a model, and so it is important to determine if the analysis should be modified in some way (such as by deleting the observation). An outlier in the data may indicate special circumstances warranting further investigation (e.g., such as the presence of an unanticipated interaction effect among the variables). Therefore, deleting the observation is not recommended immediately unless there is strong evidence that it resulted from a mistake (e.g., an error in data recording).

There are a number of statistical methods for detecting outliers that include jackknife residuals method, leverages method, and Cook's distance method. SAS provides all. Here the emphasis is on Cook's distance statistic which measures the level of the change to the parameter estimates that result from deleting the outlier observation. As a rule of thumb when the value of Cook's distance equals one for any observation that calls for checking and scrutinizing that observation.

C.3.2. Multicollinearity

Generally, when the fitted model includes *k* predictors X_1, X_2 , X_3 , ..., X_k there is said to be multicollinearity if there is a strong linear relationship between values of the predictors. Severe multicollinearity leads to instability of estimated coefficients. In order to identify such relationships, R^2 values for regressions in which the dependent variable is taken to be one of the *k* *X*'s and the predictors remaining (*k* -1) *X*'s, have to computed. Each regression yields an R^2 value. In general, there are *k* such regressions and, therefore, kR^2 resulting values. If one or more of these R^2 values is large (close to one), multicollinearity is present.

SAS procedure allows an options (TOL) in its model statement that when executed, prints tolerance values for the predictor variables included in the fitted model. Tolerance for a variable is defined as $(1- R^2)$, where R^2 is obtained from the regression of the variable on all other regressors (predictors) in the model. Therefore a high tolerance value for a predictor variable given by SAS output indicates low multicollinearity and appropriateness of including the variable in the fitted model. As a rule of thumb, when the TOL is 0, it means that the variables are related, when TOL <0.01, this indicates severe multicollinearity. In both of these cases, the SAS will automatically remove such variables. When the TOL <0.2, it causes interpretation and variable selection problems. In order to resolve the problem, variables intercorrelations must investigated and remove variables with high correlation.

C.4. INFERENCES BASED ON THE ESTIMATED MODEL

In the previous sections, a discussion was presented how to estimate the coefficients in the model $Y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \cdots\cdots + \beta_k x_k + e$ using the principle of least squares and then how the utility of the model could be confirmed by the application of the model utility F test. If the null hypothesis $H_o : \beta_1 = \beta_2 = \beta_3 = \cdots\cdots = \beta_k = 0$ can not be rejected at a reasonably small level of significance, it must be concluded that the model does not specify a useful relationship between Y and any of the predictor variables x_1, x_2, ..., x_k.. The investigator must search further for a model that does describe a useful relationship, perhaps by introducing different predictors or making variable transformations. Only if H_o can be rejected is it appropriate to proceed further with the chosen model and make inferences based on the estimated coefficients, a, b_1, b_2, ..., b_k and the estimated regression model $a - b_1 x_1 -$ . . . . . .$- b_k x_k$.

Appendix (D)-SAS Output

Part (I)

Results of 'RSQUARE' Model Selection Procedure

all possible regression procedure (RSQUARE)

N = 76 Regression Models for Dependent Variable: Y

In	R-square	Adj Rsq	C(p)	Variables in Model
1	0.621719	0.616607	288.6	D92
1	0.440049	0.432482	461.8	D72
1	0.336635	0.327671	560.4	D102
1	0.265280	0.255351	628.4	D22
1	0.181123	0.170057	708.6	D81
1	0.150713	0.107346	730.0	D32
1	0.146177	0.134639	742.0	D82
1	0.109530	0.097497	776.9	D71
1	0.098771	0.086592	787.2	D21
1	0.088130	0.075808	797.3	D11
1	0.078552	0.066100	806.4	D101
1	0.068413	0.055826	816.1	D52
1	0.067556	0.054955	816.9	D112
1	0.067032	0.054425	817.4	D31
1	0.057511	0.044774	826.5	D42
1	0.047100	0.034223	836.6	D12
1	0.042662	0.029725	840.6	D141
1	0.032771	0.019700	850.1	D62
1	0.032404	0.019410	850.3	D132
1	0.026710	0.013550	855.9	D131
1	0.026449	0.013293	856.1	D91
1	0.025331	0.012160	857.2	D121
1	0.007336	-.006080	874.3	D51
1	0.005752	-.007684	875.0	D61
1	0.005303	-.008098	876.2	D142
1	0.002465	-.011036	879.0	D111
1	0.000212	-.013290	881.1	D41
2	0.799075	0.793571	121.5	D101 D102
2	0.781549	0.775566	138.3	D91 D92
2	0.729292	0.721876	188.1	D21 D22
2	0.717892	0.710163	198.9	D72 D92
2	0.686900	0.678322	228.5	D82 D92
2	0.672976	0.664018	241.0	D92 D101
2	0.672149	0.663167	242.5	D52 D92
2	0.656010	0.647407	257.2	D22 D92
2	0.651540	0.641996	262.2	D61 D92
2	0.645166	0.635445	268.3	D31 D92
2	0.638561	0.628659	274.8	D32 D92
2	0.634314	0.624296	278.6	D41 D92
2	0.633317	0.622264	280.5	D92 D132
2	0.632267	0.622192	280.6	D81 D92
2	0.630819	0.620704	281.9	D92 D131
2	0.630591	0.620470	282.2	D92 D102
2	0.629163	0.619003	283.5	D62 D92
2	0.628407	0.618227	284.2	D12 D92
2	0.626662	0.616433	285.9	D71 D92
2	0.626065	0.615820	286.5	D92 D111
2	0.623062	0.612716	289.4	D92 D112
2	0.622620	0.612281	289.8	D92 D121
2	0.622206	0.611856	290.2	D51 D92
2	0.622189	0.611838	290.2	D92 D142

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
2	0.622173	0.611822	290.2	D32 D92
2	0.622030	0.611675	290.3	D11 D92
2	0.621787	0.611425	290.6	D42 D92
2	0.621736	0.611373	290.6	D92 D141
3	0.839010	0.832727	85.0849	D22 D101 D102
3	0.839151	0.832469	85.3399	D72 D101 D102
3	0.823290	0.815935	100.5	D92 D101 D102
3	0.819651	0.812137	103.9	D82 D91 D92
3	0.812842	0.805044	110.4	D21 D22 D92
3	0.811176	0.803309	112.0	D82 D101 D102
3	0.810127	0.802216	113.0	D81 D101 D102
3	0.808788	0.800820	114.3	D61 D101 D102
3	0.808507	0.800520	114.6	D51 D101 D102
3	0.807920	0.799917	115.1	D101 D102 D131
3	0.807905	0.799901	115.1	D62 D101 D102
3	0.805726	0.797631	117.2	D52 D91 D92
3	0.804843	0.796711	118.0	D71 D101 D102
3	0.803949	0.795780	118.9	D101 D102 D121
3	0.803809	0.795635	119.0	D101 D102 D112
3	0.803458	0.795269	119.4	D101 D102 D141
3	0.801660	0.793396	121.1	D42 D101 D102
3	0.801609	0.793343	121.1	D41 D101 D102
3	0.801496	0.793223	121.2	D31 D101 D102
3	0.801237	0.792955	121.5	D101 D102 D132
3	0.800736	0.792433	122.0	D52 D101 D102
3	0.800457	0.792122	122.2	D32 D101 D102
3	0.799784	0.791410	122.9	D91 D101 D102
3	0.799331	0.790970	123.3	D21 D101 D102
3	0.799237	0.790872	123.4	D11 D101 D102
3	0.799140	0.790771	123.5	D101 D102 D111
3	0.799133	0.790764	123.5	D101 D102 D142
3	0.799078	0.790708	123.5	D12 D101 D102
4	0.884263	0.877742	46.3360	D21 D22 D101 D102
4	0.867972	0.860536	59.0662	D22 D72 D101 D102
4	0.863702	0.856023	63.9347	D21 D22 D91 D92
4	0.855341	0.847191	71.9056	D81 D82 D101 D102
4	0.855027	0.846860	72.2065	D72 D92 D101 D102
4	0.850570	0.842160	76.4464	D21 D22 D82 D92
4	0.850431	0.842005	76.5861	D82 D92 D101 D102
4	0.850269	0.841833	76.7421	D61 D72 D101 D102
4	0.849886	0.841426	77.1001	D62 D72 D101 D102
4	0.849744	0.841300	77.2219	D72 D82 D101 D102
4	0.847622	0.839037	79.2661	D22 D81 D101 D102
4	0.847258	0.838653	79.6116	D72 D81 D101 D102
4	0.846856	0.838230	79.9963	D22 D101 D102 D131
4	0.845624	0.836927	81.1605	D72 D101 D102 D121
4	0.845499	0.836795	81.2881	D41 D42 D91 D92
4	0.845305	0.836590	81.4730	D91 D92 D131 D132
4	0.845204	0.836483	81.5695	D22 D82 D101 D102
4	0.844760	0.836014	81.9930	D21 D22 D61 D92
4	0.844391	0.835625	82.3639	D42 D72 D101 D102
4	0.843973	0.835183	82.7425	D71 D72 D101 D102
4	0.843842	0.835045	82.8875	D22 D51 D101 D102

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
4	0.843780	0.834958	82.9650	D72 D101 D102 D132
4	0.843695	0.834869	83.0081	D91 D92 D101 D102
4	0.843532	0.834695	83.1826	D22 D101 D102 D112
4	0.842702	0.833840	83.9550	D12 D22 D101 D102
4	0.842612	0.833765	84.0404	D61 D72 D101 D102
4	0.842451	0.833575	84.1962	D82 D92 D101 D102
4	0.842166	0.833272	84.4670	D72 D101 D102 D131
5	0.893902	0.886324	37.1445	D21 D22 D82 D101 D102
5	0.893045	0.885406	37.9613	D21 D22 D82 D91 D92
5	0.890850	0.883056	40.0541	D21 D22 D101 D102 D112
5	0.890040	0.882194	40.8192	D12 D21 D22 D101 D102
5	0.889849	0.881901	41.0000	D21 D22 D72 D101 D102
5	0.889695	0.881816	41.1556	D21 D22 D101 D102 D142
5	0.889050	0.881134	41.7625	D21 D22 D92 D101 D102
5	0.888215	0.880230	42.5666	D21 D22 D101 D102 D131
5	0.888189	0.880202	42.5912	D21 D22 D101 D102 D111
5	0.887697	0.879675	43.0604	D21 D22 D81 D101 D102
5	0.887066	0.878999	43.6617	D21 D22 D101 D102 D121
5	0.885707	0.877543	44.9577	D11 D21 D22 D101 D102
5	0.885656	0.877488	45.0061	D21 D22 D51 D101 D102
5	0.885569	0.877395	45.0880	D21 D22 D71 D101 D102
5	0.885376	0.877188	45.2731	D21 D22 D52 D101 D102
5	0.885361	0.877173	45.2869	D21 D22 D32 D101 D102
5	0.885353	0.877164	45.2942	D21 D22 D101 D102 D141
5	0.885139	0.876935	45.4986	D21 D22 D62 D101 D102
5	0.885048	0.876837	45.5858	D72 D81 D82 D101 D102
5	0.884810	0.876591	45.8044	D21 D22 D41 D101 D102
5	0.884756	0.876522	45.8661	D21 D22 D61 D101 D102
5	0.884505	0.876255	46.1035	D21 D22 D31 D101 D102
5	0.884472	0.876220	46.1346	D21 D22 D42 D101 D102
5	0.884382	0.876080	46.2509	D21 D22 D101 D102 D132
5	0.884332	0.876070	46.2601	D21 D22 D91 D101 D102
5	0.881171	0.872683	49.2817	D21 D22 D81 D82 D92
5	0.879422	0.870810	50.9405	D21 D22 D61 D82 D92
5	0.877061	0.868280	53.1993	D21 D22 D52 D91 D92
6	0.916045	0.908745	10.0352	D21 D22 D81 D82 D101 D102
6	0.902910	0.894467	30.5577	D21 D22 D81 D82 D91 D92
6	0.902481	0.894001	30.9662	D21 D22 D82 D92 D101 D102
6	0.902426	0.893941	31.0191	D12 D21 D22 D82 D101 D102
6	0.901789	0.893248	31.6264	D21 D22 D82 D91 D92 D102
6	0.901212	0.892621	32.1763	D12 D21 D22 D82 D91 D92
6	0.900362	0.891696	33.0056	D21 D22 D82 D101 D102 D131
6	0.900067	0.891377	33.2680	D21 D22 D82 D101 D102 D112
6	0.900016	0.891322	33.3150	D21 D22 D82 D91 D92 D111
6	0.899619	0.890890	33.6949	D21 D22 D82 D101 D102 D142
6	0.899414	0.890667	33.8905	D21 D22 D82 D91 D92 D131
6	0.899151	0.890382	34.1408	D21 D22 D71 D82 D91 D92
6	0.899011	0.890230	34.2739	D22 D72 D81 D82 D101 D102
6	0.898590	0.889780	34.6804	D21 D22 D72 D82 D101 D102
6	0.898535	0.889712	34.7279	D21 D22 D71 D72 D101 D102
6	0.898335	0.889494	34.9180	D21 D22 D91 D92 D101 D102
6	0.898086	0.889224	35.1559	D21 D22 D51 D82 D101 D102
6	0.898066	0.889203	35.1755	D21 D22 D61 D82 D91 D92

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
6	0.897894	0.889015	35.3392	D12 D21 D22 D101 D102 D112
6	0.897810	0.888924	35.4192	D21 D22 D82 D91 D92 D102
6	0.897289	0.888358	35.9154	D21 D22 D82 D101 D102 D121
6	0.897051	0.888098	36.1432	D21 D22 D42 D82 D91 D92
6	0.896967	0.888007	36.2232	D21 D22 D101 D102 D141 D142
6	0.896725	0.887745	36.4531	D11 D21 D22 D82 D91 D92
6	0.896725	0.887745	36.4535	D21 D22 D82 D91 D92 D112
6	0.896681	0.887696	36.4957	D21 D22 D82 D101 D102 D111
6	0.896656	0.887670	36.5190	D11 D21 D22 D82 D101 D102
6	0.896062	0.887024	37.0856	D72 D81 D82 D92 D101 D102
7	0.922761	0.914810	13.6331	D21 D22 D81 D82 D101 D102 D131
7	0.921615	0.913546	14.7253	D21 D22 D81 D82 D101 D102 D112
7	0.920461	0.912274	15.8252	D21 D22 D81 D82 D92 D101 D102
7	0.920338	0.912138	15.9429	D21 D22 D81 D82 D101 D102 D142
7	0.920065	0.911836	16.2035	D21 D22 D72 D81 D82 D101 D102
7	0.919139	0.910815	17.0860	D12 D21 D22 D81 D82 D101 D102
7	0.917540	0.909056	18.6068	D21 D22 D32 D81 D82 D101 D102
7	0.917181	0.908655	18.9530	D11 D21 D22 D81 D82 D101 D102
7	0.917059	0.908520	19.0693	D21 D22 D81 D82 D101 D102 D141
7	0.916860	0.908310	19.2513	D21 D22 D81 D82 D101 D102 D121
7	0.916841	0.908280	19.2768	D21 D22 D51 D81 D82 D101 D102
7	0.916596	0.908010	19.5107	D21 D22 D81 D82 D101 D102 D111
7	0.916548	0.907957	19.5565	D21 D22 D71 D81 D82 D101 D102
7	0.916460	0.907860	19.6402	D21 D22 D31 D81 D82 D101 D102
7	0.916347	0.907735	19.7481	D21 D22 D81 D82 D91 D101 D102
7	0.916330	0.907717	19.7634	D21 D22 D52 D81 D82 D101 D102
7	0.916140	0.907516	19.9376	D21 D22 D61 D81 D82 D101 D102
7	0.916084	0.907445	19.9900	D21 D22 D62 D81 D82 D101 D102
7	0.916079	0.907440	20.0031	D21 D22 D42 D81 D82 D101 D102
7	0.916059	0.907419	20.0217	D21 D22 D81 D82 D101 D102 D132
7	0.916046	0.907403	20.0360	D21 D22 D41 D81 D82 D101 D102
7	0.912587	0.903589	23.3310	D21 D22 D82 D91 D92 D101 D102
7	0.912397	0.903379	23.5134	D21 D22 D82 D91 D92 D131 D132
7	0.911344	0.902210	24.5169	D21 D22 D81 D82 D91 D92 D142
7	0.910015	0.900752	25.7860	D12 D21 D22 D82 D101 D102 D112
7	0.909897	0.900622	25.8963	D12 D21 D22 D82 D92 D101 D102
7	0.909577	0.900269	26.2010	D21 D22 D81 D82 D91 D92 D131
7	0.909360	0.900029	26.4080	D21 D22 D81 D82 D91 D92 D102
8	0.928149	0.919569	10.4971	D21 D22 D81 D82 D101 D102 D131 D132
8	0.928077	0.919489	10.5655	D21 D22 D81 D82 D101 D102 D112 D131
8	0.927307	0.918627	11.2993	D21 D22 D81 D82 D92 D101 D102 D131
8	0.926730	0.917991	11.8413	D21 D22 D81 D82 D101 D102 D141 D142
8	0.925632	0.916752	12.8965	D12 D21 D22 D81 D82 D101 D102 D112
8	0.925627	0.916747	12.9009	D21 D22 D81 D82 D101 D102 D131 D142
8	0.925450	0.916549	13.0693	D21 D22 D81 D82 D101 D102 D121 D131
8	0.925396	0.916488	13.1214	D21 D22 D81 D82 D101 D102 D112 D142
8	0.925217	0.916288	13.2918	D21 D22 D72 D81 D82 D101 D102 D131
8	0.925130	0.916190	13.3748	D21 D22 D81 D82 D92 D101 D102 D142
8	0.925004	0.916049	13.4949	D21 D22 D71 D72 D81 D82 D101 D102
8	0.924902	0.915935	13.5919	D21 D22 D81 D82 D92 D101 D102 D112
8	0.924602	0.915599	13.8781	D12 D21 D22 D81 D82 D101 D102 D131
8	0.924202	0.915151	14.2596	D21 D22 D72 D81 D82 D101 D102 D112
8	0.924111	0.915049	14.3463	D21 D22 D72 D81 D82 D92 D101 D102

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In	R-square	Adj Req	C(p)	Variables in Model
8	0.923865	0.914752	14.5999	D21 D22 D81 D82 D91 D92 D101 D102
8	0.923810	0.914723	14.6255	D11 D21 D22 D81 D82 D101 D102 D112
8	0.923581	0.914456	14.8513	D21 D22 D52 D81 D82 D101 D102 D131
8	0.923429	0.914206	14.9964	D21 D22 D71 D81 D82 D101 D102 D131
8	0.923390	0.914163	15.0330	D12 D21 D22 D81 D82 D92 D101 D102
8	0.923261	0.914090	15.1566	D11 D21 D22 D81 D82 D101 D102 D131
8	0.923239	0.914074	15.1769	D21 D22 D81 D82 D91 D92 D131 D132
8	0.923133	0.913955	15.2786	D21 D22 D81 D82 D91 D101 D102 D131
8	0.923075	0.913890	15.3337	D21 D22 D72 D81 D82 D101 D102 D142
8	0.923073	0.913888	15.3356	D21 D22 D81 D82 D101 D102 D131 D141
8	0.923007	0.913816	15.3986	D21 D22 D32 D81 D82 D101 D102 D131
8	0.922996	0.913802	15.4089	D21 D22 D51 D81 D82 D101 D102 D131
8	0.922972	0.913776	15.4332	D21 D22 D61 D81 D82 D101 D102 D131
9	0.932976	0.923836	7.8953	D21 D22 D81 D82 D92 D101 D102 D131 D132
9	0.932386	0.923166	8.4575	D21 D22 D81 D82 D101 D102 D112 D131 D132
9	0.931501	0.922160	9.3015	D21 D22 D81 D82 D92 D101 D102 D112 D131
9	0.931227	0.921849	9.5622	D21 D22 D72 D81 D82 D101 D102 D131 D132
9	0.930650	0.921202	10.1050	D12 D21 D22 D81 D82 D101 D102 D112 D131
9	0.930553	0.921083	10.2048	D21 D22 D81 D82 D101 D102 D112 D131 D142
9	0.930474	0.920993	10.2800	D21 D22 D81 D82 D92 D101 D102 D131 D142
9	0.930472	0.920990	10.2825	D21 D22 D81 D82 D91 D92 D101 D102 D131
9	0.930459	0.920976	10.2967	D21 D22 D71 D72 D81 D82 D92 D101 D102
9	0.930278	0.920771	10.4660	D21 D22 D81 D82 D101 D102 D121 D131 D132
9	0.929889	0.920320	10.8300	D21 D22 D81 D82 D91 D92 D102 D131 D132
9	0.929823	0.920254	10.9005	D12 D21 D22 D81 D82 D101 D102 D131 D132
9	0.929686	0.920097	11.0317	D21 D22 D81 D82 D101 D102 D131 D132 D142
9	0.929595	0.919994	11.1186	D21 D22 D81 D82 D101 D102 D112 D141 D142
9	0.929476	0.919857	11.2330	D21 D22 D71 D72 D81 D82 D101 D102 D131
9	0.929458	0.919838	11.2490	D21 D22 D72 D81 D82 D101 D102 D112 D131
9	0.929452	0.919832	11.2540	D21 D22 D72 D81 D82 D92 D101 D102 D131
9	0.929383	0.919753	11.3206	D21 D22 D81 D82 D92 D101 D102 D141 D142
9	0.929338	0.919703	11.3629	D11 D21 D22 D81 D82 D101 D102 D112 D131
9	0.929291	0.919649	11.4076	D21 D22 D52 D81 D82 D92 D101 D102 D131
9	0.929264	0.919618	11.4340	D21 D22 D81 D82 D101 D102 D131 D141 D142
9	0.929065	0.919370	11.6420	D21 D22 D81 D82 D92 D101 D102 D112 D142
9	0.929007	0.919324	11.6787	D12 D21 D22 D81 D82 D92 D101 D102 D131
9	0.928946	0.919256	11.7372	D21 D22 D71 D81 D82 D101 D102 D112 D131
9	0.928938	0.919248	11.7445	D21 D22 D52 D81 D82 D101 D102 D131 D132
9	0.928930	0.919239	11.7517	D21 D22 D81 D82 D101 D102 D131 D132 D141
9	0.928852	0.919149	11.8269	D12 D21 D22 D81 D82 D101 D102 D112 D142
9	0.928830	0.919125	11.8475	D21 D22 D81 D82 D101 D102 D112 D121 D131
10	0.939519	0.930216	3.6576	D21 D22 D81 D82 D91 D92 D101 D102 D131 D132
10	0.936152	0.926330	6.8669	D21 D22 D81 D82 D92 D101 D102 D112 D131 D132
10	0.935710	0.925819	7.2880	D21 D22 D72 D81 D82 D92 D101 D102 D131 D132
10	0.935035	0.925041	7.9320	D21 D22 D71 D72 D81 D82 D92 D101 D102 D131
10	0.934951	0.924944	8.0120	D21 D22 D52 D81 D82 D92 D101 D102 D131 D132
10	0.934735	0.924675	8.2375	D12 D21 D22 D81 D82 D101 D102 D112 D131 D132
10	0.934733	0.924668	8.2399	D21 D22 D81 D82 D92 D101 D102 D131 D132 D142
10	0.934500	0.924432	8.4345	D12 D21 D22 D81 D82 D92 D101 D102 D131 D132
10	0.934321	0.924217	8.6126	D21 D22 D72 D81 D82 D101 D102 D112 D131 D132
10	0.934266	0.924153	8.6652	D21 D22 D81 D82 D92 D101 D102 D112 D131 D142
10	0.934235	0.924117	8.6950	D21 D22 D61 D81 D82 D92 D101 D102 D131 D132
10	0.933992	0.923837	8.9260	D21 D22 D81 D82 D92 D101 D102 D121 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Req	C(p)	Variables in Model
10	0.933962	0.923779	8.9744	D21 D22 D81 D82 D91 D92 D101 D102 D112 D131
10	0.933901	0.923732	9.0120	D21 D22 D71 D72 D81 D82 D101 D102 D131 D132
10	0.933850	0.923683	9.0539	D12 D21 D22 D81 D82 D92 D101 D102 D112 D131
10	0.933773	0.923585	9.1349	D21 D22 D81 D82 D101 D102 D112 D131 D132 D142
10	0.933530	0.923306	9.3670	D21 D22 D52 D81 D82 D91 D92 D102 D131 D132
10	0.933524	0.923297	9.3722	D21 D22 D72 D81 D82 D101 D102 D121 D131 D132
10	0.933490	0.923258	9.4049	D11 D21 D22 D81 D82 D101 D102 D112 D131 D132
10	0.933479	0.923245	9.4155	D21 D22 D81 D82 D101 D102 D131 D132 D141 D142
10	0.933426	0.923184	9.4650	D21 D22 D71 D81 D82 D92 D101 D102 D131 D132
10	0.933407	0.923162	9.4843	D21 D22 D62 D81 D82 D92 D101 D102 D131 D132
10	0.933288	0.923026	9.5970	D21 D22 D51 D81 D82 D92 D101 D102 D131 D132
10	0.933273	0.923007	9.6123	D21 D22 D81 D82 D91 D92 D101 D102 D131 D142
10	0.933210	0.922935	9.6717	D21 D22 D71 D72 D81 D82 D101 D102 D112 D131
10	0.933146	0.922858	9.7349	D21 D22 D31 D81 D82 D92 D101 D102 D131 D132
10	0.933130	0.922840	9.7500	D21 D22 D81 D82 D92 D101 D102 D131 D132 D141
10	0.933111	0.922820	9.7665	D21 D22 D52 D81 D82 D92 D101 D102 D112 D131
11	0.941536	0.931488	3.7344	D21 D22 D52 D81 D82 D91 D92 D101 D102 D131 D132
11	0.941516	0.931466	3.7515	D21 D22 D81 D82 D91 D92 D101 D102 D112 D131 D132
11	0.940756	0.930573	4.4786	D12 D21 D22 D81 D82 D91 D92 D101 D102 D131 D132
11	0.940718	0.930529	4.5143	D21 D22 D62 D81 D82 D91 D92 D101 D102 D131 D132
11	0.940518	0.930295	4.7050	D21 D22 D81 D82 D91 D92 D101 D102 D131 D132 D142
11	0.940227	0.929954	4.9825	D21 D22 D41 D81 D82 D91 D92 D101 D102 D131 D132
11	0.940157	0.929872	5.0400	D21 D22 D71 D81 D82 D91 D92 D101 D102 D131 D132
11	0.940039	0.929733	5.1610	D21 D22 D51 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939980	0.929664	5.2179	D21 D22 D81 D82 D91 D92 D101 D102 D111 D131 D132
11	0.939952	0.929631	5.2445	D21 D22 D72 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939891	0.929559	5.3032	D21 D22 D81 D82 D91 D92 D101 D102 D121 D131 D132
11	0.939851	0.929513	5.3400	D21 D22 D61 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939693	0.929327	5.4919	D11 D21 D22 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939639	0.929265	5.5430	D21 D22 D42 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939537	0.929145	5.6404	D21 D22 D32 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939531	0.929138	5.6462	D21 D22 D81 D82 D91 D92 D101 D102 D131 D132 D141
11	0.939527	0.929133	5.6500	D21 D22 D31 D81 D82 D91 D92 D101 D102 D131 D132
11	0.939449	0.929042	5.7239	D21 D22 D71 D72 D81 D82 D92 D101 D102 D131 D132
11	0.938249	0.927636	6.8679	D12 D21 D22 D81 D82 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Req	C(p)	Variables in Model
11	0.937970	0.927308	7.1344	D21 D22 D72 D81 D82 D92 D101 D102 D112 D131 D132
11	0.937824	0.927137	7.2736	D21 D22 D61 D81 D82 D92 D101 D102 D112 D131 D132
11	0.937800	0.927110	7.2957	D21 D22 D52 D81 D82 D92 D101 D102 D112 D131 D132
11	0.937729	0.927026	7.3642	D21 D22 D81 D82 D92 D101 D102 D112 D131 D132 D142
11	0.937709	0.927003	7.3829	D21 D22 D71 D72 D81 D82 D92 D101 D102 D112 D131
11	0.937223	0.926433	7.8467	D21 D22 D52 D72 D81 D82 D92 D101 D102 D131 D132
11	0.937120	0.926312	7.9444	D12 D21 D22 D72 D81 D82 D92 D101 D102 D131 D132
11	0.937112	0.926303	7.9518	D21 D22 D61 D72 D81 D82 D92 D101 D102 D131 D132
11	0.936888	0.926041	8.1654	D21 D22 D62 D81 D82 D92 D101 D102 D112 D131 D132
12	0.943265	0.932450	4.0866	D21 D22 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.943190	0.932369	4.1577	D12 D21 D22 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.943026	0.932174	4.3140	D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D131 D132
12	0.943012	0.932157	4.3275	D21 D22 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.942517	0.931560	4.7990	D21 D22 D52 D62 D81 D82 D91 D92 D101 D102 D131 D132
12	0.942504	0.931552	4.8122	D12 D21 D22 D52 D81 D82 D91 D92 D101 D102 D131 D132
12	0.942470	0.931512	4.8445	D21 D22 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
12	0.942273	0.931278	5.0318	D21 D22 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.942215	0.931209	5.0868	D21 D22 D41 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.942145	0.931126	5.1536	D21 D22 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
12	0.942105	0.931077	5.1926	D21 D22 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.942043	0.931004	5.2510	D21 D22 D52 D71 D81 D82 D91 D92 D101 D102 D131 D132
12	0.942036	0.930995	5.2579	D21 D22 D52 D81 D82 D91 D92 D101 D102 D121 D131 D132
12	0.942035	0.930994	5.2587	D11 D21 D22 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.942001	0.930954	5.2911	D21 D22 D51 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.941973	0.930920	5.3181	D21 D22 D41 D42 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941896	0.930828	5.3919	D21 D22 D52 D81 D82 D91 D92 D101 D102 D131 D132 D142
12	0.941787	0.930699	5.4955	D21 D22 D32 D81 D82 D91 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Req	C(p)	Variables in Model
12	0.941777	0.930687	5.5048	D12 D21 D22 D62 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941772	0.930681	5.5095	D21 D22 D52 D72 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941770	0.930679	5.5111	D11 D21 D22 D52 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941747	0.930651	5.5335	D21 D22 D52 D61 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941730	0.930640	5.5423	D21 D22 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.941707	0.930603	5.5720	D21 D22 D52 D81 D82 D91 D92 D101 D102 D111 D131 D132
12	0.941697	0.930591	5.5816	D21 D22 D31 D81 D82 D91 D92 D101 D102 D112 D131 D132
12	0.941673	0.930564	5.6035	D12 D21 D22 D81 D82 D91 D92 D101 D102 D131 D132 D142
12	0.941638	0.930521	5.6377	D21 D22 D51 D52 D81 D82 D91 D92 D101 D102 D131 D132
12	0.941627	0.930508	5.6488	D21 D22 D31 D52 D81 D82 D91 D92 D101 D102 D131 D132
13	0.944791	0.933215	4.6317	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D131 D132
13	0.944686	0.933088	4.7314	D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.944618	0.933006	4.7962	D12 D21 D22 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.944514	0.932880	4.8952	D21 D22 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.944402	0.932841	4.9262	D12 D21 D22 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.944046	0.932314	5.3419	D12 D21 D22 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
13	0.944023	0.932205	5.3661	D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D131 D132
13	0.943979	0.932232	5.4050	D12 D21 D22 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943926	0.932166	5.4501	D12 D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D131 D132
13	0.943880	0.932113	5.5000	D21 D22 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943875	0.932107	5.5048	D12 D21 D22 D41 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943849	0.932076	5.5295	D11 D21 D22 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943782	0.931994	5.5939	D21 D22 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943762	0.931970	5.6126	D21 D22 D41 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943753	0.931960	5.6209	D21 D22 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
13	0.943723	0.931923	5.6500	D21 D22 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943681	0.931872	5.6895	D21 D22 D52 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
13	0.943634	0.931815	5.7344	D21 D22 D31 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943633	0.931814	5.7359	D21 D22 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
13	0.943610	0.931786	5.7570	D21 D22 D32 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943551	0.931714	5.8140	D21 D22 D51 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943499	0.931652	5.8632	D12 D21 D22 D32 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943499	0.931652	5.8636	D12 D21 D22 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943473	0.931620	5.8884	D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D121 D131 D132
13	0.943449	0.931591	5.9113	D12 D21 D22 D31 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943436	0.931576	5.9232	D21 D22 D41 D52 D71 D81 D82 D91 D92 D101 D102 D131 D132
13	0.943432	0.931571	5.9274	D12 D21 D22 D51 D81 D82 D91 D92 D101 D102 D112 D131 D132
13	0.943427	0.931565	5.9320	D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D131 D132 D142
14	0.945951	0.933547	5.5253	D12 D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945947	0.933542	5.5292	D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945903	0.933487	5.5718	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945718	0.933260	5.7474	D12 D21 D22 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945687	0.933222	5.7772	D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D131 D132
14	0.945671	0.933202	5.7930	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D121 D131 D132
14	0.945653	0.933180	5.8099	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D131 D132
14	0.945409	0.932880	6.0424	D12 D21 D22 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945408	0.932878	6.0430	D11 D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945272	0.932712	6.1726	D12 D21 D22 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945226	0.932655	6.2165	D21 D22 D41 D52 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945225	0.932653	6.2181	D12 D21 D22 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945214	0.932640	6.2281	D12 D21 D22 D61 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945195	0.932616	6.2460	D21 D22 D41 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945155	0.932568	6.2845	D12 D21 D22 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
14	0.945142	0.932552	6.2969	D21 D22 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
14	0.945108	0.932510	6.3296	D21 D22 D41 D42 D52 D61 D81 D82 D91 D92 D101 D102 D131 D132
14	0.945102	0.932502	6.3355	D21 D22 D41 D42 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
14	0.945100	0.932501	6.3365	D21 D22 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945095	0.932494	6.3410	D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
14	0.945064	0.932456	6.3713	D12 D21 D22 D31 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.945023	0.932406	6.4100	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D131 D132 D142
14	0.945010	0.932390	6.4225	D21 D22 D32 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.944998	0.932375	6.4342	D21 D22 D41 D42 D52 D62 D81 D82 D91 D92 D101 D102 D131 D132
14	0.944994	0.932370	6.4376	D12 D21 D22 D32 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.944973	0.932343	6.4584	D12 D21 D22 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
14	0.944964	0.932333	6.4666	D21 D22 D31 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
14	0.944946	0.932308	6.4861	D11 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D131 D132
15	0.947072	0.933839	6.4575	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.947067	0.933834	6.4620	D12 D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946830	0.933538	6.6876	D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946790	0.933487	6.7260	D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
15	0.946693	0.933366	6.8184	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D121 D131 D132
15	0.946579	0.933223	6.9274	D12 D21 D22 D42 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946572	0.933215	6.9340	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D131 D132
15	0.946497	0.933122	7.0048	D12 D21 D22 D41 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946420	0.933036	7.0705	D21 D22 D41 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946413	0.933016	7.0857	D21 D22 D41 D42 D52 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946373	0.932966	7.1237	D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D121 D131 D132
15	0.946368	0.932961	7.1278	D21 D22 D41 D42 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946345	0.932931	7.1501	D12 D21 D22 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
15	0.946342	0.932928	7.1527	D12 D21 D22 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946332	0.932915	7.1621	D11 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
15	0.946311	0.932089	7.1026	D11 D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946305	0.932082	7.1079	D12 D21 D22 D32 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946288	0.932060	7.2045	D21 D22 D32 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946273	0.932041	7.2187	D12 D21 D22 D41 D42 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
15	0.946265	0.932031	7.2263	D12 D21 D22 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946262	0.932028	7.2292	D12 D21 D22 D41 D52 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946255	0.932019	7.2359	D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
15	0.946244	0.932005	7.2466	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
15	0.946242	0.932003	7.2483	D12 D21 D22 D31 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946215	0.932769	7.2740	D12 D21 D22 D31 D41 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946210	0.932763	7.2787	D21 D22 D31 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
15	0.946166	0.932706	7.3223	D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
15	0.946133	0.932666	7.3520	D11 D21 D22 D41 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.948030	0.933937	7.5433	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947707	0.933526	7.8510	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
16	0.947672	0.933481	7.8852	D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947505	0.933371	7.9676	D12 D21 D22 D41 D42 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947504	0.933370	7.9687	D12 D21 D22 D41 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947539	0.933313	8.0115	D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
16	0.947470	0.933225	8.0772	D12 D21 D22 D41 D42 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947461	0.933213	8.0866	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
16	0.947435	0.933181	8.1106	D12 D21 D22 D32 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947430	0.933174	8.1159	D11 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947399	0.933134	8.1454	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D121 D131 D132
16	0.947391	0.933124	8.1532	D12 D21 D22 D31 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947368	0.933094	8.1752	D12 D21 D22 D41 D42 D52 D61 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947368	0.933094	8.1753	D12 D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
16	0.947327	0.933043	8.2141	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
16	0.947306	0.933013	8.2363	D12 D21 D22 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947277	0.932979	8.2610	D12 D21 D22 D32 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947248	0.932942	8.2895	D12 D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
16	0.947183	0.932859	8.3515	D12 D21 D22 D41 D42 D51 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947168	0.932841	8.3654	D12 D21 D22 D41 D52 D62 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
16	0.947159	0.932829	8.3745	D12 D21 D22 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
16	0.947155	0.932824	8.3770	D12 D21 D22 D31 D41 D42 D52 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947146	0.932813	8.3863	D12 D21 D22 D41 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947142	0.932808	8.3903	D21 D22 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947108	0.932764	8.4220	D12 D21 D22 D41 D51 D52 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947102	0.932757	8.4286	D12 D21 D22 D41 D52 D61 D62 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947102	0.932756	8.4288	D21 D22 D41 D42 D52 D61 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
16	0.947097	0.932750	8.4332	D12 D21 D22 D41 D52 D62 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948869	0.933882	8.7461	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948609	0.933546	8.9932	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
17	0.948285	0.933127	9.3011	D12 D21 D22 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948273	0.933112	9.3116	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
17	0.948260	0.933095	9.3245	D12 D21 D22 D32 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948243	0.933073	9.3407	D11 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948205	0.933024	9.3771	D12 D21 D22 D41 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948163	0.932969	9.4174	D12 D21 D22 D31 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948159	0.932964	9.4207	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
17	0.948145	0.932946	9.4341	D12 D21 D22 D41 D42 D52 D61 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948132	0.932929	9.4466	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
17	0.948065	0.932842	9.5107	D11 D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948053	0.932827	9.5222	D12 D21 D22 D41 D42 D51 D52 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
17	0.948044	0.932815	9.5307	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D131 D132
17	0.948034	0.932802	9.5400	D12 D21 D22 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132
17	0.948016	0.932779	9.5572	D12 D21 D22 D31 D41 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.948003	0.932762	9.5697	D12 D21 D22 D32 D41 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947967	0.932715	9.6042	D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
17	0.947947	0.932690	9.6233	D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947919	0.932654	9.6493	D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947904	0.932635	9.6635	D12 D21 D22 D31 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947878	0.932600	9.6890	D11 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
17	0.947853	0.932568	9.7127	D12 D21 D22 D41 D42 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947848	0.932562	9.7174	D12 D21 D22 D41 D42 D51 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
17	0.947826	0.932534	9.7379	D12 D21 D22 D41 D42 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
17	0.947816	0.932520	9.7481	D12 D21 D22 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D131 D132
17	0.947798	0.932498	9.7646	D12 D21 D22 D41 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
17	0.947788	0.932484	9.7740	D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.949206	0.933166	10.4222	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
18	0.949065	0.932980	10.5570	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948994	0.932887	10.6246	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948986	0.932876	10.6327	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948983	0.932872	10.6356	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948948	0.932826	10.6686	D12 D21 D22 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948906	0.932772	10.7083	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
18	0.948896	0.932758	10.7186	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132
18	0.948895	0.932757	10.7187	D11 D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948883	0.932741	10.7306	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
18	0.948732	0.932529	10.8841	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D121 D131 D132
18	0.948710	0.932514	10.8951	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
18	0.948640	0.932431	10.9550	D12 D21 D22 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.948639	0.932419	10.9637	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.948625	0.932401	10.9769	D12 D21 D22 D31 D41 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948610	0.932381	10.9909	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132 D141
18	0.948610	0.932381	10.9910	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.948609	0.932380	10.9919	D11 D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.948609	0.932380	10.9920	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132
18	0.948609	0.932380	10.9920	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D121 D131 D132 D142
18	0.948559	0.932315	11.0396	D12 D21 D22 D32 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948526	0.932271	11.0710	D11 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
18	0.948508	0.932248	11.0878	D12 D21 D22 D32 D41 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948494	0.932228	11.1019	D12 D21 D22 D31 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132
18	0.948471	0.932198	11.1237	D12 D21 D22 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
18	0.948456	0.932176	11.1399	D12 D21 D22 D32 D41 D42 D52 D71 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
18	0.948420	0.932143	11.1639	D12 D21 D22 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
18	0.948412	0.932131	11.1793	D12 D21 D22 D41 D42 D52 D62 D71 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
19	0.949352	0.932168	12.2833	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949341	0.932153	12.2938	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949285	0.932078	12.3476	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949283	0.932075	12.3497	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949249	0.932029	12.3821	D12 D21 D22 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949243	0.932021	12.3878	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949235	0.932011	12.3954	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
19	0.949226	0.931999	12.4038	D11 D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
19	0.949224	0.931996	12.4050	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949214	0.931983	12.4154	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
19	0.949213	0.931981	12.4162	D12 D21 D22 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
19	0.949120	0.931060	12.4966	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
19	0.949116	0.931052	12.5006	D12 D21 D22 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949111	0.931045	12.5130	D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949099	0.931029	12.5247	D12 D21 D22 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949085	0.931010	12.5301	D12 D21 D22 D32 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949083	0.931007	12.5403	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132
19	0.949081	0.931805	12.5410	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
19	0.949073	0.931794	12.5496	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
19	0.949071	0.931792	12.5510	D11 D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949070	0.931790	12.5523	D12 D21 D22 D31 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949066	0.931785	12.5560	D12 D21 D22 D32 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949050	0.931763	12.5715	D12 D21 D22 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949032	0.931739	12.5884	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132
19	0.949032	0.931739	12.5885	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
19	0.949010	0.931720	12.6023	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132
19	0.949016	0.931717	12.6042	D11 D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
19	0.949012	0.931712	12.6080	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D142
20	0.949466	0.931090	14.1749	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949447	0.931063	14.1934	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949437	0.931051	14.2031	D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949429	0.931040	14.2096	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
20	0.949407	0.931009	14.2315	D12 D21 D22 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949406	0.931008	14.2321	D12 D21 D22 D32 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949389	0.930985	14.2482	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
20	0.949381	0.930974	14.2559	D12 D21 D22 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949368	0.930957	14.2681	D12 D21 D22 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949368	0.930956	14.2686	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
20	0.949360	0.930945	14.2759	D11 D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949357	0.930941	14.2792	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
20	0.949349	0.930931	14.2862	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
20	0.949346	0.930927	14.2890	D11 D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949345	0.930926	14.2898	D12 D21 D22 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
20	0.949332	0.930907	14.3030	D12 D21 D22 D31 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949325	0.930897	14.3096	D12 D21 D22 D32 D41 D42 D51 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949314	0.930882	14.3200	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
20	0.949302	0.930866	14.3315	D11 D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949301	0.930865	14.3322	D11 D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949301	0.930865	14.3323	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
20	0.949298	0.930861	14.3350	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
20	0.949298	0.930860	14.3354	D12 D21 D22 D31 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
20	0.949297	0.930860	14.3359	D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132
20	0.949296	0.930856	14.3386	D12 D21 D22 D31 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
20	0.949290	0.930850	14.3425	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
20	0.949288	0.930848	14.3462	D12 D21 D22 D32 D41 D42 D52 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
20	0.949286	0.930844	14.3465	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D131 D132 D141
21	0.949524	0.929895	16.1193	D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949500	0.929861	16.1423	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949498	0.929858	16.1443	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949498	0.929858	16.1444	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
21	0.949497	0.929857	16.1451	D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949488	0.929844	16.1539	D12 D21 D22 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949485	0.929840	16.1560	D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
21	0.949480	0.929833	16.1617	D12 D21 D22 D32 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949478	0.929831	16.1630	D12 D21 D22 D31 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949474	0.929825	16.1670	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
21	0.949472	0.929822	16.1693	D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949470	0.929819	16.1710	D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949469	0.929818	16.1719	D11 D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949469	0.929818	16.1720	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
21	0.949463	0.929809	16.1778	D12 D21 D22 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949456	0.929800	16.1843	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
21	0.949451	0.929793	16.1891	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
21	0.949449	0.929790	16.1910	D11 D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949447	0.929787	16.1932	D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
21	0.949445	0.929785	16.1944	D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
21	0.949445	0.929784	16.1951	D11 D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949439	0.929776	16.2009	D12 D21 D22 D31 D32 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949438	0.929775	16.2018	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
21	0.949436	0.929772	16.2038	D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
21	0.949434	0.929769	16.2053	D12 D21 D22 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949436	0.929769	16.2057	D11 D12 D21 D22 D41 D42 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
21	0.949429	0.929763	16.2099	D12 D21 D22 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
21	0.949421	0.929751	16.2100	D12 D21 D22 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142

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all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
22	0.949586	0.928660	18.0603	D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949563	0.928627	18.0824	D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949551	0.928610	18.0938	D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
22	0.949536	0.928589	18.1079	D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949535	0.928587	18.1091	D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949531	0.928582	18.1126	D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
22	0.949531	0.928582	18.1128	D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
22	0.949527	0.928577	18.1162	D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
22	0.949526	0.928574	18.1177	D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
22	0.949525	0.928574	18.1182	D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949519	0.928566	18.1246	D12 D21 D22 D31 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949515	0.928558	18.1285	D12 D21 D22 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949514	0.928558	18.1289	D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
22	0.949513	0.928557	18.1295	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
22	0.949512	0.928555	18.1306	D12 D21 D22 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
22	0.949510	0.928552	18.1330	D12 D21 D22 D32 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
22	0.949510	0.928552	18.1331	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142
22	0.949510	0.928552	18.1331	D12 D21 D22 D31 D41 D42 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
22	0.949508	0.928549	18.1351	D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81

all possible regression procedure (RSQUARE)

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                              D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
22 0.949507 0.920548  10.1354 D12 D21 D22 D31 D41 D42 D52 D61 D71 D72 D81
                              D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
22 0.949507 0.920547  10.1360 D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132
22 0.949506 0.920546  10.1371 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132
22 0.949502 0.920541  10.1404 D11 D12 D21 D22 D31 D41 D42 D52 D61 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141
22 0.949502 0.920540  10.1405 D11 D12 D21 D22 D31 D41 D42 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141
22 0.949501 0.920539  10.1414 D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D142
22 0.949501 0.920539  10.1414 D12 D21 D22 D31 D32 D41 D42 D52 D61 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141
22 0.949499 0.920536  10.1434 D12 D21 D22 D41 D42 D52 D61 D62 D71 D72 D81
                              D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
22 0.949499 0.920536  10.1434 D11 D12 D21 D22 D32 D41 D42 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141
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23 0.949616 0.927331  20.0315 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949600 0.927307  20.0473 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
23 0.949595 0.927300  20.0523 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
23 0.949592 0.927296  20.0547 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949587 0.927289  20.0591 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949587 0.927288  20.0599 D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949581 0.927281  20.0650 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
23 0.949573 0.927268  20.0731 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
23 0.949565 0.927258  20.0801 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D111 D112 D121
                              D131 D132
23 0.949563 0.927254  20.0823 D11 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71
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all possible regression procedure (RSQUARE)

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                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949559 0.927249  20.0860 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D142
23 0.949556 0.927245  20.0886 D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
23 0.949555 0.927242  20.0902 D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
23 0.949553 0.927240  20.0918 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62
                              D71 D72 D81 D82 D91 D92 D101 D102 D112 D121
                              D131 D132
23 0.949552 0.927238  20.0932 D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62
                              D71 D72 D81 D82 D91 D92 D101 D102 D112 D121
                              D131 D132
23 0.949550 0.927236  20.0948 D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949547 0.927231  20.0979 D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
23 0.949545 0.927229  20.0992 D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
23 0.949544 0.927227  20.1002 D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
23 0.949541 0.927222  20.1036 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D142
23 0.949540 0.927222  20.1040 D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72
                              D81 D82 D91 D92 D101 D102 D112 D121 D131 D132
                              D141 D142
23 0.949538 0.927218  20.1061 D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949538 0.927218  20.1061 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949535 0.927215  20.1086 D11 D12 D21 D22 D31 D41 D42 D51 D52 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D141
23 0.949535 0.927214  20.1089 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D111 D112 D121
                              D131 D132
23 0.949534 0.927213  20.1097 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D142
23 0.949533 0.927211  20.1108 D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71
                              D72 D81 D82 D91 D92 D101 D102 D112 D121 D131
                              D132 D142
23 0.949533 0.927211  20.1110 D12 D21 D22 D32 D41 D42 D51 D52 D61 D71 D72
                              D81 D82 D91 D92 D101 D102 D111 D112 D121 D131
                              D132 D141
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24 0.949633 0.925932  22.0151 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71
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all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
				D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949629	0.925926	22.0190	D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949621	0.925913	22.0275	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
24	0.949616	0.925906	22.0315	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
24	0.949608	0.925894	22.0394	D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949605	0.925890	22.0420	D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949605	0.925890	22.0423	D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
24	0.949605	0.925890	22.0423	D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949602	0.925885	22.0455	D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949600	0.925882	22.0473	D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949595	0.925875	22.0520	D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949592	0.925871	22.0546	D11 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
24	0.949587	0.925864	22.0591	D11 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
24	0.949587	0.925864	22.0593	D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
24	0.949581	0.925855	22.0649	D11 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949578	0.925850	22.0683	D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142
24	0.949573	0.925842	22.0730	D11 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949572	0.925841	22.0738	D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949568	0.925836	22.0776	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D133
24	0.949566	0.925832	22.0797	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112

all possible regression procedure (RSQUARE)

In	R-square	Adj Rsq	C(p)	Variables in Model
				D121 D131 D132
24	0.949563	0.925828	22.0826	D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
24	0.949561	0.925826	22.0839	D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
24	0.949561	0.925825	22.0843	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
24	0.949560	0.925823	22.0852	D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
24	0.949560	0.925823	22.0853	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
24	0.949559	0.925822	22.0860	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949558	0.925820	22.0873	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
24	0.949556	0.925818	22.0887	D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949642	0.924463	24.0071	D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949639	0.924458	24.0099	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
25	0.949636	0.924453	24.0131	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949634	0.924450	24.0151	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
25	0.949630	0.924444	24.0189	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949621	0.924431	24.0275	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141
25	0.949618	0.924426	24.0303	D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949614	0.924421	24.0337	D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949608	0.924412	24.0394	D11 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949605	0.924408	24.0420	D11 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112

all possible regression procedure (RSQUARE)

D121 D131 D132 D141

In	R-square	Adj Req	C(p)	Variables in Model
25	0.949605	0.924400	24.0421	D11 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949605	0.924407	24.0423	D11 D12 D21 D22 D31 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949602	0.924403	24.0453	D11 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
25	0.949587	0.924381	24.0593	D11 D12 D21 D22 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949580	0.924371	24.0650	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142
25	0.949580	0.924370	24.0663	D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949578	0.924367	24.0670	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142
25	0.949573	0.924358	24.0737	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
25	0.949569	0.924353	24.0770	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132
25	0.949565	0.924348	24.0804	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949563	0.924344	24.0826	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949562	0.924343	24.0830	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949562	0.924342	24.0836	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D142
25	0.949560	0.924341	24.0848	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
25	0.949560	0.924340	24.0851	D11 D12 D21 D22 D31 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949556	0.924335	24.0887	D11 D12 D21 D22 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
25	0.949549	0.924324	24.0955	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
25	0.949546	0.924319	24.0985	D11 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142

all possible regression procedure (RSQUARE)

In	R-square	Adj Req	C(p)	Variables in Model
26	0.949649	0.922932	26.0003	D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949642	0.922922	26.0069	D11 D12 D21 D22 D31 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949639	0.922917	26.0099	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
26	0.949636	0.922912	26.0129	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D112 D121 D131 D132 D141 D142
26	0.949618	0.922885	26.0299	D11 D12 D21 D22 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949614	0.922879	26.0337	D11 D12 D21 D22 D31 D32 D41 D42 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949581	0.922828	26.0654	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D142
26	0.949580	0.922826	26.0663	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949566	0.922805	26.0796	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.949160	0.922643	26.1004	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D131 D132 D141 D142
26	0.948930	0.921831	26.8060	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D121 D131 D132 D141 D142
26	0.948885	0.921763	26.7207	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.948857	0.921721	26.7550	D11 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.948822	0.921666	26.7889	D11 D12 D21 D22 D31 D32 D41 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.948685	0.921457	26.9194	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141
26	0.948373	0.920979	27.2170	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.948167	0.920664	27.4129	D11 D12 D21 D22 D31 D32 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.946607	0.918276	28.9004	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D141 D142

all possible regression procedure (RSQUARE)

n	R-square	Adj Rsq	C(p)	Variables in Model
26	0.946414	0.917980	29.0046	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.945177	0.916088	30.2632	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D102 D111 D112 D121 D131 D132 D141 D142
26	0.944208	0.914604	31.1873	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.943616	0.913690	31.7510	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.943499	0.913520	31.8620	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D111 D112 D121 D131 D132 D141 D142
26	0.943074	0.912860	32.2684	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D132 D141 D142
26	0.942210	0.911559	33.0841	D11 D12 D21 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.938497	0.906140	36.4434	D11 D12 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
26	0.934961	0.900453	40.0069	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142
27	0.949449	0.921327	28.0000	D11 D12 D21 D22 D31 D32 D41 D42 D51 D52 D61 D62 D71 D72 D81 D82 D91 D92 D101 D102 D111 D112 D121 D131 D132 D141 D142

all possible regression procedure (RSQUARE)

Model: MODEL1
Dependent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	26	1.41632	0.05447	35.538	0.0001
Error	49	0.07511	0.00153		
C Total	75	1.49143			

Root MSE	0.03915	R-square	0.9496
Dep Mean	0.67899	Adj R-sq	0.9229
C.V.	5.76610		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.397997	0.02340895	16.944	0.0001
D11	1	0.000093619	0.01431404	0.007	0.9940
D12	1	0.011093	0.01361248	0.874	0.3866
D21	1	0.079782	0.02235603	3.569	0.0008
D22	1	0.080533	0.02684830	2.999	0.0042
D31	1	0.003105	0.01759044	0.181	0.0571
D32	1	-0.001317	0.01795000	-0.073	0.9418
D41	1	0.021504	0.01794163	1.199	0.2365
D42	1	0.019342	0.02160690	0.892	0.3760
D51	1	0.002989	0.01570836	0.190	0.0498
D52	1	0.015533	0.01580135	0.978	0.3320
D61	1	0.005938	0.02326817	0.255	0.7996
D62	1	-0.006416	0.02320313	-0.277	0.7833
D71	1	0.028977	0.02573000	1.126	0.2657
D72	1	0.021660	0.02522918	0.859	0.3945
D81	1	0.038380	0.01665520	2.300	0.0258
D82	1	0.075767	0.01905354	3.016	0.0004
D91	1	0.053599	0.02986152	1.795	0.0788
D92	1	0.108707	0.04301776	2.527	0.0148
D101	1	0.050594	0.02593717	2.105	0.0405
D102	1	0.080440	0.03283615	2.450	0.0178
D111	1	-0.001673	0.01247673	-0.134	0.0939
D112	1	0.011062	0.01331547	0.831	0.4101
D121	1	-0.005418	0.01335012	-0.424	0.6736
D131	1	0.045057	0.01667101	2.703	0.0094
D132	1	0.030303	0.01763700	1.723	0.0913
D141	1	-0.003112	0.01180449	-0.262	0.7945

Appendix (D) SAS Output

Part (II)

Results of 'MAXR' Model Selection Method

MAXR Procedure

Maximum R-square Improvement for Dependent Variable Y

Step 1   Variable D92 Entered   R-square = 0.62171891   C(p) =288.62093006

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	0.92724712	0.92724712	121.62	0.0001
Error	74	0.56417786	0.00762403		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.56255556	0.01455261	11.39207511	1494.26	0.0001
D92	0.22121944	0.02005939	0.92724712	121.62	0.0001

Bounds on condition number: 1,   1

The above model is the best 1-variable model found.

Step 2   Variable D91 Entered   R-square = 0.78154855   C(p) =130.25290181

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	1.16562106	0.58281053	130.59	0.0001
Error	73	0.32580393	0.00446307		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47652941	0.01620200	3.86036476	864.96	0.0001
D91	0.18299690	0.02230310	0.23837392	53.41	0.0001
D92	0.30724559	0.01934193	1.12617367	252.33	0.0001

Bounds on condition number: 1.500235,   6.352941

The above model is the best 2-variable model found.

Step 3   Variable D82 Entered   R-square = 0.81965137   C(p) =103.03910001

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	1.22244838	0.40748279	109.08	0.0001
Error	72	0.26897660	0.00373579		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47652941	0.01482404	3.86036476	1033.35	0.0001
D82	0.07970892	0.02045761	0.05682735	15.21	0.0002
D91	0.15039065	0.02065929	0.19798889	53.00	0.0001
D92	0.29128781	0.01816200	0.96086191	257.20	0.0001

Bounds on condition number: 1.673161,   13.06538

MAXR Procedure

· above model is the best 3-variable model found

·p 4 Variable D81 Entered R-square = 0.83566735 C(p) = 90.85139559

	DF	Sum of Squares	Mean Square	F	Prob>F
·gression	4	1.24603689	0.31150922	90.13	0.0001
ror	71	0.24538810	0.00345617		
·tal	75	1.49142499			

·riable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
ITERCEP	0.47344070	0.01430741	3.78446372	1094.99	0.0001
11	0.05250805	0.02009895	0.02358850	6.83	0.0110
12	0.12108947	0.02524100	0.07954118	23.01	0.0001
)1	0.12209399	0.02263204	0.10057864	29.10	0.0001
)2	0.24936077	0.02372254	0.38188190	110.49	0.0001

·nds on condition number: 3.085148, 36.6088

· above model is the best 4-variable model found.

·p 5 Variable D41 Entered R-square = 0.85157397 C(p) = 77.49672140

	DF	Sum of Squares	Mean Square	F	Prob>F
·gression	5	1.27005870	0.25401174	80.32	0.0001
rror	70	0.22136629	0.00316238		
·tal	75	1.49142499			

·riable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
ITERCEP	0.45600707	0.01507680	2.89289965	914.79	0.0001
41	0.03691036	0.01339220	0.02402181	7.60	0.0075
11	0.05359707	0.01922977	0.02456673	7.77	0.0068
12	0.12138030	0.02416467	0.07992207	25.27	0.0001
)1	0.12342467	0.02165490	0.10273107	32.49	0.0001
)2	0.25397808	0.02275363	0.39400763	124.59	0.0001

·nds on condition number: 3.101964, 50.94079

·p 6 Variable D81 Removed R-square = 0.86624283 C(p) = 63.51267532
Variable D42 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
·gression	5	1.29193621	0.25838724	90.67	0.0001
rror	70	0.19948878	0.00284984		
·tal	75	1.49142499			

·riable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F

MAXR Procedure

INTERCEP	0.41201119	0.01849096	1.41488032	496.48	0.0001
D41	0.07405614	0.01592223	0.06298944	22.10	0.0001
D42	0.07113723	0.01762143	0.04644424	16.30	0.0001
D82	0.06077316	0.01844490	0.03093796	10.86	0.0015
D91	0.18265692	0.01956166	0.24847420	87.19	0.0001
D92	0.30324918	0.01605939	1.01629291	356.61	0.0001

Bounds on condition number: 1.9134, 41.05188

The above model is the best 5-variable model found.

Step 7 Variable D21 Entered R-square = 0.88062522 C(p) = 51.80173650

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	6	1.31338646	0.21889774	84.84	0.0001
Error	69	0.17803853	0.00258027		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40509573	0.01775742	1.34282882	520.42	0.0001
D21	0.03822765	0.01325840	0.02145025	8.31	0.0052
D41	0.07243384	0.01517376	0.05879800	22.79	0.0001
D42	0.07977800	0.01703303	0.05660413	21.94	0.0001
D82	0.06594281	0.01764221	0.03604904	13.97	0.0004
D91	0.17523739	0.01879053	0.22440897	86.97	0.0001
D92	0.28884713	0.01687882	0.83270816	322.72	0.0001

Bounds on condition number: 1.949971, 58.15679

Step 8 Variable D41 Removed R-square = 0.89705053 C(p) = 36.14324766
Variable D22 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	6	1.33788357	0.22298060	100.21	0.0001
Error	69	0.15354141	0.00222524		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.45351338	0.01286704	2.76439024	1242.29	0.0001
D21	0.12115288	0.01707865	0.10210208	45.92	0.0001
D22	0.12320152	0.02013699	0.08329511	37.43	0.0001
D42	0.02128097	0.01298896	0.00597325	2.68	0.1059
D82	0.06765968	0.01628293	0.03841652	17.26	0.0001
D91	0.10363735	0.01857036	0.06930573	31.15	0.0001
D92	0.18795365	0.02061596	0.18495718	83.12	0.0001

Bounds on condition number: 3.618924, 82.81772

MAXR Procedure

Step 9 Variable D82 Removed R-square = 0.90290959 C(p) = 30.55771996
Variable D81 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	6	1.30662192	0.22043699	106.95	0.0001
Error	69	0.14480307	0.00209860		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.46045445	0.01132297	3.47041550	1653.69	0.0001
D21	0.11573015	0.01736118	0.09325306	44.44	0.0001
D22	0.12140226	0.01951367	0.08122777	38.71	0.0001
D81	0.04181400	0.01579272	0.01471160	7.01	0.0100
D82	0.10529539	0.02020263	0.05700733	27.16	0.0001
D91	0.07440383	0.01893976	0.03242181	15.45	0.0002
D92	0.15717600	0.02281022	0.09957322	47.45	0.0001

Bounds on condition number: 4.700929, 100.6121

The above model is the best 6-variable model found.

Step10 Variable D142 Entered R-square = 0.91136416 C(p) = 24.51691855

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	7	1.35920145	0.19417164	99.86	0.0001
Error	68	0.13222354	0.00194446		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.44929633	0.01176926	2.84361770	1462.31	0.0001
D21	0.12804387	0.01739860	0.10531469	54.16	0.0001
D22	0.13505309	0.01953520	0.09293402	47.79	0.0001
D81	0.04116076	0.01520388	0.01425140	7.33	0.0086
D82	0.10220641	0.01948254	0.05359750	27.56	0.0001
D91	0.06880034	0.01836550	0.02728823	14.03	0.0004
D92	0.14494734	0.02248461	0.08080857	41.56	0.0001
D142	0.02762465	0.01086087	0.01257953	6.47	0.0133

Bounds on condition number: 4.926199, 130.1814

The above model is the best 7-variable model found.

Step11 Variable D131 Entered R-square = 0.91605500 C(p) = 22.02600327

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	8	1.36622733	0.17077841	91.39	0.0001
Error	67	0.12519767	0.00186862		
Total	75	1.49142499			

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Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.44381079	0.01185994	2.61669040	1400.33	0.0001
D21	0.12342920	0.01722115	0.09599155	51.37	0.0001
D22	0.12943144	0.01936870	0.08344493	44.66	0.0001
D81	0.04177608	0.01490781	0.01467402	7.85	0.0066
D82	0.10807640	0.01933083	0.05840934	31.26	0.0001
D91	0.06065066	0.01800394	0.02716913	14.54	0.0003
D92	0.14565103	0.02204455	0.08157303	43.65	0.0001
D131	0.02010920	0.01037060	0.00702587	3.76	0.0567
D142	0.02440775	0.01074916	0.00966175	5.17	0.0262

Bounds on condition number: 4.927530, 150.9836

Step12 Variable D142 Removed R-square = 0.92323947 C(p) = 15.17694192
Variable D132 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	8	1.37694242	0.17211780	100.73	0.0001
Error	67	0.11448257	0.00170870		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42407124	0.01353006	1.67850388	982.30	0.0001
D21	0.09790212	0.01625497	0.06200490	36.33	0.0001
D22	0.09201972	0.01909700	0.03967309	23.22	0.0001
D81	0.04304470	0.01425065	0.01617104	9.46	0.0030
D82	0.10035199	0.01871304	0.04913910	28.76	0.0001
D91	0.08502010	0.01746232	0.04127012	24.16	0.0001
D92	0.16081625	0.02090531	0.11142033	65.21	0.0001
D131	0.05660605	0.01368197	0.02924859	17.12	0.0001
D132	0.05205315	0.01507338	0.02037605	11.93	0.0010

Bounds on condition number: 4.846156, 177.6859

The above model is the best 8-variable model found.

Step13 Variable D102 Entered R-square = 0.92988888 C(p) = 10.03795962

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	9	1.38685952	0.15409550	97.26	0.0001
Error	66	0.10456547	0.00158433		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42339806	0.01303113	1.67254551	1055.68	0.0001
D21	0.09909366	0.01565853	0.06345040	40.05	0.0001
D22	0.09545990	0.01044031	0.04245753	26.80	0.0001
D81	0.04763590	0.01381263	0.01884400	11.89	0.0010

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D82	0.09410059	0.01819156	0.04339251	36.76	0.0001
D91	0.08431193	0.01682572	0.03970096	25.11	0.0001
D92	0.14531193	0.02221441	0.06779103	42.79	0.0001
D102	0.03351689	0.01339657	0.00991710	6.26	0.0148
D131	0.05671624	0.01317471	0.02936142	18.53	0.0001
D132	0.05285205	0.01451196	0.02099497	13.25	0.0005

Bounds on condition number: 5.901659, 236.956

Step14 Variable D91 Removed R-square = 0.93297569 C(p) = 7.89526428
Variable D101 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	9	1.39146325	0.15460703	102.08	0.0001
Error	66	0.09996173	0.00151457		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.44680727	0.01132060	2.36015511	1558.30	0.0001
D21	0.08663222	0.01610224	0.04340019	28.66	0.0001
D22	0.09793060	0.01775795	0.04606933	30.42	0.0001
D81	0.05700137	0.01280379	0.03008463	20.38	0.0001
D82	0.09626400	0.01754550	0.04559138	30.10	0.0001
D92	0.03563707	0.01636550	0.00719335	4.75	0.0328
D101	0.09459966	0.01747502	0.04438469	29.31	0.0001
D102	0.13133846	0.02195300	0.05421000	35.79	0.0001
D131	0.04489488	0.01279419	0.01865075	12.31	0.0008
D132	0.03291417	0.01393111	0.00845463	5.58	0.0211

Bounds on condition number: 5.225153, 241.6789

The above model is the best 9-variable model found.

Step15 Variable D91 Entered R-square = 0.93951881 C(p) = 3.65761008

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	10	1.40122103	0.14012210	100.97	0.0001
Error	65	0.09020316	0.00138774		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.43083250	0.01241292	1.67177292	1204.67	0.0001
D21	0.08200573	0.01550702	0.03840840	27.68	0.0001
D22	0.08702465	0.01742064	0.03527323	25.42	0.0001
D81	0.04688171	0.01292925	0.01824603	13.15	0.0006
D82	0.08863324	0.01718300	0.03527568	25.42	0.0001
D91	0.05029705	0.01896751	0.00975858	7.03	0.0100
D92	0.09239101	0.02651142	0.01685395	12.14	0.0009
D101	0.06481713	0.02014799	0.01436231	10.35	0.0020
D102	0.09986041	0.02413474	0.02375800	17.12	0.0001

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D131	0.05096914	0.01245903	0.02322496	16.74	0.0001
D132	0.04335657	0.01390434	0.01349320	9.72	0.0027

Bounds on condition number: 9.596361, 408.7678

The above model is the best 10-variable model found.

Step16 Variable D52 Entered R-square = 0.94153624 C(p) = 3.73436323

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	11	1.40423067	0.12765733	93.70	0.0001
Error	64	0.08719431	0.00136241		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42744091	0.01250907	1.59078118	1167.62	0.0001
D21	0.08074441	0.01546021	0.03712307	27.25	0.0001
D22	0.08499798	0.01736555	0.03263985	23.96	0.0001
D52	0.01562020	0.01051630	0.00300005	2.21	0.1423
D81	0.04859934	0.01286275	0.01944919	14.28	0.0003
D82	0.08148232	0.01737470	0.02996378	21.99	0.0001
D91	0.05045974	0.01879393	0.00982117	7.21	0.0092
D92	0.09776190	0.02651581	0.01851985	13.59	0.0005
D101	0.05990565	0.02023499	0.01194091	8.76	0.0043
D102	0.09232496	0.02444487	0.01943524	14.27	0.0004
D131	0.05209130	0.01241237	0.02473014	18.16	0.0001
D132	0.04336399	0.01377686	0.01349790	9.91	0.0025

Bounds on condition number: 9.778813, 473.5523

The above model is the best 11-variable model found.

Step17 Variable D112 Entered R-square = 0.94326473 C(p) = 4.08656791

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	12	1.40680859	0.11723405	87.29	0.0001
Error	63	0.08461640	0.00134312		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42373086	0.01270560	1.49381884	1112.22	0.0001
D21	0.08363140	0.01549902	0.03910613	29.12	0.0001
D22	0.08075914	0.01745458	0.03473134	25.86	0.0001
D52	0.01450734	0.01040857	0.00260790	1.94	0.1684
D81	0.04902867	0.01277510	0.01978269	14.73	0.0003
D82	0.08167915	0.01725190	0.03010667	22.42	0.0001
D91	0.04650110	0.01887788	0.00814956	6.07	0.0165
D92	0.09004988	0.02690945	0.01504078	11.20	0.0014
D101	0.06347294	0.02035551	0.01310875	9.82	0.0026
D102	0.09210520	0.02427169	0.01934118	14.40	0.0003

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D112	0.01306786	0.00963251	0.00257791	1.92	0.1700
D131	0.05062817	0.01263196	0.02227507	16.58	0.0001
D132	0.04037962	0.01384754	0.01142071	8.50	0.0049

ounds on condition number: 10.21515, 541.8305

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he above model is the best 12-variable model found.

tep18 Variable D41 Entered R-square = 0.94468631 C(p) = 4.73135521

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	13	1.40892877	0.10837914	81.45	0.0001
Error	62	0.08249622	0.00133058		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41735564	0.01361737	1.24907957	939.35	0.0001
D21	0.07564281	0.01667422	0.02738334	20.58	0.0001
D22	0.07990331	0.01873600	0.02420014	18.19	0.0001
D41	0.01265012	0.01002142	0.00212010	1.59	0.2116
D52*	0.01787295	0.01073979	0.00368505	2.77	0.1011
D81	0.05070805	0.01279152	0.02087593	15.76	0.0002
D82	0.08151730	0.01717169	0.02998500	22.54	0.0001
D91	0.05177473	0.01924044	0.00962691	7.24	0.0092
D92	0.09996316	0.02791132	0.01708730	12.83	0.0007
D101	0.05988139	0.02036058	0.01150921	8.65	0.0046
D102	0.09024898	0.02420290	0.01850080	13.90	0.0004
D112	0.01280991	0.00939062	0.00247597	1.86	0.1775
D131	0.05178862	0.01240792	0.02317997	17.42	0.0001
D132	0.04164325	0.01388851	0.01198550	9.01	0.0039

Bounds on condition number: 11.09338, 436.8071

Step19 Variable D112 Removed R-square = 0.94479081 C(p) = 4.63172944
Variable D42 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	13	1.40908463	0.10839113	81.62	0.0001
Error	62	0.08234036	0.00132807		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40797324	0.01819010	0.84330607	634.99	0.0001
D21	0.06610597	0.01680989	0.02185151	16.45	0.0001
D22	0.06454419	0.02021342	0.01354218	10.20	0.0022
D41	0.02650190	0.01388803	0.00483552	3.64	0.0610
D42	0.02132439	0.01514809	0.00263183	1.98	0.1642
D52	0.01903378	0.01069961	0.00420277	3.16	0.0802
D81	0.04846893	0.01285051	0.01889328	14.23	0.0004
D82	0.07948998	0.01728408	0.02835195	21.35	0.0001

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D91	0.07149567	0.02204273	0.01397172	10.52	0.0019
D92	0.12627877	0.03030209	0.02306411	17.37	0.0001
D101	0.05144432	0.02046229	0.00840089	6.33	0.0145
D102	0.08034747	0.02521665	0.01348313	10.15	0.0023
D131	0.05307262	0.01230564	0.02470323	18.60	0.0001
D132	0.04063185	0.01388473	0.01137311	8.56	0.0048

Bounds on condition number: 13.10005, 737.5931

The above model is the best 13-variable model found.

Step20 Variable D112 Entered R-square = 0.94590265 C(p) = 5.57180367

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	14	1.41074284	0.10076735	76.19	0.0001
Error	61	0.08068214	0.00132266		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40705245	0.01617799	0.83733450	633.07	0.0001
D21	0.07130569	0.01701726	0.02327505	17.60	0.0001
D22	0.06955852	0.02066130	0.01498817	11.33	0.0013
D41	0.02416327	0.01401699	0.00393051	2.97	0.0898
D42	0.01803530	0.01539996	0.00181407	1.37	0.2461
D52	0.01810933	0.01070966	0.00378182	2.86	0.0960
D81	0.04900433	0.01283607	0.01934057	14.62	0.0003
D82	0.07993429	0.01717362	0.02865577	21.67	0.0001
D91	0.06573435	0.02259154	0.01119800	8.47	0.0050
D92	0.11692751	0.03137236	0.01837338	13.89	0.0004
D101	0.05519872	0.02069055	0.00941236	7.12	0.0098
D102	0.08175678	0.02519667	0.01392543	10.53	0.0019
D112	0.01087927	0.00953773	0.00165821	1.25	0.2672
D131	0.05136966	0.01237659	0.02276759	17.21	0.0001
D132	0.03875338	0.01395761	0.01019631	7.71	0.0073

Bounds on condition number: 14.09926, 841.285

Step21 Variable D42 Removed R-square = 0.94595139 C(p) = 5.52533663
Variable D12 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	14	1.41081554	0.10077254	76.26	0.0001
Error	61	0.08060945	0.00132147		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41613867	0.01360802	1.23563791	935.05	0.0001
D12	0.01191431	0.00997265	0.00188677	1.43	0.2360
D21	0.07934150	0.01690186	0.02911639	22.03	0.0001
D22	0.08763851	0.01976205	0.02598854	19.67	0.0001

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D41	0.01225609	0.00999245	0.00198026	1.50	0 2247
D52	0.01648115	0.01076613	0.00309679	2 34	0.1310
D81	0.04703171	0.01312952	0.01695666	12.83	0.0007
D82	0.08102309	0.01711776	0.02960602	22.40	0.0001
D91	0.05004113	0.01923717	0.00894186	6.77	0.0116
D92	0.09665403	0.02795294	0 01579981	11 96	0 0010
D101	0.05717167	0.02041705	0 01036164	7.84	0.0068
D102	0.08720989	0 02425356	0.01708506	12.93	0 0006
D112	0.01427749	0 00943864	0.00302371	2 29	0.1355
D131	0.04921944	0.01255080	0.02032269	15 38	0.0002
D132	0.04040413	0.01370857	0.01134669	8.59	0.0048

›unds on condition number: 11.20335, 721.706

›e above model is the best 14-variable model found

›ep22 Variable D42 Entered R-square = 0 94707155 C(p) = 6 45746944

	DF	Sum of Squares	Mean Square	F	Prob>F
›egression	15	1 41248610	0.09416575	71.57	0.0001
Error	60	0.07893881	0.00131565		
Total	75	1.49142499			

›ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40620917	0.01614868	0 83279077	632.99	0.0001
›12	0.01146373	0.00995076	0.00174333	1.33	0.2542
›21	0.07511235	0.01727811	0.02486393	18.90	0.0001
›22	0.07740925	0.02170766	0.01673012	12.72	0.0007
›41	0.02332943	0.01399056	0.00365411	2.78	0.1008
›42	0.01732169	0.01537159	0.00167066	1.27	0.2643
›52	0.01678104	0 01074527	0.00320116	2.43	0.1241
›81	0.04553807	0.01316746	0.01573565	11 96	0.0010
›82	0.07952340	0.01713179	0 02834808	21.55	0 0001
›91	0.06351425	0.02261398	0 01037834	7.89	0.0067
›92	0.11307203	0.03146770	0 01698727	12 91	0.0007
›101	0.05277218	0.02074258	0 00851608	6 47	0 0135
›102	0.07916912	0.02533015	0 01295433	9 85	0.0026
›112	0.01217542	0 00960081	0.00211580	1.61	0.2096
›131	0.04889523	0.01352652	0.02004526	15 24	0.0002
›132	0.03788088	0.01394218	0.00970155	7.37	0.0086

›unds on condition number: 14.24073, 941.7116

›e above model is the best 15-variable model found.

›ep23 Variable D71 Entered R-square = 0 94803047 C(p) = 7 54331775

	DF	Sum of Squares	Mean Square	F	Prob>F
›egression	16	1.41391633	0.08836977	67.27	0.0001
›rror	59	0.07750865	0.00131371		
›otal	75	1.49142499			

MAXR Procedure

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40096070	0.01692557	0.73725081	561.20	0.0001
D12	0.01161806	0.00995252	0.00179019	1.36	0.2478
D21	0.08223059	0.01856720	0.02577251	19.62	0.0001
D22	0.08374976	0.02252670	0.01815796	13.82	0.0004
D41	0.02483970	0.01406291	0.00409865	3.12	0.0825
D42	0.02071315	0.01570040	0.00228649	1.74	0.1922
D52	0.01588561	0.01077007	0.00285805	2.18	0.1455
D71	0.01845796	0.01769054	0.00143016	1.09	0.3010
D81	0.04236029	0.01350564	0.01292367	9.84	0.0027
D82	0.07928061	0.01712073	0.02817006	21.44	0.0001
D91	0.06665093	0.02279740	0.01123167	8.55	0.0049
D92	0.11851026	0.03187340	0.01816148	13.82	0.0004
D101	0.04929111	0.02099423	0.00724182	5.51	0.0223
D102	0.07447244	0.02561023	0.01110868	8.46	0.0051
D112	0.01234798	0.00959515	0.00217563	1.66	0.2032
D131	0.04730341	0.01260991	0.01848670	14.07	0.0004
D132	0.03458678	0.01420074	0.00770579	5.87	0.0185

Bounds on condition number: 14.65243, 1068.029

The above model is the best 16-variable model found.

Step24 Variable D72 Entered R-square = 0.94886803 C(p) = 8.74409882

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	17	1.41516660	0.08324510	63.31	0.0001
Error	58	0.07625831	0.00131480		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39309337	0.01841836	0.60133227	457.36	0.0001
D12	0.01160170	0.00995667	0.00178517	1.36	0.2487
D21	0.07790817	0.01909834	0.02187932	16.64	0.0001
D22	0.08079388	0.02273907	0.01659857	12.62	0.0008
D41	0.02381599	0.01410635	0.00374402	2.86	0.0964
D42	0.02203024	0.01576560	0.00256917	1.95	0.1675
D52	0.01336811	0.01107950	0.00191408	1.46	0.2325
D71	0.03311610	0.02256936	0.00266236	2.02	0.1601
D72	0.02153975	0.02208792	0.00125035	0.95	0.3335
D81	0.04176639	0.01352497	0.01253835	9.54	0.0031
D82	0.07930419	0.01712707	0.02818676	21.44	0.0001
D91	0.05733599	0.02473352	0.00706302	5.37	0.0240
D92	0.10771811	0.03375250	0.01339129	10.19	0.0023
D101	0.05303035	0.02151250	0.00823244	6.26	0.0152
D102	0.07916034	0.02606796	0.01212441	9.22	0.0036
D112	0.01111537	0.00968189	0.00173292	1.32	0.2557
D131	0.04352812	0.01319551	0.01430750	10.88	0.0017
D132	0.03177989	0.01457376	0.00625204	4.76	0.0333

Bounds on condition number: 16.01730, 1294.174

MAXR Procedure

he above model is the best 17-variable model found.

tep25 Variable D121 Entered R-square = 0.94920644 C(p) = 10.42224727

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	18	1.41567020	0.07864834	59.18	0.0001
Error	57	0.07575478	0.00132903		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39597378	0.01882371	0.58810862	442.51	0.0001
D12	0.01181503	0.01001661	0.00184919	1.39	0.2431
D21	0.07679855	0.01920580	0.02107475	15.86	0.0002
D22	0.07904179	0.02303834	0.01564394	11.77	0.0011
D41	0.02520260	0.01435524	0.00409644	3.08	0.0845
D42	0.02454716	0.01636440	0.00298972	2.25	0.1392
D52	0.01390490	0.01117340	0.00205828	1.55	0.2184
D71	0.03139206	0.02272166	0.00253605	1.91	0.1725
D72	0.02282227	0.02230469	0.00139143	1.05	0.3105
D81	0.04054082	0.01374317	0.01156456	8.70	0.0046
D82	0.07865495	0.01725260	0.02762348	20.78	0.0001
D91	0.05708988	0.02486999	0.00700329	5.27	0.0254
D92	0.10570063	0.03409271	0.01277519	9.61	0.0030
D101	0.05562974	0.02182537	0.00863428	6.50	0.0135
D102	0.08146456	0.02647468	0.01258379	9.47	0.0032
D112	0.00863137	0.01053764	0.00089168	0.67	0.4161
D121	-0.00717288	0.01165321	0.00050352	0.38	0.5407
D131	0.04463155	0.01330710	0.01477224	11.12	0.0015
D132	0.03069933	0.01475720	0.00575154	4.33	0.0420

ounds on condition number: 16.57054, 1421.668

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he above model is the best 18-variable model found

tep26 Variable D61 Entered R-square = 0.94935221 C(p) = 12.20328378

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	19	1.41588761	0.07452040	55.25	0.0001
Error	56	0.07553738	0.00134888		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39583861	0.01896675	0.58752199	435.56	0.0001
D12	0.01111958	0.01023054	0.00159102	1.18	0.2821
D21	0.07799176	0.01965539	0.02123774	15.74	0.0002
D22	0.08074209	0.02359302	0.01579818	11.71	0.0012
D41	0.02561171	0.01447163	0.00415928	3.08	0.0846
D42	0.02428328	0.01650127	0.00292115	2.17	0.1467
D52	0.01374553	0.01126356	0.00200885	1.49	0.2274
D61	0.00758344	0.01888948	0.00021748	0.16	0.4896
D71	0.02916753	0.02326563	0.00221196	1.64	0.2056
D72	0.02391237	0.02347177	0.00140230	1.04	0.3123
D81	0.03972045	0.01399512	0.01086549	8.06	0.0063
D82	0.07810672	0.01743452	0.02707263	20.07	0.0001
D91	0.05500765	0.02550624	0.00623458	4.62	0.0359
D92	0.10673096	0.03444212	0.01295314	9.60	0.0030
D101	0.05349255	0.02262302	0.00754153	5.59	0.0215
D102	0.07901456	0.02738093	0.01124932	8.34	0.0055
D112	0.00897091	0.01064968	0.00095714	0.71	0.4032
D121	-0.00749006	0.01176640	0.00054657	0.41	0.5270
D131	0.04517052	0.01355335	0.01498271	11.11	0.0015
D132	0.03170568	0.01507685	0.00596522	4.42	0.0400

Bounds on condition number: 16.66306, 1575.913

The above model is the best 19-variable model found.

Step27 Variable D31 Entered R-square = 0.94943738 C(p) = 14.20209334

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	20	1.41601463	0.07080073	51.64	0.0001
Error	55	0.07541036	0.00137110		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39575939	0.01912408	0.58717087	428.25	0.0001
D12	0.01129660	0.01033888	0.00163688	1.19	0.2793
D21	0.07785292	0.01983183	0.02115090	15.43	0.0002
D22	0.08084608	0.02378896	0.01583563	11.55	0.0013
D31	0.00352491	0.01158105	0.00012702	0.09	0.7620
D41	0.02424963	0.01508156	0.00354469	2.59	0.1136
D42	0.02312068	0.01706952	0.00251550	1.83	0.1811
D52	0.01481821	0.01139128	0.00207642	1.51	0.2237
D61	0.00782218	0.01906055	0.00023092	0.17	0.6831
D71	0.03004708	0.02345425	0.00225023	1.64	0.2055
D72	0.02264654	0.02267289	0.00136791	1.00	0.3222
D81	0.04000825	0.01414154	0.01097423	8.00	0.0065
D82	0.07820041	0.01758020	0.02712930	19.79	0.0001
D91	0.05306084	0.02657091	0.00546934	3.99	0.0508
D92	0.10478191	0.03531009	0.01207378	8.81	0.0044
D101	0.05349443	0.02281839	0.00750258	5.54	0.0222
D102	0.07943288	0.02761779	0.01133093	8.27	0.0057
D112	0.00998594	0.01124299	0.00108164	0.79	0.3783
D121	-0.00710581	0.01192996	0.00048643	0.35	0.5539
D131	0.04605266	0.01396849	0.01490317	10.87	0.0017
D132	0.03158719	0.01520549	0.00591684	4.32	0.0425

Bounds on condition number: 17.22972, 1724.617

MAXR Procedure

ep28 Variable D61 Removed R-square = 0.94946500 C(p) = 14.17491967
Variable D62 Entered

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	20	1.41605714	0.07080286	51.67	0.0001
rror	55	0.07536785	0.00137032		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.39823051	0.01981293	0.55359892	403.99	0.0001
12	0.01180311	0.01020156	0.00183436	1.34	0.2523
21	0.07877030	0.02017230	0.02089895	15.25	0.0003
22	0.07780118	0.02357119	0.01492907	10.89	0.0017
31	0.00436257	0.01178027	0.00018596	0.14	0.7140
41	0.02110089	0.01649936	0.00224125	1.64	0.2063
42	0.01871335	0.02008349	0.00118960	0.87	0.3555
52	0.01384677	0.01140479	0.00201997	1.47	0.2299
62	-0.00881277	0.01972889	0.00027343	0.20	0.6569
71	0.03029539	0.02331181	0.00231433	1.69	0.1992
72	0.02165464	0.02275786	0.00124069	0.91	0.3455
81	0.04062503	0.01400092	0.01153712	8.42	0.0053
82	0.07662986	0.01815963	0.02440077	17.81	0.0001
91	0.05347719	0.02631647	0.00565855	4.13	0.0470
92	0.10470816	0.03527888	0.01207166	8.81	0.0044
101	0.05718775	0.02237036	0.00895537	6.54	0.0134
102	0.08470493	0.02764094	0.01286872	9.39	0.0034
112	0.01105912	0.01167563	0.00122963	0.90	0.3477
121	-0.00594392	0.01205483	0.00033305	0.24	0.6240
131	0.04606393	0.01395675	0.01493079	10.90	0.0017
132	0.03142009	0.01511466	0.00592006	4.32	0.0423

unds on condition number: 17.20870, 1789.116

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e above model is the best 20-variable model found.

ep29 Variable D61 Entered R-square = 0.94952410 C(p) = 16.11934292

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	21	1.41614409	0.06743543	48.37	0.0001
rror	54	0.07528090	0.00139409		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.39755654	0.02016540	0.54184534	388.67	0.0001
12	0.01137917	0.01042873	0.00165978	1.19	0.2801
21	0.07904416	0.02037873	0.02098438	15.05	0.0003
22	0.07929844	0.02451919	0.01458177	10.46	0.0021
31	0.00422221	0.01189982	0.00017550	0.13	0.7241
41	0.02194602	0.01698241	0.00232811	1.67	0.2018
42	0.01966453	0.02061259	0.00126880	0.91	0.3443
52	0.01382639	0.01150355	0.00201393	1.44	0.2346

MAXR Procedure

D61	0.00524426	0.02099900	0.00008695	0.06	0.8037
D62	-0.00662540	0.02174152	0.00012946	0.09	0.7617
D71	0.02953396	0.02370994	0.00216308	1.55	0.2183
D72	0.02193379	0.02290154	0.00126987	0.91	0.3441
D81	0.04012235	0.01426454	0.01102931	7.91	0.0068
D82	0.07670336	0.01832676	0.02447112	17.55	0.0001
D91	0.05242509	0.02687594	0.00530447	3.80	0.0563
D92	0.10512878	0.03562313	0.01216144	8.72	0.0047
D101	0.05539675	0.02367580	0.00763221	5.47	0.0230
D102	0.08233800	0.02944654	0.01089992	7.82	0.0071
D112	0.01096416	0.01170258	0.00120715	0.87	0.3562
D121	-0.00636124	0.01227528	0.00037438	0.27	0.6064
D131	0.04631538	0.01411149	0.01501748	10.77	0.0018
D132	0.03189434	0.01536598	0.00600692	4.31	0.0427

Bounds on condition number: 17.24733, 2007.081

The above model is the best 21-variable model found.

Step30 Variable D141 Entered R-square = 0.94958616 C(p) = 18.06025836

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	22	1.41623652	0.06437439	45.38	0.0001
Error	53	0.07518846	0.00141865		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39797822	0.02040921	0.53943785	380.25	0.0001
D12	0.01130273	0.01052445	0.00163623	1.15	0.2877
D21	0.07962844	0.02067597	0.02104167	14.83	0.0003
D22	0.08010843	0.02493484	0.01464426	10.32	0.0022
D31	0.00388123	0.01207827	0.00014649	0.10	0.7492
D41	0.02186391	0.01713637	0.00230991	1.63	0.2075
D42	0.01947852	0.02080735	0.00124323	0.88	0.3536
D52	0.01392875	0.01161137	0.00204142	1.44	0.2356
D61	0.00655907	0.02180849	0.00012862	0.09	0.7647
D62	-0.00667786	0.02193313	0.00013148	0.09	0.7620
D71	0.02880385	0.02400830	0.00202845	1.43	0.2371
D72	0.02100849	0.02341841	0.00115041	0.81	0.3719
D81	0.03975367	0.01440194	0.01071955	7.56	0.0082
D82	0.07457921	0.01850470	0.02429570	17.13	0.0001
D91	0.05337823	0.02736757	0.00539674	3.80	0.0564
D92	0.10770930	0.03741664	0.01177329	8.30	0.0057
D101	0.05430772	0.02426150	0.00710836	5.01	0.0294
D102	0.08023448	0.03082686	0.00961087	6.77	0.0120
D112	0.01142264	0.01202086	0.00128097	0.90	0.3463
D121	-0.00630457	0.01238484	0.00036763	0.26	0.6128
D131	0.04664823	0.01429484	0.01510738	10.65	0.0019
D132	0.03103454	0.01550263	0.00598231	4.22	0.0450
D141	-0.00289027	0.01132287	0.00009244	0.07	0.7995

Bounds on condition number: 10.69834, 2203.836

MAXR Procedure

he above model is the best 22-variable model found

tep31   Variable D51 Entered   R-square = 0.94961632   C(p) = 20.03150518

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	23	1.41628151	0.06157746	42.61	0.0001
Error	52	0.07514348	0.00144507		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39728726	0.02096734	0.51881288	359.02	0.0001
D12	0.01157227	0.01073129	0.00168043	1.16	0.2858
D21	0.07915706	0.02103792	0.02045792	14.16	0.0004
D22	0.07978075	0.02523638	0.01444209	9.99	0.0026
D31	0.00395344	0.01219707	0.00015182	0.11	0.7471
D41	0.02164068	0.01733938	0.00225093	1.56	0.2176
D42	0.01940357	0.02100351	0.00123330	0.85	0.3598
D51	0.00261328	0.01481167	0.00004498	0.03	0.8606
D52	0.01568521	0.01537673	0.00150363	1.04	0.3124
D61	0.00638514	0.02202460	0.00012145	0.08	0.7730
D62	-0.00630269	0.02219918	0.00011466	0.08	0.7749
D71	0.02863773	0.02432976	0.00200212	1.39	0.2445
D72	0.02162857	0.02303284	0.00119012	0.82	0.3683
D81	0.03917237	0.01496321	0.00990372	6.85	0.0116
D82	0.07639963	0.01870399	0.02411028	16.68	0.0002
D91	0.05274126	0.02785614	0.00518021	3.58	0.0639
D92	0.10680120	0.03811260	0.01136458	7.86	0.0071
D101	0.05498028	0.02478830	0.00711107	4.92	0.0309
D102	0.08095341	0.03137806	0.00961868	6.66	0.0127
D112	0.01142845	0.01213231	0.00128226	0.89	0.3506
D121	-0.00601649	0.01260582	0.00032918	0.23	0.6352
D131	0.04550424	0.01563697	0.01228039	8.50	0.0052
D132	0.03065324	0.01701869	0.00468801	3.24	0.0775
D141	-0.00297016	0.01143677	0.00009746	0.07	0.7961

unds on condition number: 19.04575,   2449.802

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e above model is the best 23-variable model found.

ep32   Variable D111 Entered   R-square = 0.94963369   C(p) = 22.01513580

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	24	1.41630712	0.05901280	40.07	0.0001
Error	51	0.07511787	0.00147290		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39771722	0.02141796	0.50788557	344.82	0.0001
D12	0.01183213	0.01101192	0.00170049	1.15	0.2877
D21	0.07950976	0.02149156	0.02020001	13.71	0.0005
D22	0.08046800	0.02600589	0.01410185	9.57	0.0032
D31	0.00408331	0.01235330	0.00016093	0.11	0.7423
D41	0.02145147	0.01756428	0.00219698	1.49	0.2276
D42	0.01941475	0.02120498	0.00123470	0.84	0.3642
D51	0.00303750	0.01529580	0.00005808	0.04	0.8434
D52	0.01558188	0.01554307	0.00148011	1.00	0.3209
D61	0.00620373	0.02224899	0.00011749	0.08	0.7788
D62	-0.00626602	0.02242918	0.00011499	0.08	0.7811
D71	0.02916946	0.02489175	0.00202264	1.37	0.2467
D72	0.02202210	0.02424565	0.00121513	0.82	0.3680
D81	0.03839515	0.01621588	0.00825751	5.61	0.0217
D82	0.07580421	0.01941565	0.02245203	15.24	0.0003
D91	0.05306099	0.02822746	0.00520451	3.53	0.0659
D92	0.10748219	0.03874688	0.01133372	7.69	0.0077
D101	0.05459190	0.02520577	0.00690923	4.69	0.0350
D102	0.08043312	0.03192358	0.00935017	6.35	0.0149
D111	-0.00160758	0.01219156	0.00002561	0.02	0.8956
D112	0.01092970	0.01281931	0.00107068	0.73	0.3979
D121	-0.00572475	0.01291753	0.00028929	0.20	0.6595
D131	0.04503020	0.01633643	0.01119093	7.60	0.0081
D132	0.03046299	0.01724227	0.00459758	3.12	0.0833
D141	-0.00303659	0.01155737	0.00010168	0.07	0.7938

Bounds on condition number: 19.31298,   2655.516

The above model is the best 24-variable model found.

Step33   Variable D142 Entered   R-square = 0.94964193   C(p) = 24.00788650

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	25	1.41631971	0.05665279	37.72	0.0001
Error	50	0.07510528	0.00150211		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39750825	0.02174934	0.50176504	334.04	0.0001
D12	0.01181989	0.01112136	0.00169673	1.13	0.2930
D21	0.07877414	0.02346856	0.01693523	11.27	0.0015
D22	0.07940388	0.02871947	0.01148233	7.64	0.0080
D31	0.00410830	0.01247016	0.00016283	0.11	0.7434
D41	0.02149375	0.01774358	0.00220416	1.47	0.2315
D42	0.01967303	0.02159918	0.00124614	0.83	0.3668
D51	0.00298370	0.01546772	0.00005519	0.04	0.8480
D52	0.01599404	0.01632991	0.00144095	0.96	0.3321
D61	0.00642580	0.02252201	0.00012228	0.08	0.7766
D62	-0.00642288	0.02271448	0.00012010	0.08	0.7785
D71	0.02903060	0.02615386	0.00195413	1.30	0.2595
D72	0.02250618	0.02504915	0.00121260	0.81	0.3732
D81	0.03844437	0.01638534	0.00826998	5.51	0.0230
D82	0.07561752	0.01971293	0.02210258	14.71	0.0004
D91	0.05360208	0.02911286	0.00509235	3.39	0.0715
D92	0.10860089	0.04099233	0.01054295	7.02	0.0108
D101	0.05434003	0.02560266	0.00676659	4.50	0.0388
D102	0.08031484	0.03226441	0.00930775	6.20	0.0162
D111	-0.00139670	0.01252539	0.00001868	0.01	0.9117

MAXR Procedure

112	0.01100371	0 01305461	0 00100279	0 72	0 3999
121	-0.00581199	0 01307972	0 00029659	0 20	0 6587
131	0.04565406	0 01784920	0 00982693	6 54	0 0136
132	0 03069493	0 01759567	0 00457111	3 04	0 0872
141	-0 00403863	0 01599967	0 00009571	0 06	0 8018
142	-0 00148758	0 01624680	0 00001259	0 01	0 9274

unds on condition number: 21.19599, 3035.38

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e above model is the best 25-variable model found.

ep34 Variable D32 Entered R-square = 0 94964905 C(p) = 26.00030328

	DF	Sum of Squares	Mean Square	F	Prob>F
gression	26	1.41633032	0 05447424	35 54	0.0001
rror	49	0 07509467	0.00153254		
tal	75	1 49142499			

riable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
TERCEP	0.39786296	0.02237034	0.48442266	316 09	0.0001
12	0.01183009	0.01123026	0.00169965	1.11	0.2975
11	0.07893847	0.02377921	0 01688867	11.02	0 0017
12	0.07939299	0.02900929	0.01147898	7 49	0.0086
11	0.00308389	0.01761853	0 00004695	0 03	0.8618
12	-0.00150062	0.01803335	0.00001061	0.01	0.9340
11	0.02158176	0.01794108	0.00221352	1.44	0 2352
12	0.01960712	0.02183130	0.00123610	0.81	0 3735
1	0.00280051	0.01564977	0.00005321	0.03	0.8543
2	0.01590321	0.01649505	0.00143091	0.94	0.3373
51	0.00603237	0.02323518	0.00010338	0 07	0.7962
52	-0.00650325	0.02302427	0.00012529	0.08	0 7761
1	0.02970157	0.02646299	0.00193061	1.26	0.2672
2	0.02214207	0.02567725	0.00113960	0.74	0.3927
1	0.03835407	0.01658765	0.00819344	5.35	0.0250
2	0.07556640	0.01992114	0.02205170	14.39	0.0004
1	0.05420727	0.03053465	0.00480350	3.14	0.0816
2	0.11007637	0.04504266	0.00915287	5.97	0.0182
01	0.05429261	0.02586704	0.00675151	4.41	0.0410
02	0.08028013	0.03259234	0.00929810	6.07	0.0173
11	-0.00144690	0.01266604	0.00002000	0.01	0.9095
12	0.01126177	0.01335071	0.00108918	0.71	0.4033
21	-0.00569882	0.01320139	0.00028216	0.18	0.6697
31	0.04574398	0.01806150	0.00983036	6.41	0.0146
32	0.03063209	0.01778918	0.00454421	2.97	0.0914
41	-0.00421382	0.01629752	0.00010245	0.07	0.7971
42	-0.00163206	0.01650321	0.00001500	0.01	0.9216

nds on condition number: 25.08303, 3429.269

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above model is the best 26-variable model found.

MAXR Procedure

Step35 Variable D11 Entered R-square = 0.94964937 C(p) = 28.00000000

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	27	1 41633079	0.05245670	33.53	0.0001
Error	48	0.07509419	0.00156446		
Total	75	1 49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0 39772099	0.02388307	0.43386904	277.33	0.0001
D11	0.00025341	0.01455103	0.00000047	0.00	0.9862
D12	0.01196672	0.01377215	0.00118117	0.75	0.3892
D21	0.07886371	0.02460603	0.01633523	10.44	0.0022
D22	0.07929903	0.02979407	0.01108201	7.08	0.0105
D31	0.00300042	0.01780217	0.00004606	0.03	0.8634
D32	-0.00151780	0.01824606	0.00001082	0.01	0.9341
D41	0.02155384	0.01813246	0.00221051	1.41	0.2404
D42	0.01963176	0.02210278	0.00123421	0.79	0.3789
D51	0.00291532	0.01580669	0.00005268	0.03	0.8552
D52	0.01598087	0.01666640	0.00143840	0.92	0.3424
D61	0.00606249	0.02354038	0.00010377	0.07	0.7979
D62	-0.00660790	0.02355713	0.00012459	0.08	0.7798
D71	0 02965344	0.02607962	0.00190401	1.22	0.2754
D72	0.02215576	0.02595517	0.00113996	0.73	0.3976
D81	0.03832759	0.01682037	0.00811529	5.19	0.0272
D82	0.07553919	0.02018804	0.02190390	14.00	0.0005
D91	0.05425955	0.03089405	0.00482570	3.08	0.0854
D92	0.11010617	0.04590376	0.00899842	5.75	0.0204
D101	0.05434704	0.02632126	0.00666967	4.26	0.0444
D102	0.08035164	0.03310504	0.00917212	5.86	0.0193
D111	-0.00145180	0.01280020	0.00002012	0.01	0.9102
D112	0.01123764	0.01356009	0.00107319	0.69	0.4116
D121	-0.00569878	0.01341098	0.00028216	0.18	0.6730
D131	0.04576190	0.01827796	0.00980664	6.27	0.0157
D132	0.03062294	0.01790107	0.00453762	2.90	0.0950
D141	-0.00425656	0.01664829	0.00010227	0.07	0.7993
D142	-0.00166519	0.01677717	0.00001541	0.01	0.9214

Bounds on condition number: 25.56447, 3689.955

The above model is the best 27-variable model found.

No further improvement in R-square is possible.

Appendix (D) SAS Output

Part (III)

Results of 'FORWARD' Model Selection Procedure

FORWARD selection procedure

Forward Selection Procedure for Dependent Variable Y

Statistics for Entry: Step 1
DF = 1,74

Variable	Tolerance	Model R**2	F	Prob>F
D11	1.000000	0.0881	7.1520	0.0092
D12	1.000000	0.0471	3.6577	0.0597
D21	1.000000	0.0988	8.1101	0.0057
D22	1.000000	0.2653	26.7107	0.0001
D31	1.000000	0.0670	5.3160	0.0239
D32	1.000000	0.1587	13.9604	0.0004
D41	1.000000	0.0002	0.0157	0.9005
D42	1.000000	0.0328	2.5072	0.1176
D51	1.000000	0.0073	0.5467	0.4620
D52	1.000000	0.0684	5.4363	0.0225
D61	1.000000	0.0058	0.4281	0.5150
D62	1.000000	0.0575	4.5155	0.0369
D71	1.000000	0.1095	9.1022	0.0035
D72	1.000000	0.4400	58.1540	0.0001
D81	1.000000	0.1811	16.3676	0.0001
D82	1.000000	0.1462	12.6690	0.0007
D91	1.000000	0.0264	2.0104	0.1604
D92	1.000000	0.6217	121.6217	0.0001
D101	1.000000	0.0786	6.3004	0.0143
D102	1.000000	0.3366	37.5525	0.0001
D111	1.000000	0.0024	0.1813	0.6715
D112	1.000000	0.0676	5.3613	0.0234
D121	1.000000	0.0253	1.9232	0.1697
D122	.	0.0000	.	.
D131	1.000000	0.0267	2.0300	0.1583
D132	1.000000	0.0325	2.4845	0.1192
D141	1.000000	0.0427	3.2976	0.0734
D142	1.000000	0.0053	0.3975	0.5303

Step 1 Variable D92 Entered R-square = 0.62171891 C(p) =288.62093004

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	0.92724712	0.92724712	121.62	0.0001
Error	74	0.56417786	0.00762403		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.56255556	0.01455261	11.39287511	1494.34	0.0001
D92	0.22121944	0.02005939	0.92724712	121.62	0.0001

Bounds on condition number: 1, 1

FORWARD selection procedure

Statistics for Entry: Step 2
DF = 1,73

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.842370	0.6220	0.0601	0.8071
D12	0.970040	0.6284	1.3139	0.2554
D21	0.956463	0.6452	4.8230	0.0312
D22	0.806527	0.6568	7.4642	0.0079
D31	0.972427	0.6306	3.4017	0.0692
D32	0.720999	0.6222	0.0070	0.7679
D41	0.984927	0.6343	2.5144	0.1171
D42	0.942530	0.6218	0.0131	0.9093
D51	0.981409	0.6222	0.0943	0.7590
D52	0.997769	0.6721	11.2280	0.0013
D61	0.907113	0.6515	6.2470	0.0147
D62	0.836600	0.6292	1.4656	0.2300
D71	0.887279	0.6267	0.9665	0.3288
D72	0.749106	0.7179	24.8865	0.0001
D81	0.822232	0.6323	2.0939	0.1522
D82	0.972507	0.6869	15.1972	0.0003
D91	0.629630	0.7015	53.4103	0.0001
D101	0.995238	0.6730	11.4418	0.0012
D102	0.504615	0.6306	1.7532	0.1896
D111	0.999566	0.6261	0.8405	0.3600
D112	0.918536	0.6230	0.2563	0.6142
D121	0.942963	0.6226	0.1744	0.6775
D122	.	0.6217	.	.
D131	0.992475	0.6308	1.7994	0.1839
D132	0.990291	0.6323	2.1082	0.1508
D141	0.934007	0.6217	0.0033	0.9544
D142	0.995741	0.6222	0.0909	0.7640

Step 2 Variable D91 Entered R-square = 0.78154855 C(p) =130.25298181

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	1.16562108	0.58281052	130.59	0.0001
Error	73	0.32580395	0.00446307		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.67652961	0.01638288	3.86036476	864.96	0.0001
D91	0.16298690	0.02230318	0.23837392	53.41	0.0001
D92	0.30724559	0.01934193	1.12617367	252.33	0.0001

Bounds on condition number: 1.588235, 6.353941

FORWARD selection procedure

Statistics for Entry: Step 3
DF = 1,72

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.841105	0.7816	0.0015	0.9691
D12	0.960482	0.7817	0.0089	0.0255
D21	0.924050	0.7881	2.2246	0.1402
D22	0.702824	0.7961	5.1332	0.0265
D31	0.918818	0.7829	0.4525	0.5033
D32	0.720923	0.7818	0.0975	0.7557
D41	0.983699	0.7975	5.6036	0.0198
D42	0.874878	0.7921	3.6460	0.0602
D51	0.980518	0.7816	0.0331	0.8561
D52	0.965778	0.8057	8.9604	0.0038
D61	0.706633	0.7818	0.0986	0.7544
D62	0.836536	0.7920	3.9251	0.0514
D71	0.870821	0.7825	0.3270	0.5692
D72	0.561128	0.7977	5.7325	0.0193
D81	0.760968	0.7821	0.1938	0.6611
D82	0.960811	0.8197	15.2136	0.0002
D101	0.792057	0.7842	0.8909	0.3484
D102	0.584615	0.7906	3.0478	0.0851
D111	0.999307	0.7868	1.7672	0.1879
D112	0.918493	0.7827	0.3761	0.5417
D121	0.961854	0.7835	0.6367	0.4275
D122	.	0.7815	.	.
D131	0.990246	0.7874	1.9837	0.1633
D132	0.986137	0.7983	5.9580	0.0171
D141	0.910062	0.7852	1.2350	0.2701
D142	0.995622	0.7818	0.0991	0.7539

tep 3   Variable D82 Entered   R-square = 0.81965137   C(p) =103.92910001

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	1.22244838	0.40748279	109.08	0.0001
Error	72	0.26897660	0.00373579		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47652941	0.01482404	3.86036476	1033.35	0.0001
D82	0.07978892	0.02045761	0.05682735	15.21	0.0002
D91	0.15039865	0.02065929	0.19798889	53.00	0.0001
D92	0.29128781	0.01816288	0.96086191	257.20	0.0001

ounds on condition number: 1.673141,   13.06538

FORWARD selection procedure

Statistics for Entry: Step 4
DF = 1,71

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.836311	0.8198	0.0620	0.8038
D12	0.914220	0.8217	0.8223	0.3676
D21	0.905336	0.8317	5.0070	0.0282
D22	0.751420	0.8266	2.8314	0.0968
D31	0.913219	0.8201	0.1871	0.6666
D32	0.720300	0.8198	0.0517	0.8208
D41	0.903502	0.8351	6.4536	0.0130
D42	0.841956	0.8240	1.7570	0.1891
D51	0.915698	0.8214	0.6867	0.4101
D52	0.803023	0.8265	2.7947	0.0990
D61	0.703605	0.8197	0.0080	0.9289
D62	0.753124	0.8219	0.9067	0.3442
D71	0.874864	0.8200	0.1331	0.7163
D72	0.558927	0.8329	5.6106	0.0206
D81	0.450293	0.8355	6.8250	0.0110
D101	0.705265	0.8247	2.0683	0.1560
D102	0.551596	0.8221	0.8663	0.3209
D111	0.902972	0.8219	0.9101	0.3433
D112	0.910738	0.8199	0.0987	0.7543
D121	0.960050	0.8209	0.4926	0.4851
D122	.	0.8197	.	.
D131	0.866706	0.8316	5.0360	0.0279
D132	0.882626	0.8245	1.9672	0.1651
D141	0.903025	0.8216	0.7606	0.3861
D142	0.996112	0.8197	0.0373	0.8476

Step 4   Variable D81 Entered   R-square = 0.83546735   C(p) = 90.05139559

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	1.24603609	0.31150922	90.13	0.0001
Error	71	0.24538818	0.00345617		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47344878	0.01430741	3.78446372	1094.99	0.0001
D81	0.05250805	0.02009895	0.02358858	6.83	0.0110
D82	0.13108947	0.02524108	0.07954118	23.01	0.0001
D91	0.12209399	0.02263204	0.10057064	29.10	0.0001
D92	0.24936077	0.02372254	0.38180198	110.49	0.0001

Bounds on condition number: 3.885148,   38.6000

FORWARD selection procedure

Statistics for Entry: Step 5
DF = 1,70

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.830110	0.0355	0.0014	0.9704
D12	0.885527	0.0360	0.2366	0.6284
D21	0.904393	0.0484	5.9940	0.0169
D22	0.742037	0.0404	2.1560	0.1465
D31	0.913006	0.0360	0.2397	0.6259
D32	0.715900	0.0355	0.0013	0.9716
D41	0.903167	0.0516	7.5961	0.0075
D42	0.830792	0.0382	1.1639	0.2844
D51	0.860095	0.0356	0.0531	0.8185
D52	0.797593	0.0442	3.9105	0.0519
D61	0.880250	0.0361	0.2820	0.5965
D62	0.738263	0.0361	0.2725	0.6033
D71	0.857523	0.0360	0.5696	0.4530
D72	0.555735	0.0510	7.3196	0.0086
D101	0.774080	0.0387	1.4109	0.2389
D102	0.543453	0.0397	1.8431	0.1789
D111	0.940132	0.0360	0.2087	0.6500
D112	0.905500	0.0361	0.2745	0.6020
-D121	0.920254	0.0379	1.0647	0.3057
D122	.	0.0355	.	.
D131	0.964679	0.0476	5.5525	0.0213
D132	0.882261	0.0400	1.9747	0.1644
D141	0.901795	0.0370	0.6560	0.4204
D142	0.993905	0.0356	0.0560	0.8133

ep 5 Variable D41 Entered R-square = 0.85157397 C(p) = 77.49672140

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	1.27005870	0.25401174	80.33	0.0001
Error	70	0.22136629	0.00316238		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.45600707	0.01507400	2.89289965	914.79	0.0001
D41	0.03691034	0.01339320	0.02402101	7.60	0.0075
D81	0.05359707	0.01922977	0.02456673	7.77	0.0068
D82	0.12130020	0.02414467	0.07992207	25.27	0.0001
D91	0.12302487	0.02165490	0.10273387	32.49	0.0001
D92	0.25397800	0.02275363	0.39400763	124.59	0.0001

ounds on condition number: 3.101964, 50.94079

FORWARD selection procedure

Statistics for Entry: Step 6
DF = 1,69

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.819359	0.0518	0.1246	0.7252
D12	0.883210	0.0525	0.4227	0.5177
D21	0.869416	0.0590	4.0526	0.0480
D22	0.735310	0.0549	1.5003	0.2130
D31	0.864905	0.0516	0.0145	0.9045
D32	0.713260	0.0516	0.0173	0.8957
D42	0.527652	0.0776	16.6625	0.0003
D51	0.833651	0.0517	0.0677	0.7955
D52	0.777599	0.0640	6.7293	0.0116
D61	0.664730	0.0516	0.0088	0.9254
D62	0.720360	0.0522	0.3045	0.5829
D71	0.846536	0.0521	0.2302	0.6330
D72	0.526743	0.0613	4.8174	0.0315
D101	0.720521	0.0523	0.3353	0.5646
D102	0.531436	0.0580	3.5110	0.0653
D111	0.937653	0.0524	0.3813	0.5389
D112	0.895672	0.0531	0.7086	0.4020
D121	0.927534	0.0537	1.0037	0.3199
D122	.	0.0516	.	.
D131	0.963345	0.0627	5.5725	0.0211
D132	0.880089	0.0553	1.7721	0.1875
D141	0.899639	0.0527	0.5070	0.4785
D142	0.935917	0.0535	0.8987	0.3406

Step 6 Variable D42 Entered R-square = 0.87758678 C(p) = 54.69032666

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	6	1.30885405	0.21814367	82.44	0.0001
Error	69	0.18257016	0.00264594		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41279393	0.01781989	1.41003301	534.41	0.0001
D41	0.07246423	0.01537120	0.05880475	22.22	0.0001
D42	0.06556251	0.01712109	0.03879615	14.66	0.0003
D81	0.04485185	0.01773732	0.01691866	6.39	0.0137
D82	0.09748060	0.02394901	0.04776526	18.04	0.0001
D91	0.15613193	0.02157115	0.13861736	52.39	0.0001
D92	0.26703305	0.02169037	0.42417222	160.31	0.0001

Bounds on condition number: 3.1052, 79.91836

FORWARD selection procedure

Statistics for Entry: Step 7
DF = 1,68

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.817610	0.8777	0.0443	0.8339
D12	0.870014	0.8801	1.4265	0.2365
D21	0.843167	0.8921	9.1686	0.0035
D22	0.605397	0.8777	0.0699	0.7923
D31	0.829200	0.8791	0.8612	0.3567
D32	0.699719	0.8786	0.4575	0.5011
D51	0.831927	0.8779	0.1576	0.6926
D52	0.760337	0.8860	5.0320	0.0281
D61	0.855393	0.8778	0.1267	0.7251
D62	0.553667	0.8813	2.1527	0.1469
D71	0.810740	0.8777	0.0695	0.7920
D72	0.517766	0.8837	3.5595	0.0635
D101	0.725601	0.8790	0.7726	0.3826
D102	0.509601	0.8806	1.6127	0.2086
D111	0.937653	0.8786	0.4517	0.5038
D112	0.872710	0.8778	0.0968	0.7566
D121	0.901264	0.8780	0.2068	0.6508
D122	.	0.8776	.	.
D131	0.961522	0.8902	7.8316	0.0067
D132	0.803509	0.8770	0.1096	0.7416
D141	0.892755	0.8779	0.1991	0.6569
D142	0.928860	0.8785	0.4895	0.4865

7 Variable D21 Entered R-square = 0.89213074 C(p) = 62.83334932

	DF	Sum of Squares	Mean Square	F	Prob>F
ression	7	1.33054600	0.19007801	80.34	0.0001
or	68	0.16087890	0.00236587		
al	75	1.49142499			

iable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
ERCEP	0.40584516	0.01700594	1.34746101	569.53	0.0001
	0.03844254	0.01269595	0.02169123	9.17	0.0035
	0.07801129	0.01655787	0.05472103	23.13	0.0001
	0.07421327	0.01644044	0.04820753	20.38	0.0001
	0.04517805	0.01677264	0.01715963	7.25	0.0089
	0.10294861	0.02177599	0.05287803	22.35	0.0001
	0.14848191	0.02055342	0.12347215	52.19	0.0001
	0.25227205	0.02053011	0.35722827	150.99	0.0001

ds on condition number: 3.375525, 103.6805

FORWARD selection procedure

Statistics for Entry: Step 8
DF = 1,67

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.816238	0.8921	0.0098	0.9213
D12	0.863122	0.8930	0.5415	0.4644
D22	0.220001	0.9120	15.1272	0.0002
D31	0.828039	0.8941	1.2155	0.2742
D32	0.698600	0.8927	0.3594	0.5508
D51	0.819638	0.8921	0.0030	0.9567
D52	0.755245	0.8989	4.4025	0.0388
D61	0.651247	0.8922	0.0188	0.8913
D62	0.369060	0.8922	0.0650	0.7996
D71	0.770291	0.8934	0.8167	0.3694
D72	0.488024	0.8947	1.6291	0.2062
D101	0.710625	0.8928	0.3971	0.5307
D102	0.502407	0.8937	0.9645	0.3296
D111	0.937467	0.8928	0.4467	0.5062
D112	0.872099	0.8924	0.3602	0.8030
D121	0.886197	0.8921	0.0085	0.9268
D122	.	0.8921	.	.
D131	0.961438	0.9045	8.6951	0.0044
D132	0.803128	0.8924	0.1785	0.6740
D141	0.883660	0.8922	0.0284	0.8666
D142	0.926400	0.8934	0.8055	0.3727

Step 8 Variable D22 Entered R-square = 0.91199938 C(p) = 25.09228402

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	8	1.36017867	0.17002233	86.79	0.0001
Error	67	0.13124632	0.00195890		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42038910	0.01652428	1.31657035	672.10	0.0001
D21	0.09788759	0.01915886	0.05113638	26.10	0.0001
D22	0.08950704	0.02303385	0.02963258	15.13	0.0002
D61	0.03476287	0.01604893	0.00918961	4.69	0.0339
D62	0.04354619	0.01691039	0.01298909	6.63	0.0122
D81	0.03968308	0.01532718	0.01313160	6.70	0.0118
D82	0.09646905	0.01988468	0.04610533	23.54	0.0001
D91	0.10525465	0.02175554	0.04585151	23.41	0.0001
D92	0.18633705	0.02522649	0.10688019	54.56	0.0001

Bounds on condition number: 6.155312, 211.4961

FORWARD selection procedure

Statistics for Entry: Step 9
DF = 1,66

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.774707	0.9133	1.0271	0.3146
D12	0.791520	0.9160	3.4747	0.0669
D31	0.825496	0.9147	2.0700	0.1550
D32	0.698012	0.9128	0.6101	0.4376
D51	0.818658	0.9120	0.0374	0.8472
D52	0.737952	0.9158	2.9767	0.0892
D61	0.598231	0.9143	1.7523	0.1902
D62	0.357866	0.9122	0.1591	0.6912
D71	0.735757	0.9170	4.0056	0.0495
D72	0.441964	0.9121	0.0442	0.8342
D101	0.700006	0.9120	0.0054	0.9418
D102	0.490711	0.9158	2.9490	0.0906
D111	0.905172	0.9149	2.3469	0.1307
D112	0.833441	0.9142	1.7119	0.1953
D121	0.885857	0.9120	0.0007	0.9795
D122	.	0.9120	.	.
D131	0.941658	0.9205	7.0317	0.0100
D132	0.790563	0.9120	0.0300	0.8631
D141	0.880437	0.9122	0.1762	0.6761
D142	0.854537	0.9181	4.9223	0.0300

ep 9 Variable D131 Entered R-square = 0.92047237 C(p) = 19.81486436

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	9	1.37281569	0.15253505	84.88	0.0001
Error	66	0.11860958	0.00179711		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41622222	0.01647885	1.14649545	637.96	0.0001
21	0.09190407	0.01840517	0.04449935	24.76	0.0001
22	0.08110818	0.02229267	0.02378924	13.24	0.0005
41	0.03800176	0.01542131	0.01091289	6.07	0.0163
42	0.04803252	0.01620516	0.01563375	8.70	0.0044
81	0.04015509	0.01460161	0.01344395	7.48	0.0080
82	0.10279223	0.01919454	0.05153958	28.68	0.0001
91	0.10727131	0.02085166	0.04750217	26.47	0.0001
92	0.18821090	0.02417264	0.10894745	60.62	0.0001
131	0.03680945	0.01011013	0.01263682	7.03	0.0100

unds on condition number: 6.160577, 249.5205

FORWARD selection procedure

Statistics for Entry: Step 10
DF = 1,65

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.753030	0.9209	0.3896	0.5347
D12	0.770514	0.9232	2.2917	0.1349
D31	0.724100	0.9209	0.3551	0.5533
D32	0.633697	0.9205	0.0002	0.9893
D51	0.798563	0.9210	0.4161	0.5212
D52	0.723126	0.9262	5.0092	0.0286
D61	0.596735	0.9223	1.5580	0.2163
D62	0.357700	0.9206	0.1425	0.7070
D71	0.733614	0.9263	5.0961	0.0273
D72	0.426623	0.9206	0.0762	0.7834
D101	0.699378	0.9205	0.0241	0.8770
D102	0.489726	0.9238	2.7976	0.0992
D111	0.867104	0.9217	1.0591	0.3072
D112	0.831362	0.9223	1.5197	0.2221
D121	0.813422	0.9212	0.5784	0.4497
D122	.	0.9205	.	.
D132	0.411815	0.9301	8.9290	0.0040
D141	0.856645	0.9214	0.7876	0.3781
D142	0.820130	0.9244	3.4086	0.0694

Step10 Variable D132 Entered R-square = 0.93007756 C(p) = 12.65009411

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	10	1.38714091	0.13871409	86.46	0.0001
Error	65	0.10428408	0.00160437		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39861886	0.01667111	0.91633750	571.15	0.0001
D21	0.08250653	0.01774667	0.03674676	21.66	0.0001
D22	0.06580120	0.02167726	0.01478307	9.21	0.0035
D41	0.03247563	0.01460770	0.00784336	4.89	0.0306
D42	0.03797084	0.01575120	0.00932340	5.81	0.0188
D81	0.04204463	0.01388647	0.01472106	9.18	0.0035
D82	0.09513776	0.01831604	0.04330590	26.98	0.0001
D91	0.11150967	0.01975275	0.05112960	31.87	0.0001
D92	0.19377761	0.02291945	0.11472417	71.51	0.0001
D131	0.05447156	0.01330223	0.02690264	16.77	0.0001
D132	0.04470224	0.01495907	0.01432542	8.93	0.0040

Bounds on condition number: 6.201563, 317.9307

FORWARD selection procedure

Statistics for Entry: Step 11
DF = 1,64

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.753409	0.9306	0.4570	0.5011
D12	0.767200	0.9322	1.9790	0.1643
D31	0.726099	0.9305	0.4027	0.5279
D32	0.630644	0.9301	0.0487	0.8261
D51	0.729694	0.9329	2.6963	0.1055
D52	0.723019	0.9356	5.4760	0.0224
D61	0.593103	0.9327	2.4604	0.1211
D62	0.354915	0.9301	0.0179	0.8939
D71	0.491210	0.9330	2.7917	0.0996
D72	0.426550	0.9301	0.0652	0.7993
D101	0.679597	0.9302	0.1152	0.7354
D102	0.485020	0.9345	4.2935	0.0423
D111	0.887052	0.9313	1.1377	0.2901
D112	0.826494	0.9313	1.1564	0.2862
D121	0.797773	0.9302	0.1555	0.6947
D122	.	0.9301	.	.
D141	0.852099	0.9306	0.5310	0.4727
D142	0.800140	0.9322	1.9715	0.1651

ep11 Variable D52 Entered R-square = 0.93550951 C(p) = 9.40346622

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	11	1.39536150	0.12685105	84.51	0.0001
rror	64	0.09606341	0.00150099		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.39232645	0.01633304	0.86595706	576.92	0.0001
21	0.07516320	0.01745400	0.02783908	18.54	0.0001
22	0.05766407	0.02125346	0.01104995	7.36	0.0085
41	0.03696061	0.01433537	0.00997778	6.65	0.0122
42	0.03594993	0.01525926	0.00834040	5.56	0.0215
52	0.02803338	0.01132413	0.00822067	5.48	0.0224
81	0.04594607	0.01353304	0.01729940	11.53	0.0012
82	0.08562695	0.01817626	0.03331116	22.19	0.0001
91	0.10780078	0.01916057	0.04750301	31.67	0.0001
92	0.19501377	0.02210194	0.11696750	77.93	0.0001
131	0.05731202	0.01292364	0.02951886	19.67	0.0001
132	0.04420878	0.01447095	0.01405955	9.37	0.0032

unds on condition number: 6.211119, 370.3649

FORWARD selection procedure

Statistics for Entry: Step 12
DF = 1,63

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.752722	0.9362	0.5945	0.4436
D12	0.756089	0.9370	1.3755	0.2453
D31	0.711419	0.9357	0.1226	0.7274
D32	0.627330	0.9356	0.0036	0.9523
D51	0.399560	0.9356	0.0186	0.8918
D61	0.584041	0.9374	1.7029	0.1966
D62	0.354312	0.9356	0.0550	0.8154
D71	0.482289	0.9377	2.1327	0.1492
D72	0.423077	0.9358	0.2269	0.6355
D101	0.679329	0.9358	0.1577	0.6926
D102	0.481724	0.9392	3.6951	0.0591
D111	0.821469	0.9359	0.3347	0.5649
D112	0.823325	0.9365	0.9349	0.3373
D121	0.791770	0.9360	0.3753	0.5423
D122	.	0.9356	.	.
D141	0.852099	0.9362	0.5575	0.4580
D142	0.729076	0.9362	0.4039	0.4404

Step12 Variable D102 Entered R-square = 0.93915002 C(p) = 8.00155425

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	12	1.40068374	0.11672364	81.04	0.0001
Error	63	0.09074125	0.00144034		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39598457	0.01611320	0.86987590	603.94	0.0001
D21	0.07695609	0.01712512	0.02908654	20.19	0.0001
D22	0.06359413	0.02104676	0.01315006	9.13	0.0036
D41	0.03399460	0.01412734	0.00834111	5.79	0.0191
D42	0.02772246	0.01555133	0.00457712	3.18	0.0795
D52	0.02410193	0.01094320	0.00698671	4.85	0.0313
D81	0.04937923	0.01337733	0.01962519	13.63	0.0005
D82	0.08302651	0.01785655	0.03113885	21.62	0.0001
D91	0.10272049	0.01896021	0.04228017	29.35	0.0001
D92	0.17409960	0.02430000	0.07461069	51.80	0.0001
D102	0.02593047	0.01349374	0.00532216	3.70	0.0591
D131	0.05783273	0.01266273	0.03004392	20.86	0.0001
D132	0.04677301	0.01423436	0.01555170	10.80	0.0017

Bounds on condition number: 7.760290, 453.9639

FORWARD selection procedure

Statistics for Entry: Step 13
DF = 1,62

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.752292	0.9390	0.6952	0.4076
D12	0.755733	0.9406	1.5402	0.2193
D31	0.703793	0.9392	0.0258	0.8730
D32	0.622617	0.9392	0.0109	0.9171
D51	0.399522	0.9392	0.0143	0.9057
D61	0.503561	0.9400	1.7096	0.1959
D62	0.334093	0.9392	0.0497	0.8244
D71	0.870789	0.9409	1.8288	0.1812
D72	0.422923	0.9394	0.2023	0.6545
D101	0.379361	0.9440	6.3256	0.0145
D111	0.814299	0.9393	0.1687	0.6827
D112	0.799461	0.9396	0.4451	0.5072
D121	0.791131	0.9395	0.3261	0.5700
D122	.	0.9392	.	.
D141	0.812639	0.9393	0.1276	0.7222
D142	0.690450	0.9393	0.1295	0.7202

ep13 Variable D101 Entered R-square = 0.94479081 C(p) = 4.63172944

	DF	Sum of Squares	Mean Square	F	Prob>F
legression	13	1.40908463	0.10839113	81.62	0.0001
rror	62	0.08234036	0.00132807		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.40797324	0.01619010	0.84330807	634.99	0.0001
)21	0.06810597	0.01600989	0.02105151	18.65	0.0001
)22	0.06454019	0.02021341	0.01354118	10.20	0.0022
141	0.02650190	0.01380883	0.00483552	3.64	0.0610
142	0.02132439	0.01514809	0.00263103	1.98	0.1642
152	0.01903278	0.01069961	0.00420277	3.16	0.0802
181	0.04844893	0.01285051	0.01889328	14.23	0.0004
182	0.07948998	0.01720400	0.02035195	21.35	0.0001
)91	0.07149567	0.02204273	0.01397172	10.52	0.0019
)92	0.12627877	0.03030209	0.02306411	17.37	0.0001
1101	0.05144632	0.02046229	0.00840089	6.33	0.0145
1102	0.08034747	0.02521465	0.01348313	10.15	0.0023
1131	0.05307262	0.01230564	0.02470323	18.60	0.0001
1132	0.04063105	0.01388473	0.01137311	8.56	0.0048

unds on condition number: 13.10005, 737.5931

FORWARD selection procedure

Statistics for Entry: Step 14
DF = 1,61

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.726757	0.9449	0.1692	0.6822
D12	0.744211	0.9457	0.9676	0.3292
D31	0.702832	0.9448	0.0056	0.9405
D32	0.622610	0.9448	0.0137	0.9071
D51	0.390957	0.9448	0.0596	0.8079
D61	0.526354	0.9451	0.3522	0.5551
D62	0.330892	0.9450	0.2290	0.6336
D71	0.660816	0.9457	1.0067	0.3197
D72	0.300736	0.9448	0.0637	0.8017
D111	0.810505	0.9449	0.0673	0.7962
D112	0.770733	0.9459	1.2537	0.2672
D121	0.772649	0.9457	0.9870	0.3242
D122	.	0.9448	.	.
D141	0.804511	0.9448	0.0150	0.9028
D142	0.680520	0.9450	0.2501	0.6133

Step14 Variable D112 Entered R-square = 0.94590265 C(p) = 5.57180367

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	14	1.41074208	0.10076735	76.19	0.0001
Error	61	0.08068214	0.00132266		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40705265	0.01617799	0.83733650	633.07	0.0001
D21	0.07138569	0.01701726	0.02327505	17.60	0.0001
D22	0.06955052	0.02066330	0.01498817	11.33	0.0013
D41	0.02416327	0.01401699	0.00393051	2.97	0.0898
D42	0.01803530	0.01539996	0.00181407	1.37	0.2461
D52	0.01810933	0.01070966	0.00378182	2.86	0.0960
D81	0.04908433	0.01283607	0.01934057	14.62	0.0003
D82	0.07993629	0.01717362	0.02865577	21.67	0.0001
D91	0.06573435	0.02259154	0.01119800	8.47	0.0050
D92	0.11692751	0.03137236	0.01837328	13.89	0.0004
D101	0.05519473	0.02069055	0.00941236	7.12	0.0098
D102	0.08175678	0.02519687	0.01392543	10.53	0.0019
D112	0.01067927	0.00953773	0.00165821	1.25	0.2672
D131	0.05134946	0.01237659	0.02276759	17.21	0.0001
D132	0.03875330	0.01395761	0.01019631	7.71	0.0073

Bounds on condition number: 14.09924, 841.285

FORWARD selection procedure

Statistics for Entry: Step 15
DF = 1,60

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.687022	0.9463	0.4804	0.4909
D12	0.730572	0.9471	1.3251	0.2542
D31	0.653107	0.9459	0.0523	0.8199
D32	0.574290	0.9461	0.1980	0.6579
D51	0.390319	0.9459	0.0399	0.8423
D61	0.516481	0.9464	0.5710	0.4528
D62	0.317360	0.9464	0.5211	0.4732
D71	0.660660	0.9468	1.0466	0.3104
D72	0.383784	0.9459	0.0164	0.8984
D111	0.679550	0.9459	0.0416	0.8390
D121	0.663316	0.9462	0.3808	0.5395
D122	.	0.9459	.	.
D141	0.780391	0.9460	0.0801	0.7781
D142	0.687994	0.9462	0.2917	0.5911

ep15 Variable D12 Entered R-square = 0.94707155 C(p) = 6.45746944

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	15	1.41248610	0.09416575	71.57	0.0001
rror	60	0.07893881	0.00131565		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.40620917	0.01614860	0.83279077	632.99	0.0001
12	0.01146373	0.00995076	0.00174333	1.33	0.2542
21	0.07511235	0.01727811	0.02486393	18.90	0.0001
22	0.07760925	0.02170766	0.01673012	12.72	0.0007
41	0.02332943	0.01399056	0.00365411	2.78	0.1008
42	0.01732169	0.01537159	0.00167064	1.27	0.2643
52	0.01676104	0.01074527	0.00320116	2.43	0.1241
81	0.04553807	0.01316746	0.01573565	11.96	0.0010
82	0.07952348	0.01713179	0.02834808	21.55	0.0001
91	0.06351625	0.02261398	0.01037834	7.89	0.0067
92	0.11307283	0.03148778	0.01690727	12.91	0.0007
101	0.05277316	0.02074258	0.00851680	6.47	0.0135
102	0.07916912	0.02523015	0.01295423	9.85	0.0026
112	0.01217542	0.00960081	0.00211580	1.61	0.2096
131	0.04889523	0.01252652	0.02004526	15.24	0.0002
132	0.03786688	0.01394218	0.00970155	7.37	0.0086

unds on condition number: 14.26073, 961.7116

FORWARD selection procedure

Statistics for Entry: Step 16
DF = 1,59

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.467156	0.9471	0.0032	0.9553
D31	0.650255	0.9472	0.0933	0.7611
D32	0.573820	0.9473	0.2298	0.6336
D51	0.383692	0.9472	0.1242	0.7258
D61	0.502585	0.9474	0.3319	0.5667
D62	0.316635	0.9475	0.4488	0.5059
D71	0.660514	0.9480	1.0886	0.3010
D72	0.383741	0.9471	0.0136	0.9077
D111	0.666405	0.9471	0.0022	0.9630
D121	0.662341	0.9475	0.4369	0.5112
D122	.	0.9471	.	.
D141	0.707927	0.9472	0.0971	0.7566
D142	0.687970	0.9473	0.2860	0.5948

Step16 Variable D71 Entered R-square = 0.94803067 C(p) = 7.54331775

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	16	1.41391633	0.08836977	67.27	0.0001
Error	59	0.07750865	0.00131371		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40096070	0.01692557	0.73725081	561.20	0.0001
D12	0.01161006	0.00995252	0.00179019	1.36	0.2470
D21	0.08233059	0.01856720	0.02577251	19.62	0.0001
D22	0.08374976	0.02252670	0.01815798	13.82	0.0004
D41	0.02483970	0.01406291	0.00409865	3.12	0.0825
D42	0.02071315	0.01570040	0.00228649	1.74	0.1922
D52	0.01580561	0.01077087	0.00285885	2.18	0.1455
D71	0.01845796	0.01769856	0.00143018	1.09	0.3010
D81	0.04236029	0.01350564	0.01292367	9.84	0.0027
D82	0.07920061	0.01712073	0.02817008	21.44	0.0001
D91	0.06665093	0.02279740	0.01123107	8.55	0.0049
D92	0.11051026	0.03107348	0.01816148	13.82	0.0004
D101	0.04929111	0.02099423	0.00724162	5.51	0.0223
D102	0.07447244	0.02561023	0.01110860	8.46	0.0051
D112	0.01236794	0.00959515	0.00217563	1.66	0.2032
D131	0.04730341	0.01260991	0.01848670	14.07	0.0004
D132	0.03458670	0.01420074	0.00778579	5.87	0.0185

Bounds on condition number: 14.65243, 1048.039

FORWARD selection procedure

Statistics for Entry: Step 17
DF = 1,58

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.458926	0.9481	0.0382	0.8458
D31	0.646601	0.9482	0.1470	0.7020
D32	0.573417	0.9483	0.2573	0.6139
D51	0.369839	0.9481	0.0307	0.8756
D61	0.478629	0.9481	0.1282	0.7216
D62	0.310875	0.9483	0.2850	0.5955
D72	0.235963	0.9489	0.9510	0.3335
D111	0.659181	0.9480	0.0038	0.9508
D121	0.649854	0.9483	0.2725	0.6037
D122	.	0.9480	.	.
D141	0.787461	0.9481	0.1137	0.7372
D142	0.671624	0.9483	0.1439	0.7058

pl7 Variable D72 Entered R-square = 0.94886883 C(p) = 0.74409882

	DF	Sum of Squares	Mean Square	F	Prob>F
gression	17	1.41516660	0.08324510	63.31	0.0001
ror	58	0.07625831	0.00131480		
tal	75	1.49142499			

riable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
TERCEP	0.39389337	0.01841836	0.60133237	457.36	0.0001
12	0.01160178	0.00995667	0.00178517	1.36	0.2487
11	0.07790817	0.01909836	0.02187932	16.64	0.0001
12	0.08079388	0.02273907	0.01659857	12.62	0.0008
11	0.02303599	0.01610635	0.00375402	2.86	0.0964
12	0.02203824	0.01576560	0.00256917	1.95	0.1675
2	0.01336811	0.01107950	0.00191408	1.46	0.2325
1	0.03211610	0.02256936	0.00266236	2.02	0.1601
2	0.02153975	0.02208792	0.00125035	0.95	0.3335
11	0.04176639	0.01352497	0.01253835	9.54	0.0031
12	0.07930619	0.01712787	0.02818674	21.44	0.0001
1	0.05732599	0.02473352	0.00706302	5.37	0.0240
2	0.10771811	0.03375250	0.01339139	10.19	0.0023
01	0.05383035	0.02151250	0.00823244	6.26	0.0152
02	0.07916836	0.02606796	0.01212441	9.22	0.0036
12	0.01111537	0.00968199	0.00173292	1.32	0.2557
31	0.04352912	0.01319551	0.01430758	10.88	0.0017
32	0.03177989	0.01457374	0.00625204	4.76	0.0333

nds on condition number: 16.41738, 1394.174

FORWARD selection procedure

Statistics for Entry: Step 18
DF = 1,57

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.458667	0.9489	0.0297	0.8638
D31	0.646070	0.9490	0.1272	0.7227
D32	0.562105	0.9490	0.1400	0.7096
D51	0.362300	0.9489	0.0885	0.7672
D61	0.470623	0.9490	0.1306	0.7191
D62	0.309447	0.9491	0.2197	0.6411
D111	0.650426	0.9489	0.0300	0.8631
D121	0.643985	0.9492	0.3789	0.5407
D122	.	0.9489	.	.
D141	0.772339	0.9489	0.0419	0.8385
D142	0.623907	0.9489	0.0158	0.9005

No other variable met the 0.5000 significance level for entry into the model.

Summary of Forward Selection Procedure for Dependent Variable Y

Step	Variable Entered	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	D92	1	0.6217	0.6217	288.6209	121.6217	0.0001
2	D91	2	0.1598	0.7815	138.2530	53.4103	0.0001
3	D82	3	0.0381	0.8197	103.9291	15.2116	0.0002
4	D81	4	0.0158	0.8355	90.0514	6.0250	0.0110
5	D41	5	0.0161	0.8516	77.4967	7.5961	0.0075
6	D42	6	0.0260	0.8776	54.6903	14.6625	0.0003
7	D21	7	0.0145	0.8921	42.0333	9.1604	0.0035
8	D22	8	0.0199	0.9120	25.0933	15.1273	0.0002
9	D131	9	0.0085	0.9205	19.0149	7.0317	0.0100
10	D132	10	0.0096	0.9301	13.6581	8.9290	0.0040
11	D52	11	0.0055	0.9356	9.4035	5.4740	0.0224
12	D102	12	0.0036	0.9392	8.0016	3.6951	0.0591
13	D101	13	0.0056	0.9448	4.6317	6.3256	0.0145
14	D112	14	0.0011	0.9459	5.5710	1.3537	0.2073
15	D12	15	0.0012	0.9471	6.4575	1.3251	0.2542
16	D71	16	0.0010	0.9480	7.5433	1.0806	0.3010
17	D72	17	0.0008	0.9489	0.7441	0.9510	0.3335

FORWARD selection procedure

odel: MODEL1
pendent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	1.41517	0.08325	63.314	0.0001
Error	58	0.07626	0.00131		
C Total	75	1.49142			

Root MSE	0.03626	R-square	0.9489
Dep Mean	0.67899	Adj R-sq	0.9339
C.V.	5.34033		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.393093	0.01841836	21.386	0.0001
D12	1	0.011603	0.00995667	1.165	0.2487
D21	1	0.077900	0.01909036	4.079	0.0001
D22	1	0.080796	0.02273907	3.553	0.0008
D41	1	0.023036	0.01610635	1.690	0.0964
D42	1	0.022030	0.01514560	1.390	0.1675
D52	1	0.013368	0.01107950	1.207	0.2325
D71	1	0.032116	0.02256926	1.423	0.1601
D72	1	0.021540	0.02208792	0.975	0.3335
D81	1	0.041766	0.01392497	3.000	0.0031
D82	1	0.079306	0.01712707	4.630	0.0001
D91	1	0.057326	0.02473352	2.318	0.0240
D92	1	0.107710	0.03375250	3.191	0.0023
D101	1	0.053930	0.02151250	2.502	0.0152
D102	1	0.079160	0.02606796	3.037	0.0036
D112	1	0.011115	0.00960199	1.160	0.2557
D131	1	0.043520	0.01319551	3.299	0.0017
D132	1	0.031780	0.01457374	2.181	0.0333

STEPWISE selection procedure

Stepwise Procedure for Dependent Variable Y

Statistics for Entry: Step 1
DF = 1,74

Variable	Tolerance	Model R**2	F	Prob>F
D11	1.000000	0.0881	7.1520	0.0092
D12	1.000000	0.0471	3.6577	0.0597
D21	1.000000	0.0988	8.1101	0.0057
D22	1.000000	0.2653	26.7187	0.0001
D31	1.000000	0.0670	5.3160	0.0239
D32	1.000000	0.1587	13.9606	0.0004
D41	1.000000	0.0002	0.0157	0.9005
D42	1.000000	0.0320	2.5073	0.1176
D51	1.000000	0.0073	0.5467	0.4620
D52	1.000000	0.0684	5.4343	0.0225
D61	1.000000	0.0056	0.4201	0.5150
D62	1.000000	0.0575	4.5155	0.0369
D71	1.000000	0.1095	9.1022	0.0035
D72	1.000000	0.4400	58.1544	0.0001
D81	1.000000	0.1811	16.3676	0.0001
D82	1.000000	0.1462	12.6690	0.0007
D91	1.000000	0.0264	2.0106	0.1604
D92	1.000000	0.6217	121.6217	0.0001
D101	1.000000	0.0786	6.3084	0.0143
D102	1.000000	0.3366	37.5525	0.0001
D111	1.000000	0.0024	0.1813	0.6715
D112	1.000000	0.0676	5.3633	0.0234
D121	1.000000	0.0253	1.9232	0.1697
D122	.	0.0000	.	.
D131	1.000000	0.0267	2.0308	0.1583
D132	1.000000	0.0325	2.4865	0.1191
D141	1.000000	0.0427	3.2976	0.0734
D142	1.000000	0.0053	0.3975	0.5303

Step 1 Variable D92 Entered R-square = 0.62171091 C(p) =288.62093804

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	1	0.92724712	0.92724712	121.62	0.0001
Error	74	0.56417786	0.00762403		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.56255556	0.01455261	11.39207511	1494.30	0.0001
D92	0.22121944	0.02005939	0.92724712	121.62	0.0001

Bounds on condition number: 1, 1

STEPWISE selection procedure

Statistics for Entry: Step 2
DF = 1,73

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.842370	0.6220	0.0601	0.8071
D12	0.970080	0.6284	1.3139	0.2554
D21	0.956663	0.6452	4.8230	0.0312
D22	0.806527	0.6568	7.4642	0.0079
D31	0.972427	0.6386	3.4017	0.0692
D32	0.720999	0.6222	0.0870	0.7679
D41	0.984927	0.6343	2.5144	0.1171
D42	0.942530	0.6218	0.0131	0.9092
D51	0.981609	0.6222	0.0942	0.7598
D52	0.997769	0.6721	11.2288	0.0013
D61	0.907113	0.6515	6.2474	0.0147
D62	0.836600	0.6292	1.4654	0.2300
D71	0.887279	0.6267	0.9665	0.3288
D72	0.769104	0.7179	24.8865	0.0001
D81	0.822222	0.6323	2.0939	0.1522
D82	0.972507	0.6869	15.1972	0.0002
D91	0.629630	0.7815	53.6103	0.0001
D101	0.995230	0.6730	11.4410	0.0012
D102	0.504615	0.6306	1.7531	0.1896
D111	0.999564	0.6261	0.8405	0.3600
D112	0.918534	0.6230	0.2562	0.6142
D121	0.942963	0.6226	0.1744	0.6775
D122	.	0.6217	.	.
D131	0.992475	0.6308	1.7994	0.1839
D132	0.990291	0.6323	2.1082	0.1508
D141	0.934007	0.6217	0.0033	0.9544
D142	0.995741	0.6222	0.0909	0.7640

tep 2 Variable D91 Entered R-square = 0.70154855 C(p) =138.25298181

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	2	1.16562104	0.58281052	130.59	0.0001
Error	73	0.32580395	0.00446307		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47652941	0.01620208	3.86036476	864.96	0.0001
D91	0.16299690	0.02230318	0.23837392	53.41	0.0001
D92	0.30724559	0.01934193	1.12617367	252.33	0.0001

ounds on condition number: 1.588235, 6.352941

STEPWISE selection procedure

Statistics for Removal: Step 3
DF = 1,73

Variable	Partial R**2	Model R**2
D91	0.1598	0.6217
D92	0.7551	0.0264

Statistics for Entry: Step 3
DF = 1,72

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.841105	0.7816	0.0015	0.9691
D12	0.940482	0.7817	0.0489	0.8255
D21	0.924050	0.7881	2.2244	0.1402
D22	0.782824	0.7961	5.1332	0.0265
D31	0.918810	0.7829	0.4525	0.5033
D32	0.720923	0.7818	0.0975	0.7557
D41	0.983699	0.7975	5.8036	0.0186
D42	0.874878	0.7921	3.4460	0.0682
D51	0.980516	0.7816	0.0331	0.8561
D52	0.965776	0.8057	8.9684	0.0038
D61	0.706633	0.7818	0.0986	0.7544
D62	0.830536	0.7920	3.9251	0.0514
D71	0.870821	0.7825	0.3270	0.5692
D72	0.561128	0.7977	5.7335	0.0193
D81	0.740948	0.7821	0.1930	0.6611
D82	0.948811	0.8197	15.2116	0.0002
D101	0.792857	0.7842	0.8909	0.3484
D102	0.504615	0.7904	3.0470	0.0851
D111	0.899307	0.7868	1.7672	0.1879
D112	0.919493	0.7827	0.3781	0.5417
D121	0.941856	0.7835	0.6367	0.4275
D122	.	0.7815	.	.
D131	0.990246	0.7874	1.9837	0.1633
D132	0.986137	0.7983	5.9580	0.0171
D141	0.910842	0.7852	1.2350	0.2701
D142	0.995622	0.7818	0.0991	0.7539

Step 3 Variable D82 Entered R-square = 0.81965127 C(p) =103.92910001

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	3	1.22264838	0.40748279	109.08	0.0001
Error	72	0.26877660	0.00373579		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47652941	0.01482404	3.86036476	1033.35	0.0001
D82	0.07970892	0.02045761	0.05682735	15.21	0.0002
D91	0.15039865	0.02065929	0.19790089	53.00	0.0001
D92	0.39120781	0.01816200	0.96086191	257.20	0.0001

STEPWISE selection procedure

Bounds on condition number: 1.673141, 13.06538

Statistics for Removal: Step 4
DF = 1,72

Variable	Partial R**2	Model R**2
D82	0.0381	0.7815
D91	0.1320	0.6869
D92	0.6443	0.1754

Statistics for Entry: Step 4
DF = 1,71

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.836311	0.0190	0.0620	0.8028
D12	0.914220	0.0217	0.8223	0.3674
D21	0.905336	0.0317	5.0870	0.0272
D22	0.751024	0.0260	2.8314	0.0960
D31	0.913219	0.0201	0.1871	0.6666
D32	0.720300	0.0190	0.0517	0.8208
D41	0.983502	0.0351	6.6526	0.0120
D42	0.841954	0.0240	1.7570	0.1891
D51	0.915698	0.0214	0.6867	0.4101
D52	0.803023	0.0265	2.7947	0.0990
D61	0.783605	0.0197	0.0080	0.9289
D62	0.753124	0.0219	0.9067	0.3442
D71	0.874866	0.0200	0.1331	0.7163
D72	0.550927	0.0329	5.6106	0.0206
D81	0.450293	0.0355	6.8250	0.0110
D101	0.785265	0.0247	2.0603	0.1560
D102	0.551596	0.0221	0.9663	0.3289
D111	0.902972	0.0219	0.9101	0.3433
D112	0.910730	0.0199	0.0987	0.7543
D121	0.940050	0.0209	0.4926	0.4851
D122	.	0.0197	.	.
D131	0.960706	0.0316	5.0360	0.0279
D132	0.882428	0.0245	1.9872	0.1651
D141	0.903025	0.0216	0.7606	0.3861
D142	0.994112	0.0197	0.0373	0.8474

ep 4 Variable D81 Entered R-square = 0.83546735 C(p) = 90.85139559

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	4	1.24603609	0.31150922	90.13	0.0001
Error	71	0.24538810	0.00345617		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.47344070	0.01430741	3.78446372	1094.99	0.0001
D81	0.05250805	0.02009895	0.02358850	6.83	0.0110

STEPWISE selection procedure

D82	0.12108947	0.02524100	0.07954118	23.01	0.0001
D91	0.12209399	0.02263284	0.10057864	29.10	0.0001
D92	0.24936077	0.02372254	0.38180190	110.49	0.0001

Bounds on condition number: 3.085140, 36.6088

Statistics for Removal: Step 5
DF = 1,71

Variable	Partial R**2	Model R**2
D81	0.0158	0.8197
D82	0.0533	0.7821
D91	0.0674	0.7680
D92	0.2561	0.5794

Statistics for Entry: Step 5
DF = 1,70

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.830110	0.0355	0.0016	0.9704
D12	0.885527	0.0360	0.2366	0.6284
D21	0.906393	0.0484	5.9940	0.0169
D22	0.742827	0.0404	2.1560	0.1465
D31	0.913006	0.0360	0.2397	0.6259
D32	0.715900	0.0355	0.0013	0.9716
D41	0.903167	0.0516	7.5961	0.0075
D42	0.830792	0.0382	1.1639	0.2844
D51	0.860995	0.0356	0.0531	0.8185
D52	0.797593	0.0442	3.9105	0.0519
D61	0.600250	0.0361	0.2828	0.5965
D62	0.720263	0.0361	0.2725	0.6033
D71	0.857523	0.0360	0.5696	0.4530
D72	0.555725	0.0510	7.3196	0.0086
D101	0.774060	0.0387	1.4109	0.2389
D102	0.543453	0.0397	1.8431	0.1788
D111	0.940132	0.0360	0.2067	0.6508
D112	0.905500	0.0361	0.2745	0.6020
D121	0.920256	0.0379	1.0647	0.3057
D122	.	0.0355	.	.
D131	0.964679	0.0476	5.5525	0.0213
D132	0.882361	0.0400	1.9767	0.1644
D141	0.981795	0.0370	0.6560	0.4204
D142	0.993905	0.0356	0.0560	0.8133

Step 5 Variable D41 Entered R-square = 0.85157397 C(p) = 77.49872140

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	5	1.27005870	0.25401174	80.33	0.0001
Error	70	0.22136629	0.00316238		
Total	75	1.49142499			

Parameter Standard Type II

STEPWISE selection procedure

Variable	Estimate	Error	Sum of Squares	F	Prob>F
INTERCEP	0.45600707	0.01507608	2.89289965	914.79	0.0001
D41	0.03691034	0.01339220	0.02402101	7.60	0.0075
D81	0.05359707	0.01932977	0.02456673	7.77	0.0068
D82	0.12138020	0.02414467	0.07992207	25.27	0.0001
D91	0.12342467	0.02165490	0.10273107	32.49	0.0001
D92	0.25397808	0.02275363	0.39400763	124.59	0.0001

Bounds on condition number: 3.101964, 50.94019

Statistics for Removal: Step 6
DF = 1,70

Variable	Partial R**2	Model R**2
D41	0.0161	0.0355
D81	0.0165	0.0351
D82	0.0536	0.7980
D91	0.0689	0.7027
D92	0.2642	0.5074

Statistics for Entry: Step 6
DF = 1,69

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.819359	0.0518	0.1246	0.7252
D12	0.893210	0.0525	0.4227	0.5177
D21	0.869416	0.0598	4.0526	0.0480
D22	0.735318	0.0549	1.5003	0.2130
D31	0.864905	0.0516	0.0145	0.9045
D32	0.713268	0.0516	0.0173	0.8957
D42	0.527653	0.0776	14.6625	0.0003
D51	0.832651	0.0517	0.0677	0.7955
D52	0.777599	0.0640	6.7293	0.0116
D61	0.664730	0.0516	0.0088	0.9254
D62	0.720260	0.0522	0.3065	0.5029
D71	0.846536	0.0521	0.2302	0.6329
D72	0.526743	0.0613	4.8174	0.0315
D101	0.720521	0.0523	0.3353	0.5644
D102	0.531036	0.0580	3.5118	0.0652
D111	0.937653	0.0526	0.3813	0.5389
D112	0.895672	0.0531	0.7086	0.4028
D121	0.927534	0.0537	1.0037	0.3199
D122	.	0.0516	.	.
D131	0.963345	0.0627	5.5735	0.0211
D132	0.880089	0.0553	1.7721	0.1875
D141	0.899629	0.0527	0.5070	0.4785
D142	0.935917	0.0535	0.8907	0.3486

STEPWISE selection procedure

Step 6 Variable D42 Entered R-square = 0.87758618 C(p) = 54.69832666

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	6	1.30885405	0.21814267	82.44	0.0001
Error	69	0.18257014	0.00264594		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41279393	0.01781989	1.41983201	536.61	0.0001
D41	0.07246423	0.01537120	0.05880475	22.22	0.0001
D42	0.06556251	0.01712109	0.03879615	14.66	0.0003
D81	0.04485105	0.01773733	0.01691864	6.39	0.0137
D82	0.09748860	0.02294901	0.04774526	18.04	0.0001
D91	0.15613193	0.02157115	0.13861736	52.39	0.0001
D92	0.26703305	0.02109037	0.42417222	160.31	0.0001

Bounds on condition number: 3.1852, 79.91836

Statistics for Removal: Step 7
DF = 1,69

Variable	Partial R**2	Model R**2
D41	0.0394	0.8382
D42	0.0260	0.8516
D81	0.0113	0.8662
D82	0.0320	0.8456
D91	0.0929	0.7846
D92	0.2844	0.5932

STEPWISE selection procedure

Statistics for Entry: Step 7
DF = 1,68

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.817610	0.8777	0.0443	0.8339
D12	0.870014	0.8801	1.4265	0.2365
D21	0.843167	0.8921	9.1604	0.0035
D22	0.605297	0.8777	0.0699	0.7923
D31	0.829208	0.8791	0.8612	0.3567
D32	0.699719	0.8784	0.4575	0.5011
D51	0.831927	0.8779	0.1576	0.6926
D52	0.760337	0.8860	5.0320	0.0281
D61	0.655293	0.8778	0.1247	0.7251
D62	0.553667	0.8813	2.1527	0.1469
D71	0.810748	0.8777	0.0695	0.7928
D72	0.517766	0.8837	3.5595	0.0635
D101	0.725601	0.8790	0.7726	0.3826
D102	0.509601	0.8804	1.6127	0.2084
D111	0.937453	0.8784	0.4517	0.5038
D112	0.872718	0.8778	0.0968	0.7566
D121	0.901284	0.8780	0.2060	0.6508
D122	.	0.8776	.	.
D131	0.961522	0.8902	7.8310	0.0067
D132	0.803589	0.8778	0.1096	0.7416
D141	0.892755	0.8779	0.1991	0.6569
D142	0.928840	0.8785	0.4895	0.4865

tep 7 Variable D21 Entered R-square = 0.89213074 C(p) = 42.83334932

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	7	1.33054608	0.19007801	80.34	0.0001
Error	68	0.16087890	0.00236587		
Total	75	1.49142499			

/ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40504516	0.01700594	1.34744101	569.53	0.0001
D21	0.03844256	0.01269595	0.02169123	9.17	0.0035
D41	0.07001129	0.01455767	0.05472103	23.13	0.0001
D42	0.07421227	0.01644044	0.04820753	20.38	0.0001
D81	0.04517105	0.01677264	0.01715963	7.25	0.0089
D82	0.10294861	0.02177599	0.05287803	22.35	0.0001
D91	0.14848191	0.02055342	0.12347215	52.19	0.0001
D92	0.25227205	0.02053011	0.35722827	150.99	0.0001

ounds on condition number: 3.375525, 103.6805

STEPWISE selection procedure

Statistics for Removal: Step 8
DF = 1,68

Variable	Partial R**2	Model R**2
D21	0.0145	0.8776
D41	0.0367	0.8554
D42	0.0323	0.8598
D81	0.0115	0.8806
D82	0.0355	0.8567
D91	0.0828	0.8093
D92	0.2395	0.6526

Statistics for Entry: Step 8
DF = 1,67

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.816238	0.8921	0.0098	0.9213
D12	0.843132	0.8930	0.5615	0.4464
D22	0.220001	0.9120	15.1372	0.0002
D31	0.828039	0.8941	1.2155	0.2742
D32	0.698600	0.8927	0.3594	0.5508
D51	0.819638	0.8921	0.0030	0.9567
D52	0.755245	0.8989	4.4025	0.0388
D61	0.651267	0.8922	0.0188	0.8912
D62	0.369060	0.8922	0.0650	0.7996
D71	0.770391	0.8936	0.8167	0.3694
D72	0.488024	0.8947	1.6291	0.2063
D101	0.718825	0.8928	0.3971	0.5307
D102	0.502407	0.8937	0.9645	0.3296
D111	0.937467	0.8928	0.4467	0.5062
D112	0.872089	0.8924	0.1602	0.6838
D121	0.886197	0.8921	0.0085	0.9268
D122	.	0.8921	.	.
D131	0.961038	0.9045	8.6951	0.0044
D132	0.803128	0.8924	0.1705	0.6740
D141	0.883460	0.8922	0.0204	0.8868
D142	0.926408	0.8934	0.8055	0.3727

Step 8 Variable D22 Entered R-square = 0.91199938 C(p) = 25.09228402

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	8	1.36017867	0.17002233	86.79	0.0001
Error	67	0.13124632	0.00195890		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42030910	0.01652420	1.31657035	672.10	0.0001
D21	0.09708759	0.01615884	0.05113630	36.10	0.0001
D22	0.08958704	0.02303305	0.02963258	15.13	0.0002
D41	0.03476287	0.01604993	0.00918961	4.69	0.0339
D42	0.04354619	0.01691039	0.01298989	6.63	0.0122

STEPWISE selection procedure

D81	0.03960388	0.01532710	0.01313160	6.70	0.0118
D82	0.09646905	0.01988460	0.04610532	23.54	0.0001
D91	0.10525645	0.02175554	0.04585151	23.41	0.0001
D92	0.18633705	0.02522649	0.10688019	54.56	0.0001

Bounds on condition number: 6.155312, 211.4961

Statistics for Removal: Step 9
DF = 1,67

Variable	Partial R**2	Model R**2
D21	0.0343	0.8777
D22	0.0199	0.8921
D41	0.0062	0.9050
D42	0.0087	0.9033
D81	0.0088	0.9033
D82	0.0309	0.8811
D91	0.0307	0.8813
D92	0.0717	0.8403

Statistics for Entry: Step 9
DF = 1,66

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.776707	0.9131	1.0271	0.3146
D12	0.791520	0.9164	3.4747	0.0668
D31	0.825696	0.9147	2.0700	0.1550
D32	0.698012	0.9128	0.6101	0.4376
D51	0.818658	0.9120	0.0374	0.8472
D52	0.727952	0.9158	2.9767	0.0892
D61	0.598231	0.9143	1.7533	0.1902
D62	0.357866	0.9122	0.1591	0.6912
D71	0.735757	0.9170	4.0056	0.0495
D72	0.441964	0.9121	0.0442	0.8342
D101	0.700006	0.9120	0.0056	0.9418
D102	0.490711	0.9158	2.9490	0.0906
D111	0.905173	0.9149	2.3469	0.1307
D112	0.833441	0.9142	1.7119	0.1953
D121	0.885857	0.9120	0.0007	0.9795
D122	.	0.9120	.	.
D131	0.961658	0.9205	7.0317	0.0100
D132	0.790563	0.9120	0.0180	0.8631
D141	0.880437	0.9123	0.1782	0.6761
D142	0.854537	0.9181	4.9223	0.0300

Step 9 Variable D131 Entered R-square = 0.92047237 C(p) = 19.81486436

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	9	1.37281549	0.15253505	84.88	0.0001
Error	66	0.11860950	0.00179711		
Total	75	1.49142499			

STEPWISE selection procedure

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41622222	0.01647885	1.14649545	637.96	0.0001
D21	0.09198407	0.01860517	0.04449935	24.76	0.0001
D22	0.08110818	0.02229267	0.02378924	13.24	0.0005
D41	0.03800176	0.01542331	0.01091289	6.07	0.0163
D42	0.04803252	0.01828514	0.01563375	8.70	0.0044
D81	0.04015589	0.01468161	0.01344395	7.48	0.0080
D82	0.10279223	0.01919454	0.05153958	28.68	0.0001
D91	0.10727131	0.02005166	0.04756237	26.47	0.0001
D92	0.18821090	0.02417264	0.10894745	60.62	0.0001
D131	0.02680945	0.01011013	0.01263602	7.03	0.0100

Bounds on condition number: 6.160577, 249.5205

Statistics for Removal: Step 10
DF = 1,66

Variable	Partial R**2	Model R**2
D21	0.0298	0.8906
D22	0.0160	0.9045
D41	0.0073	0.9133
D42	0.0105	0.9100
D81	0.0090	0.9115
D82	0.0346	0.8859
D91	0.0319	0.8886
D92	0.0730	0.8474
D131	0.0085	0.9120

Statistics for Entry: Step 10
DF = 1,65

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.753430	0.9209	0.3896	0.5347
D12	0.770516	0.9232	2.2817	0.1369
D31	0.734100	0.9209	0.3551	0.5533
D32	0.633697	0.9205	0.0002	0.9893
D51	0.796563	0.9210	0.4161	0.5212
D52	0.723126	0.9262	5.0092	0.0286
D61	0.596735	0.9223	1.5580	0.2163
D62	0.357780	0.9206	0.1425	0.7070
D71	0.733614	0.9263	5.0961	0.0273
D72	0.426623	0.9206	0.0762	0.7836
D101	0.699370	0.9205	0.0241	0.8770
D102	0.489728	0.9238	2.7974	0.0992
D111	0.867104	0.9217	1.0591	0.3072
D112	0.831362	0.9223	1.5197	0.2221
D121	0.813622	0.9212	0.5704	0.4497
D122	.	0.9205	.	.
D132	0.411015	0.9301	0.9290	0.0060
D141	0.856645	0.9216	0.7876	0.3781
D142	0.820120	0.9244	3.4086	0.0694

STEPWISE selection procedure

tep10 Variable D132 Entered R-square = 0.93007756 C(p) = 12.65809411

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	10	1.38714091	0.13871409	86.46	0.0001
Error	65	0.10428408	0.00160437		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39841886	0.01667131	0.91633758	571.15	0.0001
D21	0.08258653	0.01774467	0.03474476	21.66	0.0001
D22	0.06580128	0.02167736	0.01478307	9.21	0.0035
D41	0.03207583	0.01460778	0.00788336	4.89	0.0306
D42	0.03797084	0.01575120	0.00932368	5.81	0.0188
D81	0.04206443	0.01388667	0.01472104	9.18	0.0035
D82	0.09513776	0.01831606	0.04328598	26.98	0.0001
D91	0.11150947	0.01975275	0.05112968	31.87	0.0001
D92	0.19377761	0.02291565	0.11472417	71.51	0.0001
D131	0.05447156	0.01330223	0.02690264	16.77	0.0001
D132	0.04470228	0.01495987	0.01432542	8.93	0.0040

ounds on condition number: 6.201563, 317.9307

Statistics for Removal: Step 11
DF = 1,65

Variable	Partial R**2	Model R**2
D21	0.0233	0.9068
D22	0.0099	0.9202
D41	0.0053	0.9248
D42	0.0063	0.9238
D81	0.0099	0.9202
D82	0.0290	0.9011
D91	0.0343	0.8958
D92	0.0769	0.8532
D131	0.0180	0.9120
D132	0.0096	0.9205

STEPWISE selection procedure

Statistics for Entry: Step 11
DF = 1,64

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.753409	0.9306	0.4578	0.5011
D12	0.767288	0.9322	1.9790	0.1643
D31	0.724099	0.9305	0.4027	0.5279
D32	0.630644	0.9301	0.0487	0.8261
D51	0.729694	0.9329	2.6963	0.1055
D52	0.723019	0.9356	5.4768	0.0224
D61	0.593103	0.9327	2.4686	0.1211
D62	0.356915	0.9301	0.0179	0.8939
D71	0.691210	0.9330	2.7917	0.0996
D72	0.426558	0.9301	0.0652	0.7993
D101	0.679597	0.9302	0.1152	0.7354
D102	0.685020	0.9305	0.3935	0.6423
D111	0.867052	0.9313	1.1377	0.2901
D112	0.826494	0.9313	1.1566	0.2862
D121	0.797773	0.9302	0.1555	0.6947
D122	.	0.9301	.	.
D141	0.852099	0.9306	0.5218	0.4727
D142	0.800140	0.9322	1.9715	0.1651

Step11 Variable D52 Entered R-square = 0.93558951 C(p) = 9.40344622

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	11	1.39536150	0.12685105	84.51	0.0001
Error	64	0.09606341	0.00150099		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39232645	0.01633384	0.86595786	576.92	0.0001
D21	0.07516320	0.01745609	0.02782900	18.54	0.0001
D22	0.05766607	0.02125344	0.01104995	7.36	0.0085
D41	0.03696041	0.01433537	0.00997770	6.65	0.0122
D42	0.03596993	0.01525924	0.00834048	5.56	0.0215
D52	0.02603330	0.01112413	0.00822067	5.48	0.0224
D81	0.04594607	0.01353388	0.01729948	11.53	0.0012
D82	0.08562695	0.01817428	0.03331116	22.19	0.0001
D91	0.10788078	0.01916057	0.04754101	31.67	0.0001
D92	0.19501377	0.02210196	0.11696158	77.92	0.0001
D131	0.05731202	0.01292364	0.02951888	19.67	0.0001
D132	0.04428078	0.01447095	0.01405955	9.37	0.0032

Bounds on condition number: 6.211119, 370.3649

STEPWISE selection procedure

Statistics for Removal: Step 12
DF = 1,64

Variable	Partial R**2	Model R**2
D21	0.0187	0.9169
D22	0.0074	0.9282
D41	0.0067	0.9289
D42	0.0056	0.9300
D52	0.0055	0.9301
D81	0.0116	0.9240
D82	0.0223	0.9133
D91	0.0319	0.9037
D92	0.0784	0.8572
D131	0.0198	0.9158
D132	0.0094	0.9262

Statistics for Entry: Step 12
DF = 1,63

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.752722	0.9362	0.5945	0.4436
D12	0.756089	0.9370	1.3755	0.2453
D31	0.711419	0.9357	0.1226	0.7274
D32	0.627338	0.9356	0.0036	0.9523
D51	0.399560	0.9356	0.0186	0.8918
D61	0.504041	0.9374	1.7029	0.1966
D62	0.354312	0.9356	0.0550	0.8154
D71	0.682289	0.9377	2.1327	0.1492
D72	0.423077	0.9358	0.2269	0.6355
D101	0.679329	0.9358	0.1577	0.6926
D102	0.401724	0.9392	3.6951	0.0591
D111	0.821669	0.9359	0.3347	0.5649
D112	0.833325	0.9365	0.9349	0.3373
D121	0.791770	0.9360	0.3753	0.5423
D122	.	0.9356	.	.
D141	0.852099	0.9362	0.5575	0.4580
D142	0.729016	0.9362	0.6029	0.4404

Step12 Variable D102 Entered R-square = 0.93915802 C(p) = 8.00155425

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	12	1.40068374	0.11672364	81.04	0.0001
Error	63	0.09074125	0.00144034		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39598457	0.01611320	0.86987590	603.94	0.0001
D21	0.07695609	0.01712512	0.02908654	20.19	0.0001
D22	0.06359413	0.02104676	0.01315006	9.13	0.0036
D41	0.03399640	0.01412716	0.00834111	5.79	0.0191
D42	0.02772246	0.01555133	0.00457712	3.18	0.0795
D52	0.02410193	0.01094320	0.00698671	4.85	0.0313
D81	0.04937923	0.01337733	0.01962519	13.63	0.0005
D82	0.08302651	0.01785655	0.03113805	21.62	0.0001
D91	0.10272049	0.01896021	0.04224017	29.33	0.0001
D92	0.17489968	0.02430000	0.07461069	51.80	0.0001
D102	0.02593867	0.01349374	0.00532216	3.70	0.0591
D131	0.05783273	0.01266273	0.03004392	20.86	0.0001
D132	0.04677301	0.01423436	0.01555170	10.80	0.0017

STEPWISE selection procedure

Bounds on condition number: 7.760290, 453.9639

Statistics for Removal: Step 13
DF = 1,63

Variable	Partial R**2	Model R**2
D21	0.0195	0.9197
D22	0.0088	0.9303
D41	0.0056	0.9336
D42	0.0031	0.9361
D52	0.0047	0.9345
D81	0.0132	0.9260
D82	0.0209	0.9183
D91	0.0283	0.9109
D92	0.0500	0.8891
D102	0.0036	0.9356
D131	0.0201	0.9190
D132	0.0104	0.9287

Statistics for Entry: Step 13
DF = 1,62

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.752292	0.9398	0.6952	0.4076
D12	0.755733	0.9406	1.5402	0.2193
D31	0.703793	0.9392	0.0250	0.8730
D32	0.622617	0.9392	0.0109	0.9171
D51	0.399522	0.9392	0.0142	0.9057
D61	0.503561	0.9400	1.7096	0.1959
D62	0.334093	0.9392	0.0497	0.8246
D71	0.670789	0.9409	1.0288	0.1012
D72	0.432923	0.9394	0.2023	0.6545
D101	0.179361	0.9440	6.3256	0.0145
D111	0.814299	0.9393	0.1687	0.6827
D112	0.799461	0.9396	0.4451	0.5072
D121	0.791131	0.9395	0.3361	0.5700
D122	.	0.9392	.	.
D141	0.812639	0.9393	0.1276	0.7222
D142	0.690450	0.9393	0.1295	0.7202

STEPWISE selection procedure

ep13 Variable D101 Entered R-square = 0.94479081 C(p) = 4.63172944

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	13	1.40908463	0.10839113	81.62	0.0001
rror	62	0.08234036	0.00132807		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40797324	0.01619010	0.84330807	634.99	0.0001
D21	0.06810597	0.01680989	0.02185151	16.45	0.0001
D22	0.06454619	0.02021341	0.01354118	10.20	0.0022
D41	0.02850190	0.01300803	0.00483552	3.64	0.0610
D42	0.02132639	0.01514809	0.00263183	1.98	0.1642
D52	0.01903370	0.01069961	0.00420277	3.16	0.0802
D81	0.04846893	0.01285051	0.01889328	14.23	0.0004
D82	0.07940990	0.01720400	0.02835195	21.35	0.0001
D91	0.07149567	0.02204273	0.01397172	10.52	0.0019
D92	0.12627077	0.03030209	0.02306411	17.37	0.0001
D101	0.05146432	0.02046229	0.00840089	6.33	0.0145
D102	0.08034747	0.02521665	0.01348313	10.15	0.0023
D131	0.05307262	0.01230564	0.02470323	18.60	0.0001
D132	0.04063105	0.01380473	0.01137311	8.56	0.0048

ounds on condition number: 13.10005, 737.5931

Statistics for Removal: Step 14
DF = 1,62

Variable	Partial R**2	Model R**2
D21	0.0147	0.9301
D22	0.0091	0.9357
D41	0.0032	0.9415
D42	0.0018	0.9430
D52	0.0028	0.9420
D81	0.0127	0.9321
D82	0.0190	0.9258
D91	0.0094	0.9354
D92	0.0155	0.9293
D101	0.0056	0.9392
D102	0.0090	0.9358
D131	0.0166	0.9282
D132	0.0076	0.9372

STEPWISE selection procedure

Statistics for Entry: Step 14
DF = 1,61

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.726757	0.9449	0.1692	0.6822
D12	0.744211	0.9457	0.9676	0.3292
D31	0.702032	0.9448	0.0056	0.9405
D32	0.622610	0.9448	0.0137	0.9071
D51	0.390957	0.9448	0.0596	0.8079
D61	0.526356	0.9451	0.3522	0.5551
D62	0.330892	0.9450	0.2298	0.6334
D71	0.660816	0.9457	1.0067	0.3197
D72	0.388734	0.9448	0.0637	0.8017
D111	0.810585	0.9449	0.0673	0.7962
D112	0.770733	0.9459	1.2537	0.2672
D121	0.772649	0.9457	0.9870	0.3242
D122	.	0.9448	.	.
D141	0.806511	0.9448	0.0150	0.9028
D142	0.688520	0.9450	0.2581	0.6133

Step14 Variable D42 Removed R-square = 0.94302617 C(p) = 4.31399026

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	12	1.40645279	0.11720440	86.90	0.0001
Error	63	0.08497219	0.00134876		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42086082	0.01346662	1.31720895	976.60	0.0001
D21	0.07262620	0.01663946	0.02569476	19.05	0.0001
D22	0.07600908	0.01864361	0.02241949	16.62	0.0001
D41	0.01294760	0.01008727	0.00222213	1.65	0.2040
D52	0.01897005	0.01078255	0.00417478	3.10	0.0834
D81	0.05040876	0.01287557	0.02067357	15.33	0.0002
D82	0.08132064	0.01728800	0.02984340	22.13	0.0001
D91	0.05577740	0.01915300	0.01143076	8.48	0.0050
D92	0.10775249	0.02750609	0.02069702	15.35	0.0002
D101	0.05630172	0.02032024	0.01034618	7.67	0.0074
D102	0.09042252	0.02436735	0.01857261	13.77	0.0004
D131	0.05603332	0.01230206	0.02560465	19.04	0.0001
D132	0.04439233	0.01373108	0.01409752	10.45	0.0020

Bounds on condition number: 10.62908, 561.8836

STEPWISE selection procedure

Statistics for Removal: Step 15
DF = 1,63

Variable	Partial R**2	Model R**2
D21	0.0172	0.9250
D22	0.0150	0.9280
D41	0.0015	0.9415
D52	0.0028	0.9402
D81	0.0139	0.9292
D82	0.0200	0.9230
D91	0.0077	0.9356
D92	0.0139	0.9291
D101	0.0069	0.9361
D102	0.0125	0.9306
D131	0.0172	0.9258
D132	0.0095	0.9336

Statistics for Entry: Step 15
DF = 1,62

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.741429	0.9434	0.3606	0.5505
D12	0.746366	0.9439	0.9927	0.3230
D31	0.722059	0.9430	0.0233	0.8791
D32	0.628729	0.9431	0.0531	0.8202
D42	0.338357	0.9440	1.9817	0.1642
D51	0.380963	0.9431	0.0612	0.8054
D61	0.526306	0.9433	0.3347	0.5650
D62	0.412365	0.9440	1.1036	0.2976
D71	0.492595	0.9434	0.4493	0.5052
D72	0.391552	0.9431	0.1349	0.7146
D111	0.813286	0.9431	0.1136	0.7372
D112	0.808137	0.9447	1.8600	0.1775
D121	0.801453	0.9435	0.4897	0.4867
D122	.	0.9430	.	.
D141	0.806554	0.9430	0.0174	0.8955
D142	0.697896	0.9434	0.4391	0.5100

ep15   Variable D41 Removed   R-square = 0.94153624   C(p) = 3.73436323

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	11	1.40423067	0.12765733	93.70	0.0001
rror	66	0.08719431	0.00136241		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0.42744091	0.01250907	1.59070110	1167.62	0.0001
21	0.08074461	0.01546021	0.03712307	27.25	0.0001
22	0.08499790	0.01736555	0.03263905	23.96	0.0001
52	0.01562020	0.01051630	0.00300805	2.21	0.1422
11	0.04059934	0.01206275	0.01944919	14.28	0.0003

STEPWISE selection procedure

D82	0.08140232	0.01737470	0.02996370	21.99	0.0001
D91	0.05045974	0.01879393	0.00982117	7.21	0.0092
D92	0.09776190	0.02651581	0.01851905	13.59	0.0005
D101	0.05990565	0.02023499	0.01194091	8.76	0.0043
D102	0.09232696	0.02444407	0.01943526	14.27	0.0004
D131	0.05289130	0.01241237	0.02473814	18.16	0.0001
D132	0.04334399	0.01377686	0.01349790	9.91	0.0025

Bounds on condition number: 9.778013,   473.5523

Statistics for Removal: Step 16
DF = 1,64

Variable	Partial R**2	Model R**2
D21	0.0249	0.9166
D22	0.0219	0.9197
D52	0.0020	0.9395
D81	0.0130	0.9285
D82	0.0201	0.9214
D91	0.0066	0.9350
D92	0.0124	0.9291
D101	0.0080	0.9335
D102	0.0130	0.9285
D131	0.0166	0.9249
D132	0.0091	0.9325

Statistics for Entry: Step 16
DF = 1,63

Variable	Tolerance	Model R**2	F	Prob>F
D11	0.765332	0.9418	0.2536	0.6160
D12	0.765029	0.9425	1.0599	0.3072
D31	0.734017	0.9416	0.0978	0.7555
D32	0.636703	0.9416	0.0570	0.8121
D41	0.739106	0.9430	1.6075	0.2040
D42	0.651441	0.9415	0.0133	0.9085
D51	0.392727	0.9416	0.1090	0.7419
D61	0.539419	0.9417	0.2279	0.6347
D62	0.412301	0.9425	1.0756	0.3037
D71	0.695077	0.9420	0.5511	0.4606
D72	0.396403	0.9418	0.2552	0.6182
D111	0.817016	0.9417	0.1841	0.6693
D112	0.800519	0.9433	1.9196	0.1708
D121	0.802470	0.9420	0.5432	0.4638
D122	.	0.9415	.	.
D141	0.806363	0.9416	0.0359	0.8503
D142	0.698419	0.9419	0.3095	0.5340

STEPWISE selection procedure

Summary of Stepwise Procedure for Dependent Variable Y

Step	Variable Entered	Variable Removed	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	D92		1	0.6217	0.6217	288.6209	121.6217	0.0001
2	D91		2	0.1598	0.7815	138.2530	53.4103	0.0001
3	D82		3	0.0381	0.8197	103.9291	15.2116	0.0002
4	D81		4	0.0158	0.8355	90.8516	6.8250	0.0110
5	D41		5	0.0161	0.8516	77.4967	7.5961	0.0075
6	D42		6	0.0260	0.8776	54.4983	14.4625	0.0003
7	D21		7	0.0145	0.8921	42.8333	9.1684	0.0035
8	D22		8	0.0199	0.9120	25.8923	15.1272	0.0002
9	D131		9	0.0085	0.9205	19.8149	7.0317	0.0100
10	D132		10	0.0096	0.9301	12.6581	8.9290	0.0040
11	D52		11	0.0055	0.9356	9.4035	5.4768	0.0224
12	D102		12	0.0036	0.9392	8.0016	3.6951	0.0591
13	D101		13	0.0056	0.9448	4.6317	6.3256	0.0145
14		D42	12	0.0018	0.9430	4.3140	1.9817	0.1642
15		D41	11	0.0015	0.9415	3.7344	1.6475	0.2040

STEPWISE selection procedure

Model: MODEL1
Dependent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	1.40423	0.12766	93.700	0.0001
Error	64	0.08719	0.00136		
C Total	75	1.49142			

Root MSE	0.03691	R-square	0.9415
Dep Mean	0.67899	Adj R-sq	0.9315
C.V.	5.43617		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.427461	0.01250907	34.170	0.0001
D21	1	0.080744	0.01546021	5.220	0.0001
D22	1	0.084990	0.01736555	4.895	0.0001
D52	1	0.015620	0.01051630	1.486	0.1422
D81	1	0.048599	0.01288275	3.770	0.0003
D82	1	0.081402	0.01737470	4.690	0.0001
D91	1	0.050460	0.01079393	2.485	0.0092
D92	1	0.097762	0.02651581	3.687	0.0005
D101	1	0.059906	0.02023499	2.960	0.0043
D102	1	0.092327	0.02444487	3.777	0.0004
D131	1	0.052891	0.01241237	4.261	0.0001
D132	1	0.043364	0.01377686	3.148	0.0025

Variable	DF	Tolerance
INTERCEP	1	.
D21	1	0.32710116
D22	1	0.26929079
D52	1	0.73432044
D81	1	0.43339032
D82	1	0.47970038
D91	1	0.27060125
D92	1	0.10237027
D101	1	0.10015526
D102	1	0.13004550
D131	1	0.47361975
D132	1	0.41234569

Appendix (D) SAS Output

Part (V)

Results of 'BACKWARD' Model Selection Procedure

BACKWARD selection procedure

Backward Elimination Procedure for Dependent Variable Y

Step 0 All Variables Entered R-square = 0.94964937 C(p) = 28.00000000
NOTE: The model is not of full rank A subset of the model which is of full rank is chosen.

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	27	1.41633079	0.05245670	33.53	0.0001
Error	48	0.07509419	0.00156446		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39772899	0.02388307	0.63386984	277.33	0.0001
D11	0.00025341	0.01055103	0.00000047	0.00	0.9862
D12	0.01196672	0.01377215	0.00118117	0.75	0.3892
D21	0.07886371	0.02440603	0.01633523	10.44	0.0022
D22	0.07929983	0.02979407	0.01108281	7.08	0.0105
D31	0.00308042	0.01780217	0.00004684	0.03	0.8634
D32	-0.00151780	0.01824686	0.00001082	0.01	0.9341
D41	0.02155386	0.01813266	0.00221051	1.41	0.2406
D42	0.01963176	0.02210270	0.00123421	0.79	0.3789
D51	0.00291532	0.01580669	0.00005268	0.03	0.8552
D52	0.01590087	0.01666640	0.00143040	0.92	0.3424
D61	0.00606269	0.02354038	0.00010377	0.07	0.7979
D62	-0.00664790	0.02355713	0.00012459	0.08	0.7790
D71	0.02965344	0.02687962	0.00190401	1.22	0.2754
D72	0.02215576	0.02595517	0.00113996	0.73	0.3976
D81	0.03832759	0.01682837	0.00811529	5.19	0.0272
D82	0.07553919	0.02018804	0.02190390	14.00	0.0005
D91	0.05425955	0.03089405	0.00482578	3.08	0.0854
D92	0.11010617	0.04590376	0.00899842	5.75	0.0204
D101	0.05434704	0.02632124	0.00666967	4.26	0.0444
D102	0.08035166	0.03310506	0.00917212	5.86	0.0193
D111	-0.00145168	0.01280020	0.00002012	0.01	0.9102
D112	0.01123744	0.01356889	0.00107319	0.69	0.4116
D121	-0.00569878	0.01341898	0.00028216	0.18	0.6730
D131	0.04576198	0.01827794	0.00980466	6.27	0.0157
D132	0.03062294	0.01798187	0.00453762	2.90	0.0950
D141	-0.00425656	0.01664829	0.00010227	0.07	0.7993
D142	-0.00166519	0.01677717	0.00001541	0.01	0.9214

Bounds on condition number: 25.56447, 3609.955

BACKWARD selection procedure

Statistics for Removal: Step 1
DF = 1,48

Variable	Partial R**2	Model R**2
D11	0.0000	0.9496
D12	0.0008	0.9489
D21	0.0110	0.9387
D22	0.0074	0.9422
D31	0.0000	0.9496
D32	0.0000	0.9496
D41	0.0015	0.9482
D42	0.0008	0.9488
D51	0.0000	0.9496
D52	0.0010	0.9487
D61	0.0001	0.9496
D62	0.0001	0.9496
D71	0.0013	0.9484
D72	0.0008	0.9489
D81	0.0054	0.9442
D82	0.0147	0.9350
D91	0.0032	0.9464
D92	0.0060	0.9436
D101	0.0045	0.9452
D102	0.0061	0.9435
D111	0.0000	0.9496
D112	0.0007	0.9489
D121	0.0002	0.9495
D131	0.0066	0.9431
D132	0.0030	0.9466
D141	0.0001	0.9496
D142	0.0000	0.9496

Step 1 Variable D11 Removed R-square = 0.94964905 C(p) = 26.00030320

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	26	1.41633032	0.05447424	35.54	0.0001
Error	49	0.07509467	0.00153254		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39786296	0.02237834	0.48442366	316.09	0.0001
D12	0.01183089	0.01123426	0.00169865	1.11	0.2975
D21	0.07893867	0.02377931	0.01688867	11.02	0.0017
D22	0.07939299	0.02900929	0.01147898	7.49	0.0086
D31	0.00308389	0.01761853	0.00004695	0.03	0.8618
D32	-0.00150062	0.01803335	0.00001061	0.01	0.9340
D41	0.02156176	0.01794188	0.00221352	1.44	0.2352
D42	0.01960712	0.02183130	0.00123610	0.81	0.3735
D51	0.00288051	0.01564977	0.00005221	0.03	0.8543
D52	0.01590321	0.01649585	0.00142891	0.93	0.3373
D61	0.00603237	0.02323518	0.00010330	0.07	0.7963
D62	-0.00650325	0.02302427	0.00012529	0.08	0.7761
D71	0.02970157	0.02644299	0.00193061	1.26	0.2672

BACKWARD selection procedure

D72	0.02214207	0.02567725	0.00113960	0.74	0.3927
D81	0.03835407	0.01658765	0.00819344	5.35	0.0250
D82	0.07556640	0.01992316	0.02205170	14.39	0.0004
D91	0.05420727	0.03053665	0.00484358	3.16	0.0816
D92	0.11007637	0.04504266	0.00915287	5.97	0.0182
D101	0.05429261	0.02586704	0.00675151	4.41	0.0410
D102	0.08020012	0.03259234	0.00929818	6.07	0.0173
D111	-0.00144690	0.01266604	0.00002000	0.01	0.9095
D112	0.01126177	0.01335871	0.00108918	0.71	0.4033
D121	-0.00569882	0.01320139	0.00028216	0.18	0.6697
D131	0.04574398	0.01806158	0.00983036	6.41	0.0144
D132	0.03083209	0.01778910	0.00654421	2.97	0.0916
D141	-0.00421302	0.01629752	0.00010245	0.07	0.7971
D142	-0.00163206	0.01650321	0.00001500	0.01	0.9218

Bounds on condition number: 25.08303, 3429.369

Statistics for Removal: Step 2
DF = 1,49

Variable	Partial R**2	Model R**2
D12	0.0011	0.9485
D21	0.0113	0.9383
D22	0.0077	0.9420
D31	0.0000	0.9496
D32	0.0000	0.9496
D41	0.0015	0.9482
D42	0.0008	0.9488
D51	0.0000	0.9496
D52	0.0010	0.9487
D61	0.0001	0.9496
D62	0.0001	0.9496
D71	0.0013	0.9484
D72	0.0008	0.9489
D81	0.0055	0.9442
D82	0.0148	0.9349
D91	0.0032	0.9464
D92	0.0061	0.9435
D101	0.0045	0.9451
D102	0.0062	0.9434
D111	0.0000	0.9496
D112	0.0007	0.9489
D121	0.0002	0.9495
D131	0.0066	0.9431
D132	0.0030	0.9466
D141	0.0001	0.9496
D142	0.0000	0.9496

Step 2 Variable D32 Removed R-square = 0.94964193 C(p) = 24.00708650

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	25	1.41631971	0.05665279	37.72	0.0001
Error	50	0.07510528	0.00150211		
Total	75	1.49142499			

BACKWARD selection procedure

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39750825	0.02174934	0.50176506	334.04	0.0001
D12	0.01181909	0.01112138	0.00169673	1.13	0.2930
D21	0.07877414	0.02346056	0.01693523	11.27	0.0015
D22	0.07940300	0.02871947	0.01148233	7.64	0.0080
D31	0.00410830	0.01267836	0.00016283	0.11	0.7434
D41	0.02149375	0.01774350	0.00220416	1.47	0.2315
D42	0.01967303	0.02159918	0.00124614	0.83	0.3668
D51	0.00296370	0.01546772	0.00005515	0.04	0.8488
D52	0.01599404	0.01632991	0.00144095	0.96	0.3321
D61	0.00642500	0.02252201	0.00012228	0.08	0.7766
D62	-0.00642288	0.02271440	0.00012010	0.08	0.7785
D71	0.02983060	0.02615388	0.00195413	1.30	0.2595
D72	0.02250610	0.02504915	0.00121260	0.81	0.3732
D81	0.03844637	0.01638534	0.00826990	5.51	0.0230
D82	0.07561752	0.01971293	0.02210250	14.71	0.0004
D91	0.05360208	0.02911206	0.00509235	3.39	0.0718
D92	0.10060009	0.04099233	0.01054295	7.02	0.0108
D101	0.05434003	0.02560266	0.00676659	4.50	0.0388
D102	0.08031404	0.03226441	0.00930775	6.20	0.0162
D111	-0.00139670	0.01252539	0.00001868	0.01	0.9117
D112	0.01108371	0.01305461	0.00108279	0.72	0.3999
D121	-0.00581199	0.01307973	0.00029659	0.20	0.6587
D131	0.04565406	0.01784920	0.00982693	6.54	0.0136
D132	0.03069493	0.01759567	0.00457111	3.04	0.0872
D141	-0.00403863	0.01599967	0.00009571	0.06	0.8018
D142	-0.00148750	0.01624600	0.00001259	0.01	0.9274

Bounds on condition number: 21.19599, 3035.38

BACKWARD selection procedure

Statistics for Removal: Step 3
DF = 1,50

Variable	Partial R**2	Model R**2
D12	0.0011	0.9485
D21	0.0114	0.9383
D22	0.0077	0.9419
D31	0.0001	0.9495
D41	0.0015	0.9482
D42	0.0008	0.9488
D51	0.0000	0.9496
D52	0.0010	0.9487
D61	0.0001	0.9496
D62	0.0001	0.9496
D71	0.0013	0.9483
D72	0.0008	0.9488
D81	0.0055	0.9441
D82	0.0148	0.9348
D91	0.0034	0.9462
D92	0.0071	0.9426
D101	0.0045	0.9451
D102	0.0062	0.9434
D111	0.0000	0.9496
D112	0.0007	0.9489
D121	0.0002	0.9494
D131	0.0066	0.9431
D132	0.0031	0.9466
D141	0.0001	0.9496
D142	0.0000	0.9496

Step 3 Variable D142 Removed R-square = 0.94963369 C(p) = 22.01513580

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	24	1.41630712	0.05901280	40.07	0.0001
Error	51	0.07511787	0.00147290		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39771722	0.02141796	0.50788557	344.82	0.0001
D12	0.01183213	0.01101192	0.00170069	1.15	0.2877
D21	0.07950976	0.02149156	0.02020001	13.71	0.0005
D22	0.08046800	0.02600589	0.01410185	9.57	0.0032
D31	0.00408331	0.01235330	0.00016093	0.11	0.7423
D41	0.02145147	0.01756428	0.00219690	1.49	0.2276
D42	0.01941475	0.02120490	0.00123470	0.84	0.3642
D51	0.00303750	0.01539580	0.00005800	0.04	0.8434
D52	0.01550188	0.01554387	0.00148011	1.00	0.3209
D61	0.00620373	0.02224899	0.00011749	0.08	0.7788
D62	-0.00626602	0.02242916	0.00011499	0.08	0.7811
D71	0.02916946	0.02489175	0.00202264	1.37	0.2467
D72	0.02202218	0.02424565	0.00121513	0.82	0.3680
D81	0.03839515	0.01621588	0.00825751	5.61	0.0217
D82	0.07580421	0.01941565	0.02245203	15.24	0.0003

BACKWARD selection procedure

D91	0.05306099	0.02822746	0.00520451	3.53	0.0659
D92	0.10740219	0.03874680	0.01133372	7.69	0.0077
D101	0.05459190	0.02520577	0.00690923	4.69	0.0350
D102	0.08043312	0.03192358	0.00935017	6.35	0.0149
D111	-0.00160758	0.01219156	0.00002561	0.02	0.8956
D112	0.01092970	0.01281931	0.00107068	0.73	0.3979
D121	-0.00572475	0.01291753	0.00028929	0.20	0.6595
D131	0.04503020	0.01633443	0.01119093	7.60	0.0081
D132	0.03046299	0.01724227	0.00459750	3.12	0.0833
D141	-0.00303659	0.01155731	0.00010168	0.07	0.7938

Bounds on condition number: 19.31298, 2655.516

Statistics for Removal: Step 4
DF = 1,51

Variable	Partial R**2	Model R**2
D12	0.0011	0.9485
D21	0.0135	0.9361
D22	0.0093	0.9402
D31	0.0001	0.9495
D41	0.0015	0.9482
D42	0.0008	0.9488
D51	0.0000	0.9496
D52	0.0010	0.9486
D61	0.0001	0.9496
D62	0.0001	0.9496
D71	0.0014	0.9483
D72	0.0008	0.9488
D81	0.0055	0.9441
D82	0.0151	0.9346
D91	0.0035	0.9461
D92	0.0076	0.9420
D101	0.0046	0.9450
D102	0.0063	0.9434
D111	0.0000	0.9496
D112	0.0007	0.9489
D121	0.0002	0.9494
D131	0.0075	0.9421
D132	0.0031	0.9466
D141	0.0001	0.9496

Step 4 Variable D111 Removed R-square = 0.94961632 C(p) = 20.03150510

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	23	1.41628151	0.06157746	42.61	0.0001
Error	52	0.07514348	0.00144507		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39720726	0.02096734	0.51881288	359.02	0.0001
D12	0.01157227	0.01073129	0.00168043	1.16	0.2858

BACKWARD selection procedure

21	0.07915706	0.02103792	0.02045792	14.16	0.0004
22	0.07970075	0.02523638	0.01444209	9.99	0.0026
31	0.00395344	0.01219707	0.00015102	0.11	0.7471
41	0.02164060	0.01733930	0.00225093	1.56	0.2176
42	0.01940357	0.02100351	0.00123330	0.85	0.3598
51	0.00261320	0.01481167	0.00004498	0.03	0.8606
52	0.01568521	0.01537673	0.00150363	1.04	0.3124
61	0.00638514	0.02202460	0.00012145	0.08	0.7730
62	-0.00630269	0.02219910	0.00011946	0.08	0.7769
71	0.02063773	0.02432976	0.00200212	1.39	0.2445
72	0.02162857	0.02303204	0.00119012	0.82	0.3683
81	0.03917237	0.01696321	0.00990372	6.85	0.0116
82	0.07639963	0.01870399	0.02411020	16.68	0.0002
91	0.05274126	0.02705614	0.00518023	3.58	0.0639
92	0.10600120	0.03811260	0.01136450	7.86	0.0071
101	0.05490020	0.02470030	0.00713107	4.93	0.0309
102	0.08095361	0.03137006	0.00961040	6.66	0.0127
112	0.01142005	0.01213331	0.00120226	0.89	0.3506
121	-0.00801649	0.01260502	0.00032910	0.23	0.6352
131	0.04550424	0.01503697	0.01220039	8.50	0.0052
132	0.03065324	0.01701049	0.00460001	3.24	0.0775
141	-0.00297016	0.01143677	0.00009746	0.07	0.7961

unds on condition number: 19.04575, 2449.002

Statistics for Removal: Step 5
DF = 1,52

Variable	Partial R**2	Model R**2
D12	0.0011	0.9485
D21	0.0137	0.9359
D22	0.0097	0.9399
D31	0.0001	0.9495
D41	0.0015	0.9481
D42	0.0008	0.9488
D51	0.0000	0.9496
D52	0.0010	0.9486
D61	0.0001	0.9495
D62	0.0001	0.9495
D71	0.0013	0.9483
D72	0.0008	0.9488
D81	0.0066	0.9430
D82	0.0162	0.9335
D91	0.0035	0.9461
D92	0.0076	0.9420
D101	0.0048	0.9448
D102	0.0064	0.9432
D112	0.0009	0.9488
D121	0.0002	0.9494
D131	0.0082	0.9414
D132	0.0031	0.9465
D141	0.0001	0.9494

BACKWARD selection procedure

Step 5 Variable D51 Removed R-square = 0.94958616 C(p) = 18.06025836

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	22	1.41623652	0.06437439	45.30	0.0001
Error	53	0.07518846	0.00141865		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39797822	0.02060921	0.53943705	380.25	0.0001
D12	0.01130273	0.01052445	0.00163623	1.15	0.2877
D21	0.07962844	0.02067597	0.02104167	14.83	0.0003
D22	0.08010843	0.02493606	0.01464036	10.32	0.0022
D31	0.00380123	0.01207827	0.00014049	0.10	0.7492
D41	0.02186391	0.01713437	0.00230991	1.63	0.2075
D42	0.01947052	0.02080725	0.00124223	0.88	0.3538
D52	0.01392875	0.01161137	0.00204142	1.44	0.2356
D61	0.00655907	0.02180049	0.00012842	0.09	0.7647
D62	-0.00667706	0.02193313	0.00013148	0.09	0.7620
D71	0.02080385	0.02408838	0.00202045	1.43	0.2371
D72	0.02108849	0.02341841	0.00115041	0.81	0.3719
D81	0.03975367	0.01446194	0.01071955	7.56	0.0082
D82	0.07657921	0.01850478	0.02429570	17.13	0.0001
D91	0.05337823	0.02736757	0.00539674	3.80	0.0560
D92	0.10778838	0.03741466	0.01177329	8.30	0.0057
D101	0.05430772	0.02426150	0.00710836	5.01	0.0294
D102	0.08023440	0.03082666	0.00961047	6.77	0.0120
D112	0.01142264	0.01202086	0.00128097	0.90	0.3463
D121	-0.00630457	0.01238406	0.00036763	0.26	0.6128
D131	0.04664823	0.01429404	0.01510738	10.65	0.0019
D132	0.03183456	0.01550263	0.00598221	4.22	0.0450
D141	-0.00289027	0.01132287	0.00009244	0.07	0.7995

Bounds on condition number: 18.69834, 2203.836

BACKWARD selection procedure

Statistics for Removal: Step 6
DF = 1,53

Variable	Partial R**2	Model R**2
D12	0.0011	0.9485
D21	0.0141	0.9355
D22	0.0098	0.9398
D31	0.0001	0.9495
D41	0.0015	0.9480
D42	0.0008	0.9488
D52	0.0014	0.9482
D61	0.0001	0.9495
D62	0.0001	0.9495
D71	0.0014	0.9482
D72	0.0008	0.9488
D81	0.0072	0.9424
D82	0.0163	0.9333
D91	0.0036	0.9460
D92	0.0079	0.9417
D101	0.0048	0.9448
D102	0.0464	0.9031
D112	0.0009	0.9487
D121	0.0003	0.9493
D131	0.0101	0.9395
D132	0.0040	0.9456
D141	0.0001	0.9495

Step 6 Variable D141 Removed R-square = 0.96952418 C(p) = 16.11934292

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	21	1.41614409	0.06743543	48.37	0.0001
Error	54	0.07528090	0.00139409		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39755654	0.02016540	0.54184524	388.67	0.0001
D12	0.01137917	0.01042073	0.00165970	1.19	0.2801
D21	0.07906616	0.02037873	0.02098438	15.05	0.0003
D22	0.07929864	0.02451919	0.01458177	10.46	0.0021
D31	0.00422321	0.01109902	0.00017550	0.13	0.7201
D41	0.02194602	0.01690241	0.00233811	1.67	0.2018
D42	0.01966653	0.02061259	0.00126880	0.91	0.3443
D52	0.01302639	0.01150355	0.00201393	1.44	0.2346
D61	0.00524626	0.02099908	0.00008695	0.06	0.8037
D62	-0.00662540	0.02174152	0.00012946	0.09	0.7617
D71	0.02953396	0.02370996	0.00216308	1.55	0.2183
D72	0.02193379	0.02298156	0.00126987	0.91	0.3441
D81	0.04012235	0.01424454	0.01102931	7.91	0.0068
D82	0.07670336	0.01832676	0.02447112	17.55	0.0001
D91	0.05242509	0.02687594	0.00530447	3.80	0.0563
D92	0.10512870	0.03562313	0.01214144	8.71	0.0047
D101	0.05539675	0.02367580	0.00763221	5.47	0.0230
D102	0.08233800	0.02944654	0.01089992	7.82	0.0071

BACKWARD selection procedure

D112	0.01096416	0.01178258	0.00120715	0.87	0.3562
D121	-0.00636126	0.01227520	0.00037438	0.27	0.6064
D131	0.04631538	0.01411149	0.01501744	10.77	0.0018
D132	0.03189634	0.01536598	0.00600692	4.31	0.0427

Bounds on condition number: 17.24733, 2007.081

Statistics for Removal: Step 7
DF = 1,54

Variable	Partial R**2	Model R**2
D12	0.0011	0.9484
D21	0.0141	0.9355
D22	0.0098	0.9397
D31	0.0001	0.9494
D41	0.0016	0.9480
D42	0.0009	0.9487
D52	0.0014	0.9482
D61	0.0001	0.9495
D62	0.0001	0.9494
D71	0.0015	0.9481
D72	0.0009	0.9487
D81	0.0074	0.9421
D82	0.0164	0.9331
D91	0.0036	0.9460
D92	0.0081	0.9414
D101	0.0051	0.9444
D102	0.0073	0.9422
D112	0.0008	0.9487
D121	0.0003	0.9493
D131	0.0101	0.9395
D132	0.0040	0.9455

Step 7 Variable D61 Removed R-square = 0.94946508 C(p) = 14.17491967

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	20	1.41605714	0.07080286	51.67	0.0001
Error	55	0.07536785	0.00137032		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39023051	0.01901293	0.55159892	403.99	0.0001
D12	0.01180311	0.01020156	0.00183434	1.34	0.2523
D21	0.07877030	0.02017230	0.02089805	15.25	0.0003
D22	0.07700110	0.02357119	0.01462907	10.68	0.0019
D31	0.00434257	0.01170027	0.00018596	0.14	0.7160
D41	0.02110009	0.01649016	0.00224125	1.64	0.2063
D42	0.01871235	0.02000369	0.00119960	0.87	0.3555
D52	0.01384677	0.01140479	0.00201997	1.47	0.2299
D62	-0.00881277	0.01972009	0.00027363	0.20	0.6569
D71	0.03029539	0.02331101	0.00231433	1.69	0.1992
D72	0.02165464	0.02275784	0.00124069	0.91	0.3455

BACKWARD selection procedure

D81	0.04062503	0.01400092	0.01153712	8.42	0.0053
D82	0.07662966	0.01815963	0.02440077	17.81	0.0001
D91	0.05347719	0.02631647	0.00565855	4.13	0.0470
D92	0.10470816	0.03527868	0.01207146	8.81	0.0044
D101	0.05718775	0.02237036	0.00895537	6.54	0.0134
D102	0.08470493	0.02764094	0.01286872	9.39	0.0034
D112	0.01105912	0.01167583	0.00122983	0.90	0.3477
D121	-0.00594392	0.01205683	0.00033305	0.24	0.6240
D131	0.04608293	0.01395475	0.01493079	10.90	0.0017
D132	0.03142009	0.01511666	0.00592006	4.32	0.0423

Bounds on condition number: 17.20870, 1789.116

Statistics for Removal: Step 8
DF = 1,55

Variable	Partial R**2	Model R**2
D12	0.0012	0.9482
D21	0.0140	0.9355
D22	0.0100	0.9395
D31	0.0001	0.9493
D41	0.0015	0.9480
D42	0.0008	0.9487
D52	0.0014	0.9481
D62	0.0002	0.9493
D71	0.0016	0.9479
D72	0.0009	0.9486
D81	0.0077	0.9417
D82	0.0164	0.9331
D91	0.0038	0.9457
D92	0.0081	0.9414
D101	0.0060	0.9435
D102	0.0086	0.9408
D112	0.0008	0.9486
D121	0.0002	0.9492
D131	0.0100	0.9395
D132	0.0040	0.9455

Step 8 Variable D31 Removed R-square = 0.94934120 C(p) = 12.29378405

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	19	1.41587118	0.07451954	55.23	0.0001
Error	56	0.07555381	0.00134918		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39795010	0.01964492	0.55363677	410.35	0.0001
D12	0.01159008	0.01010756	0.00177466	1.32	0.2560
D21	0.07864898	0.02001298	0.02083574	15.44	0.0002
D22	0.07794576	0.02338534	0.01498876	11.11	0.0015
D41	0.02298328	0.01558405	0.00292938	2.17	0.1462
D42	0.02083473	0.01909032	0.00160781	1.19	0.2798

BACKWARD selection procedure

D52	0.01356818	0.01129153	0.00194808	1.44	0.2346
D62	-0.00741438	0.01921022	0.00020098	0.15	0.7010
D71	0.03012474	0.02312675	0.00228951	1.70	0.1988
D72	0.02211039	0.02254697	0.00129837	0.96	0.3308
D81	0.04028650	0.01388250	0.01139473	8.45	0.0053
D82	0.07683605	0.01801037	0.02455575	18.20	0.0001
D91	0.05599204	0.02521869	0.00665083	4.93	0.0305
D92	0.10691940	0.03449495	0.01296195	9.61	0.0030
D101	0.05665947	0.02215181	0.00882695	6.54	0.0133
D102	0.08368846	0.02728981	0.01268816	9.40	0.0033
D112	0.00963291	0.01092971	0.00104801	0.78	0.3819
D121	-0.00654753	0.01185263	0.00041173	0.31	0.5829
D131	0.04493907	0.01351168	0.01492443	11.06	0.0016
D132	0.03146137	0.01499914	0.00593595	4.40	0.0405

Bounds on condition number: 16.71058, 1623.542

Statistics for Removal: Step 9
DF = 1,56

Variable	Partial R**2	Model R**2
D12	0.0012	0.9481
D21	0.0140	0.9354
D22	0.0100	0.9393
D41	0.0020	0.9474
D42	0.0011	0.9483
D52	0.0013	0.9480
D62	0.0001	0.9492
D71	0.0015	0.9478
D72	0.0009	0.9485
D81	0.0076	0.9417
D82	0.0165	0.9329
D91	0.0045	0.9449
D92	0.0087	0.9407
D101	0.0059	0.9434
D102	0.0085	0.9408
D112	0.0007	0.9486
D121	0.0003	0.9491
D131	0.0100	0.9393
D132	0.0040	0.9454

Step 9 Variable D62 Removed R-square = 0.94920644 C(p) = 10.42224737

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	18	1.41567028	0.07864834	59.10	0.0001
Error	57	0.07575470	0.00132903		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.39597378	0.01883271	0.58818083	442.51	0.0001
D12	0.01181503	0.01003661	0.00184939	1.39	0.2433
D21	0.07679055	0.01920580	0.02107475	15.86	0.0002

BACKWARD selection procedure

2	0.07904179	0.02303036	0.01564396	11.77	0.0011
1	0.02520260	0.01435526	0 00409644	3.00	0.0845
2	0.02456716	0.01636660	0.00298972	2 25	0.1392
2	0.01390490	0.01117360	0.00205020	1.55	0.2184
1	0.03139206	0.02272166	0 00253685	1.91	0.1725
2	0.02282227	0.02230469	0.00139143	1 05	0.3105
1	0.04054002	0.01374317	0.01156456	8.70	0.0046
2	0.07865495	0.01725260	0.02762348	20.78	0.0001
1	0.05708900	0.02486999	0.00700329	5.27	0.0256
2	0.10570063	0.03409271	0.01277519	9.61	0.0030
101	0.05582974	0.02182537	0.00863420	6.50	0.0135
102	0.08146456	0 02647460	0.01258379	9.47	0.0032
112	0.00863137	0.01053764	0.00089160	0.67	0.4161
121	-0.00717280	0.01165321	0.00050352	0.38	0.5407
131	0.04463155	0.01338710	0.01477224	11.12	0.0015
132	0.03069931	0.01475720	0.00575154	4.33	0.0420

unds on condition number: 16.57056, 1421.660

Statistics for Removal: Step 10
DF = 1,57

Variable	Partial R**2	Model R**2
D12	0.0012	0.9480
D21	0.0161	0.9351
D22	0.0105	0.9387
D41	0.0027	0.9465
D42	0.0020	0.9472
D52	0.0014	0.9478
D71	0 0017	0.9475
D72	0.0009	0.9483
D81	0.0078	0.9415
D82	0.0185	0.9307
D91	0.0047	0.9445
D92	0 0086	0.9406
D101	0.0058	0.9434
D102	0.0084	0.9408
D112	0.0006	0.9486
D121	0.0003	0.9489
D131	0.0099	0.9393
D132	0.0039	0.9454

ep10 Variable D121 Removed R-square = 0.94886083 C(p) = 8.74409882

	DF	Sum of Squares	Mean Square	F	Prob>F
egression	17	1.41516660	0 08324510	63 31	0 0001
rror	58	0 07625831	0 00131480		
tal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
NTERCEP	0 39389337	0 01841836	0 60133227	457 36	0 0001
12	0.01160178	0.00995467	0 00178517	1 36	0 2487

BACKWARD selection procedure

D21	0.07790817	0.01909834	0.02187932	16.66	0.0001
D22	0.00079380	0.02273907	0.01659857	12.62	0.0008
D41	0.02381599	0.01410635	0.00375402	2.86	0.0964
D42	0.02203824	0.01576560	0.00256917	1.95	0.1675
D52	0.01336811	0.01107950	0.00191400	1.46	0.2325
D71	0.03211610	0.02256936	0.00266236	2.02	0.1601
D72	0.02153975	0.02200792	0.00125035	0.95	0.3335
D81	0.04176639	0.01352497	0.01253835	9.58	0.0031
D82	0.07930419	0.01712787	0.02818674	21.44	0.0001
D91	0.05732599	0.02473352	0.00706302	5.37	0.0240
D92	0.10771811	0.03375250	0.01339129	10.19	0.0023
D101	0.05303035	0.02151258	0.00823244	6.26	0.0152
D102	0.07916034	0.02606796	0.01212441	9.22	0 0036
D112	0.01111537	0.00960199	0.00173292	1.32	0.2557
D131	0.04352912	0.01319551	0.01430750	10.88	0.0017
D132	0.03177989	0.01457374	0.00625204	4.76	0.0333

Bounds on condition number: 16.41738, 1294.174

Statistics for Removal: Step 11
DF = 1,58

Variable	Partial R**2	Model R**2
D12	0.0012	0.9477
D21	0.0147	0.9342
D22	0.0111	0.9377
D41	0.0025	0.9464
D42	0.0017	0.9471
D52	0.0013	0.9474
D71	0.0018	0.9471
D72	0.0008	0.9480
D81	0.0084	0.9405
D82	0.0189	0.9300
D91	0.0047	0.9441
D92	0.0090	0.9399
D101	0.0055	0.9433
D102	0.0081	0.9407
D112	0.0012	0.9477
D131	0.0096	0.9393
D132	0.0042	0.9447

Step11 Variable D72 Removed R-square = 0.94803067 C(p) = 7.56331775

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	16	1.41391633	0.08836977	67.27	0.0001
Error	59	0.07750865	0.00131371		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40096070	0 01692557	0.73725081	561.20	0.0001
D12	0.01161006	0 00995252	0.00179019	1.36	0.2478
D21	0 00223059	0.01056720	0.02577251	19.62	0.0001

BACKWARD selection procedure

D22	0.00374976	0.02252670	0.01015796	13.02	0.0004
D41	0.02403970	0.01406291	0.00409865	3.12	0.0825
D42	0.02071315	0.01570040	0.00220649	1.74	0.1922
D52	0.01500561	0.01077007	0.00285005	2.10	0.1455
D71	0.01045796	0.01769050	0.00143016	1.09	0.3010
D81	0.06236029	0.01350564	0.01292367	9.84	0.0027
D82	0.07920061	0.01712073	0.02817004	21.44	0.0001
D91	0.06665093	0.02279740	0.01123167	8.55	0.0049
D92	0.11051024	0.03107340	0.01816140	13.82	0.0004
D101	0.04929111	0.02099423	0.00724182	5.51	0.0223
D102	0.07447244	0.02561023	0.01110060	8.46	0.0051
D112	0.01234794	0.00959515	0.00217563	1.66	0.2032
D131	0.04730341	0.01260991	0.01840670	14.07	0.0004
D132	0.03450670	0.01420074	0.00770579	5.87	0.0185

Bounds on condition number: 10.65243, 1060.029

Statistics for Removal: Step 12
DF = 1,59

Variable	Partial R**2	Model R**2
D12	0.0012	0.9460
D21	0.0173	0.9300
D22	0.0122	0.9359
D41	0.0027	0.9453
D42	0.0015	0.9465
D52	0.0019	0.9461
D71	0.0010	0.9471
D81	0.0087	0.9394
D82	0.0189	0.9291
D91	0.0075	0.9405
D92	0.0122	0.9359
D101	0.0049	0.9432
D102	0.0074	0.9406
D112	0.0015	0.9466
D131	0.0124	0.9356
D132	0.0052	0.9429

Step12 Variable D71 Removed R-square = 0.94707155 C(p) = 6.45746944

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	15	1.41248618	0.09416575	71.57	0.0001
Error	60	0.07893881	0.00131565		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.40420917	0.01614068	0.83279077	632.99	0.0001
D12	0.01146373	0.00995076	0.00174333	1.33	0.2542
D21	0.07511235	0.01727011	0.02486393	18.90	0.0001
D22	0.07740925	0.02170766	0.01673012	12.72	0.0007
D41	0.02332943	0.01399056	0.00365411	2.78	0.1000
D42	0.01732169	0.01537159	0.00167084	1.27	0.2643

BACKWARD selection procedure

D52	0.01676104	0.01074527	0.00320116	2.43	0.1201
D81	0.04553007	0.01316746	0.01573565	11.96	0.0010
D82	0.07952340	0.01713179	0.02834000	21.55	0.0001
D91	0.06351425	0.02261390	0.01037036	7.89	0.0067
D92	0.11307203	0.03146770	0.01698727	12.91	0.0007
D101	0.05277316	0.02074250	0.00851600	6.47	0.0135
D102	0.07916912	0.02523015	0.01295423	9.85	0.0026
D112	0.01217542	0.00960081	0.00211580	1.61	0.2096
D131	0.04009523	0.01352652	0.02004526	15.24	0.0002
D132	0.03786000	0.01394210	0.00970155	7.37	0.0086

Bounds on condition number: 14.26073, 941.7116

Statistics for Removal: Step 13
DF = 1,60

Variable	Partial R**2	Model R**2
D12	0.0012	0.9459
D21	0.0167	0.9304
D22	0.0112	0.9359
D41	0.0025	0.9446
D42	0.0011	0.9460
D52	0.0021	0.9449
D81	0.0106	0.9365
D82	0.0190	0.9281
D91	0.0070	0.9401
D92	0.0114	0.9357
D101	0.0057	0.9414
D102	0.0087	0.9384
D112	0.0014	0.9457
D131	0.0134	0.9336
D132	0.0065	0.9406

Step13 Variable D42 Removed R-square = 0.94595139 C(p) = 5.52533863

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	14	1.41081554	0.10077254	76.26	0.0001
Error	61	0.08060945	0.00132147		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41613847	0.01360082	1.23563791	935.05	0.0001
D12	0.01191631	0.00997265	0.00188677	1.43	0.2360
D21	0.07934150	0.01690284	0.02911639	22.03	0.0001
D22	0.08743051	0.01976205	0.02590054	19.67	0.0001
D41	0.01225609	0.00999265	0.00198026	1.50	0.2207
D52	0.01640115	0.01076613	0.00309679	2.34	0.1310
D81	0.04703371	0.01312952	0.01695444	12.83	0.0007
D82	0.08102309	0.01711776	0.02960602	22.40	0.0001
D91	0.05006113	0.01923717	0.00894106	6.77	0.0116
D92	0.09665403	0.02795294	0.01579941	11.96	0.0010
D101	0.05717147	0.02041705	0.01036164	7.84	0.0068

BACKWARD selection procedure

102	0 08720989	0 02425356	0 01708586	12 93	0 0006
112	0 01427749	0 00943864	0 00302371	2 29	0.1355
131	0 04921944	0 01255088	0 02032269	15 38	0 0002
132	0.04040413	0 01370857	0 01134669	8 59	0 0048

unds on condition number: 11.20335, 721 706

Statistics for Removal: Step 14
DF = 1,61

Variable	Partial R**2	Model R**2
D12	0 0013	0 9447
D21	0 0195	0 9264
D22	0.0174	0 9285
D41	0.0013	0 9446
D52	0 0021	0 9439
D81	0 0114	0 9346
D82	0 0199	0 9261
D91	0.0060	0 9400
D92	0.0106	0 9354
D101	0 0069	0 9390
D102	0.0115	0 9345
D112	0 0020	0 9439
D131	0 0136	0 9323
D132	0 0076	0 9383

ep14 Variable D12 Removed R-square = 0 94460631 C(p) = 4 73135521

	DF	Sum of Squares	Mean Square	F	Prob>F
legression	13	1 40892877	0 10837914	81.45	0.0001
rror	62	0.08249622	0 00133058		
otal	75	1.49142499			

ariable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.41735564	0.01361737	1.24987957	939.35	0.0001
21	0.07564201	0.01487422	0.02730334	20.58	0.0001
22	0.07990331	0.01873600	0.02420014	18.19	0.0001
41	0.01265012	0 01002162	0.00212018	1 59	0.2116
52	0.01787295	0.01073979	0.00368505	2.77	0.1011
81	0.05078885	0.01279152	0.02097593	15.76	0.0002
82	0.08151738	0.01717169	0.02998588	22.54	0 0001
91	0.05177473	0.01924844	0.00962691	7.24	0.0092
92	0.09996316	0.02791122	0.01706730	12.83	0.0007
101	0.05988139	0.02036058	0.01150921	8 65	0.0046
102	0.09024898	0 02420298	0.01850088	13 90	0 0004
112	0.01288991	0.00939062	0 00247597	1.86	0.1775
131	0.05178862	0.01240792	0.02317997	17.42	0 0001
132	0.04144325	0.01380851	0 01198550	9.01	0 0039

unds on condition number: 11 09338, 636.8071

BACKWARD selection procedure

Statistics for Removal: Step 15
DF = 1,62

Variable	Partial R**2	Model R**2
D21	0.0184	0.9263
D22	0.0162	0.9285
D41	0.0014	0.9433
D52	0.0025	0.9422
D81	0.0141	0.9306
D82	0 0201	0.9246
D91	0.0065	0.9382
D92	0.0114	0.9332
D101	0.0077	0.9370
D102	0.0124	0.9323
D112	0.0017	0.9430
D131	0.0155	0.9291
D132	0 0080	0.9367

Step15 Variable D41 Removed R-square = 0.94326473 C(p) = 4.08656791

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	12	1.40680859	0 11723405	87.29	0 0001
Error	63	0.08461640	0.00134312		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42373086	0.01270560	1.49383884	1112.22	0.0001
D21	0.08363140	0.01549902	0.03910613	29.12	0.0001
D22	0.08875914	0.01745458	0.03473134	25.86	0.0001
D52	0.01450734	0.01044057	0.00260798	1.94	0.1684
D81	0.04902867	0.01277518	0.01978269	14.73	0.0003
D82	0.08167915	0.01725190	0.03010667	22.42	0.0001
D91	0.04650110	0.01887700	0.00814956	6.07	0.0165
D92	0.09006988	0.02690945	0.01506878	11.20	0.0014
D101	0.06347294	0.02025553	0.01318875	9.82	0.0026
D102	0.09210528	0.02427169	0.01934118	14.40	0.0003
D112	0.01306786	0.00943251	0.00257791	1.92	0.1708
D131	0.05062817	0.01243196	0.02227507	16.58	0.0001
D132	0.04037962	0.01384754	0.01142071	8.50	0.0049

Bounds on condition number: 10.21515, 541.8305

BACKWARD selection procedure

Statistics for Removal: Step 16
DF = 1,63

Variable	Partial R**2	Model R**2
D21	0.0262	0.9170
D22	0.0233	0.9200
D52	0.0017	0.9415
D81	0.0133	0.9300
D82	0.0202	0.9231
D91	0.0055	0.9378
D92	0.0101	0.9332
D101	0.0088	0.9344
D102	0.0130	0.9303
D112	0.0017	0.9415
D131	0.0149	0.9283
D132	0.0077	0.9356

tep16 Variable D112 Removed R-square = 0.94153624 C(p) = 3.73436323

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	11	1.40423067	0.12765733	93.70	0.0001
Error	64	0.08719431	0.00136241		
Total	75	1.49142499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.42744091	0.01250907	1.59070118	1167.62	0.0001
D21	0.08074441	0.01546021	0.03712307	27.25	0.0001
D22	0.08499790	0.01736555	0.03263985	23.96	0.0001
D52	0.01562020	0.01051630	0.00300085	2.21	0.1422
D81	0.08059934	0.02206275	0.01944919	14.28	0.0003
D82	0.08140233	0.01737470	0.02996370	21.99	0.0001
D91	0.05045974	0.01879393	0.00982117	7.21	0.0092
D92	0.09776190	0.02651581	0.01851985	13.59	0.0005
D101	0.05990565	0.02023499	0.01194091	8.76	0.0043
D102	0.09332696	0.02444407	0.01943524	14.27	0.0004
D131	0.05209130	0.01241337	0.02473014	18.16	0.0001
D132	0.04336399	0.01377686	0.01349790	9.91	0.0025

ounds on condition number: 9.778013, 473.5523

BACKWARD selection procedure

Statistics for Removal: Step 17
DF = 1,64

Variable	Partial R**2	Model R**2
D21	0.0249	0.9146
D22	0.0219	0.9197
D52	0.0020	0.9395
D81	0.0130	0.9285
D82	0.0201	0.9214
D91	0.0066	0.9350
D92	0.0124	0.9291
D101	0.0080	0.9335
D102	0.0130	0.9285
D131	0.0166	0.9249
D132	0.0091	0.9325

Step17 Variable D52 Removed R-square = 0.93951881 C(p) = 3.65761808

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	10	1.40122183	0.14012218	100.97	0.0001
Error	65	0.09020316	0.00138774		
Total	75	1.49162499			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	0.43083250	0.01241292	1.67177292	1204.67	0.0001
D21	0.08200573	0.01550702	0.03840840	27.68	0.0001
D22	0.08702665	0.01742066	0.03527223	25.42	0.0001
D81	0.04680171	0.01292925	0.01824403	13.15	0.0006
D82	0.08663326	0.01710300	0.03527560	25.42	0.0001
D91	0.05029785	0.01896751	0.00975858	7.03	0.0100
D92	0.09239101	0.02651142	0.01685395	12.14	0.0009
D101	0.06481713	0.02014799	0.01436231	10.35	0.0020
D102	0.09984081	0.02413474	0.02375800	17.12	0.0001
D131	0.05094914	0.01265903	0.02322496	16.74	0.0001
D132	0.04335457	0.01390436	0.01349320	9.72	0.0027

Bounds on condition number: 9.598361, 408.7678

BACKWARD selection procedure

Statistics for Removal: Step 18
DF = 1,65

Variable	Partial R**2	Model R**2
D21	0.0250	0.9138
D22	0.0237	0.9159
D81	0.0122	0.9273
D82	0.0237	0.9159
D91	0.0065	0.9330
D92	0.0113	0.9282
D101	0.0096	0.9299
D102	0.0159	0.9236
D131	0.0156	0.9239
D132	0.0090	0.9305

All variables left in the model are significant at the 0.1000 level.

Summary of Backward Elimination Procedure for Dependent Variable Y

Step	Variable Removed	Number In	Partial R**2	Model R**2	C(p)	F	Prob>F
1	D11	26	0.0000	0.9496	26.0003	0.0003	0.9862
2	D32	25	0.0000	0.9496	24.0071	0.0069	0.9340
3	D142	24	0.0000	0.9496	22.0151	0.0084	0.9274
4	D111	23	0.0000	0.9496	20.0315	0.0174	0.8956
5	D51	22	0.0000	0.9496	18.0603	0.0311	0.8606
6	D141	21	0.0001	0.9495	16.1193	0.0652	0.7995
7	D61	20	0.0001	0.9495	14.1749	0.0624	0.8037
8	D31	19	0.0001	0.9493	12.2938	0.1357	0.7140
9	D62	18	0.0001	0.9492	10.4222	0.1490	0.7010
10	D121	17	0.0003	0.9489	8.7441	0.3789	0.5407
11	D72	16	0.0008	0.9480	7.5433	0.9510	0.3335
12	D71	15	0.0010	0.9471	6.4575	1.0886	0.3010
13	D42	14	0.0011	0.9460	5.5253	1.2698	0.2643
14	D12	13	0.0013	0.9447	4.7314	1.4270	0.2360
15	D41	12	0.0014	0.9433	4.0868	1.5934	0.2116
16	D112	11	0.0017	0.9415	3.7344	1.9194	0.1708
17	D52	10	0.0020	0.9395	3.6574	2.2085	0.1422

BACKWARD selection procedure

Model: MODEL1
Dependent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	1.40122	0.14012	100.971	0.0001
Error	65	0.09020	0.00139		
C Total	75	1.49142			

Root MSE	0.03725	R-square	0.9395
Dep Mean	0.67899	Adj R-sq	0.9302
C.V.	5.48647		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.430833	0.01241292	34.708	0.0001
D21	1	0.082006	0.01558782	5.261	0.0001
D22	1	0.087827	0.01742064	5.042	0.0001
D81	1	0.046882	0.01292925	3.626	0.0006
D82	1	0.086633	0.01718308	5.042	0.0001
D91	1	0.050298	0.01896751	2.652	0.0100
D92	1	0.092391	0.02651142	3.485	0.0009
D101	1	0.064817	0.02014799	3.217	0.0020
D102	1	0.099860	0.02413474	4.138	0.0001
D131	1	0.050969	0.01245903	4.091	0.0001
D132	1	0.043357	0.01390434	3.118	0.0027

Variable	DF	Tolerance
INTERCEP	1	.
D21	1	0.32808895
D22	1	0.27257356
D81	1	0.43692615
D82	1	0.49959005
D91	1	0.27069035
D92	1	0.10430617
D101	1	0.19331211
D102	1	0.16508491
D131	1	0.47881908
D132	1	0.41234574

Appendix (D) SAS Output

Part (VI)

Fitted Model and Diagnosis

Model fitting procedure

del: MODEL1
pendent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	1.40122	0 14012	100.971	0 0001
Error	65	0.09020	0 00139		
C Total	75	1.49142			

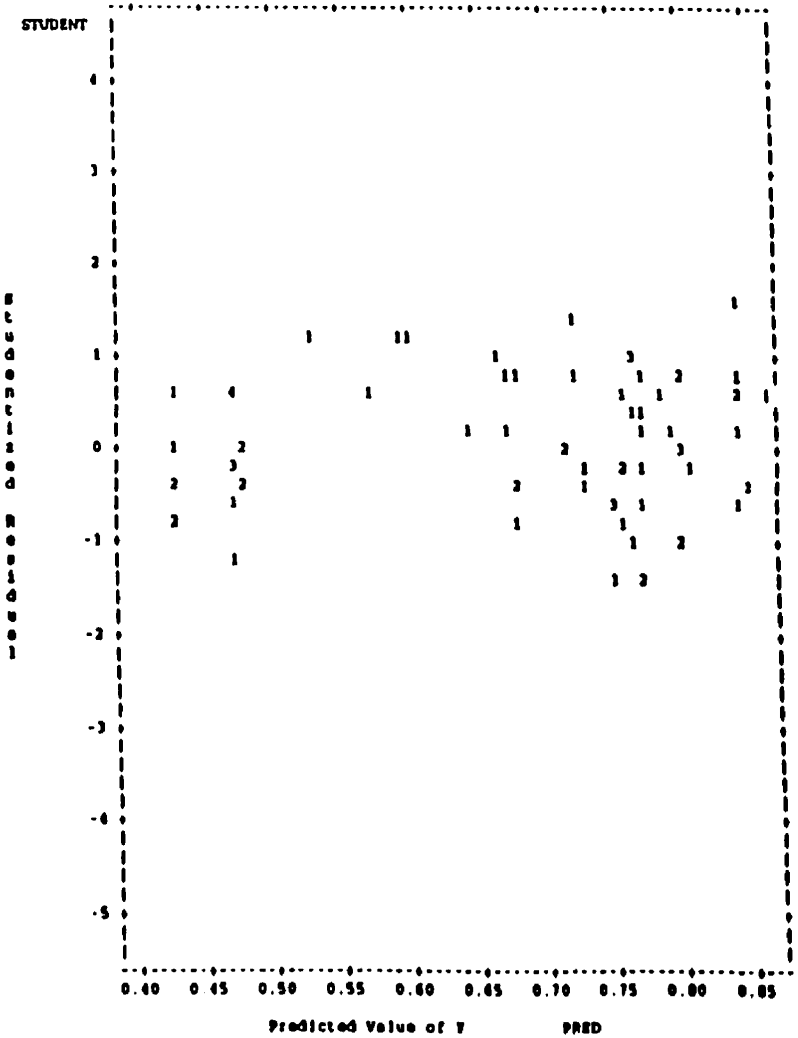
Root MSE	0 03725	R-square	0.9395
Dep Mean	0 67899	Adj R-sq	0.9302
C.V.	5.48647		

Parameter Estimates

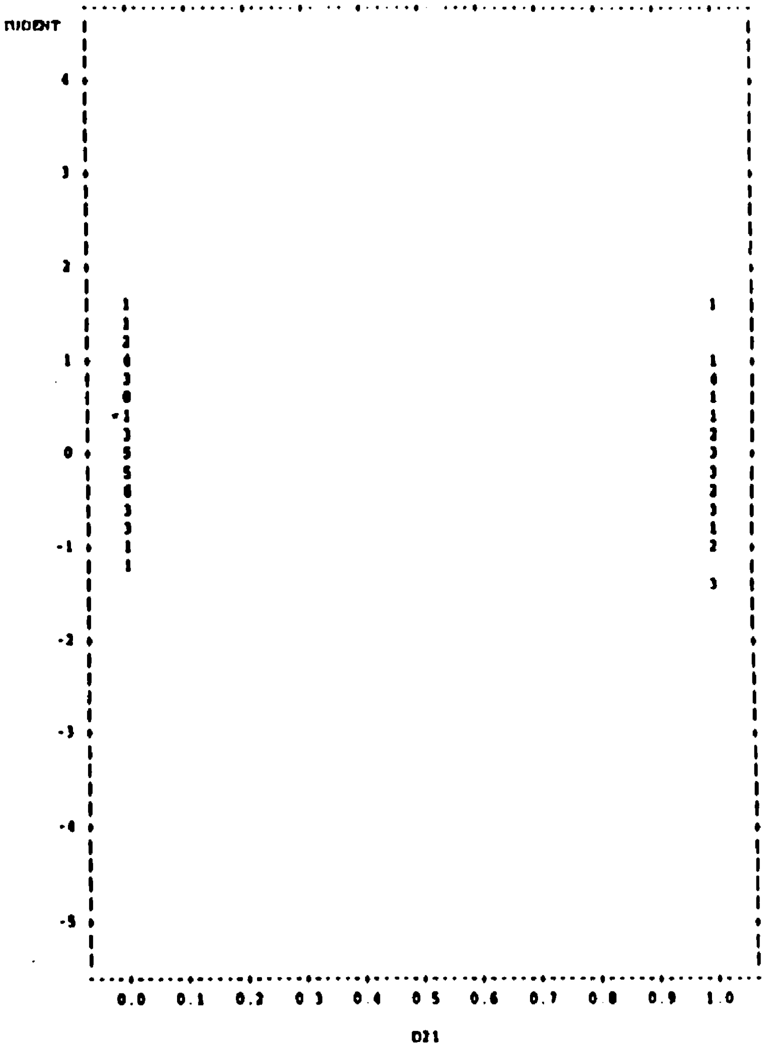
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > |T|
INTERCEP	1	0.430833	0.01241392	34.708	0 0001
D21	1	0 082006	0 01558702	5.261	0 0001
D22	1	0.087827	0 01742064	5.042	0.0001
D81	1	0.046882	0.01292925	3.626	0.0006
D82	1	0.086633	0.01718308	5.042	0.0001
D91	1	0.050298	0.01896751	2 652	0.0100
D92	1	0.092391	0.02651162	3.485	0.0009
D101	1	0.066817	0 02014799	3.317	0.0020
D102	1	0.099860	0.02613474	4.138	0.0001
D131	1	0.050969	0.01245903	4.091	0.0001
D132	1	0.043357	0.01390434	3.118	0.0027

Variable	DF	Tolerance
INTERCEP	1	.
D21	1	0.32808895
D22	1	0.27257356
D81	1	0.43692615
D82	1	0.49959005
D91	1	0.27049035
D92	1	0.10420617
D101	1	0.19331211
D102	1	0.14508491
D131	1	0.47881908
D132	1	0.41234574

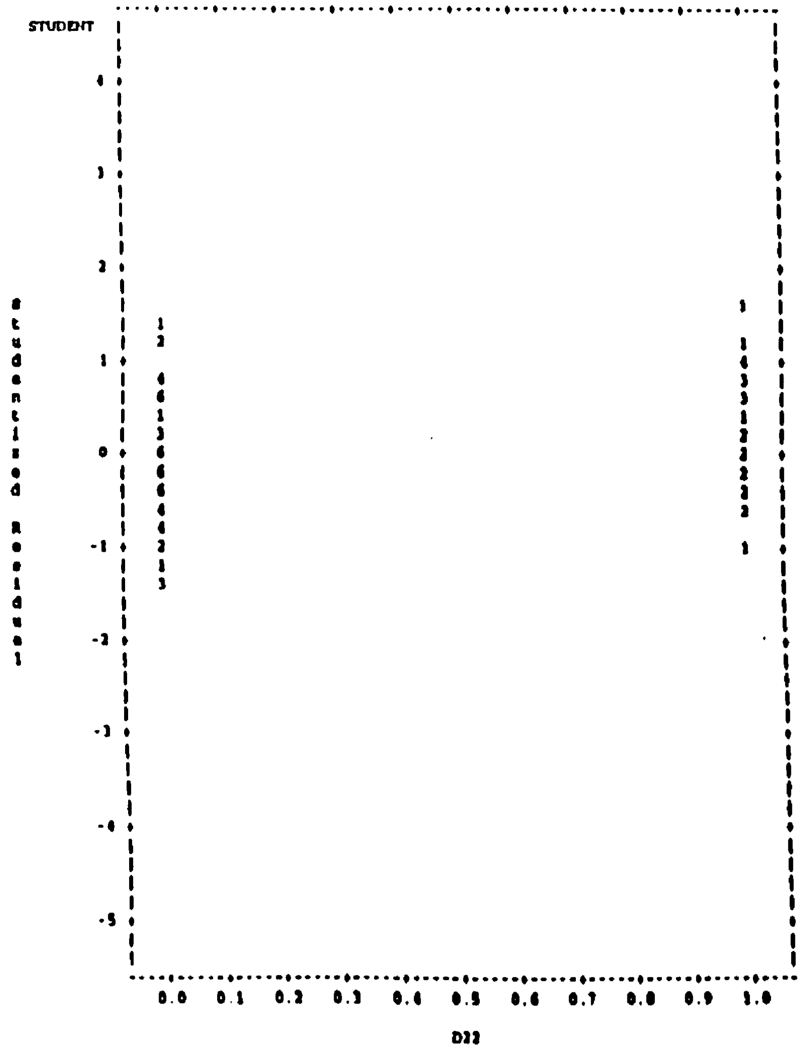
Model Diagnostic
(1) Residual plots to check on normality assumptions

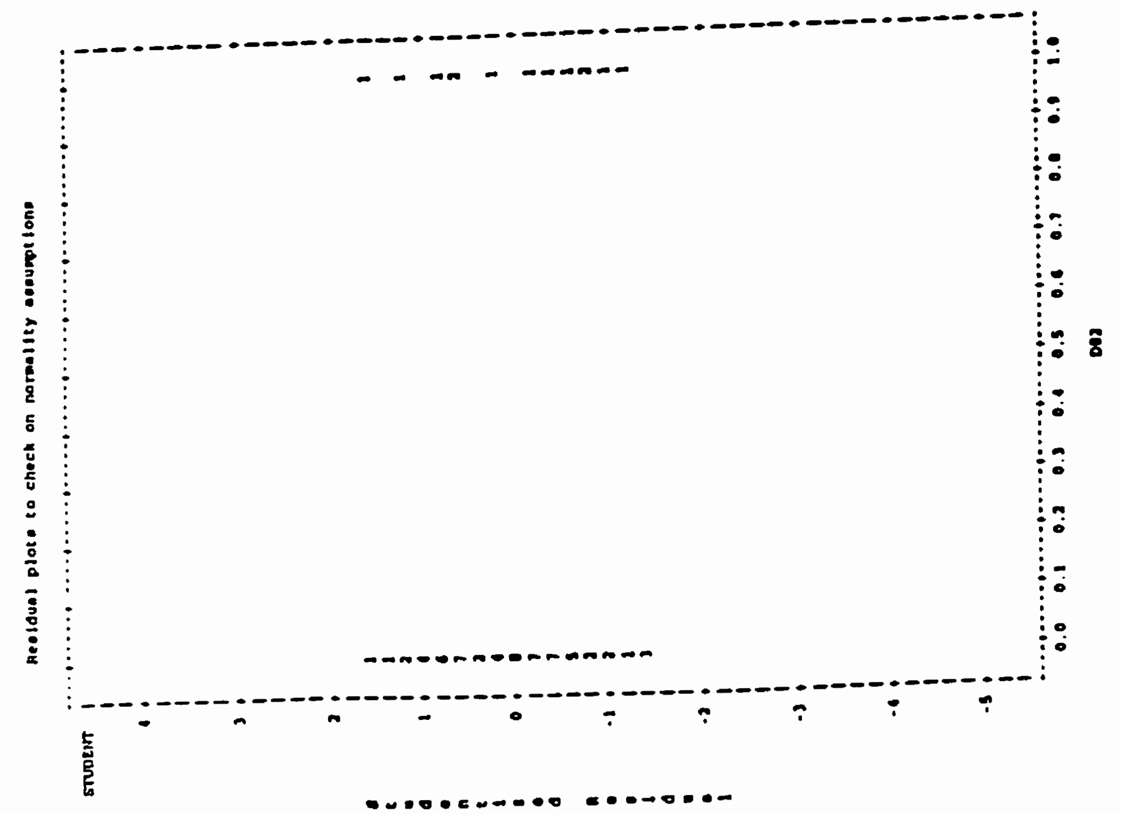


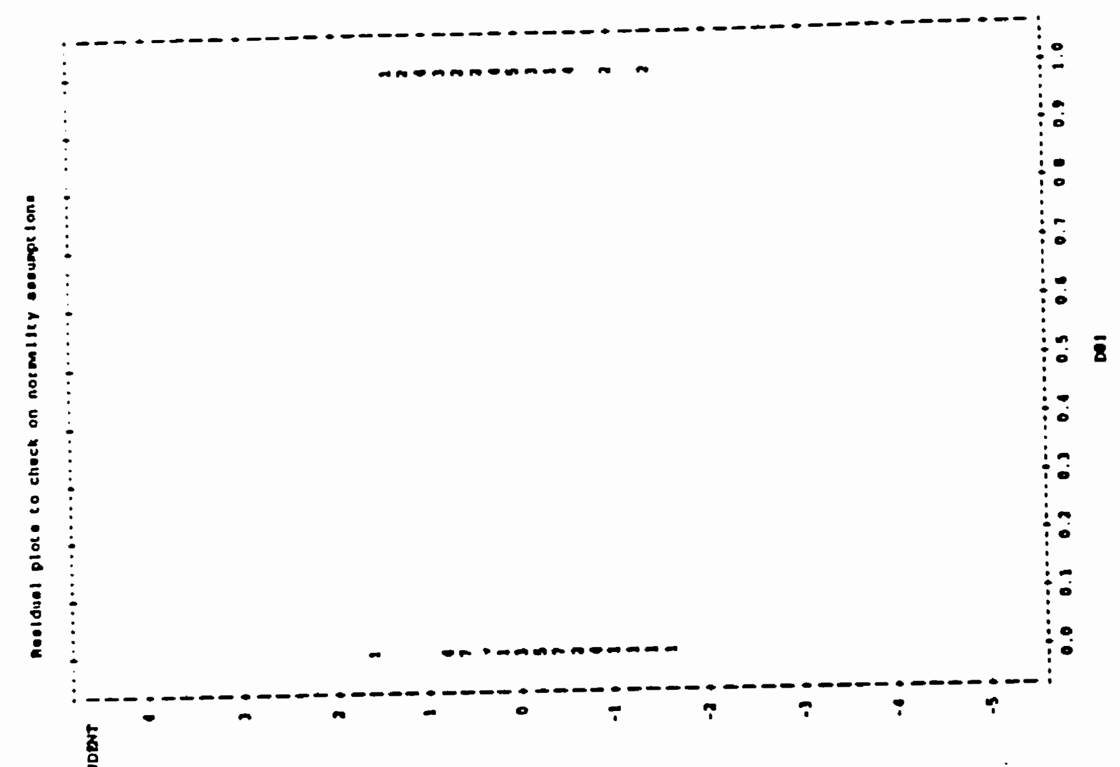
Residual plots to check on normality assumptions

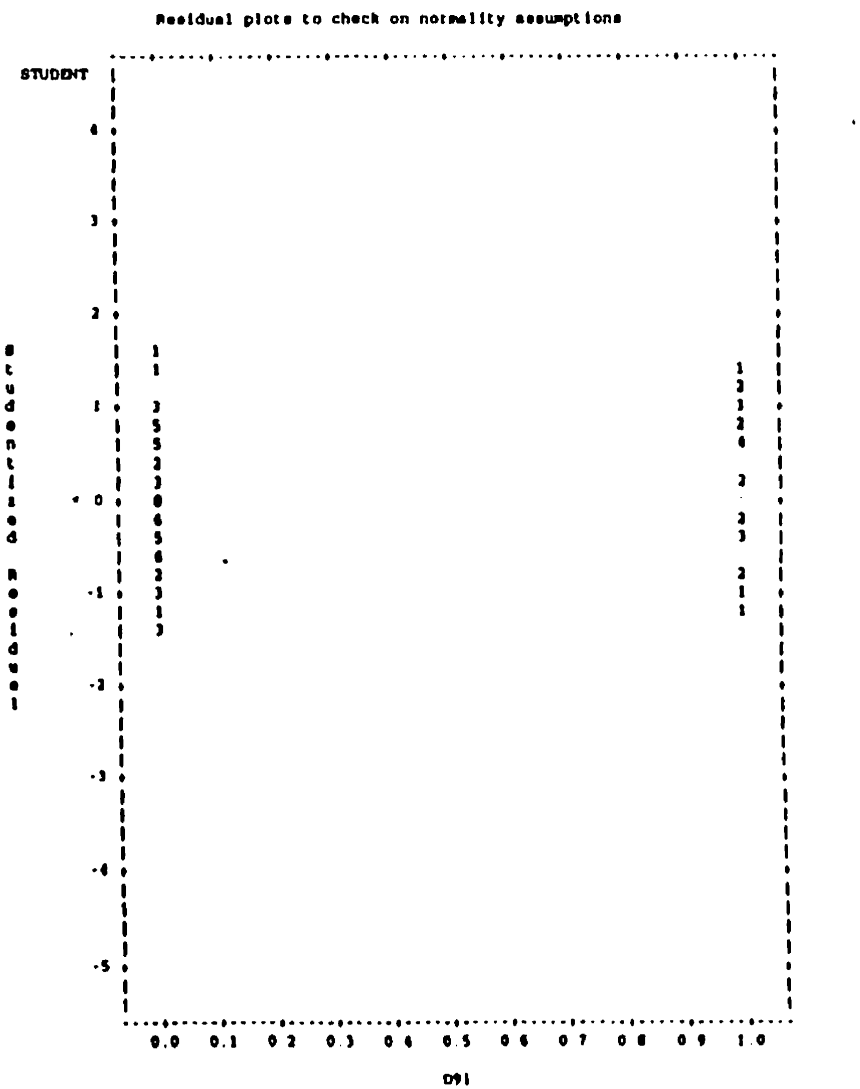


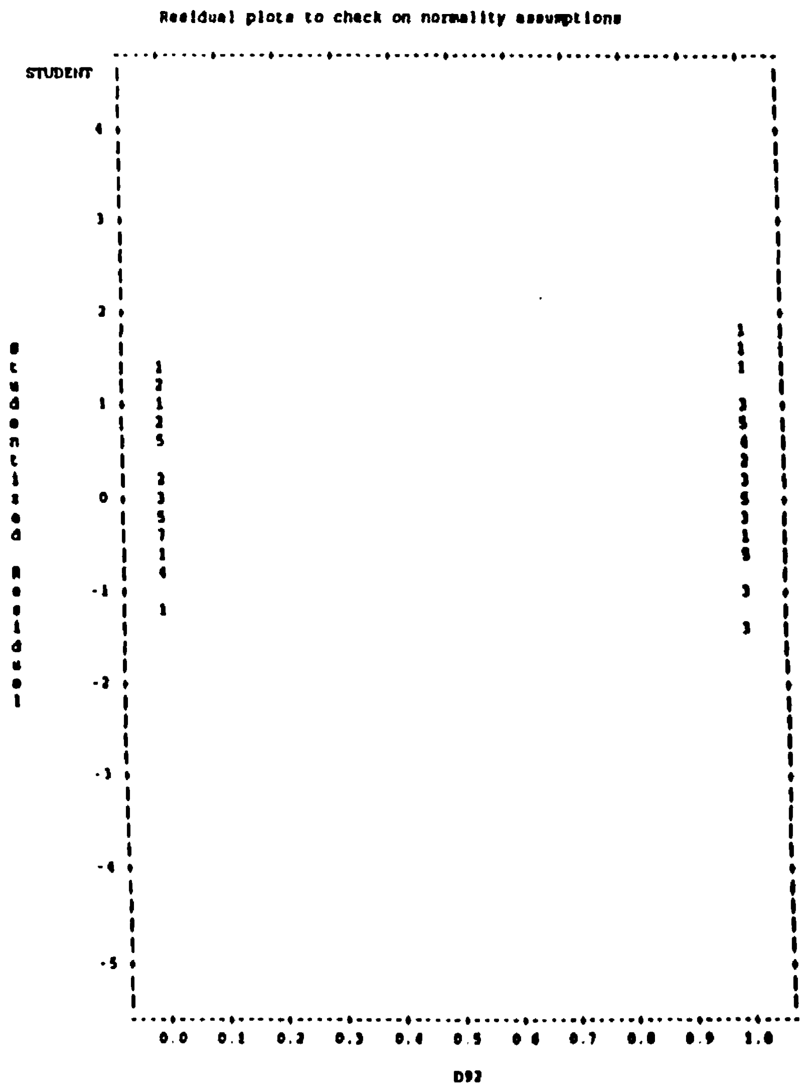
Residual plots to check on normality assumptions



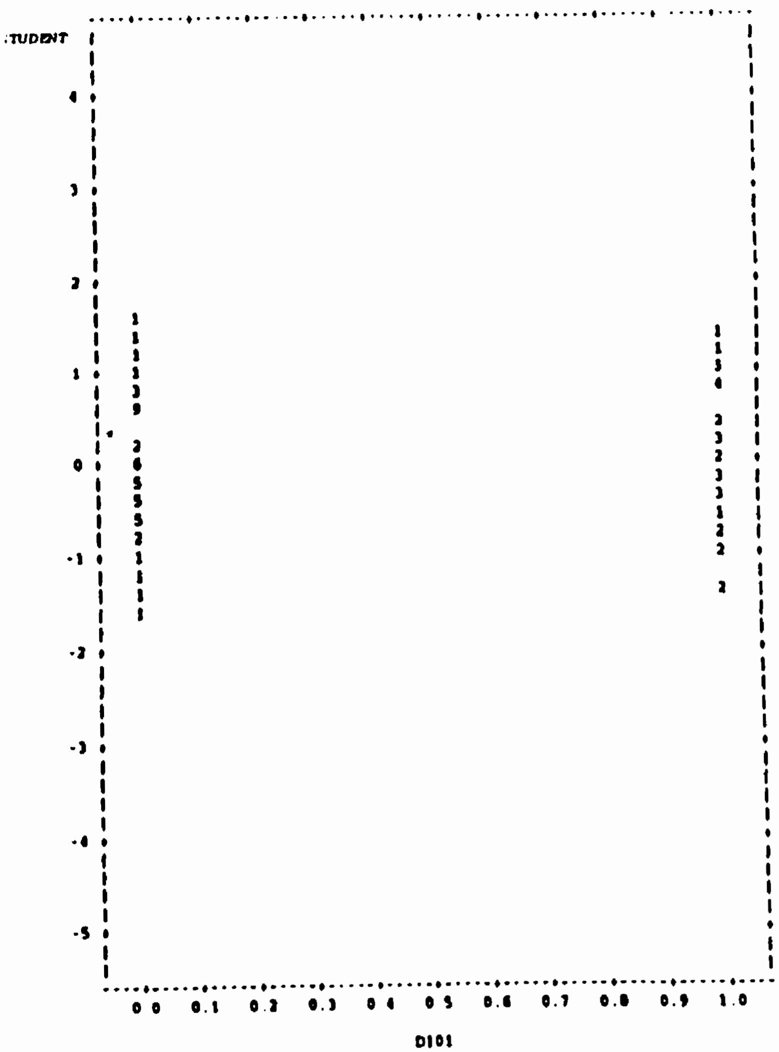

Residual plots to check on normality assumptions
STUDENT
DB2
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
4 3 2 1 0 -1 -2 -3 -4 -5


Residual plots to check on normality assumptions
DB1
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
4 3 2 1 0 -1 -2 -3 -4 -5

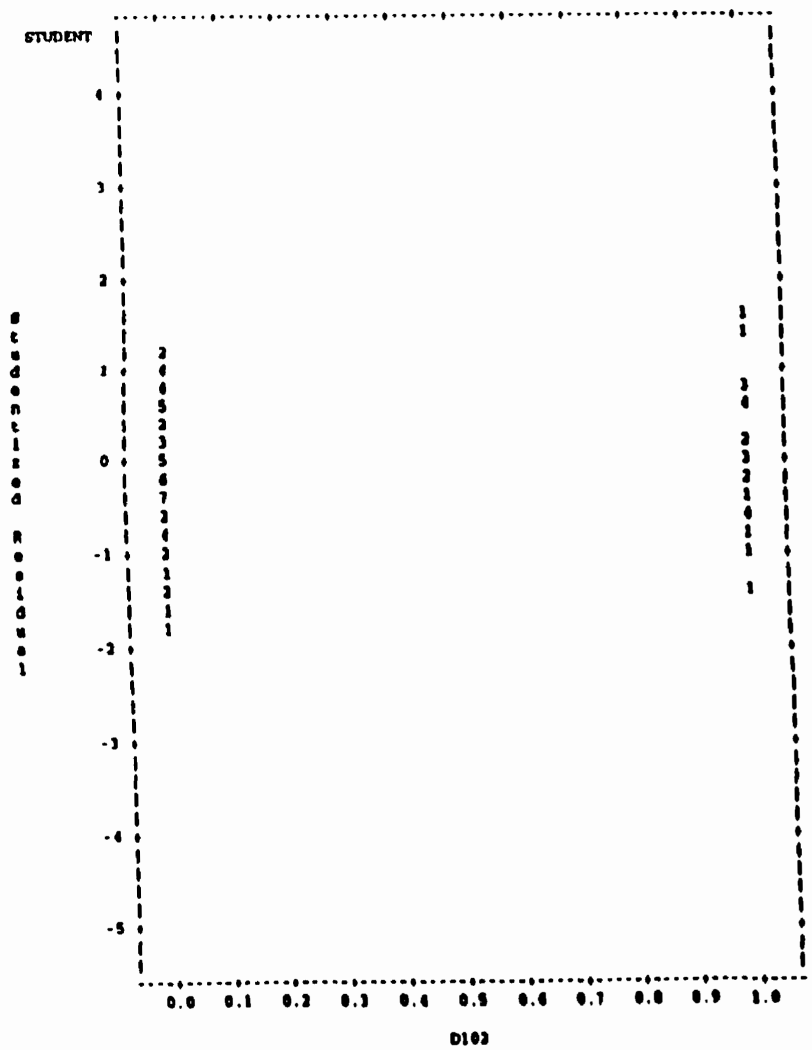

Residual plots to check on normality assumptions
STUDENT
Studentised Residual
D91

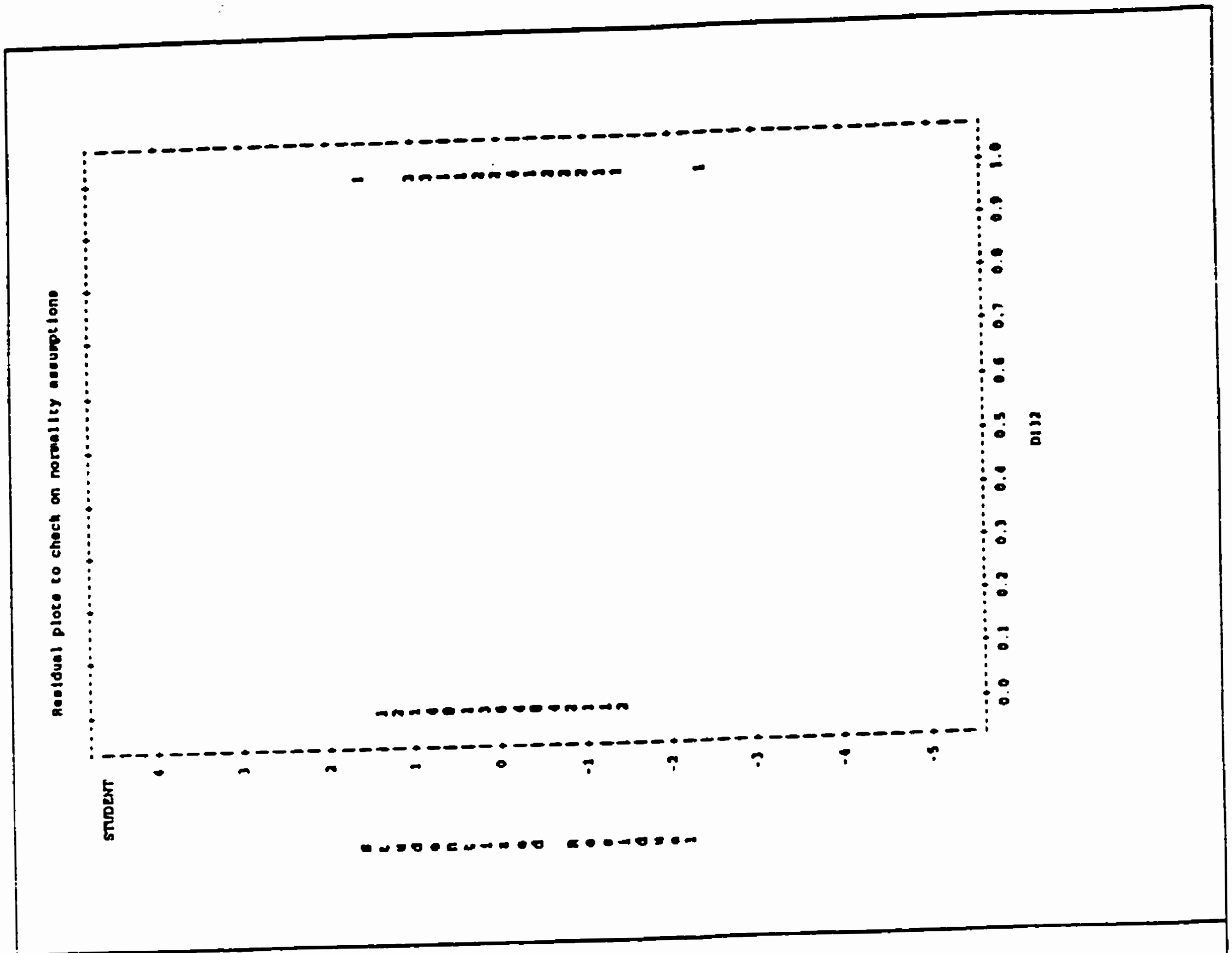

Residual plots to check on normality assumptions
STUDENT
Studentised Residual
D92

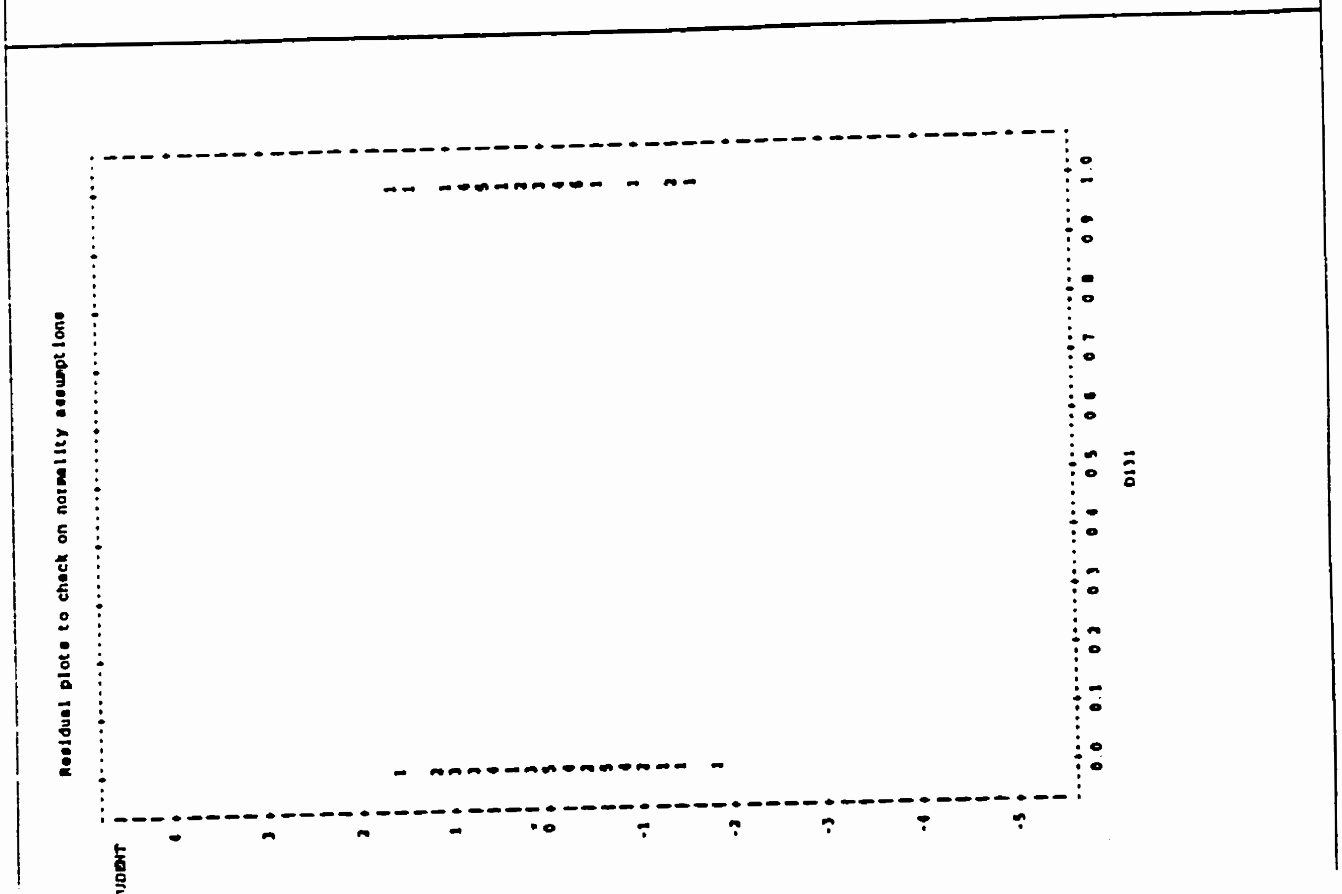
Residual plots to check on normality assumptions

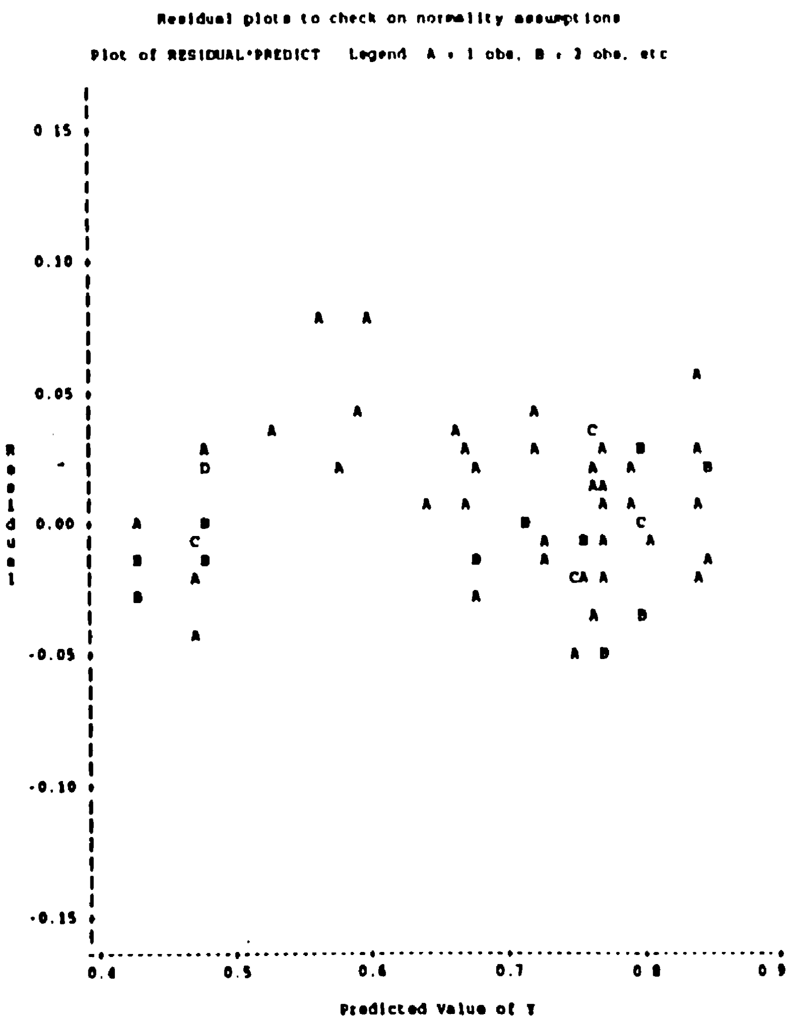


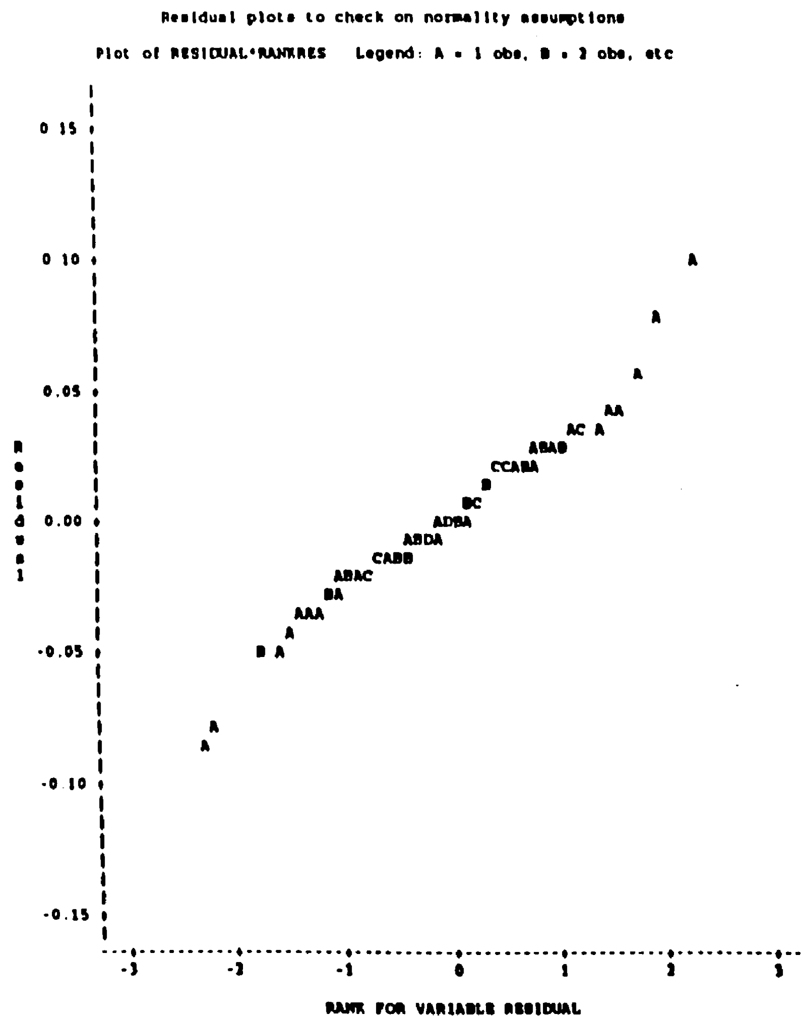
Residual plots to check on normality assumptions




Residual plots to check on normality assumptions
STUDENT
4
3
2
1
0
-1
-2
-3
-4
-5
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
DI12

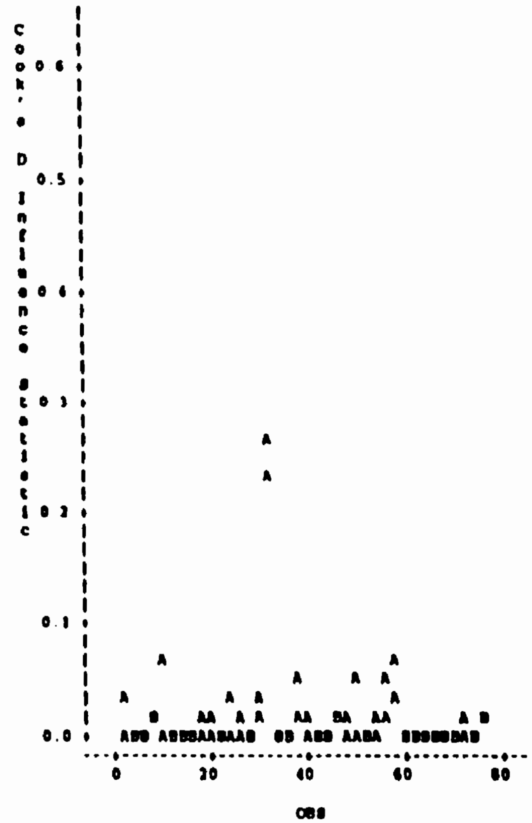

Residual plots to check on normality assumptions
4
3
2
1
0
-1
-2
-3
-4
-5
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
DI11


Residual plots to check on normality assumptions
Plot of RESIDUAL*PREDICT   Legend A = 1 obs, B = 2 obs, etc
Residual
Predicted Value of Y


Residual plots to check on normality assumptions
Plot of RESIDUAL*RANKRES   Legend: A = 1 obs, B = 2 obs, etc
Residual
RANK FOR VARIABLE RESIDUAL

Model Diagnostic
(2) Plot of Cook's Distance to check for influential outlie
te

Plot of COOKD*OBS Legend: A = 1 obs, B = 2 obs, etc.



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