A VALIDATION OF THE FUNDAMENTAL RESEARCH MODEL OF GROUP SUPPORT SYSTEMS

A Dissertation

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Doctorate of Philosophy Degree

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DEDICATION

I dedicate this work to my wife, Denise.

Without her support and faith, this Dissertation would certainly have never been possible.

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I would like to thank the members of my committee for their help with this dissertation. In particular, I would like to thank Dr. Aiken.

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ABSTRACT

The body of research addressing group support systems (GSS) has made use of the Dennis Model of GSS as its primary research tool since 1988. Nonetheless, the model has never before been validated. This failure can be attributed to two primary reasons. First, the model's constructs are broadly defined, requiring any quantitative analysis, by necessity, to be reductionist. Second, there has been an absence of appropriate longitudinal data.

This dissertation suggests six reductions of the Dennis Model. Each associates certain measurable variables as proxies for the overall model's broad constructs. Each reduction is a functional model, sharing the structure of the overall model in part. These reduced models were validated through the use of multiple linear regression, using archival data representing longitudinal research. This validation supports the strength of the overall model, as well as providing insight into the particular influence of certain independent variables (group size, homogeneity, mood, organization, prior knowledge, prior history, topic familiarity, tool experience, task complexity, and idea generation technique) on their associated dependent variables (process time, evaluation apprehension, comment generation rate, group process satisfaction, and production blocking).

Limitations of this dissertation include the relatively small sample sizes of the research groups, the homogeneity of the group participants, the research instruments used in data collection, and the assumptions of multiple linear regression generally. Future research may address larger groups, propose additional reductions of the Dennis Mode,

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make use of different analysis tools such as structural equation modeling, and attempt to reconcile proposed reduced models into a coherent whole.

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TABLE OF CONTENTS

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Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.

LIST OF TABLES

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LIST OF FIGURES

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CHAPTER 1

INTRODUCTION

1.1 Statement of the Problem

This dissertation explores the well known Dennis model (Dennis, et al., 1988) of group support systems (GSS) – the seminal theoretical model of electronic meeting research. Specifically, the dissertation examines several reduced versions of the model to determine the effect of group size, idea generation technique, homogeneity, mood, organization, prior knowledge, prior history, topic familiarity, and tool experience on evaluation apprehension, comment generation rate, group process satisfaction, production blocking, and process time. The reduced models are then validated, providing support for the overall model.

This study strengthens the role of the Dennis model as the fundamental paradigm of GSS research and provides a greater understanding of the inter-relationships among GSS variables. With this new knowledge, improvements in electronic meeting techniques can be made.

1.2 Group Support Systems

Group support systems are variously characterized in the literature, but can be essentially defined as any processing systems that make use of networked computer technology to facilitate decision making within a group (Aiken, et al., 1995b). Born of earlier research in the area of decision support systems (DSS), GSS marries DSS principles to decision scenarios involving groups (Huber, 1984).

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GSS-enabled meetings generally have been compared to traditional, verbal meetings. While research has not shown that GSS-enabled meetings are uniformly better than traditional, verbal meetings (Iacono, 1990), participants in electronic meetings have been demonstrated to show an increased level of participation while simultaneously saving time relative to participants in traditional, oral meetings. Participants in electronic meetings further have been shown to be generally more satisfied with their meeting process and outcomes than participants in purely verbal meetings (McLeod, 1992). Relative advantages in terms of collaboration, deliberation, and negotiation have also been observed (Aiken, 1992; Aiken, et al., 1991).

GSS are expected to continue to evolve, incorporating new methods and technologies such as automated facilitation, speech recognition, and natural language processing (Limayem, et al., 1993; Rebman, 2001; Wong, 2003). With established advantages over traditional, verbal systems and potential new advances in technology, GSS are expected to become increasingly more important, evolving to serve an ever more diverse range of organizations (Paul, 2004).

A great deal of contemporary GSS research is based upon the seminal work of Dennis (Dennis, et al., 1988). This research added two major elements to the literature. First, the time spent by organizational personnel in meetings was examined. Based upon that review, it was concluded that organizational meetings failed to meet their potential in terms of productivity. Second, software solutions development was studied. The research emphasized the role that evolving software solutions might have in empowering participants in organizational meetings to be more productive.

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Dennis suggested that these software solutions could be classified into two groups: task-oriented group decision support systems (GDSS) designed to provide tools for a group to collaborate and resolve a problem, and computer supported cooperative work systems (CSCW) designed to provide tools to enable small groups to communicate more easily. While the two groups were distinct, it was suggested that ultimately, the distinction would vanish as software solutions grew more sophisticated and overlapped each others' functionality. The authors defined the term Electronic Meeting Systems (EMS) as the ultimate mutual evolution of both GDSS and CSCW. Contemporary researchers prefer the term GSS, using that term interchangeably with Dennis' EMS.

To illustrate the factors the authors considered significant in EMS meetings, systems, and technologies, a conceptual research model of EMS was proposed (see Figure 1). The Dennis model has since proven to be fundamentally important in the field of GSS research.

1.3 Contribution

Since its publication in 1988, the Dennis model of GSS has served as the primary guide in this area's research. According to the Social Science Citation Index in 2005, the article has been cited almost 200 times. However, the model has never been validated. Few studies have attempted to investigate more than two or three variables at a time, and certainly, none have attempted to determine the mapping among variables, or the relative weights assigned to model links.

While research studying GSS variables in isolation is useful and should continue, the field can benefit from the introduction of measurable models – those that can be

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tested and verified with robust statistical techniques. In furtherance of this goal, the Dennis model must be pared down into smaller – more manageable – subsets. Such sub-models can be operationalized and evaluated. A variety of such models are possible, each tailored to the interests of researchers focused upon a particular knowledge domain.

Prior research has analyzed subsets of Dennis model variables with a variety of techniques, but the overall model has never been studied as a whole. This failing has likely been due to the lack of appropriate longitudinal data. It is difficult to acquire a robust data set incorporating more than a small number of variables for GSS research, and few longitudinal studies have been attempted (Burke & Chidambaram, 1994; Chidambaram, et al., 1990; Hollingshead, et al., 1993)

This dissertation presents several reduced versions of the Dennis model, each validated by the technique of multiple regression utilizing two datasets of longitudinal data. In this way, the actual causal relationships among the variables of the reduced models can be test and measured as regression coefficients. Knowledge of these coefficients may guide future researchers to innovative GSS applications.

A greater understanding of the Dennis model allows practitioners to hold more effective and efficient electronic meetings by allowing them to optimize meeting topics, group size, and other meeting logistics. Academics similarly benefit, their research enabled by a greater understanding of the intricacies of human behavior in meetings.

1.4 Proposed Research Models

The Dennis research model includes six general constructs: group, task, context, electronic meeting systems (EMS), process, and outcome. Each represents not a single

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variable, but rather a family of related variables. Dennis provides examples for each variable construct, but these examples are not intended to be exhaustive (see Figure 1).

Based as it is upon such variable categories, each representing a family of measures, the Dennis model continues to prove a difficult subject for quantitative research. Some research has attempted to refine the model, adding elements such as the effect of a facilitator or distinguishing between individual and group characteristics (Aiken, et al., 1997c). Most research, however, has focused on the study of particular variables in isolation (Benbasat & Lim, 1993; McLeod, 1992). Comparatively little research has been done on the complicated interrelationship of the variables within a specified model (Vogel & Nunamaker, 1990).

This relatively small body of research has made use of a wide variety of tools, including linear equations (Valacich & Dennis, 1994), neural networks (Aiken, 1997a; Aiken, et al., 1999), and logical abduction (Aiken & Paolillo, 2000).

Any such research must inevitably be largely reductionist in its specification of the Dennis model. The sheer number of sub-variables suggested in the model defeats the possibility of completely specifying the model in any normal research context. The fact that each of the six designated main variables is actually a family of variables suggests that a complete quantitative specification of the model is unlikely.

A researcher must select manageable variables if a meaningful reduced model is to be specified and measured. Thankfully, guidelines exist within the GSS literature, and are further suggested by the anecdotal experiences of GSS practitioners (Aiken & Paolillo, 2000). Two potential models suggested by these guidelines are shown in Figures 2 and 3.

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1.4.1 Model I – Process Time

Given the general character of the variables described by the Dennis model, group size, group homogeneity, group mood, organizational level, prior knowledge, prior history, topic familiarity, and tool experience are measures of the model's Group variable construct. Task complexity is a measure of the Task variable construct; while process time is a measure of the model's Outcome variable construct. If the overall model holds true, these given measures of Group and Task variables should predict the given Outcome variable. These associations are supported in the literature (Aiken & Paolillo, 1997).

The model proposed in Figure 2 uses three of the original six constructs, yet maintains the original model's structure. Its overall predictive quality can be tested, and the results of this test can be generalized to the Dennis model overall. To this end, archival data was obtained representing 36 cases of facilitator summaries of GSS sessions held over a period of four years (1987 to 1999) at a Southwestern university. In all, 36 groups including more than 570 individuals were represented, each meeting at or near the university. Some groups met multiple times.

Meetings took place at one of three of sites. In all, 60 meetings took place at Site 1, which featured a large U-shaped conference table fitted with 16 workstations. A large display screen was visible to individuals using the workstations. Site 2 hosted 169 meetings. This site featured 24 workstations, arranged in two tiers, with two additional workstations at the room's front. Two large screens and whiteboards were visible to individuals using the workstations. Site 3 hosted six meetings, and featured 12 workstations arranged in a U-shape, with an additional central facilitator workstation at

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the bottom of the U. Those groups who engaged in EMS sessions made use of dedicated software: specifically, a well known software package called GroupSystems.

At the conclusion of each group session, a designated group facilitator prepared reports consisting of general information about the group, the task confronting the group, the proposed meeting agenda, the actual meeting agenda, as well as any additional comments the facilitator felt were relevant.

Based upon these facilitator reports, session data were recorded representing eight distinct variables: group size, group homogeneity, group mood, organizational rank, prior knowledge of group members, prior history as group, topic familiarity, and tool experience. The time required for each session was also recorded, as was a measure of the complexity of each group's designated task. Due to incomplete reporting, only 36 group reports included measures of all desired variables (Aiken & Paolillo, 1997).

The presence of this data enables exploratory and confirmatory tests of proposed Research Model I as shown in Figure 2. It should be possible to calculate various measures of the degree to which each independent variable influences each dependent variable. Knowledge of these weights would provide a useful predictive tool for additional research. It should further be possible to determine the model's predictive character and overall validity. Testing the expected signs (positive or negative) of each dependent variable within the model is an obvious extension.

In accord with the literature, we hypothesize that group size and task complexity positively influence process time, while homogeneity, mood, organizational level, prior knowledge, prior history, topic familiarity, and tool experience negatively influence process time. As group size or task complexity increases, we expect process time to also

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increase. As homogeneity, mood, organizational level, prior knowledge, prior history, topic familiarity or tool experience increases, we expect process time to decrease (Aiken, 1998; Aiken, et al., 1994; Dennis, 2003; Diehle & Straube, 1987; Dugosh, et al., 2000; Hwang & Guynes, 1994; Latane, 1981; Mullen, et al., 1991; Paulus & Yang, 2000). These variable effects are illustrated in Figure 4.

1.4.2 Model II – Outcome Variables

The model proposed in Figure 3 uses four of the original six Dennis model constructs. Like proposed Model I, Model II retains the Dennis model's overall structure. As it includes Production Blocking as an intermediate variable, however, it cannot easily be tested. For the purpose of this analysis, it proves easier to dissect this model into yet smaller pieces, as shown in Figures 5 through 8. Each of these retains the same overall structure as Model II.

Each of these smaller models is validated. The degree to which each independent variable influences each dependent variable is calculated, and the overall models' predictive qualities are measured. The expected signs (positive or negative) of each dependent variable within the model are similarly determined.

For this purpose, archival data representing a meta-analysis of 70 observations of GSS data gathered over a period of eight years at a southern university were obtained. The data set represented longitudinal data for four separate studies involving more than 1000 participants (the large majority of whom were undergraduate students) during the period from 1991 to 1999. The data set is one of the largest within the field of GSS

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research (Aiken, et al., 2002a). Locally developed software was provided for the meetings.

Primarily intended to distinguish between two forms of GSS (electronic poolwriting and electronic gallery writing), the data provides measures for the following six variables: group size, meeting type, group process satisfaction, rate of comment generation (number of comments generated per person per minute), evaluation apprehension, and production blocking (communication difficulty). Measures for group size and comment generation rate were compiled by the GSS facilitator. All other measures were self-reported by individual group participants on a five point scale (Aiken & Paolillo, 2000). Evaluation Apprehension was rated on an inverse scale.

The groups were provided the same or similar conversation topics to serve as the focus of their meetings. One such topic was "the campus parking problem." While no measures were provided for Task or Context variables, those variables were held as constant as practically possible given the character of the experiment.

1.4.3 Model III – Evaluation Apprehension

A reduced version of the Dennis model was prepared for validation based upon proposed Model II. This model posits that group size represents the Dennis model's Group variable construct, that Idea Generation Technique represents the Dennis model's EMS variable construct, and that Evaluation Apprehension represents the Dennis model's Outcome variable construct (see Figure 5).

This model was validated using longitudinal data. Additionally, hypotheses concerning the influence (positive or negative) of each independent variable were also

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tested. We hypothesize that group size and transcription in verbal meetings both positively influence Evaluation Apprehension. The presence of an EMS (either electronic gallery writing or electronic poolwriting) is expected to negatively influence Evaluation Apprehension, relative to purely verbal meetings (see Figure 9).

1.4.4 Model IV– Comment Generation Rate

A second reduced version of the Dennis model was prepared for validation based upon proposed Model II. As above, this model posits that group size represents the Dennis model's Group variable construct, and that Idea Generation Technique represents the Dennis model's EMS variable construct. Comment Generation Rate is assumed to represent the Dennis model's Outcome variable construct (see Figure 6).

This model was validated using longitudinal data. Additionally, hypotheses concerning the influence (positive or negative) of each independent variable were also tested. We hypothesize that group size will have no effect on Comment Generation Rate, that transcription in verbal meetings will negatively influence Comment Generation Rate, and that the presence of an EMS (either electronic gallery writing or electronic poolwriting) will positively influence Comment Generation Rate, relative to purely verbal meetings (see Figure 10).

1.4.5 Model V– Group Process Satisfaction

A third reduced version of the Dennis model was prepared for validation based upon proposed Model II. This model again posits that group size represents the Dennis model's Group variable construct, and that Idea Generation Technique represents the

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Dennis model's EMS variable construct. Group Process Satisfaction is assumed to represent the Dennis model's Outcome variable construct (see Figure 7).

This model was validated using longitudinal data. Additionally, hypotheses concerning the influence (positive or negative) of each independent variable were also tested. We hypothesize that group size and transcription in verbal meetings both negatively influence Process Satisfaction. The presence of an EMS (either electronic gallery writing or electronic poolwriting) is expected to positively influence Process Satisfaction, relative to purely verbal meetings (see Figure 11).

1.4.6 Proposed Model VI – Production Blocking

A fourth reduced version of the Dennis model was prepared for validation based upon proposed Model II. This model once again posits that group size represents the Dennis model's Group variable construct, and that Idea Generation Technique represents the Dennis model's EMS variable construct. Production Blocking (as represented by communication difficulty) represents the Dennis model's Process variable construct (see Figure 8).

This model was validated using longitudinal data. Additionally, hypotheses concerning the influence (positive or negative) of each independent variable were also tested. We hypothesize that group size and transcription in verbal meetings both positively influence Production Blocking. The presence of an EMS (either electronic gallery writing or electronic poolwriting) is expected to negatively influence Production Blocking, relative to purely verbal meetings (see Figure 12).

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CHAPTER 2

REVIEW OF THE LITERATURE

2.1 Group Support Systems

While terms may vary, Group Support Systems (GSS) can generally be characterized as any information system that makes use of computer technology to enhance, facilitate or enable decisions within a group setting (Aiken & Chrestman, 1995). Not a particularly new concept, GSS can be traced to the earlier and more mature sphere of decision support systems (DSS). The evolutionary link between DSS and GSS can be found in the work of Huber (1984) who extended well known principles of decision support systems to include group decision scenarios.

Group Support Systems are enabling systems, designed to assist those persons with a shared responsibility for decision making to be more productive and to produce decisions of greater diversity and quality (Aiken & Chrestman, 1995). GSS are an alternative to traditional systems of purely verbal discourse, and can demonstrate certain advantages over those purely verbal systems. While advantages are not universal, participants in GSS sessions generally are more satisfied than participants in purely verbal meeting, and are also more likely to participate. GSS meetings generally take less time than traditional verbal meetings as well (McLeod, 1992).

Since GSS are diverse, it is not easy to characterize them with great confidence, but at an elemental level most are largely the same, consisting of three fundamental elements: (1) some form of automated or facilitated documentation system to record decisions and the decision process which created them, (2) a mechanism to suggest

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potential solutions and to distinguish between alternative solutions, and (3) a computer-enabled interface to enable or enhance communication between group participants (Pollack & Kanachowski, 1993).

As computer technology has proliferated, GSS have become more diverse and powerful (Schwab, 1998). Increasing levels of confidence in electronic solutions and higher levels of overall computer sophistication continue to spur greater advances in GSS technology in terms of both power and flexibility (Broome & Chen, 1992). Not limited to formal meetings within discrete organizations, GSS include elements as fundamentally simple as e-mail, and as elaborate as sophisticated GSS meeting rooms enabled by specialized computer hardware and software to monitor, facilitate, and enable meetings of all sorts (Rebstock, et al., 1997; Teng & Ramamurthy, 1993).

It is difficult to envision the limits of the application of GSS, but in their classical form GSS are simply a replacement for, or an augmentation to, those technologies and props that have always enhanced traditional verbal meetings. In the same way that a dry-erase board and markers can record ideas generated by participants in a face to face meeting, so can specifically designed GSS technologies record ideas generated in a GSS-enabled meeting. Analogs to traditional forms of record-keeping, group prompting, and communications channels all exist within the variety of GSS technology. GSS are particularly user-oriented, existing to enhance the group process of any group's constituents, and are therefore designed for maximum ease of use (Aiken, 1992).

Advantages greater than simple ease of use, however, have been associated with GSS technologies. Because GSS alleviate or reduce the logistical burden of group participants, those participants are likely to produce more and better ideas (Satzinger, et

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al., 1999; Sosik & Avolio, 1998). Relative to traditional verbal meetings, participants in GSS sessions demonstrate greater productivity and satisfaction, largely due to the facility of GSS technologies to enable parallel communication, provide anonymity, and automatically keep records of group activity (Aiken & Hassan, 1996; Aiken & Vanjani, 1995; Cooper & Gallupe, 1998).

GSS, however, have some disadvantages as well. The benefits of GSS vary considerably with group size (Aiken, 1998; Aiken, et al., 1994; Dennis, 2003; Diehle & Straube, 1987; Dugosh, et al., 2000; Hwang & Guynes, 1994; Latane, 1981; Mullen, et al., 1991; Paulus & Yang, 2000), and GSS technology, no matter how user-friendly, requires greater sophistication than simple verbal discourse. Furthermore, some participants in GSS sessions may feel dissatisfied due to an absence of media richness compared to traditional face-to-face communication (Paul, et al., 2004; Reinig, et al., 1996).

Additionally, any scholarly findings concerning the advantages of GSS are limited by the scope of that research. While a great deal of GSS literature exists, most GSS research has focused on a fairly small number of observable measures – most often group effectiveness and process satisfaction (Fjermestad & Hiltz, 2001). Most often, research has been done to compare the performance of traditional verbal meetings with GSS-enabled meetings directly (Chidambaram & Jones, 1993; Gallupe & McKeen, 1990; Murthy & Kerr, 2003; Olaniran, 1994).

Comparative research between GSS and traditional verbal meetings is relatively plentiful compared to rigorous examination of the intrinsic qualities of specific GSS, or the comparative qualities of alternative meeting system technologies. The intrinsic technology of EMS sessions has simply not often been addressed in studies (Benbasat &

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Lim, 1993). In those studies that have been done, different EMS technologies have been shown to have a significantly different impact on meeting outcomes (Easton, et al., 1990). It is surprising that more research has not been done comparing EMS technologies directly, as they can be broadly lumped into one of two categories: electronic poolwriting (a GSS variation of traditional poolwriting) or electronic gallery writing (a GSS variation of traditional gallery writing) (Aiken, 2002). These techniques are further described in subsection 3.3.2.

In addition to the relative paucity of research addressing GSS directly or comparing alternative GSS with each other, there is also a scarcity of rigorous research addressing theoretical research models of GSS models in their entirety. Most GSS research concerns only isolated variables within a broader GSS model (Benbasat & Lim 1993; McLeod 1992). Few researchers have taken a broader view and addressed the interrelationship among meeting behavior variables (Vogel & Nunamaker 1990).

Although studies have been done using linear equations (Valacich & Dennis, 1994) and neural networks (Aiken, 1997a), there is a further need for a mathematically intensive body of research in GSS (Aiken & Vanjani, 2002). Many research models simply neglect mathematically rigorous research methods (Zigurs, 1993).

2.2 Origins of the Dennis model of GSS

Like most fields of information systems research, the study of group support systems is not without its share of potential research models. Various academics have proposed models to support the study of group processes and outcomes (Gallupe, et al.,

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1988). McGrath's Circumplex categorizes tasks, demonstrating those tasks best suited for GSS meetings (see Figure 13).

McGrath's model proved influential, and was adapted by Murthy, who further modeled the interaction of individuals and groups, based upon six constructs: Individual (individuals with characteristics that distinguish one person from another), Standing Group (pre-existing groups such as members of a common organization), Acting Group (the subgroup of a standing group that is acting in any given instance), Tasks/Situation (the task for which an acting group assembles and attempts to resolve), Environment (physical aspects of the meeting room, cultural aspects of those individuals involved, and technological aspects of any GSS present), and Behavior Setting (the unique combination of all model variables) (Murthy, 1989) (see Figure 14).

Although a model demonstrating the general relationship among task, group, technology and outcome was proposed by DeSanctis and Poole in 1987 (DeSanctis & Poole, 1987) (see Figure 15), Murthy's model provides one of the first hints of the complex interrelationship among groups and individuals (Aiken, et al., 1997c). Murthy's model, while influential, has nonetheless not proved to be the fundamental research model for GSS.

Based upon specific variables of interest in GSS sessions proposed by researchers such as Huber (Huber, 1984), and McGrath (McGrath, 1984), a paper was published in 1988 that incorporated and elaborated GSS variables into a coherent research model (Dennis, et al., 1988). The proposed Dennis model has proved to be the fundamental theoretical research model of GSS in the decades since its publication.

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In the Dennis model, four primary variables (group, task, context, and GSS environment) influence both process and outcome (Aiken, et al., 1990). Flexible and robust, the model was quickly adopted and elaborated (Nunamaker, et al., 1991). While most models focus on a small number of isolated variables (Benbasat & Lim 1993; McLeod 1992), the Dennis model approaches GSS dynamics in a broader, more holistic way.

The primary virtue of the Dennis model is its capacity to capture all those variables that might influence GSS behavior and outcome. It accomplishes this task by featuring variables that are much more abstract and general than specific or discrete (see Figure 1).

2.3 The Dennis Research Model

As discussed in subsection 1.4, the Dennis research model includes six distinct sets of variables: group, task, context, electronic meeting systems (EMS), process, and outcome. Each represents not a single variable, but rather a category of related variables. This categorical approach invites a wide variety of specific examples. Dennis provides general examples for each variable construct, and researchers have proposed many additional, more specific, examples.

2.3.1 Group Variables

The model's group variables include such specific factors as the number of participants in the group (group size), whether the group is geographically local or more widely distributed, past group experience with the problem at hand, as well as the individual motives, experiences, biases, and other characteristics of group participants. While specific examples are provided below, the group variable construct characterizes

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all aspects of the EMS group and group participants. No list of examples can be considered exhaustive.

Example Group Variables

- Member Characteristics – measures of personal characteristics, such as the age or gender of group participants, or their typing speed. Member characteristics are extremely diverse, but have been addressed in GSS research, often in the form of cultural differences among group members (Aiken, et al., 1993; Daily, et al., 1996). One member characteristic measure is the fluency of a group member in the language of a given meeting, as self-reported on a scale of 1 to 5, with 1 indicating poor fluency, and 5 representing complete fluency.
- Group Size – the number of participants in the group. Numerous studies have shown that group size is an important factor in GSS performance. Of particular interest are studies that have discovered that the productivity of GSS sessions relative to verbal meetings have a clear break-even point at group size approximately equal to eight. (Dennis & Williams, 2003; Dennis & Williams, 2005).
- History – participants' past experience with each other, including whether or not they have participated together in prior group sessions, or even if they have simply met previously. Group history is often associated with the group variable of formality (Benbasat & Lim, 1993), but has also been studied as a distinct variable on its own (Mennecke, et al., 1995). A measure of group

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history is a scale of 1 to 5, 1 indicating group participants are complete strangers, and 5 indicating group participants know each other very well.

- Formal / Informal – whether the group has established protocols, including whether there is an established group hierarchy, as well as the presence or absence of a designated group leader or other facilitator. Researchers have observed that groups with established social orders have less potential for anonymity, leading to difficulty in equalizing participation (Benbasat & Lim, 1993). One measure of group formality is be a scale of 1 to 5, 1 indicating an ad hoc group organization, and 5 indicating a group with a rigid itinerary and established protocols.
- Ongoing / One Time – whether the group persists after a given session, either in furtherance of the group meeting's goal, or for other purposes. Research has addressed both adoption patterns (Zigurs, et al., 1991), and organizational memory (Schwabe, 1994) in the context of ongoing GSS groups. A measure of group persistence is the number of times the group has met for any purpose previous to a given GSS session.
- Experience – participants' experience with the session topic, such as prior thought on the subject, prior discussion, or related formal education. Domain experience and topic effects have been addressed in the literature (Aiken, 2002). A measure of group experience is a scale of 1 to 5, 1 indicating a group member had never before considered the topic of a GSS session, and 5 indicating the group member had extensive practical experience with the session topic.

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- Cohesiveness – participants' willingness and ability to cooperate, including participants' willingness to abide by group procedures, seek consensus, and minimize antagonistic behavior. Group cohesiveness has been explored minimally in the literature (Liou, et al., 1993; Zigurs, et al., 1991). One measure of group cohesiveness is the degree to which participants in a GSS session deviate from the session's itinerary.

2.3.2 Task Variables

The model's task variables include aspects of the complexity and rationality of the group task, incorporating "the number of issues and alternatives that must be considered and the time required to identify and assess the issues and alternatives" (Dennis, et al., 1988; Hackman, 1968; Shaw, 1973). Task variables are particularly difficult to generalize between GSS sessions as they are often quite domain-specific. Nonetheless, GSS researchers consistently hold that group performance cannot be adequately studied without consideration of group task.

Specific examples of task variables include:

- Type of Task – the nature of the group's task, be it legislative or innovative, encompassing possibilities such as the generation of potential solutions to a given problem, reaching consensus about such potential solutions, or the appointment of group participants to particular areas of responsibility, within the group or without. A measure of task type is whether group participants are

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asked to choose between a discrete number of alternative solutions to a problem, or generate a completely new set of alternative solutions.

- Rational / Political – the degree to which the group's task requires thoughtfulness, creativity or delicacy, including issues such as the potentially provocative nature of certain group tasks, the awarding of praise or blame, or the discomfort of expressing unpopular opinions. One measure of task delicacy is a scale of 1 to 5, 1 indicating that a group participant cannot be negatively impacted by the group's activity, and 5 indicating that a group participant could be profoundly negatively impacted.
- Complexity – whether the group's task requires sophistication, or more generally whether meaningful group participation requires special training, experience, technical expertise, rhetorical ability, or precision. Some researchers suggest that complex tasks lend themselves particularly well to GSS. As task complexity increases, the effectiveness of GSS-supported groups grows as compared to groups that do not have GSS support (Bui & Sivasankaran, 1990). Task type has been addressed in the literature as it applies to group conflict (Jain & Solomon, 2000), choice of GSS technology (Hwang, 1998; Nunamaker, et al., 1989b), and GSS leadership roles (Kahai, et al., 1997). A measure of task complexity is the time spent on mathematical analysis of potential alternatives generated during a GSS session.

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2.3.3 Context Variables

The model's context variables include the "larger context in which the group meeting occurs," as well as any significant incentives to the individual group participants" (Dennis, et al., 1988; DeSanctis & Poole, 1987; Jessup, 1987). Specific examples of context variables are given below.

- Incentives and Rewards – whether participants receive a benefit from their participation, outside of any intrinsic benefit, such as whether participants who propose a successful solution to a problem are likely to receive promotion within their organization, or whether students participating in a meeting as a class assignment might receive extra credit. One of the few research topics in this area has addressed the issue of monetary remuneration for GSS participation (Aiken, et al., 1997a).
- Organizational Culture – the degree to which participants are expected to participate, or the role they are expected to play, as a result of their organizational status or ambition. Examples include whether senior organizational personnel are expected to take leadership roles in meetings, or whether less senior participants are expected to defer. A measure of organizational culture is a scale indicating the willingness of GSS participants to criticize ideas generated by their organizational superiors, rated on a scale of 1 (extremely unwilling) to 5 (quite willing).
- Environment – the impact that the physical context of the meeting has on its participants, including such factors as whether the participants are physically

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comfortable, share the same workspace, have access to useful tools and props, and are free from distractions. Relatively little research has been done on GSS environments, although comparisons between local and distributed groups have been made (Aiken & Vanjani, 1997). One measure of environmental context is whether all participants have sufficient room to work comfortably.

2.3.4 EMS Variables

The model's EMS variables denote whether an EMS is present, as well as the degree of influence a present EMS has on group process and outcome. As there are many general EMS types, and many disparate designs within each type, this variable covers a wide range of possible variation. It is both inclusive and categorical. Specific examples of EMS variables are provided below.

- Presence of EMS tools – whether technologies are provided to assist group participants in their session, perhaps by automating the proceeding or enabling easier communication. Examples include electronic systems recording group activity, sorting comments, or providing the possibility of anonymous communication. GSS research has often addressed EMS Presence by comparing the performance of groups provided with different technologies (Aiken, et al., 1996; Aiken, et al., 1997b; and Easton, et al., 1990).
- Methods Design – the meeting's general scheme, including such issues as whether the meeting has an established itinerary tracked by the EMS technology.

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- Environmental Design – the degree to which EMS technology is incorporated into the session location, including such aspects as whether the technology is available to all participants, its ease of use, and its ergonomy.

As shown in Figure 1, within the theoretical Dennis model, group, task, context and EMS, are all independent variables that influence process and outcome both directly and indirectly.

2.3.5 Process Variables

The model's process variables include various aspects of group process. The level of formal process within a group, the degree of anonymity afforded to the participants, and the degree of conflict within the group all fall within the general category of group process. More generally, process variables attempt to capture all aspects of group participants' status and behavior that either enable or inhibit group function. Specific examples of process variables may be found below.

- Degree of Structure – to what degree is the operation of the group outlined in advance, including factors such as whether the meeting is timed or open-ended, or whether any aspect of the meeting has been in some way scripted. One measure of structural process is whether a GSS session is allowed to continue only until a certain number of comments have been generated.
- Number of Sessions – the number of sessions a group participates in, and whether this number designated in advance.

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- Anonymity – to what degree may group participants contribute to the group while maintaining their anonymity. Lack of anonymity may inhibit participation, while anonymity may encourage off-topic behavior. A measure of process anonymity is whether group participants are all present and visible in the same room during a GSS session. Studies have addressed the disinhibition associated with anonymity (Aiken & Rebman, 2000; Connolly, et al., 1990; Kahai, et al., 1998).
- Leadership – whether or not a group leader or moderator exists, and the degree of authority that leader or moderator assumes; examples include whether a leader has been designated in advance, is chosen by the group participants during the group session, or emerges de facto from the group's activity. Leadership has been the focus of several GSS studies, addressing such research topics as leadership style and formality (Ho, 1991; Sosik, et al., 1997), and effects of group facilitation (Dickson, 1993; Limayem, et al., 1993).
- Participation – to what degree do any and all participants actually participate; do all participants contribute ideas, comment on those ideas, or assist in the logistics of the meeting. The participation variable represents the amount and equality of participation, generally. Research has addressed participation in terms of the distribution of ideas generated during a GSS session (Aiken & Vanjani, 1996). A measure of process participation is the discrete number of unique comments generated by each group participant.

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- Conflict – whether there is tension within the group, such as conflict between participants with differing ideas, or general enmity between participants for reasons foreign to the meeting itself. Research has addressed conflict as characterized by anonymous verbal abuse (Aiken & Waller, 2000; Alonzo & Aiken, 2004). A possible measure of process conflict might be the proportion of session time devoted to critiquing a given comment.
- Non-Task Behavior – to what degree do participants engage in activities outside of their purported group responsibilities, such as engaging in off-topic conversations, ignoring the group's activity, or actively sabotaging the group's function. Non-task behavior can include the generation of comments irrelevant to a group's purported function (Aiken & Vanjani, 2003). One measure of non-task behavior is the proportion of off-topic comments relative to the total number of comments generated.

As shown in Figure 1, process is a dependent variable in respect to group, task, context and EMS, but is itself an influence on the dependent variable outcome. In large part the dual nature of the process variable is responsible for the difficulty in testing the Dennis model in its totality. Many statistical techniques, including multiple regression, must identify variables as either dependent or independent, but not both.

2.3.6 Outcome Variables

The model's outcome variables are a catchall for the various measurable outcomes of a group meeting. These outcomes include both objective measures such as

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the number of distinct ideas generated in the meeting as well as more subjective measures, such as the degree to which the participants express confidence in a meeting's overall performance. The construct variable attempts to capture all measurable outcomes of a given meeting, including the group participants' feelings of well-being (or not) about their contributions and the contributions of others.

The GSS literature is largely focused upon the identification and measurement of particular outcome variables. While most research has studied these variables in isolation, the selected variables are quite diverse. Examples include measures for group performance, individual perceptions and group development (Mennecke, et al., 1992), particular outcomes related to group tasks (Pinsonneault & Kraemer, 1990), and the distinction between group performance and group process satisfaction (Zigurs & Dickson, 1990).

Example Outcome Variables

- Satisfaction with the Process – the degree to which group participants are content with the session's proceedings, including whether group participants are pleased with the way the meeting was organized or its logistical design. Process satisfaction has been addressed in the literature (Aiken, et al., 1995a; Aiken, et al., 2002b). A measure of process satisfaction is a simple scale of 1 to 5, 1 indicating a group participant thought a group session was helpful, and 5 indicating the group participant thought the session quite unhelpful.
- Satisfaction with the Outcome – the degree to which group participants are content with the session's results, such as whether or not group participants

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feel the meeting was time well spent, and have enthusiasm for ideas generated in the meeting. One measure of process satisfaction is a scale of 1 to 5, 1 indicating a group participant thought the ideas generated during a group session were beneficial, and 5 indicating the group participant thought the ideas generated were ultimately of no benefit.

- Satisfaction Generally – Outcome satisfaction and process satisfaction are sometimes considered together as a single outcome measure. Satisfaction is the most frequently measured variable in field studies, and is often used to demonstrate the general benefits of GSS use (Nunamaker, et al., 1989a). This approach is somewhat justifiable. If group participants are not satisfied with their GSS experience, they are unlikely to recognize more tangible benefits. While the literature clearly indicates that GSS-supported groups are more satisfied than unsupported groups in terms of both process and outcome (Pervan, 1994), researchers have found it difficult to specify exactly what is meant by satisfaction (Dennis, et al., 1991). Satisfaction measures are generally calculated from the response of group participants to subjective post-session questionnaires.
- Time Required – the amount of time required to complete the session or sessions. Process time has often been addressed in GSS research (Aiken, et al., 2002b; Wong & Aiken, 2003), but not often as an outcome variable. This is somewhat odd as field studies consistently demonstrate that GSS-supported groups are more efficient than unsupported groups (Adelman, 1984; Dennis, et al., 1990; Nunamaker, et al., 1988). Time savings are difficult to measure,

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however, as they do not necessarily mean shorter meetings, but may mean fewer meetings instead.

- Number of Alternatives – the number of potential solutions or options suggested to address the session's topic, or more specifically, the number of relevant, unique ideas generated during the meeting.
- Number of Comments – the number of comments made by the group participants within the session. A related variable is the number of unique comments, although uniqueness can be a difficult quality to judge. Comment distribution has been the subject of some GSS research (Aiken & Vanjani, 2003).
- Consensus – the degree to which group participants agree on those alternatives suggested by the session. A possible measure of consensus might be a comparison of the ranking by individual group participants of ideas generated during the session from best to worst.
- Confidence – the degree to which group participants are confident in the efficacy of the session and its results, or more generally whether group participants see the meeting activity as ultimately useful in the context of the meeting's purported goal.
- Other potential outcome variables include: decision quality, depth of analysis, participation and influence, and conflict (Zigurs & Dickson, 1990).

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As shown in Figure 1, outcome is a dependent variable, influenced by group, task, context, EMS and process. Outcome variables are the most commonly explored subject of quantitative GSS research

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CHAPTER 3

METHODOLOGY

3.1 Multiple Regression

Multiple regression is one of a family of techniques that allows a researcher to explore and quantify the relationships between a single continuous dependent variable and several (two or more) independent variables or predictors. The technique is the multivariate extension of simple linear regression (Pallant, 2001).

While one must approach multiple regression with a sound model in mind, it is a powerful, versatile tool that is very much applicable to information systems applications generally and GSS applications specifically. Proper application of the technique allows a researcher to do all of the following:

- Determine the degree to which a proposed model is predictive;
- Test the soundness of a proposed model;
- Determine the relative contribution of each proposed independent variable within a proposed model, and
- Determine whether additional variables over and above those within the proposed model contribute to the model's predictive ability.

Before multiple regression can be applied to a particular model, several choices must be made, and several assumptions must be satisfied. A researcher must first choose

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among the three main types of multiple regression analyses: standard or simultaneous, hierarchical or sequential, or stepwise.

The first of these, standard or simultaneous regression, is the most common choice. The technique evaluates each proposed independent variable in terms of the variable's predictive power, compared to the predictive power of all other proposed independent variables. This technique is best for models where the researcher wishes to determine how much of the variance of a specified dependent variable(s) can be explained by the dependent variables collectively, and singly.

The second type of multiple regression, hierarchical or sequential regression, allows a researcher to add independent variables into a model, one at a time in whatever order can be justified theoretically. Each variable's addition to the predictive power of the model, after the effects of previous variables are accounted for, is assessed as the new variable is added. This technique evaluates the overall predictive quality of the model, as well as the predictive quality of each iteration of added independent variables.

The final major type of multiple regression, stepwise regression, is a variant of the approach of hierarchical or sequential regression. In stepwise regression, proposed independent variables are added to the model one at a time, with each new variable selected according to one of several statistical criteria. The particular criteria approach selected – forward selection, backward selection, or stepwise regression – must be made carefully as misuse is common.

The models proposed in chapter 1 (see Figures 2-3, 5-8) are amenable to any of the three approaches. Since we are most interested in evaluating the models as a whole

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with all proposed variables present, however, we select standard or simultaneous regression as the technique of choice.

3.2 Assumptions

While multiple regression is very flexible and robust, it is somewhat unforgiving. It is appropriate only when the following assumptions can be demonstrated or safely assumed: sufficient sample size, absence of singularity, absence of multicollinearity, minimal effect of outliers, normality, linearity and homoscedasticity (Pallant, 2001).

3.2.1 Sample Size

A data set must be of sufficiently large sample size for the results of multiple regression to be completely trustworthy. There is no definitive answer as to what sample size is sufficient, but many guidelines exist. Stevens suggests that approximately 15 subjects are needed for each proposed independent variable (Stevens, 1996) while Tabachnick & Fidel propose a required sample size greater than 50 + 8m (where m = the number of proposed independent variables) (Tabachnick & Fidel, 1996). Some researchers suggest that regression is not appropriate with a ratio lower than 5:1 (i.e., five cases for every independent variable in the model). Certainly meaningful results have been generated from smaller sample sizes, but a larger sample size is always preferred. In GSS research this poses a particular challenge, as few large data sets are available. This dissertation makes use of two data sets, each considered large by the standards of GSS research.

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The first data set features a sample size of 36 with nine proposed independent variables. This data set is not ideally large on its face, but represents group data, encompassing the results of group activities involving over 570 participants.

The second data set is significantly more robust, featuring a sample size of 70 with five proposed independent variables, or eight proposed independent variables counting dummy variables. This data set is sufficiently large by most regression standards. Also, as each data observation represents a larger group, with all total groups including over 1000 participants, the data is more robust than it might otherwise appear.

3.2.2 Singularity

Regression assumes the absence of singularity. Singularity exists when some or all of a model's proposed independent variables are not truly separate variables, but rather a combination of other independent variables within the model. Therefore, the independent variables are perfectly correlated. Singularity is problematic in regression as regression coefficients are calculated through matrix inversion. If singularity does exist, inversion is consequently impossible (Tabachnick & Fidel, 1996).

Avoiding singularity requires a mature and proper construction of the proposed model. Singularity normally exists when both total scale and subscale scores are included within a model. The proposed models feature sufficiently diverse variables that singularity should cause little concern. Sub scale scores are not included. Furthermore, the variables selected in the model are similar to those variables studied by GSS researchers throughout the literature (Benbasat & Lim, 1993; McLeod, 1992).

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3.2.3 Multicollinearity

Related to singularity, multicillonearity is assumed absent from multiple regression models as well. Multicollinearity exists when a model's independent variables are highly correlated, typically r = 0.9 or above. Matrix inversion in such cases is unstable. Highly correlated independent variables are redundant with one another. No additional predictive qualities are added by their mutual inclusion, while degrees of freedom are lost nonetheless (Tabachnick & Fidel, 1996).

It is a simple matter to test for multicollinearity by observing a model's correlation matrix. One calculates the squared multiple correlation (R^2) for each independent variable, treating that independent variable as a dependent variable relative to the other independent variables within the model. R^2 values greater than or equal to 0.9 indicate multicollinearity, while those of 0.70 or greater are suspect. Tables 1 – 5 represent the calculated R^2 values for each independent variable within the proposed models, treated as dependent.

As demonstrated by Tables 1 – 5, no independent variable within the proposed model has an R^2 >= 0.9 when treated as a dependent variable. Hence, there is no indication of multicollinearity, although several variables are suspect.

3.2.4 Outliers

Outliers are those data that fall unusually far from the mean of the value they purport to measure. Such values can skew the results of multiple regression. Such data can sometimes be deleted from a data set before analysis. In the available data sets, however, outliers can be expected to pose few problems, as each data observation

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represents the mean value of survey scale results. Furthermore, as the data is already sensitive to sample size concerns, deletion is counter-indicated.

Outliers on the dependent variables within a given model can be identified from a plot of standardized residuals, a typical feature of statistical software packages such as SPSS. Outliers can be characterized as those dependent variables with standardized residual values > 3.3 or less than -3.3 (Pallant, 2001; Tabachnick & Fidel, 1996).

Figures 16 through 20 represent the plot of standardized residuals for each of the proposed research models. Models I, III, and VI display no evidence of outliers. Models IV and V do demonstrate some outliers, although the majority of data observations seem well-clustered about the mean in each case (see Figures 16 through 20).

3.2.5 Normality

Multiple regression assumes that the populations from which samples are taken are normally distributed. Normality can be inferred by constructing histograms to represent the distribution of the data. If the data conforms to a superimposed normal curve to a reasonable degree, it is fairly safe to assume a normal distribution (Pallant, 2001; Tabachnick & Fidel, 1996). The data used in this dissertation conforms to a normal curve when depicted as a histogram (see Figures 16 through 20).

Additional assurances of normality can be achieved by calculating the skewness of each variable. Extreme values of skewness (typically greater than +3, or less than -3) indicate a lack of normality. Measures of skewness for the variables within the model further support the assumption of normality in all cases but two: the dependent variable

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Comment Generation Rate of Model III (skewness = 5.490), and the independent variable EMS Type 2 of Models III – VI (skewness = 3.402) (see Table 6).

3.2.6 Linearity

Regression analysis has the assumption of linearity. That is to say that it is assumed that there is a straight line relation ship between the independent variables and the dependent variables specified within the model. Lack of linearity does not invalidate a regression, but does weaken it. One can test for linearity between an independent variable and a given dependent variable by examining a plot of regression residuals.

Nonlinearity can be demonstrated when a clear majority of the plotted residuals are above the zero line at certain predicted values, and below the zero line at other predicted values. If the plot of residuals is a discernible curve, then the data is nonlinear. If the plot of residuals is essentially rectangular, then the data is linear (Tabachnick & Fidel, 1996). Although sometimes quite disperse, the residual plots of the data generally correspond to a rectangular shape, indicating linearity. In no case is a discernible curve evident (see Figures 16 through 20).

3.2.7 Homoscedasticity

The final major assumption of regression is that of homoscedasticity. Homoscedasticity states that regression residuals are approximately equal for all predicated values of a given dependent variable. Absence of homoscedasticity (termed heteroscedasticity) weakens, but does not invalidate regression.

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As with linearity, homoscedasticity can be demonstrated by examining a plot of regression residuals. Data are homoscedastic if the plot of residuals is essentially identical for all values of a predicated dependent variable. Conversely, heteroscedasticity is indicated by a point cluster that grows wider as the values for a given predicated dependent value grow larger. Heteroscedasticity is sometimes the result of skewness due to data not being normally distributed (Tabachnick & Fidel, 1996). Examination of the regression residuals for the data generally confirms the quality of homoscedasticity (see Figures 16 through 20).

3.3 Data Sets

This dissertation makes use of two data sets, each representing the results of a number of GSS sessions conducted over an extended period of time. Longitudinal data of this sort is rare in the GSS literature, suggesting the value of the two datasets not only to this dissertation but to future researchers as well.

3.3.1 Data Set 1 – Process Time

This data set represents archival data acquired from 36 GSS sessions, including 571 participants in total, mostly students. Measured independent variables include Task Complexity, Group Size, Homogeneity of Group, Mood of Group, Organizational Rank of Group Participants, Prior Knowledge of Group Participants, Prior History as Group, Topic Familiarity, and Tool Experience. The data includes a measure for the dependent variable Process Time. Average group size was 15.86, encompassing groups as large as

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36 and as small as 6. The modal value for group size was 10, and the median value was 14. This data is further described in subsection 1.4.1.

Multiple regression was done to test each of the following hypotheses: first that the overall model's variance can be explained by the proposed independent variables and their associated beta coefficient values; second that each proposed independent variable X_i has a significant role in explaining the model's variance; and third that the sign of each significant beta is specifically positive or negative as hypothesized (see Figure 4).

3.3.2 Data Set 2 – Outcome Variables

This data set represents archival data acquired from 70 GSS sessions taking place over a period of eight years. The sessions included 1049 participants, mostly students but including some parents and teachers. The GSS sessions were similar in character, featuring mostly undergraduate students given similar subjects to discuss as the subject of their meetings. The most common subject was the issue of campus parking. Five groups instead were given the task of generating ideas for the strategic planning of a local private school. This data proves extremely convenient, as it included measures for four of the six Dennis model variables (Group, EMS, Process, and Outcome), while minimizing the effects of the two unrepresented variables (Task and Context) by featuring a largely homogenous task and context.

There were 70 groups in all. Average group size was 14.98, encompassing groups as large as 55 and as small as 4. The modal value for group size was 8, and the median value was 11. The majority of the groups engaged in electronic gallery writing (57.14 %),

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while a smaller number of groups engaged in electronic poolwriting (31.43%), oral meetings without transcription (7.14 %), or oral meetings with transcription (4.29 %).

The data includes measures for group size, meeting type (Type 1: oral meeting with a simultaneously recorded transcript; Type 2: oral meeting without a transcript; Type 3: electronic poolwriting; Type 4: electronic gallery writing), rate of comment generation per participant per minute, process satisfaction, evaluation apprehension, and production blocking. This data is further described in subsection 1.4.2.

- Type 1: Oral Meetings (No Transcript)
- Type 2: Oral Meetings (Transcript Provided)
- Type 3: Electronic Poolwriting.
- Type 4: Electronic Gallery Writing

Oral meetings are those where participants speak directly to each other. Such meetings generally feature little anonymity, and some inhibition may result. Verbal discourse is serial – only one person can speak at a time. This may reduce participation levels, and perhaps lengthen meetings as well. Oral meetings held for the purpose of generating ideas are sometimes called brainstorming (Aiken, 1997b). Type 1 meetings were typical oral meetings with the addition of a transcript of all comments made during the meeting. Type 2 meetings lacked this transcript.

Electronic poolwriting and electronic gallery writing are variants of electronic brainwriting. Like brainstorming, brainwriting is a group process used to generate ideas. Brainwriting, however, makes use of silent, written communication. This enables both

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anonymity and parallel communication. Electronic brainwriting simply replaces pen and paper with a computer keyboard.

Type 3 meetings made use of electronic poolwriting. In electronic poolwriting, "A group of N people at computer terminals exchange typed comments on N+1 files. Comments are almost totally anonymous, ideas are recorded, and the group can communicate in parallel" (Aiken, 1997b). Unfortunately, due to the nature of the file-swapping, not all group members can read all comments generated during the meeting. Generally, a printed transcript available after the meeting minimizes this limitation (Vogel & Nunamaker, 1990).

Type 4 meetings made use of electronic gallery writing. In electronic gallery writing, group participants type their comments on a computer keyboard. As they do so, their comments are displayed on a centralized screen. All group members can read all comments as they appear. The technique enables anonymous, parallel communication. While electronic poolwriting has dominated the GSS research, electronic gallery writing is considered by some researchers to be the superior technique (Aiken, 1997b, Gallupe, et al., 1992).

To facilitate analysis of the data, it proved necessary to transform the categorical EMS Type variable into three dummy variables, each representing the particular EMS type used for a given GSS session. The use of dummy variables is well established in the literature (Greene, 1997; Pallant, 2001).

With this dummy coding, multiple regression was done to test each of the following hypotheses: first that the overall model's variance can be explained by the proposed independent variables and their associated beta coefficient values; second that

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each proposed independent variable X_i has a significant role in explaining the model's variance; and third that the sign of each significant beta is specifically positive or negative as hypothesized (see Figures 9 through 12).

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CHAPTER 4

RESULTS

4.1 Summary

Regression was performed on the data for the five proposed models using SPSS 13.0 for Windows. This chapter elaborates the statistical analyses that were performed on the various proposed models. Each model is addressed in turn.

4.2 Model I – Process Time

Model I suggests that the dependent variable Process Time may serve as a proxy for the Dennis model construct for Outcome variables generally. As a dependent variable, Process Time is assumed to be influenced by four Dennis model construct variables: Group, Task, Context, and EMS.

Model I proposes that Group Size, Group Homogeneity, Mood, Organization, Prior Knowledge, Prior History, Topic Familiarity, and Tool Experience serve as proxies for the Group Construct, while Task Complexity serves as a proxy for the Task Construct. Context and EMS are excluded (see Figure 2).

An analysis was performed, yielding statistical measures for both the overall model as well as the proposed independent variables. Table 7 summarizes the hypotheses for Model I.

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4.2.1 Process Time – Overall Model

Analysis of the data using multiple regression produced several measures of the model's overall predictive quality.

An R^2 value of 0.157 suggests that 15.7% of the model's variance can be explained by the model's statistically significant independent variables.

The calculated F statistic of 0.538 does not allow us to reject the null hypothesis that $\sum B_i X_i = 0$ with independent variables X_i at a level of significance equal to 0.05. Contrary to expectation, the hypothesis that $\sum B_i X_i \neq 0$ is not supported. The difference between the actual values of process time and the predicted values of process time are called standardized residuals. Figure 21 illustrates the model's cumulative standardized residuals (see Figure 21).

4.2.2 Process Time – Dependent Variables

Analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

With 36 observations and a significance level of 0.05, we fail to reject the null hypothesis that $B_i = 0$ for the following independent variables: Complexity, Group Size, Homogeneity, Mood, Organizational Level, Prior Knowledge, Prior History, Topic Familiarity, and Tool Experience (see Table 8). Figure 22 represents the model with superimposed standardized B values.

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4.3 Model III – Evaluation Apprehension

Model III suggests that the dependent variable Evaluation Apprehension may serve as a proxy for the Dennis model construct for Outcome variables generally. As a dependent variable, Evaluation Apprehension is assumed to be influenced by four Dennis model construct variables: Group, Task, Context, and EMS.

Model III proposes that Group Size serves as a proxy for the Group Construct, while four categorical EMS type variables serve as proxies for the EMS Construct. Once again, Task and Context are excluded (see Figure 5).

An analysis was performed, yielding statistical measures for both the overall model as well as the proposed independent variables. Table 9 summarizes the hypotheses for Model III.

4.3.1 Evaluation Apprehension – Overall Model

An analysis of the data using multiple regression produced several measures of the model's overall predictive quality.

An R^2 value of 0.411 suggests that 41.1% of the model's variance can be explained by the model's statistically significant independent variables.

The calculated F statistic of 11.361 allows us to reject the null hypothesis that $\sum B_i X_i = 0$ with independent variables X_i at a level of significance equal to 0.05. Rejection of the null hypothesis provides no assurance that the alternate hypothesis is true, but the alternate hypothesis that $\sum B_i X_i \neq 0$ is nonetheless supported. Figure 23 illustrates the cumulative standardized residuals for the model (see Figure 23).

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4.3.2 Evaluation Apprehension – Dependent Variables

As with Model I, analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

With 70 observations, these statistics allow us to reject the null hypothesis that $B_i = 0$ for a single variable, Type 4 (electronic gallery writing), at a significance level of 0.05. We fail to reject the null hypothesis for the independent variables Group Size, Type 2 and Type 3, however.

Rejection of the null hypothesis provides no assurance that alternate hypotheses are true. Even so, the alternate hypothesis that $B_i \neq 0$ for the variable, Type 4, is nonetheless supported (see Table 10). Figure 24 represents the model with superimposed standardized B values.

Analysis of those variables which prove significant can yield further information about their role in the model. The test for the null hypothesis that $B_i \geq 0$ for the variable, Type 4, is inconclusive. We fail to reject the null hypothesis that $B_i \geq 0$ for variable Type 4 at a significance level of 0.05.

4.4 Model IV – Comment Generation Rate

Model IV suggests that the dependent variable Comment Generation Rate may serve as a proxy for the Dennis model construct for Outcome variables generally. As a dependent variable, Comment Generation Rate is assumed to be influenced by four Dennis model construct variables: Group, Task, Context, and EMS.

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As in Models I and III, Model IV proposes that Group Size serves as a proxy for the Group Construct, while four categorical EMS type variables serve as proxies for the EMS Construct. Once again, Task and Context are excluded (see Figure 6).

As for Models I and III, an analysis was performed, yielding statistical measures for both the overall model as well as the proposed independent variables. Table 9 summarizes the hypotheses for Model IV.

4.4.1 Comment Generation Rate – Overall Model

Analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

An R^2 Square value of 0.386 suggests that 38.6% of the model's variance can be explained by the model's statistically significant independent variables.

The calculated F statistic of 10.212 allows us to reject the null hypothesis that $\sum B_i X_i = 0$ with independent variables X_i at a level of significance equal to 0.05. As always, rejection of the null hypothesis provides no assurance that the alternate hypothesis is true, but the alternate hypothesis that $\sum B_i X_i \neq 0$ is nonetheless supported. Figure 25 illustrates the cumulative standardized residuals for the model (see Figure 25).

4.4.2 Comment Generation Rate – Dependent Variables

As with Models I and III, analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

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With 70 observations, these statistics allow us to reject the null hypothesis that $B_i = 0$ for the independent variable, Type 2 (verbal meetings transcribed), at a significance level of 0.05. We fail to reject the null hypothesis for the independent variables Group Size, Type 3, and Type 4, however.

As always, rejection of the null hypothesis provides no assurance that alternate hypotheses are true, but the alternate hypothesis that $B_i \neq 0$ for the variable, Type 2, is supported by implication (see Table 11). Figure 26 represents the model with superimposed standardized B values.

Analysis of those variables which prove significant can yield further information about their role in the model. The test for the null hypothesis that $B_i \geq 0$ for the variable, Type 2, is inconclusive. We fail the reject the null hypothesis that $B_i \geq 0$ for variable Type 2 at a significance level of 0.05.

4.5 Model V – Process Satisfaction

Model V suggests that the dependent variable Process Satisfaction may serve as a proxy for the Dennis model construct for Outcome variables generally. As a dependent variable, Process Satisfaction is assumed to be influenced by four Dennis model construct variables: Group, Task, Context, and EMS.

As in Models I, III and IV above, Model V proposes that Group Size serves as a proxy for the Group Construct, while four categorical EMS type variables serve as proxies for the EMS Construct. Once again, Task and Context are excluded (see Figure 7).

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As for the previous models, an analysis was performed, yielding statistical measures for both the overall model as well as the proposed independent variables. Table 9 summarizes the hypotheses for Model V.

4.5.1 Process Satisfaction – Overall Model

Analysis of the data using multiple regression produced several measures of the model's overall predictive quality.

An R^2 value of 0.768 suggests that 76.8% of the model's variance can be explained by the model's statistically significant independent variables.

The calculated F statistic of 53.695 allows us to reject the null hypothesis that $\sum B_i X_i = 0$ with independent variables X_i at a level of significance equal to 0.05. As always, rejection of the null hypothesis provides no assurance that the alternate hypothesis is true, but the alternate hypothesis that $\sum B_i X_i \neq 0$ is supported by implication. Figure 27 illustrates the cumulative standardized residuals for the model (see Figure 27).

4.5.2 Process Satisfaction – Dependent Variables

As with Models I, III, and IV above, analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

With 70 observations, these statistics allow us to reject the null hypothesis that $B_i = 0$ for the following independent variables: Type 2, Type 3, and Type 4 at a significance level of 0.05. We fail to reject the null hypothesis for the independent variable Group Size however.

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As always, rejection of the null hypothesis provides no assurance that the alternate hypotheses are true, but the alternate hypotheses that $B_i \neq 0$ for the variables Type 2, Type 3, and Type 4 nonetheless are supported (see Table 12). Figure 28 represents the model with superimposed standardized B values.

Analysis of those variables which prove significant can yield further information about their role in the model. Testing for the null hypothesis that $B_i \leq 0$ for the variables Type 3, and Type 4, allows us to reject the null hypothesis for Type 4 at a significance level of 0.05. We fail to reject the null hypothesis that $B_i \leq 0$ for Type 3, however. Testing for the null hypothesis that $Bi \geq 0$ for Type 2 allows us to reject the null hypothesis at a significance level of 0.05.

4.6 Model VI – Production Blocking

Model VI suggests that the dependent variable Production Blocking may serve as a proxy for the Dennis model construct for Process variables generally. As a dependent variable, Production Blocking is assumed to be influenced by four Dennis model construct variables: Group, Task, Context, and EMS.

Model VI proposes that Group Size serves as a proxy for the Group Construct, while four categorical EMS type variables serve as proxies for the EMS Construct. Task and Context are excluded (see Figure 8).

An analysis was performed, yielding statistical measures for both the overall model as well as the proposed independent variables. Table 9 summarizes the hypotheses for Model VI.

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4.6.1 Production Blocking – Overall Model

Analysis of the data using multiple regression produced several measures of the model's overall predictive quality.

An R^2 value of 0.503 suggests that 50.3% of the model's variance can be explained by the model's statistically significant independent variables.

The F statistic of 16.433 is similarly optimistic, as the null hypothesis that $\sum B_i X_i = 0$ with independent variables X_i is rejected at a level of significance equal to 0.05. Rejection of the null hypothesis provides no assurance that the alternate hypothesis is true, but the alternate hypothesis that $\sum B_i X_i \neq 0$ is nonetheless supported by implication. Figure 29 illustrates the cumulative standardized residuals for the model (see Figure 29).

4.6.2 Production Blocking – Dependent Variables

As with Models I, III, IV, and V analysis of the data using multiple regression produced several measures of the role each proposed independent variable plays in the overall model.

With 70 observations, these statistics allow us to reject the null hypothesis that Bi = 0 for the independent variable, Type 4 (electronic gallery writing), at a significance level of 0.05. We fail to reject the null hypothesis for the independent variables Group Size, Type 2, and Type 3, however.

As before, Rejection of the null hypothesis provides no assurance that alternate hypotheses are true, but the alternate hypothesis that Bi $\neq$ 0 for the variable, Type 4, is nonetheless supported (see Table 13). Figure 30 represents the model with superimposed standardized B values.

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Analysis of those variables which prove significant can yield further information about their role in the model. The test for the null hypothesis that $Bi \geq 0$ for the variable, Type 4 is inconclusive. We must, therefore, fail to reject the null hypotheses for variable Type 4 at a significance level of 0.05.

4.7 Outcome Variables – Dependent Variables

Having determined the significance of each dependent variable, and the standardized regression coefficients for Models III – VI, it is now possible to recombine these models. This recombined model is still a reduction of the overall Dennis Model, but it is more comprehensive than models III – VI individually.

Figure 31 illustrates the significance level of each dependent variable; while Figure 32 superimposes the standardized regression coefficients for each model link (see Figures 31-32). Only dependent variables significant at a significance level of 0.05 are included.

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CHAPTER 5

DISCUSSION OF RESULTS

5.1 Overview

This chapter presents a discussion of the statistical results presented in Chapter 4. The various hypotheses presented in chapter 3 are examined, with discussion given to each in turn. Each hypothesis is considered in the light of the results of multiple regression, and the implications of those results are discussed.

Discussion is given to those results that are consistent with expectations, elaborating the extent to which those results are of interest to GSS research. Discussion is also given to those results that are not consistent with expectations. Possible explanations are provided to account for these inconsistencies where possible.

Considerations for future extensions of this research are presented, encouraging further research into related fields of inquiry. Finally, the assumptions and limitations of the research techniques and data used in this dissertation are discussed, providing the appropriate context for an informed reader to fully appreciate the methodology and results.

5.2 Model I – Process Time

Model I proposed Process Time as a proxy for the Dennis model's Outcome construct. Eight independent variables - Group Size, Homogeneity, Mood, Organization, Prior Knowledge, Prior History, Topic Familiarity, Tool Experience, and Task Complexity – were proposed as having a direct, linear effect on Process Time. Group

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Size, Homogeneity, Mood, Organization, Prior Knowledge, Prior History, Topic Familiarity, and Tool Experience were associated with the Dennis model's Group construct, while Task Complexity was associated with the Dennis model's Task construct.

Results showed that the proposed model not predictive. Only a small proportion of the variance of the dependent variable Process Time was explained by the model's independent variables, as demonstrated by the calculated R^2 value of 0.157 (see Table 14) (see Figure 21).

The Process Time model yielded an F statistic of 0.538, not sufficient to reject the null hypothesis that $\sum BiX_i = 0$ for each independent variable X_i at a level of significance equal to 0.05. This fails to support the proposition that the model's independent variables actually impact the model's dependent variable as expected. The alternate hypothesis that $\sum BiX_i \neq 0$ is therefore not supported. The proposed independent variables do not seem likely to influence the model as expected (see Tables 7 and 15).

The particular role of each independent variable is shown by the t-statistics given in chapter 4. We fail to reject the null hypothesis that Beta = 0 for each independent variables at a significance level of 0.05. The expectation that the associated regression coefficient Beta $\neq 0$ for each variable X_i is therefore not supported. While no particular independent variable was shown to be predictive, each rendered a B value that can perhaps guide the direction of future research (see Figure 22).

We are then left with no evidence that the overall model is predictive, or that the singular influence of any independent variable is significant. This may indicate that the variable relationships are more complicated than they might at first appear. Additional

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research with alternate variables might help shed light on this problem. Of course, it is also possible that Process Time may prove an elusive variable to predict under the best of circumstances, and the selection of demonstrably significant independent variables may continue to prove a challenge.

The weakness of the regression results for Model I is perhaps most easily explained by the fairly small sample size. A sample size of 36 observations with nine independent variables is below the ideal values suggested by Sevens (Steven, 1996) or Tabachnick (Tabachnick, 1996). Additional data would doubtless prove useful.

5.3 Model III – Evaluation Apprehension

Model III proposed Evaluation Apprehension as a proxy for the Dennis model's Outcome construct. Five independent variables - Group Size, EMS Type 1, EMS Type 2, EMS Type 3, and EMS Type 4 – were proposed as having a direct, linear effect on Evaluation Apprehension. As before, Group Size was associated with the Dennis model's Group construct, while the four Type variables were associated with the Dennis model's EMS construct.

Results showed that the proposed model was predictive. A large proportion of the variance of the dependent variable Process Satisfaction was explained by the model's independent variables, as demonstrated by the calculated R^2 square value of 0.411. A high R^2 value indicates a robust model, but may also indicate the presence of multicollinearity (see Table 16) (see Figure 23).

The Evaluation Apprehension model yielded an F statistic of 11.361. At a level of significance equal to 0.05, this value of F is sufficient to reject the null hypothesis that

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$\sum BiX_i = 0$ for each independent variable X_i. This supports the proposition that the model's independent variables actually impact the model's dependent variable as expected. The alternate hypothesis that $\sum BiX_i \neq 0$ is therefore supported. Unlike the results for Model I above, at least some of the proposed independent variables seem likely to singly influence Model III as expected (see Tables 9 and 17).

The particular role of each independent variable is shown by the t-statistics given in chapter 4. Only one of the EMS Type variables (Type 4) was shown to be significant at a significance level of 0.05. For this variable, the expectation that the associated regression coefficient Beta $\neq 0$ is supported. The calculated B values can perhaps guide the direction of future research (see Figure 24).

Contrary to expectations, however, the other variables (Group Size, Type 2,and Type 3) prove not to be significant at a significance level of 0.05. This seems peculiar given that GSS literature often purports group size to be quite important (Dennis & Williams, 2003; Dennis & Williams, 2005).

A possible explanation for this inconsistency is that a large proportion of the data features groups of relatively large size. In total, 91.7% (68/70) of the data describes groups of size eight or greater. The GSS literature suggests that the productivity of GSS groups increases significantly as group size approaches eight and then shows significantly less improvement with larger groups. A more diverse data set including more observations of smaller group size ($n \leq 8$) might alter these results and more clearly demonstrate the significance of group size.

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5.4 Model IV – Comment Generation Rate

Model IV proposed Comment Generation Rate as a proxy for the Dennis model's Outcome construct. Five independent variables - Group Size, EMS Type 1, EMS Type 2, EMS Type 3, and EMS Type 4 – were proposed as having a direct, linear effect on Comment Generation Rate. Group Size was associated with the Dennis model's Group construct, while the four Type variables were associated with the Dennis model's EMS construct.

Results showed that the proposed model was reasonably predictive. An appreciable proportion of the variance of the dependent variable Comment Generation Rate was explained by the model's independent variables, as demonstrated by the calculated R^2 value of 0.386. A relatively high R^2 value indicates a fairly robust model (see Table 18) (see Figure 25).

The Comment Generation Rate model yielded an F statistic of 10.212. At a level of significance equal to 0.05, this value of F is sufficient to reject the null hypothesis that $\sum BiX_i = 0$ for each independent variable X_i. This supports the proposition that the model's independent variables actually impact the model's dependent variable. The alternate hypothesis that $\sum BiX_i \neq 0$ is therefore supported. As in Model III, at least some of the proposed independent variables seem likely to influence the model as expected (see Tables 9 and 19).

The particular role of each independent variable is shown by the t-statistics given in chapter 4. One of the EMS Type variables was shown to be significant at a significance level of 0.05, EMS Type 2 (oral meeting with no transcription). For this variable, the expectation that the associated regression coefficient Beta $\neq 0$ is supported,

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and the variable seems to impact Comment Generation Rate as expected. The calculated B values can perhaps guide the direction of future research (see Figure 26).

It is not particularly odd that other variables may have no significant impact on Comment Generation Rate, as it is a measure of individual performance, not group performance. Future study with more diverse data might clarify this result. One possible consideration is that the comments generated during the meetings expressed by the data featured few redundant comments, reducing the significance of record keeping, either automatic or manual.

Again contrary to expectations, the Group Size variable again proves not to be significant at a significance level of 0.05. As before, this contradicts the emphasis in the GSS literature on the effects of group size, but could be explained by the lack of diversity of group size within the model.

5.5 Model V – Process Satisfaction

Model V proposed Process Satisfaction as a proxy for the Dennis model's Outcome construct. Five independent variables - Group Size, EMS Type 1, EMS Type 2, EMS Type 3 and EMS Type 4 – were proposed as having a direct, linear effect on Process Satisfaction. As before, Group Size was associated with the Dennis model's Group construct, while the four Type variables were associated with the Dennis model's EMS construct.

Results showed that the proposed model was predictive. A large proportion of the variance of the dependent variable Process Satisfaction was explained by the model's independent variables, as demonstrated by the calculated R_2 value of 0.768. A high R^2

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value indicates a robust model, but may indicate the presence of multicollinearity (see Table 20) (see Figure 27).

The Process Satisfaction model yielded an F statistic of 53.695. At a level of significance equal to 0.05, this value of F is sufficient to reject the null hypothesis that $\sum B_i X_i = 0$ for each independent variable X_i. This supports the proposition that the model's independent variables actually impact the model's dependent variable as expected. The alternate hypothesis that $\sum B_i X_i \neq 0$ is therefore supported. As in Models I and II, at least some of the proposed independent variables seem likely to influence the model as expected (see Tables 9 and 21).

The particular role of each independent variable is shown by the t-statistics given in chapter 4. Three EMS Type variables (Type 2, Type 3, and Type 4) were shown to be significant at a significance level of 0.05. Thus, support for the proposition that each EMS Type variable impacts Process Satisfaction is established. For each variable, the expectation that the associated regression coefficient Beta $\neq 0$ is supported. The calculated B values can perhaps guide the direction of future research (see Figure 28).

Once again and contrary to expectations, however, the Group Size variable proves not to be significant at a significance level of 0.05. As before, this contradicts the emphasis in the GSS literature on the effects of group size, but, once again, could be explained by the lack of diversity of group size within the model.

5.6 Model VI – Production Blocking

Model VI proposed Production Blocking as a proxy for the Dennis model's Process construct. Five independent variables - Group Size, EMS Type 1, EMS Type 2,

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EMS Type 3, and EMS Type 4 – were proposed as having a direct, linear effect on Production Blocking. Group Size was associated with the Dennis model's Group construct, while the four Type variables were associated with the Dennis model's EMS construct.

Results showed that the proposed model was predictive. An appreciable proportion of the variance of the dependent variable Production Blocking was explained by the model's independent variables, as demonstrated by the calculated R^2 value of 0.503 (see Table 22) (see Figure 29).

The Production Blocking model also yielded an F statistic of 16.433. At a level of significance equal to 0.05, this value of F is sufficient to reject the null hypothesis that $\sum B_i X_i = 0$ for each independent variable X_i. This supports the proposition that the model's independent variables actually impact the model's dependent variable. The alternate hypothesis that $\sum B_i X_i \neq 0$ is therefore supported. At least some of the proposed independent variables seem likely to influence the model as expected (see Tables 9 and 23).

The particular role of each independent variable is shown by the t-statistics given in chapter 4. One EMS Type variable (Type 4) was shown to be significant at a significance level of 0.05. Some support that EMS selection type impacts Production Blocking is established. For the variable, Type 4, the expectation that the associated regression coefficient Beta $\neq 0$ is supported. The calculated B values can perhaps guide the direction of future research (see Figure 30).

Once again and contrary to expectations, however, the Group Size variable proves not to be significant at a significance level of 0.05. As before, this contradicts the

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emphasis in the GSS literature on the effects of group size, but, once again, could be explained by the lack of diversity of group size within the model.

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CHAPTER 6

CONCLUSION

6.1 Validation

Since its publication in 1988, the Dennis research model for GSS has served as the primary foundation for GSS research. Due to its complex structure, and a lack of longitudinal data, however, the model has never before been validated. This dissertation offers four reduced versions of the Dennis model, and validates each through multiple regression.

The validation of these reduced models reinforces the role of the Dennis model as a research tool. Moreover, these reduced models suggest that the overall model can be studied by quantitative techniques. While the variables addressed by this dissertation are important ones, the demonstration that careful variable choice can lead to tractable models is equally important.

6.2 Extensions

This dissertation made use of two data sets to test five proposed reductions of the Dennis Research Model. These are, however, not the only possible reductions of the Dennis model. Indeed, by virtue of the model's abstraction, endless model variations are possible.

Future research may propose and test new variations. Some of these variations may include proxies for each Dennis construct, while others may focus more tightly on particularly relevant variables. In any case, the introduction of new model variations with

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measurable statistics may encourage a greater emphasis on quantitative research among GSS researchers. Greater diversity of models and approaches can only add to the understanding of the impact of GSS technologies on group dynamics, synergy and cognition.

Researchers are further encouraged to attempt to use alternate and novel techniques to explore the Dennis model. One weakness of regression is that it is unequipped to deal with intermediate variables – dependent variables that impact other dependent variables. The requirements of linearity in regression also handicap analysis of some potential models. Heuristic techniques such as neural networks may provide a solution. Structural Equation Modeling may be another good choice, assuming continuous data is available.

6.3 Assumptions and Limitations – Methodology

This dissertation makes use of the technique of multiple regression. As such, it is subject to the assumptions common to regression. Of those, the ones most worth noting are: sufficient sample size, absence of multicollinearity, absence of singularity, minimal effect of outliers, normality, linearity, and homoscedasticity.

These issues having been discussed in chapter 3, it is sufficient to note that the two datasets used for this dissertation proved in most ways quite suitable, particularly given the scarcity of longitudinal data in GSS research.

As noted in the discussion of Model I above, the associated data set was fairly small for regression analysis. Even so, while results for this data set may be equivocal,

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they may still prove useful to future researchers in suggesting additional paths of research.

Other limitations are imposed by the software used for each EMS sessions, and the inclusion of only two EMS technologies (electronic poolwriting and electronic gallery writing). Both software and EMS selections were typical for GSS research, but do not encompass the totality of possible choices. Additional research using more sophisticated software might cause results to vary. Introduction of additional EMS technologies might alter the results as well.

6.4 Assumptions and Limitations - Data

The data used for this dissertation was produced largely by participants in GSS sessions self-reporting subjective variables through the use of survey instruments. As in all such cases, the data produced in such a manner is only as good as the honesty and integrity of the research subjects.

The potential for biased or unresponsive participants may cloud the validity of the data produced. It must be assumed that all participants took part in the GSS sessions with which they are associated. It is further assumed that those participants accurately reported their impressions of those sessions through the use of the provided survey instruments.

An additional limitation of the data is the homogeneity of those persons who participated in the group sessions. The large majority were undergraduate students. A more varied group might produce different results. Results might also vary with the topic of each group session. The majority of groups were given a common topic – the parking problem on campus. Different topics might produce different results.

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6.5 Final Remarks

This dissertation attempts to elaborate the well known Dennis Research Model of GSS and suggest ways researchers might grapple with the model's complexity and abstraction. Five reduced versions of the Dennis model were proposed, tested, and discussed. As each reduced model was based upon the overall structure and scheme of the Dennis model, it was suggested that the exploration and validation of these reduced models might partially validate their parent model by implication.

It is further hoped that the exercise of introducing and testing reduced versions of the Dennis model using regression techniques may lead to a greater emphasis on quantitative research within the discipline of GSS. The collection of large datasets for GSS research is logistically difficult, and it is hoped that the robust datasets made use of in this dissertation may themselves provide a useful resource for future researchers.

The Dennis model lies at the heart of GSS research. Its abstract nature provides researchers limitless flexibility in choosing what GSS variables they may wish to study. That abstraction, however, is both strength and weakness. The Dennis Research Model need not exclusively be studied in its entirety. Reduced versions of the model can feature measurable variables, each serving as a proxy for one of the overall model's corresponding constructs. Such reduced models may provide researchers with the best of both worlds. With such model variety, researchers not only have access to a highly flexible, abstract model that purports to incorporate all the disparate elements of GSS (the Dennis Research Model), but also to an associated family of simpler models. These reduced models can serve as the subject for rigorous quantitative testing. Researchers

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may make use of both model types to mutually advance the understanding of GSS in all of its forms and complexity.

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Table 1. Model I Squared Multiple Correlations

Model	Dependent Variable	Squared Multiple Correlation (R^2)
I	Group Size	0.287
	Homogeneity	0.629
	Mood	0.494
	Organizational Rank	0.626
	Prior Knowledge	0.592
	Prior History	0.611
	Topic Familiarity	0.541
	Tool Experience	0.376
	Task Complexity	0.441

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Table 2. Model III Squared Multiple Correlations

Model	Dependent Variable	Squared Multiple Correlation (R^2)
III	Group Size	0.870
	EMS Type 2	0.853
	EMS Type 3	0.168
	EMS Type 4	0.639

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Table 3. Model IV Squared Multiple Correlations

Model	Dependent Variable	Squared Multiple Correlation (R^2)
IV	Group Size	0.863
	EMS Type 2	0.859
	EMS Type 3	0.195
	EMS Type 4	0.721

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Table 4. Model V Squared Multiple Correlations

Model	Dependent Variable	Squared Multiple Correlation (R^2)
V	Group Size	0.879
	EMS Type 2	0.862
	EMS Type 3	0.177
	EMS Type 4	0.649

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Table 5. Model VI Squared Multiple Correlations

Model	Dependent Variable	Squared Multiple Correlation (R^2)
VI	Group Size	0.873
	EMS Type 2	0.852
	EMS Type 3	0.165
	EMS Type 4	0.621

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Table 6. Skewness and Descriptive Statistics

Model(s)	Variable	Skewness	Mean	Median	Mode	Variance
I	Complexity	-0.287	3.139	3.000	4.000	1.266
	Group Size	1.063	15.861	14.000	10.000	48.069
	Homogeneity	0.376	2.639	2.500	2.000	1.209
	Mood	0.030	2.33	2.000	2.000	0.800
	Rank	-0.215	3.694	3.500	3.000	1.018
	Prior Knowledge	-0.014	2.944	3.000	4.000	1.254
	Prior History	0.379	2.694	2.000	2.000	1.875
	Topic Familiarity	-0.652	3.944	4.000	4.000	0.797
	Tool Experience	2.103	1.556	1.000	1.000	1.283
	Process Time	1.450	48.1	45.000	45.000	422.000
III - IV	Group Size	1.917	14.986	11.000	8.000	103.637
	EMS Type 2	3.401	0.071	0.000	0.000	3.402
	EMS Type 3	0.818	0.314	0.000	0.000	0.219
	EMS Type 4	-0.295	0.571	1.000	1.000	0.248
	Prod Blocking	0.337	3.637	3.370	3.000	0.454
	Evaluation Apprehension	-0.210	3.993	4.000	4.560	0.293
	Comment Rate	5.490	0.390	0.310	0.280	0.210
	Process Satisfaction	-0.588	3.666	4.015	4.650	0.873

		Process Satisfaction	Comment Rate	Evaluation Apprehension	Production Blocking
Electronic Gallery Writing	**Mean**	4.360	0.293	4.235	4.046
	Median	4.270	0.280	4.560	4.440
	Mode	4.650	0.280	4.560	4.440
	Variance	0.078	0.003	0.221	0.311
Electronic Poolwriting	**Mean**	2.715	0.388	3.823	3.091
	Median	2.820	0.370	4.000	3.000
	Mode	1.840	0.370	4.000	3.000
	Variance	0.428	0.001	0.067	0.039
Verbal Groups (transcribed)	**Mean**	2.540	1.348	3.000	3.000
	Median	2.500	0.400	3.000	3.000
	Mode	2.500	3.000	3.000	3.000
	Variance	0.073	2.283	0.000	0.000
Purely Verbal Groups	**Mean**	3.267	0.097	3.667	3.267
	Median	2.700	0.100	3.200	2.700
	Mode	2.700	-	-	-
	Variance	0.963	0.003	0.973	1.343

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Table 7. Hypotheses Testing: Model I

Construct Tested	**Hypotheses**
Overall Model	H_0: $\sum B_i X_i = 0$ H_A: $\sum B_i X_i \neq 0$
Group Size	H_0: $B_i = 0$ H_A: $B_i \neq 0$
Complexity	H_0: $B_i \leq 0$ H_A: $B_i > 0$
Homogeneity Mood Organizational Rank Prior Knowledge Prior History Topic Familiarity Tool Experience	H_0: $B_i = 0$ H_A: $B_i \neq 0$ H_0: $B_i \geq 0$ H_A: $B_i < 0$

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Table 8. Process Time: Variable Significance Summary

Variable	Standardized B Value	t-Statistic	P-Value
Complexity	-0.057	-0.235	0.816
Group Size	0.059	0.278	0.783
Homogeneity	-0.203	-0.694	0.494
Mood	0.145	0.576	0.570
Organizational Rank	-0.278	-0.961	0.345
Prior Knowledge	0.127	0.454	0.653
Prior History	0.108	0.376	0.710
Topic Familiarity	-0.303	-1.168	0.253
Tool Experience	0.228	1.021	0.317

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Table 9. Hypotheses Testing: Models III – VI

Construct Tested	**Hypotheses**
Overall Model	H_0: $\sum B_i X_i = 0$ H_A: $\sum B_i X_i \neq 0$

	Comment Rate	**Evaluation Apprehension**	**Process Satisfaction**	**Production Blocking**
Group Size	H_0: $B_i \neq 0$	H_0: $B_i \leq 0$	H_0: $B_i \geq 0$	H_0: $B_i \leq$
EMS Type 2 (Oral Meeting without Transcript)	H_0: $B_i \geq 0$	H_0: $B_i \leq 0$	H_0: $B_i \geq 0$	H_0: $B_i \leq$
EMS Type 3 (Electronic Pool Writing)	H_0: $B_i \leq 0$	H_0: $B_i \geq 0$	H_0: $B_i \leq 0$	H_0: $B_i \geq$
EMS Type 4 (Electronic Gallery Writing)	H_0: $B_i \leq 0$	H_0: $B_i \geq 0$	H_0: $B_i \leq 0$	H_0: $B_i \geq$

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Table 10. Evaluation Apprehension: Variable Significance Summary

Variable	Standardized B Value	t-Statistic	P-Value
Group Size	0.072	0.692	0.491
EMS Type 2 (Oral Meeting without Transcript)	-0.294	-1.907	0.061
EMS Type 3 (Electronic Pool Writing)	0.201	0.816	0.418
EMS Type 4 (Electronic Gallery Writing)	0.587	2.319	0.024

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Table 11. Comment Generation Rate: Variable Significance Summary

Variable	Standardized B Value	t-Statistic	P-Value
Group Size	0.174	1.637	0.106
EMS Type 2 (Oral Meeting without Transcript)	0.770	4.888	<0.001
EMS Type 3 (Electronic Pool Writing)	0.458	1.815	0.074
EMS Type 4 (Electronic Gallery Writing)	0.367	1.421	0.160

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Table 12. Process Satisfaction: Variable Significance Summary

Variable	Standardized B Value	t-Statistic	P-Value
Group Size	-0.071	-1.095	0.278
EMS Type 2 (Oral Meeting without Transcript)	-0.227	-2.344	0.022
EMS Type 3 (Electronic Pool Writing)	-0.342	-2.205	0.031
EMS Type 4 (Electronic Gallery Writing)	0.520	3.269	0.002

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Table 13. Production Blocking: Variable Significance Summary

Variable	Standardized B Value	t-Statistic	P-Value
Group Size	0.052	0.549	0.585
EMS Type 2 (Oral Meeting without Transcript)	-0.084	-0.594	0.555
EMS Type 3 (Electronic Pool Writing)	-0.073	-0.324	0.747
EMS Type 4 (Electronic Gallery Writing)	0.623	2.675	0.009

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Table 14. Process Time: Overall Model Summary

R^2	Adjusted R^2	F Statistic	P-Value
0.157	-0.135	0.538	0.834

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Table 15. Process Time: Summary of Hypotheses

Construct	Hypotheses		Conclusion
Overall Model	H_0:	$\sum B_iX_i = 0$	Failed to reject at $\alpha = 0.05$
Complexity	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Group Size	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Homogeneity	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Mood	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Organizational Rank	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Prior Knowledge	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Prior History	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Topic Familiarity	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Tool Experience	H_0:	$B_i = 0$	Failed to reject at $\alpha = 0.05$
Complexity	H_0:	$B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Group Size	H_0:	$B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Homogeneity	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Mood	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Organizational Rank	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Prior Knowledge	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Prior History	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Topic Familiarity	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Tool Experience	H_0:	$B_i \geq 0$	Failed to reject at $\alpha = 0.05$

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Table 16. Evaluation Apprehension: Overall Model Summary

R^2	Adjusted R^2	F Statistic	P-Value
0.411	0.375	11.361	< 0.001

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Table 17. Evaluation Apprehension: Summary of Hypotheses

Construct	Hypotheses	Conclusion
Overall Model	H_0: $\sum B_i X_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 3	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 3	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$

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Table 18. Comment Generation Rate: Overall Model Summary

R^2	Adjusted R^2	F Statistic	P-Value
0.386	0.348	10.212	< 0.001

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Table 19. Comment Generation Rate: Summary of Hypotheses

Construct	Hypotheses	Conclusion
Overall Model	H_0: $\sum B_i X_i = 0$	Rejected at $\alpha = 0.01$
Group Size	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Type 3	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Group Size	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Type 3	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$

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Table 20. Process Satisfaction: Overall Model Summary

R^2	Adjusted R^2	F Statistic	P-Value
0.768	0.753	53.695	< 0.001

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Table 21. Process Satisfaction: Summary of Hypotheses

Construct	Hypotheses	Conclusion
Overall Model	H_0: $\sum B_i X_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Type 3	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Type 4	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i \geq 0$	Rejected at $\alpha = 0.05$
Type 3	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i \leq 0$	Rejected at $\alpha = 0.05$

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Table 22. Production Blocking: Overall Model Summary

R^2	Adjusted R^2	F Statistic	P-Value
0.503	0.472	16.433	< 0.001

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Table 23. Production Blocking: Summary of Hypotheses

Construct	Hypotheses	Conclusion
Overall Model	H_0: $\sum B_i X_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 3	H_0: $B_i = 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i = 0$	Rejected at $\alpha = 0.05$
Group Size	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 2	H_0: $B_i \leq 0$	Failed to reject at $\alpha = 0.05$
Type 3	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$
Type 4	H_0: $B_i \geq 0$	Failed to reject at $\alpha = 0.05$

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Figure 1. Dennis Research Model (Dennis, et al., 1988)

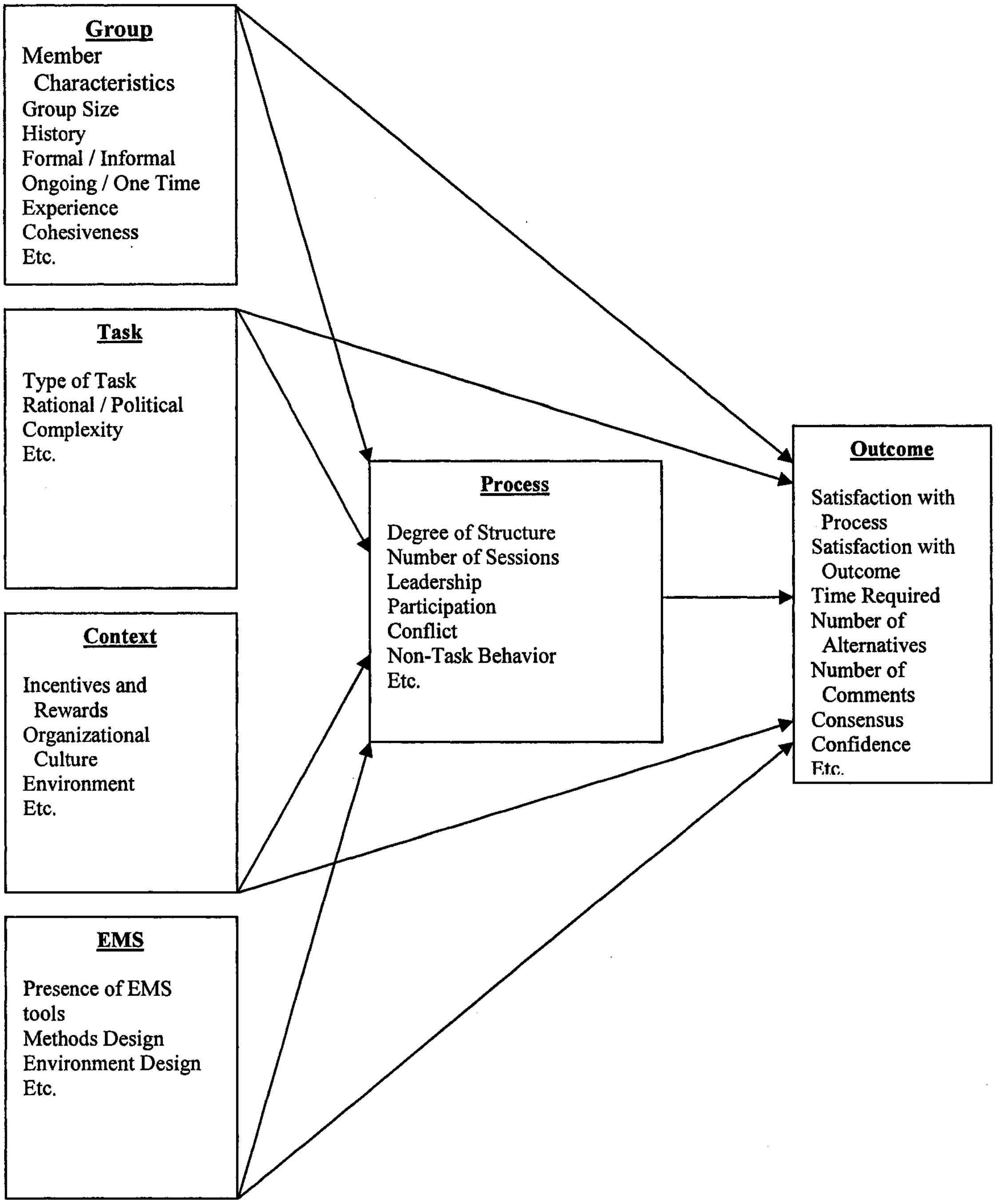

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Figure 2. Proposed Model I

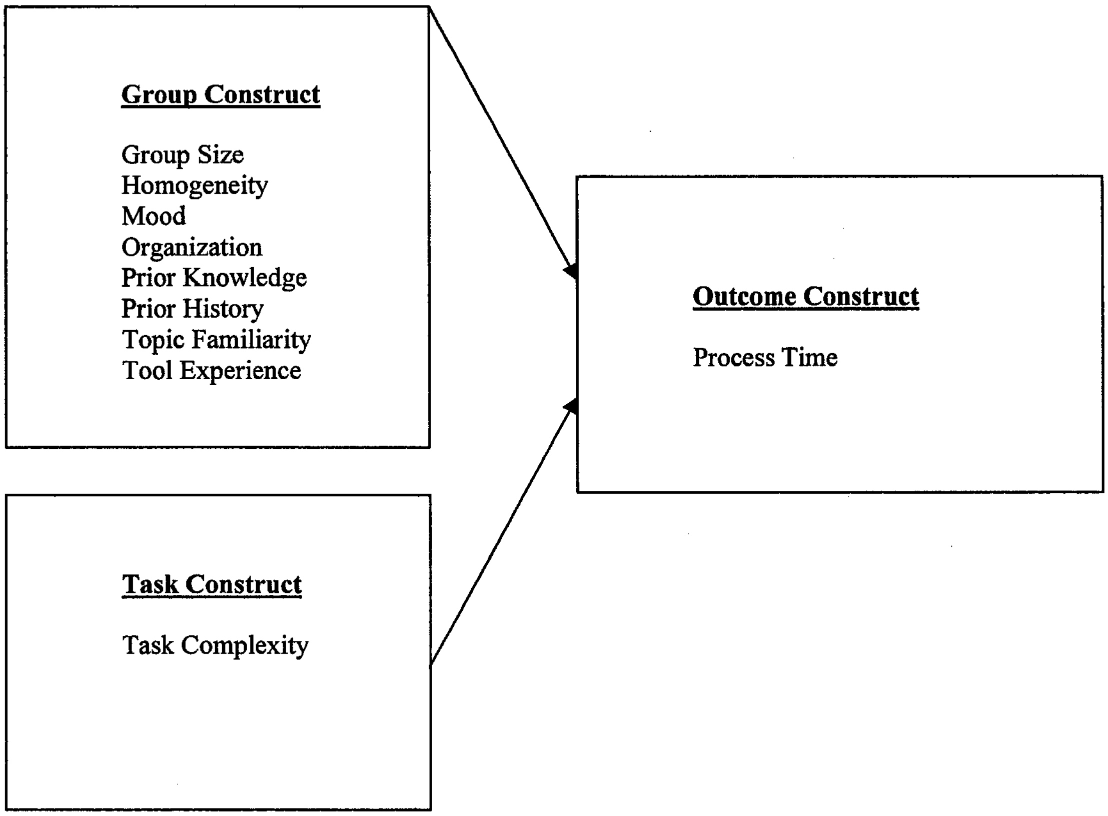

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Figure 3. Proposed Model II

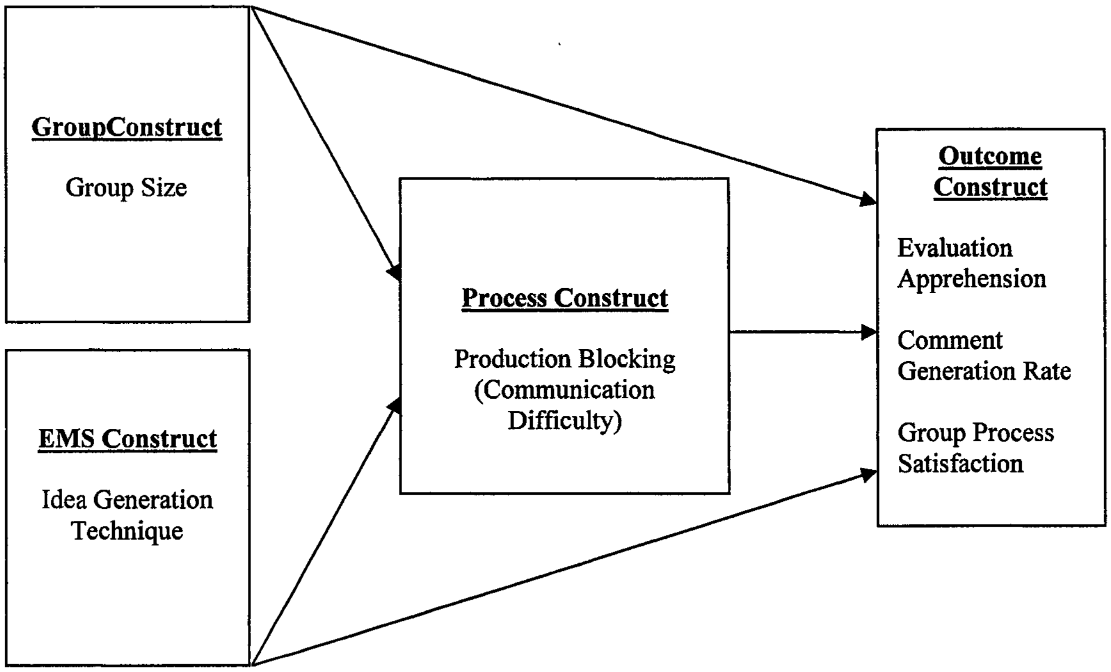

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Figure 4. Model I – Hypothetical Variable Influences

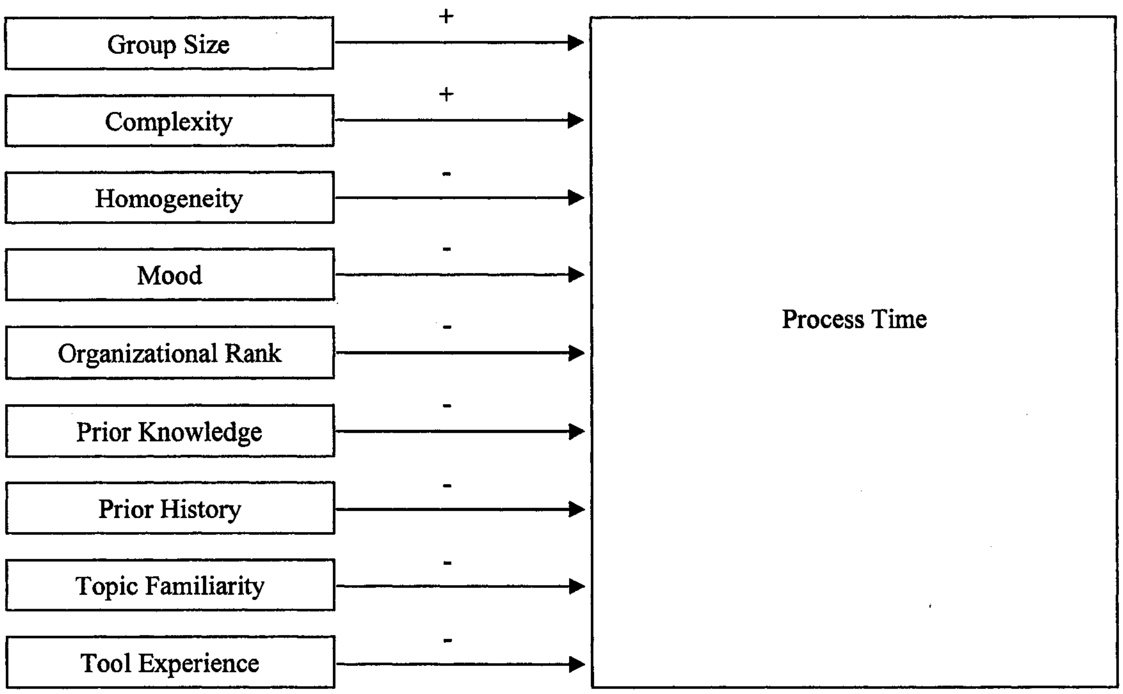

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Figure 5. Model III – Evaluation Apprehension

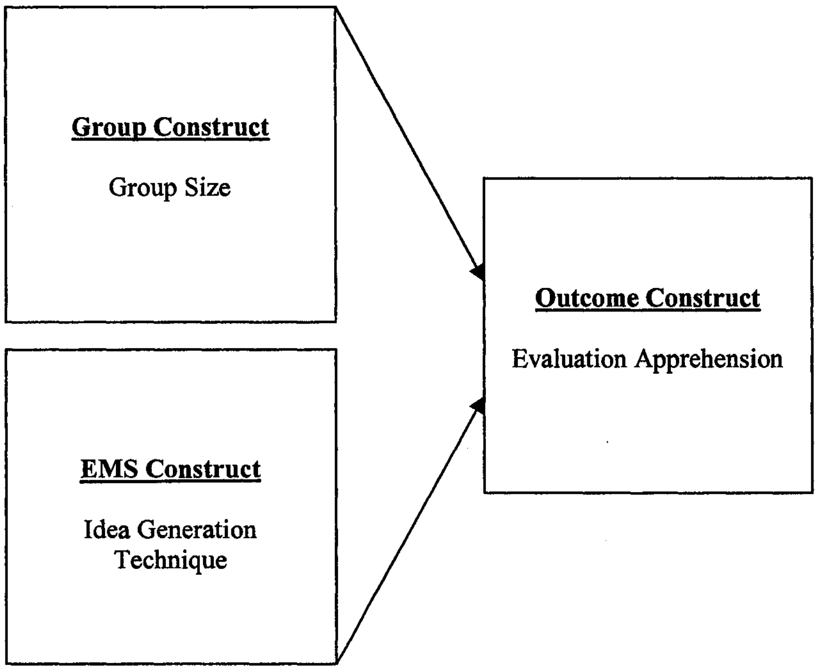

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Figure 6. Model IV – Comment Generation Rate

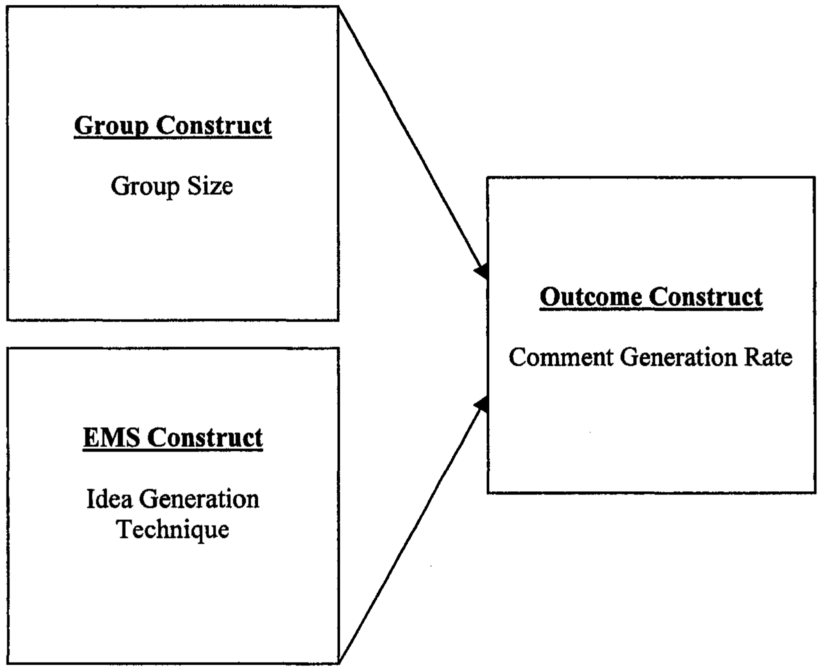

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Figure 7. Model V – Group Process Satisfaction

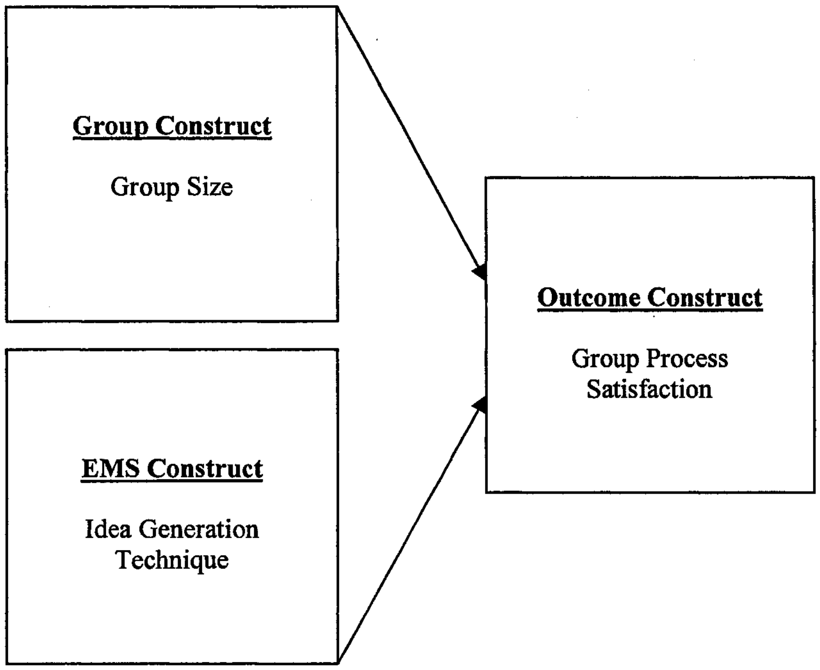

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Figure 8. Model VI – Production Blocking

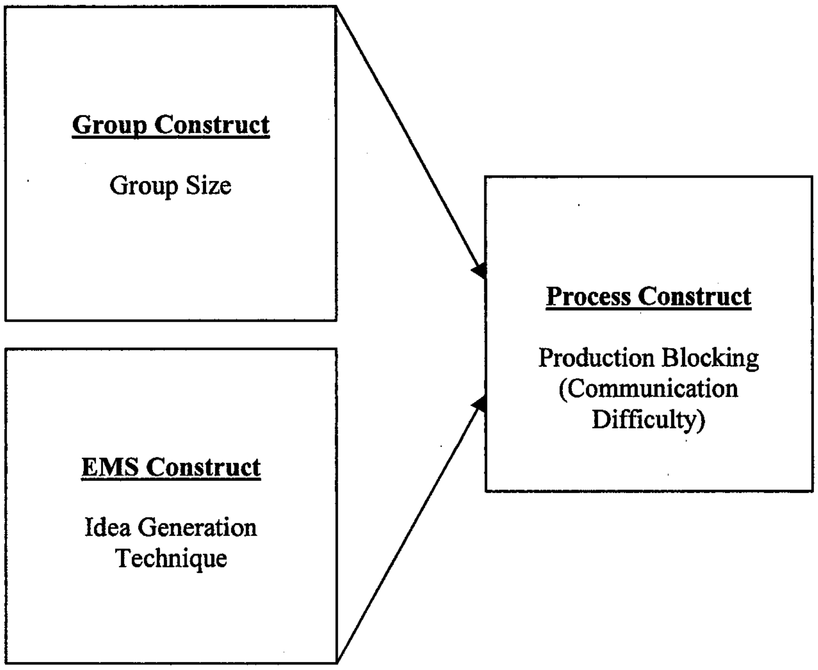

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Figure 9. Model III – Hypothetical Variable Influences

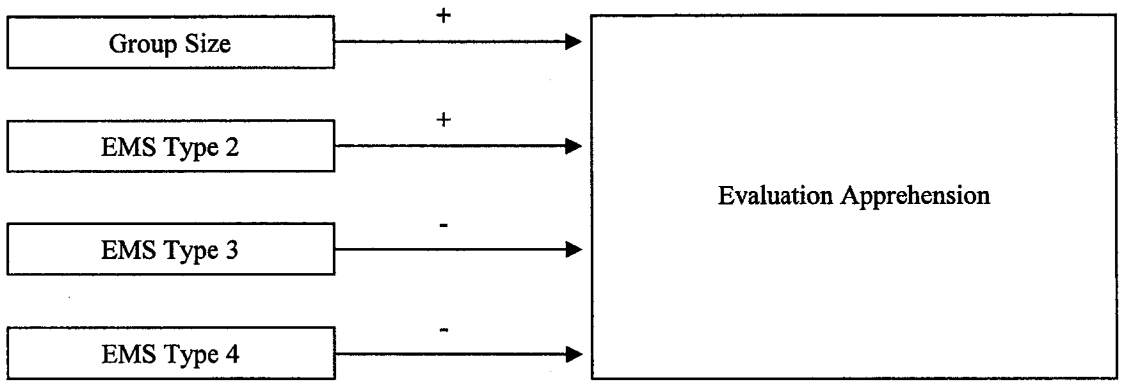

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Figure 10. Model IV – Hypothetical Variable Influences

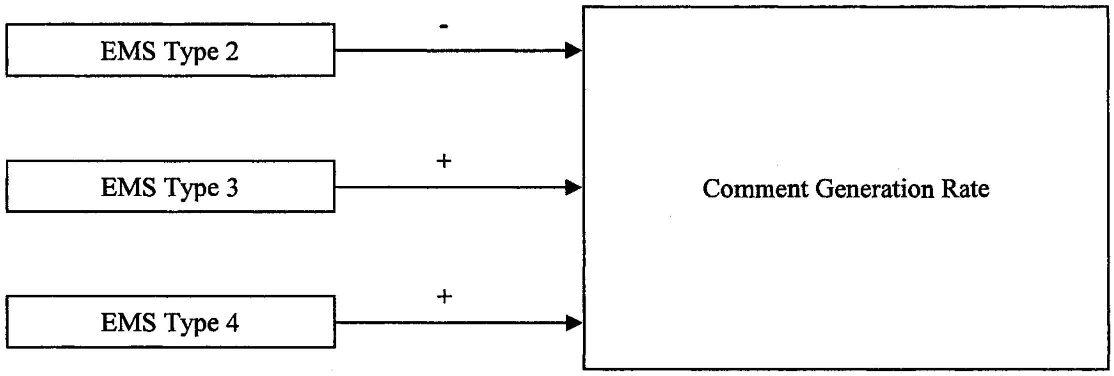

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Figure 11. Model V – Hypothetical Variable Influences

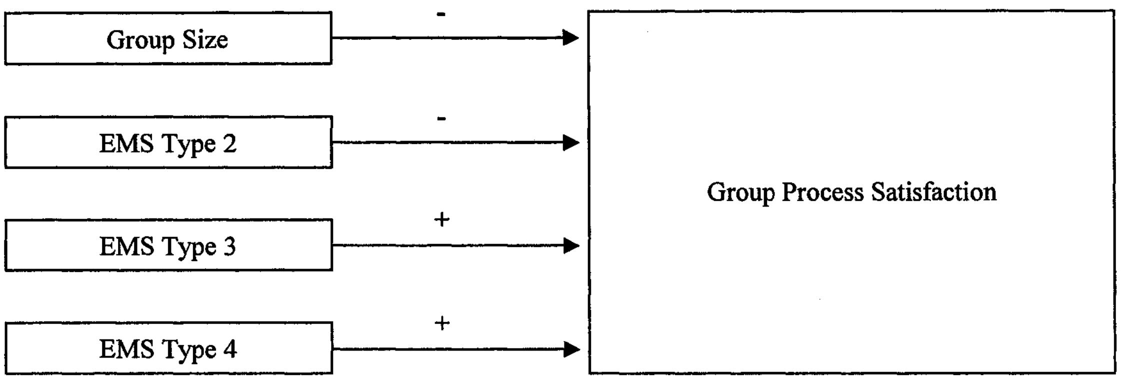

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Figure 12. Model VI – Hypothetical Variable Influences

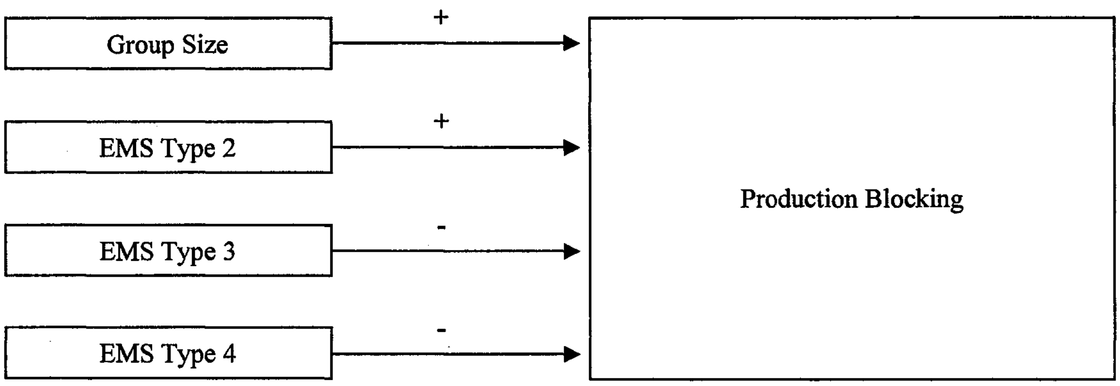

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Figure 13. McGrath's Circumplex (McGrath, 1984)

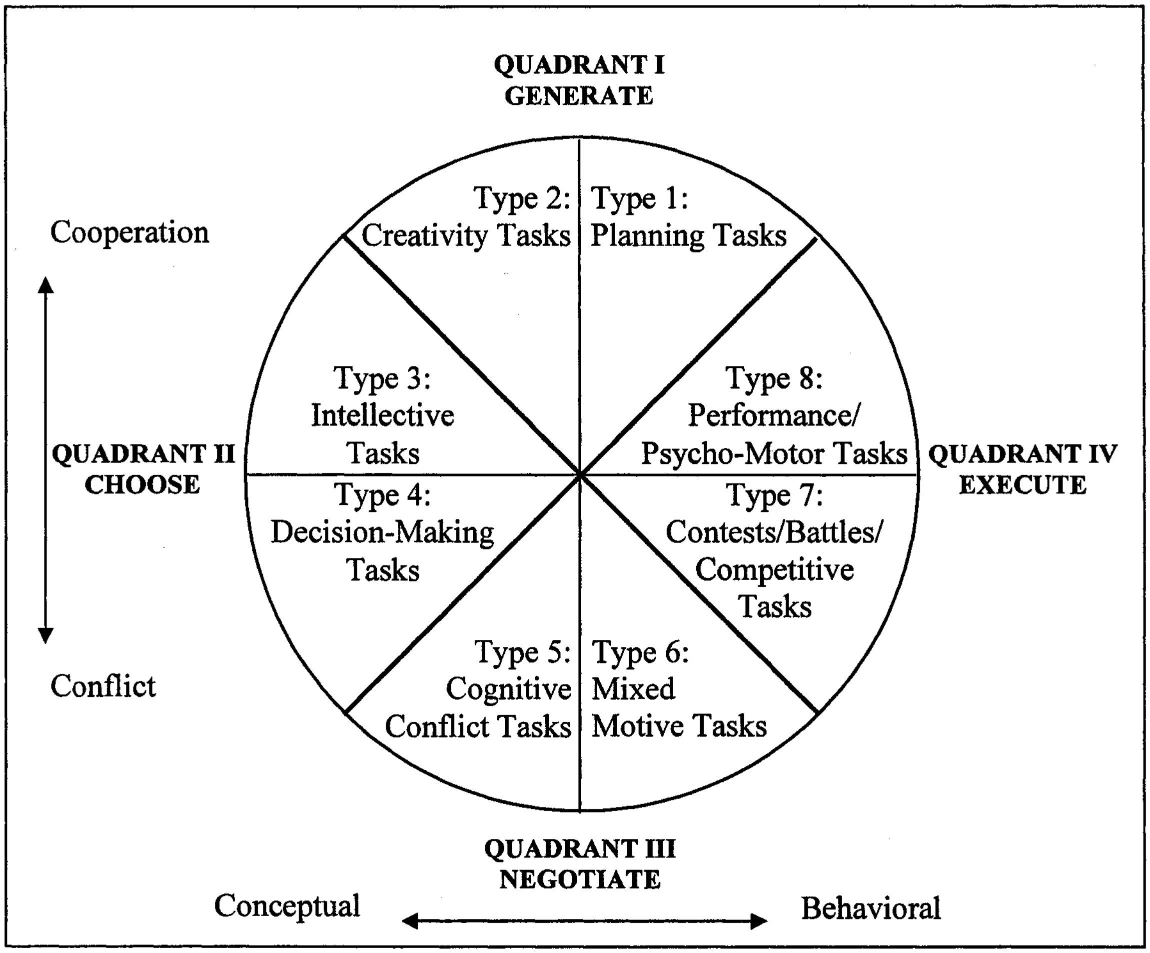

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Figure 14. Murthy's Relationship Model (Murthy, 1989)

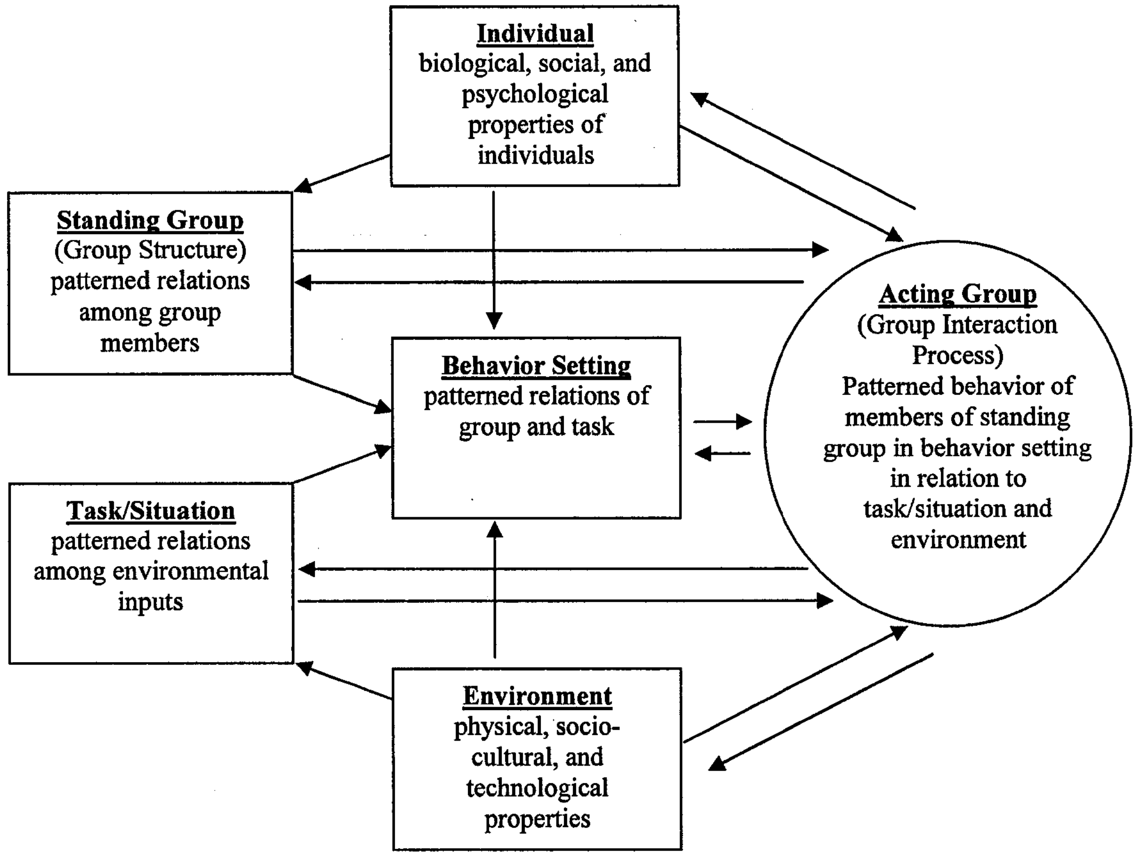

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Figure 15. DeSanctis and Poole's Relationship Model (DeSanctis & Poole, 1987)

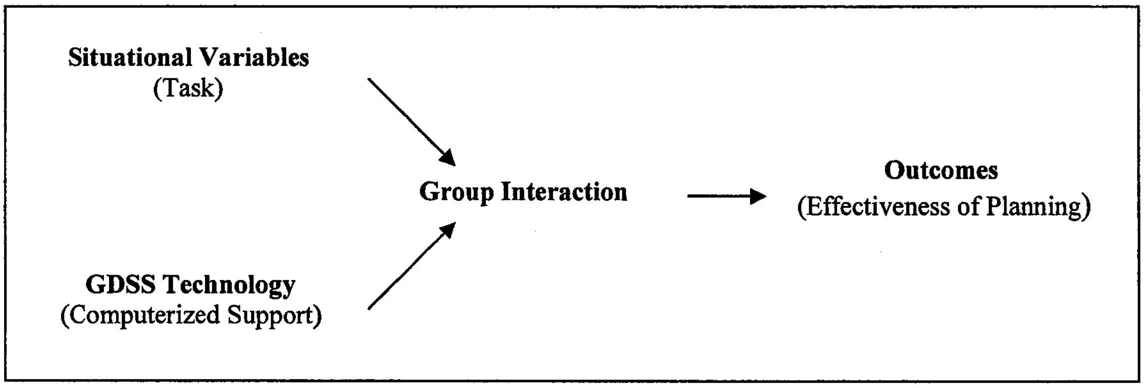

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Figure 16. Standardized Residuals: Process Time

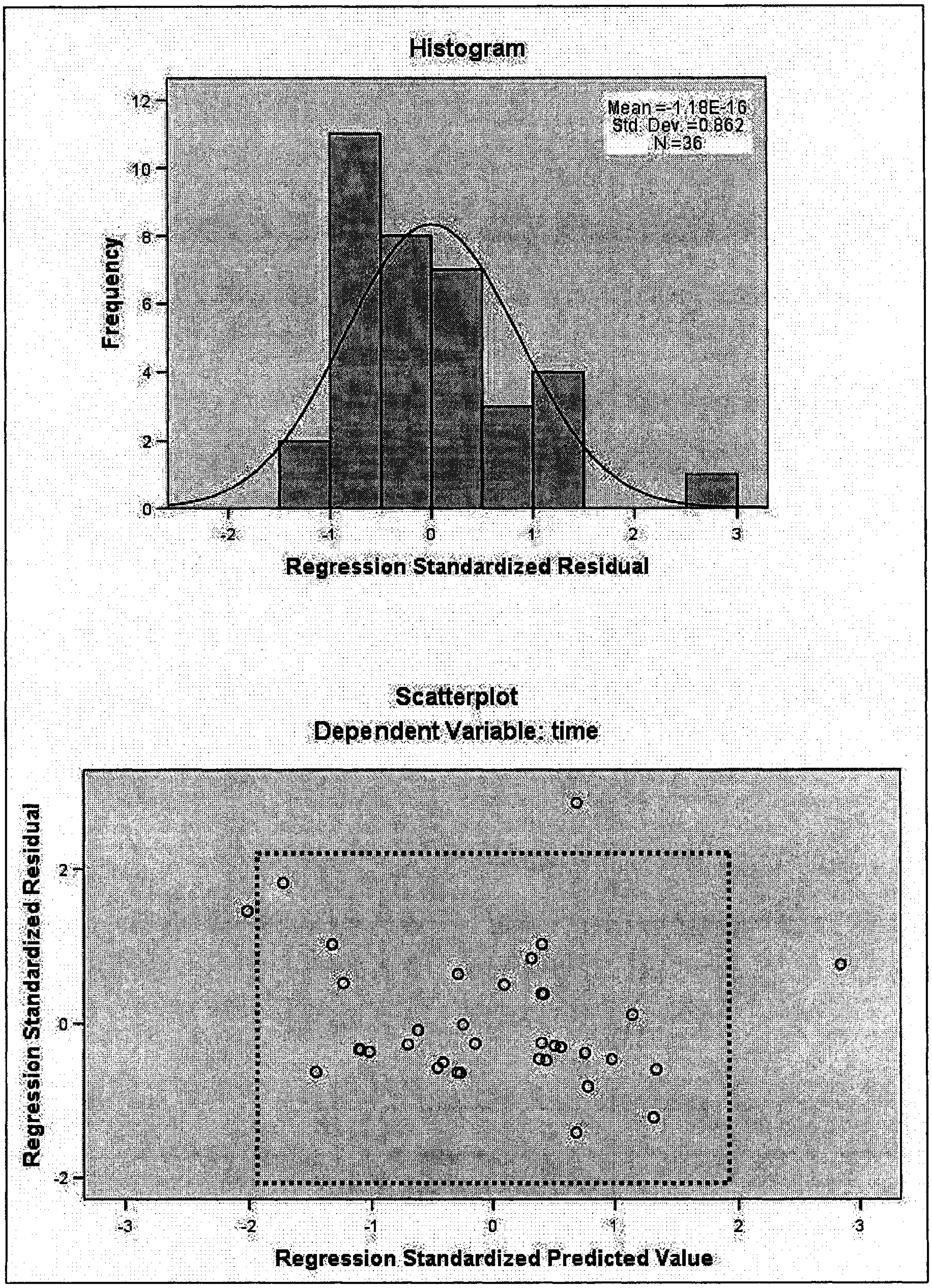

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Figure 17. Standardized Residuals: Evaluation Apprehension

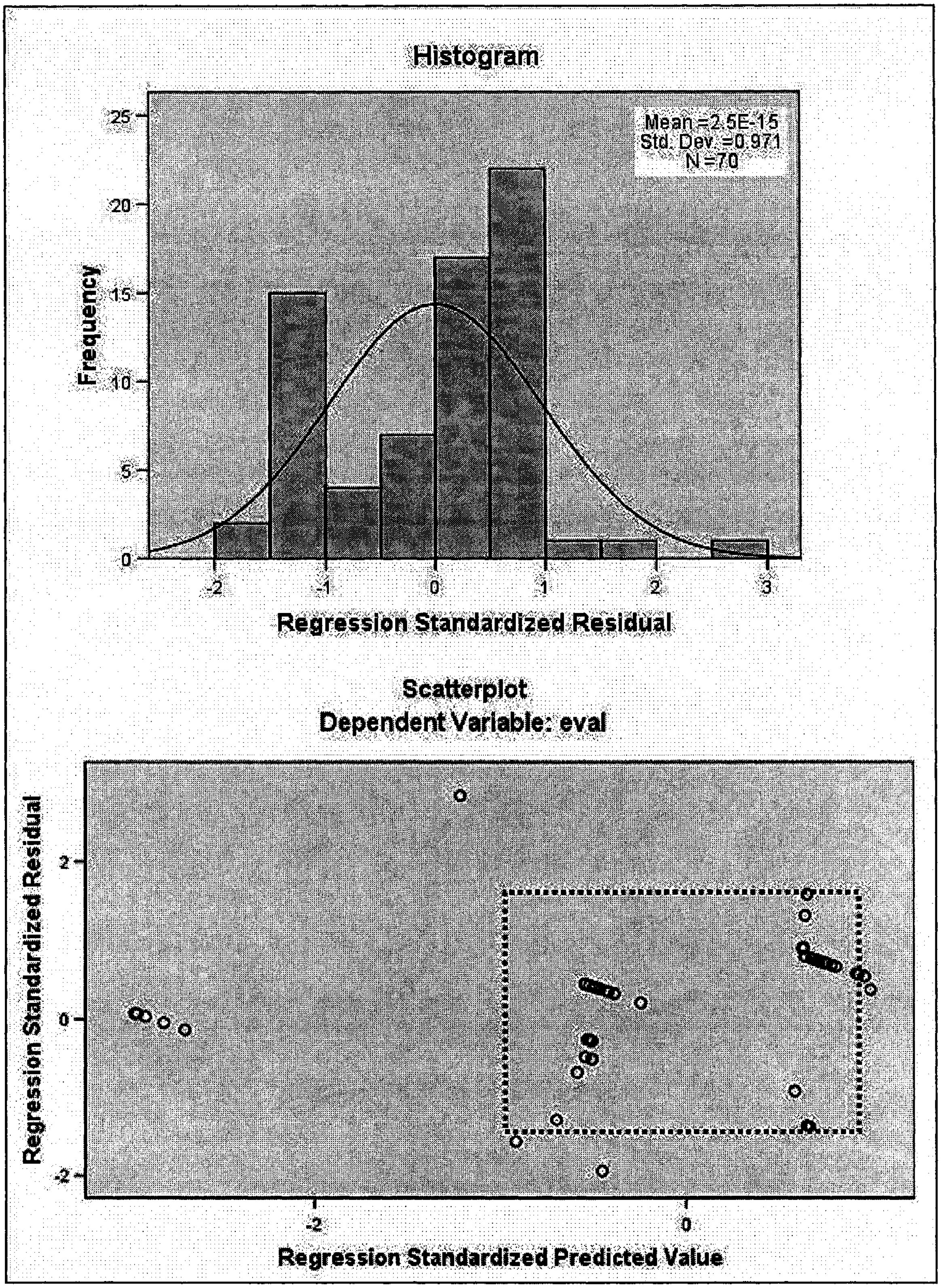

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Figure 18. Standardized Residuals: Comment Generation Rate

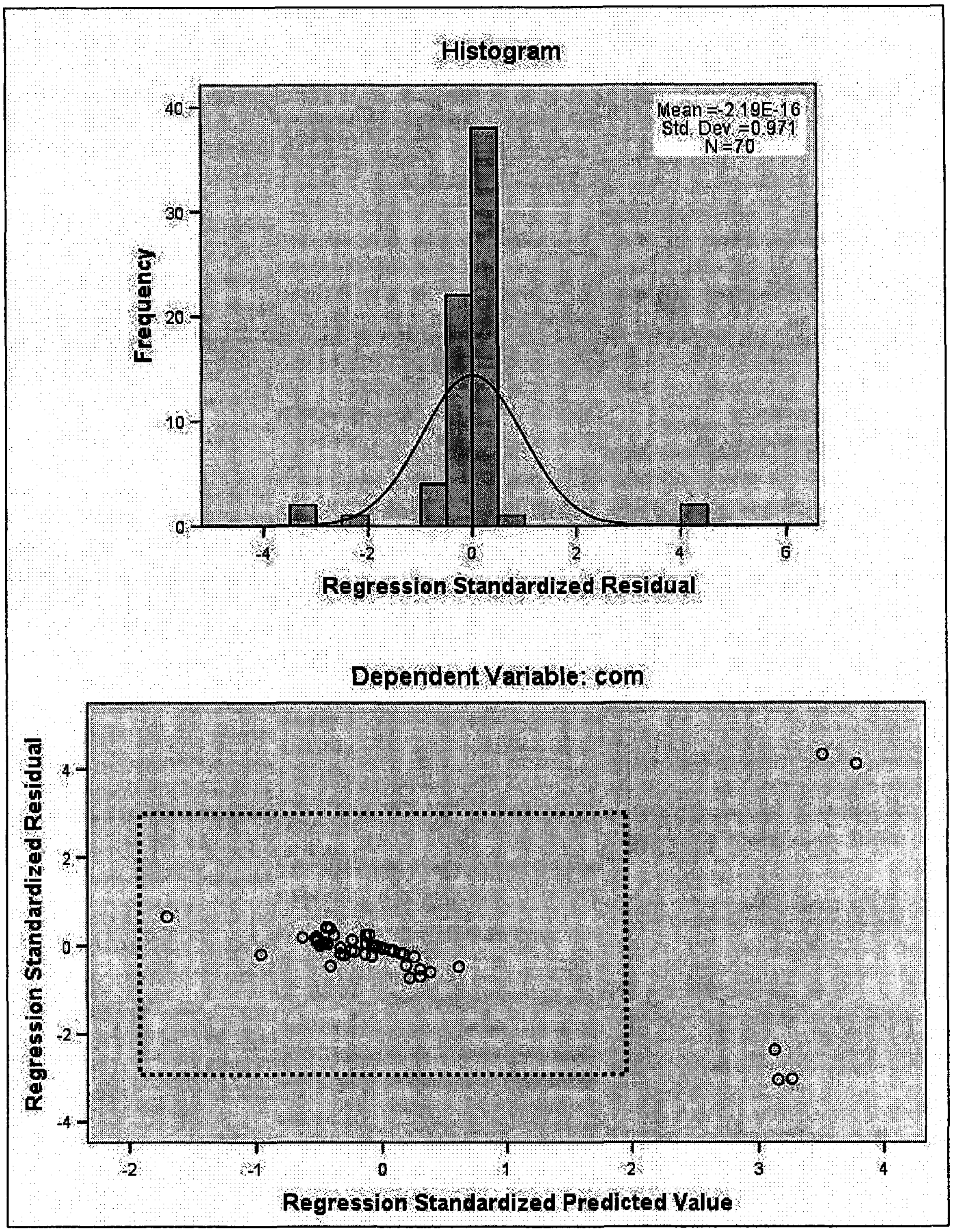

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Figure 19. Standardized Residuals: Process Satisfaction

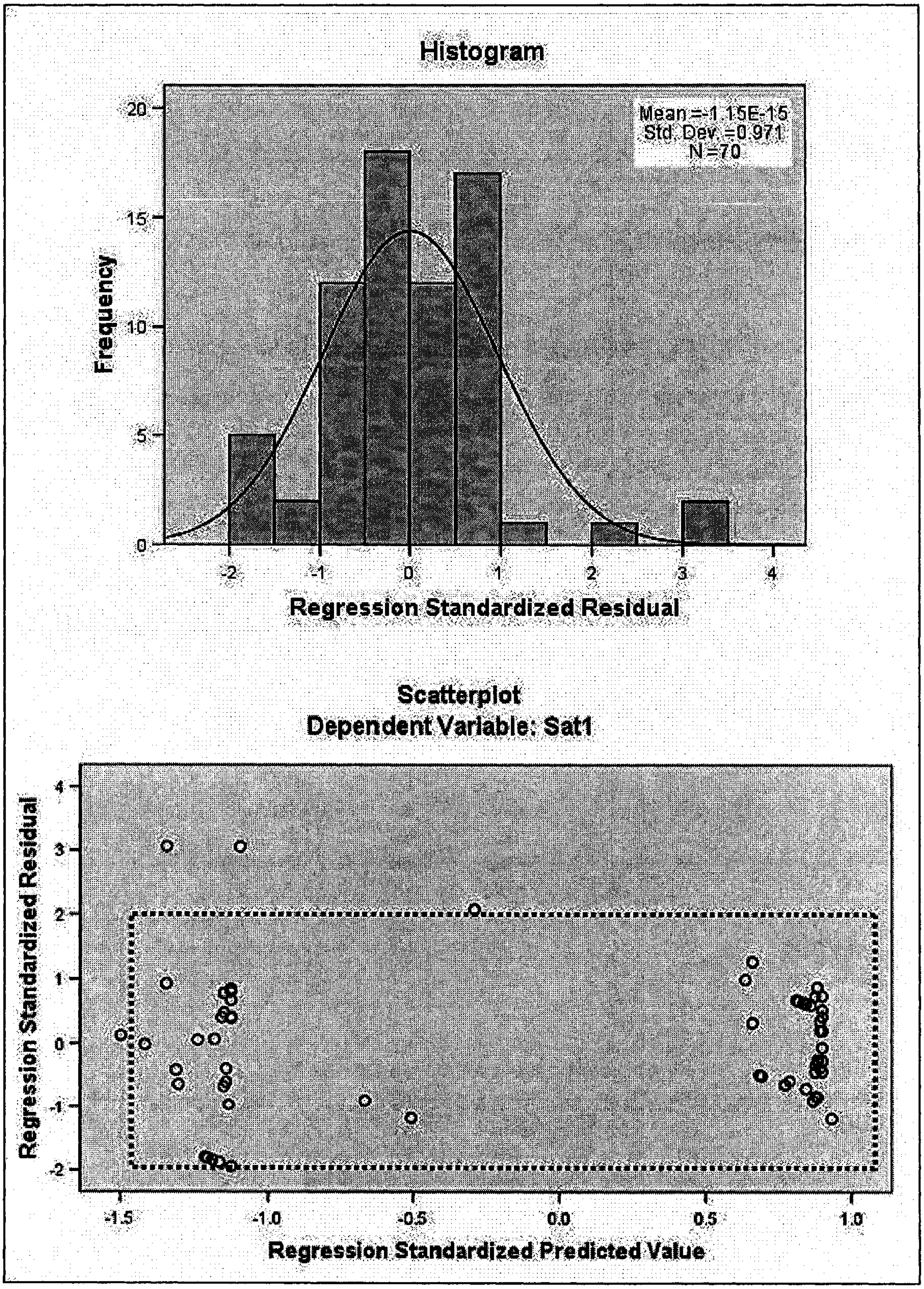

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Figure 20. Standardized Residuals: Production Blocking

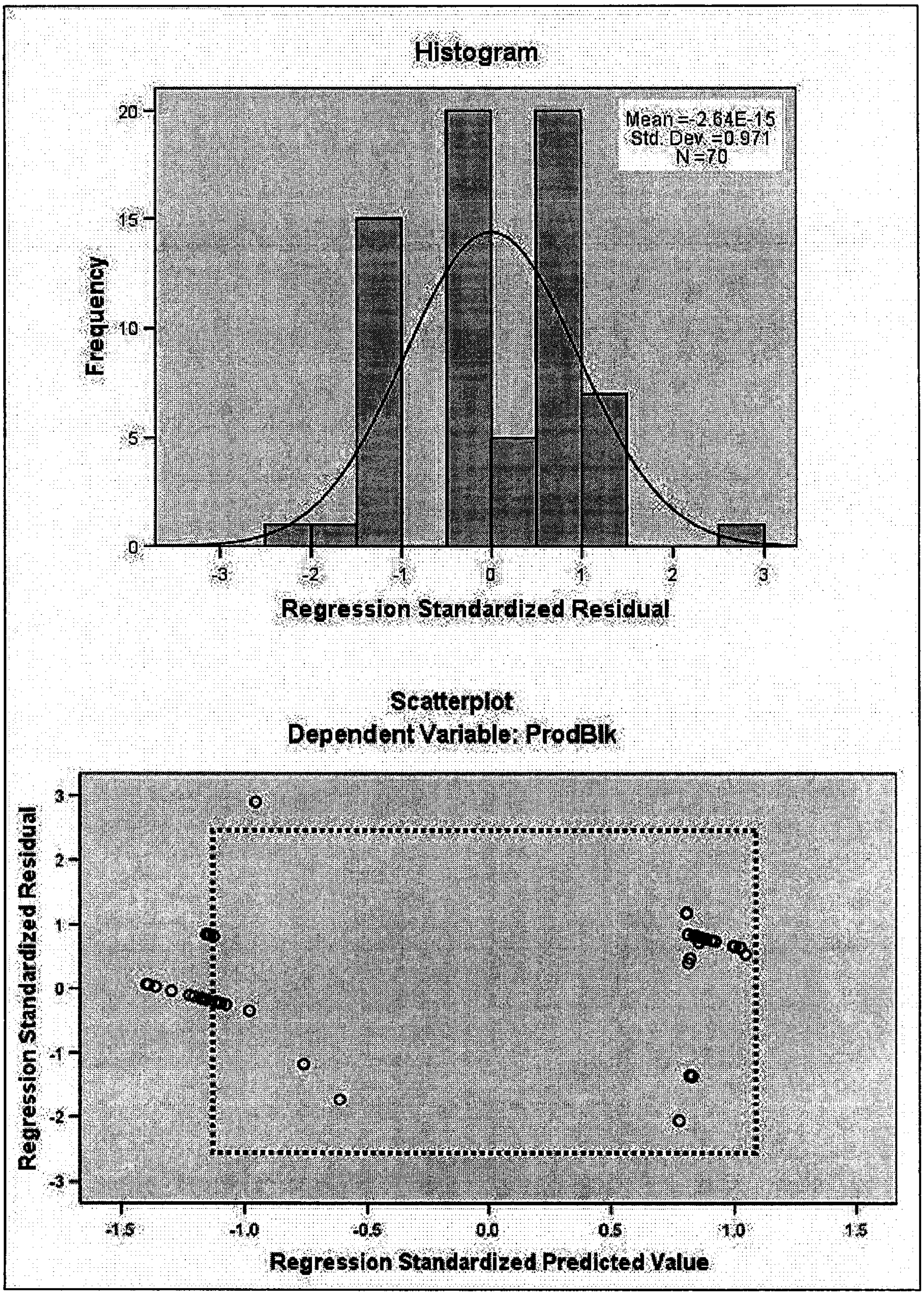

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Figure 21. Model I: Expected vs. Observed Values of Process Time

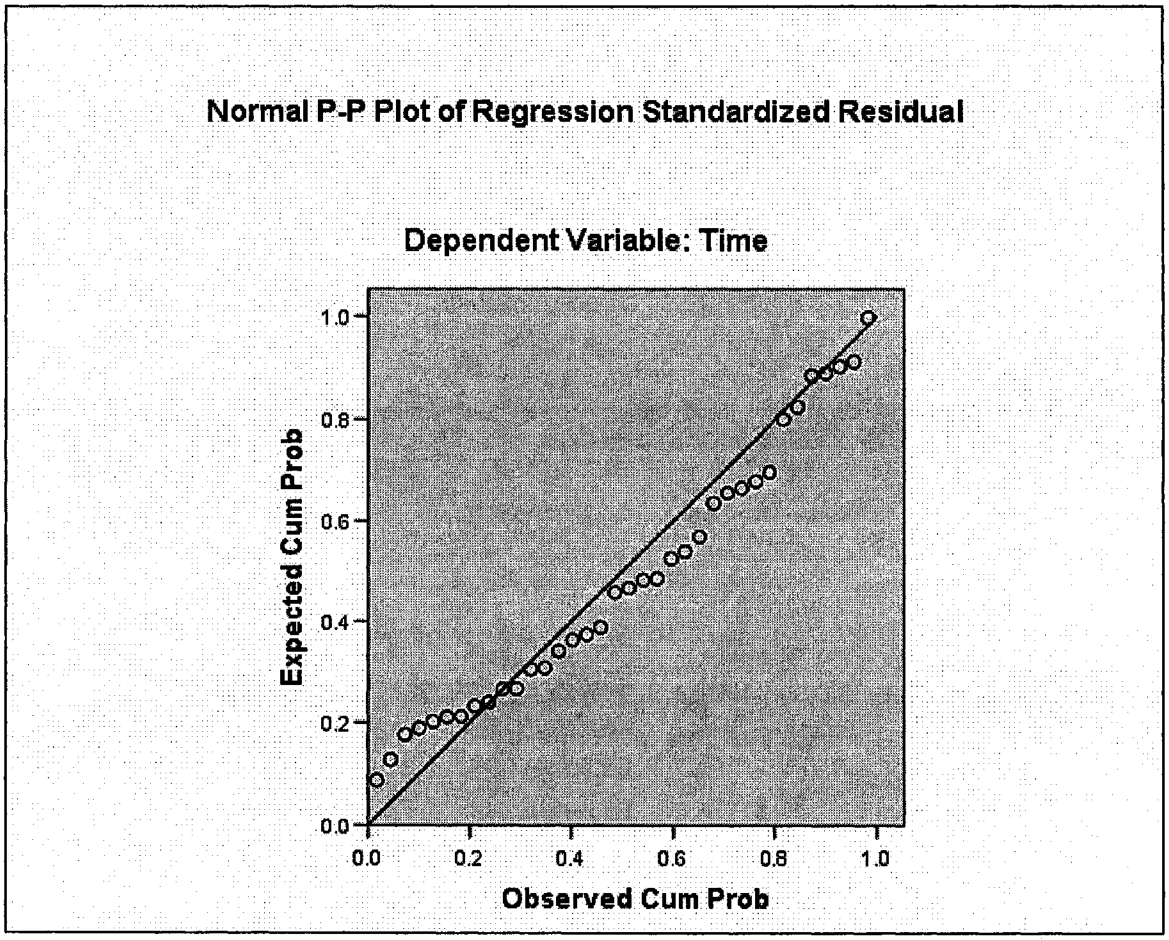

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Figure 22. Model I: Standardized B Values Superimposed

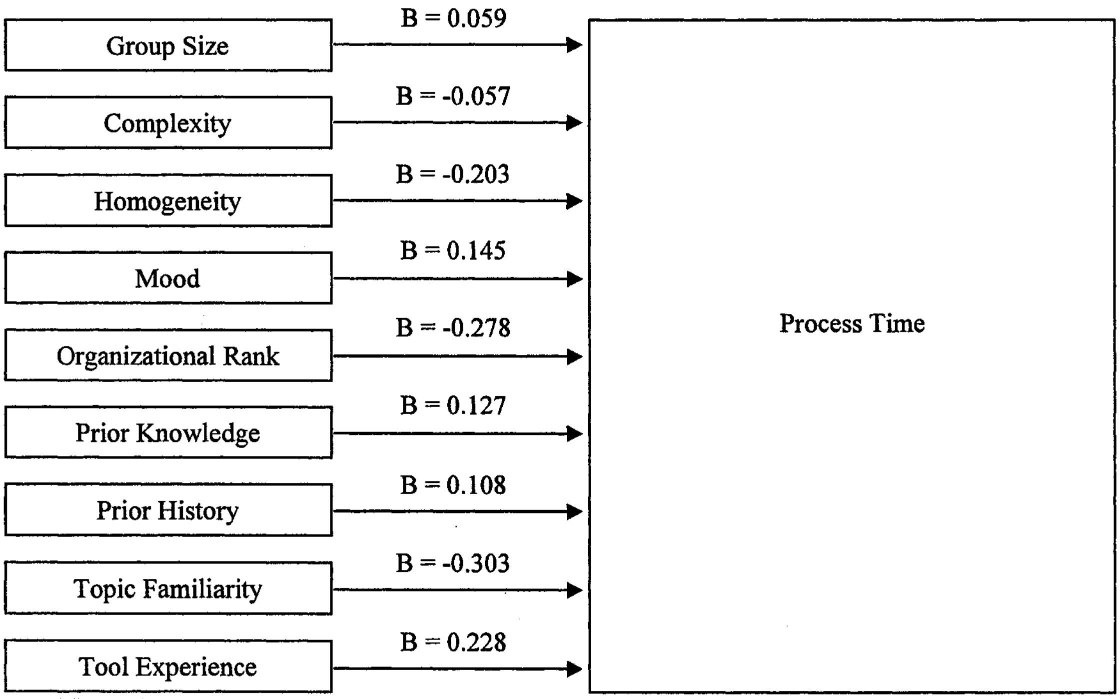

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Figure 23. Model III: Expected vs. Observed Values of Evaluation Apprehension

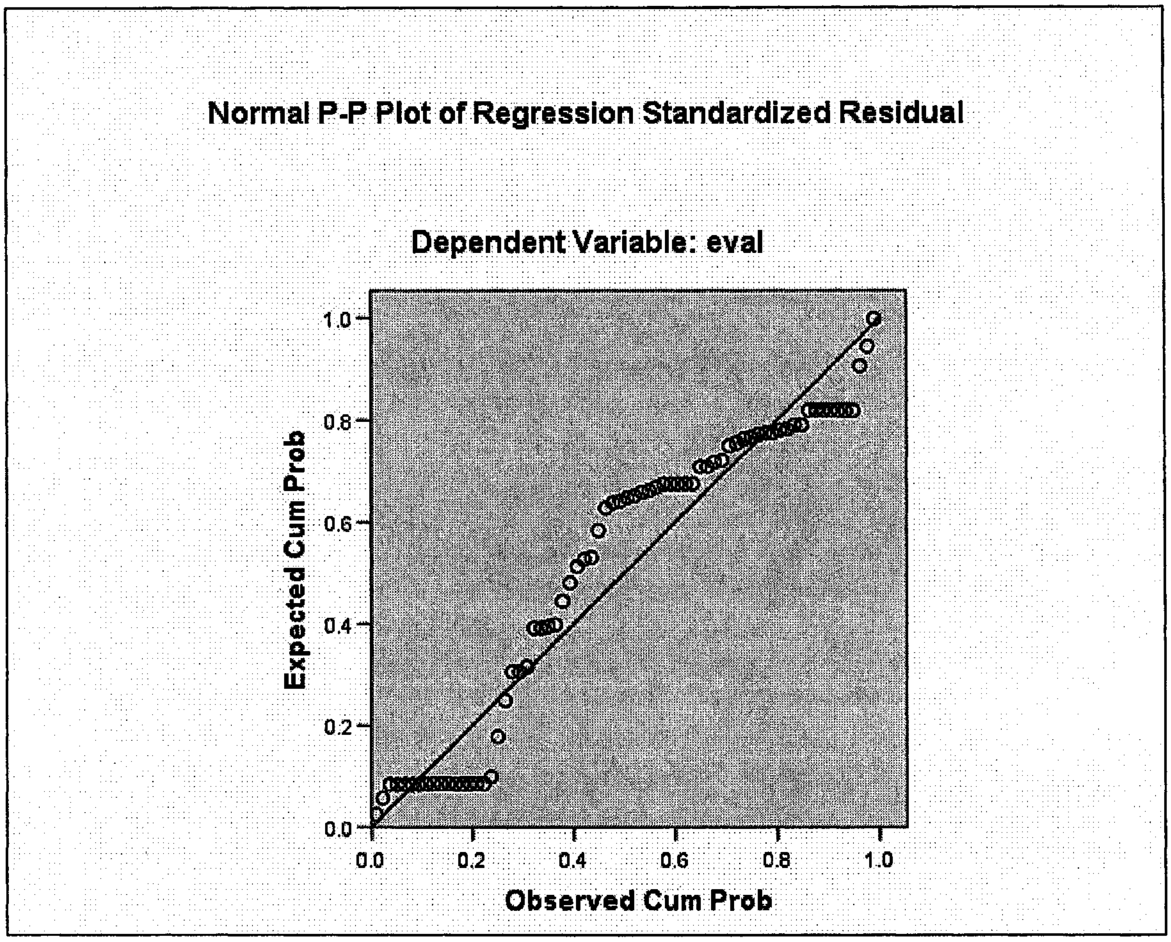

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Figure 24. Model III: Standardized B Values Superimposed

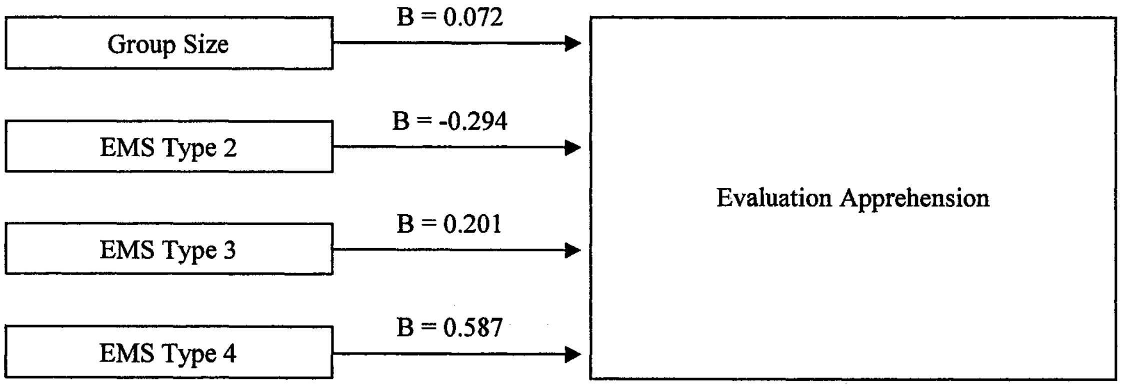

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Figure 25. Model IV: Expected vs. Observed Values of Comment Generation Rate

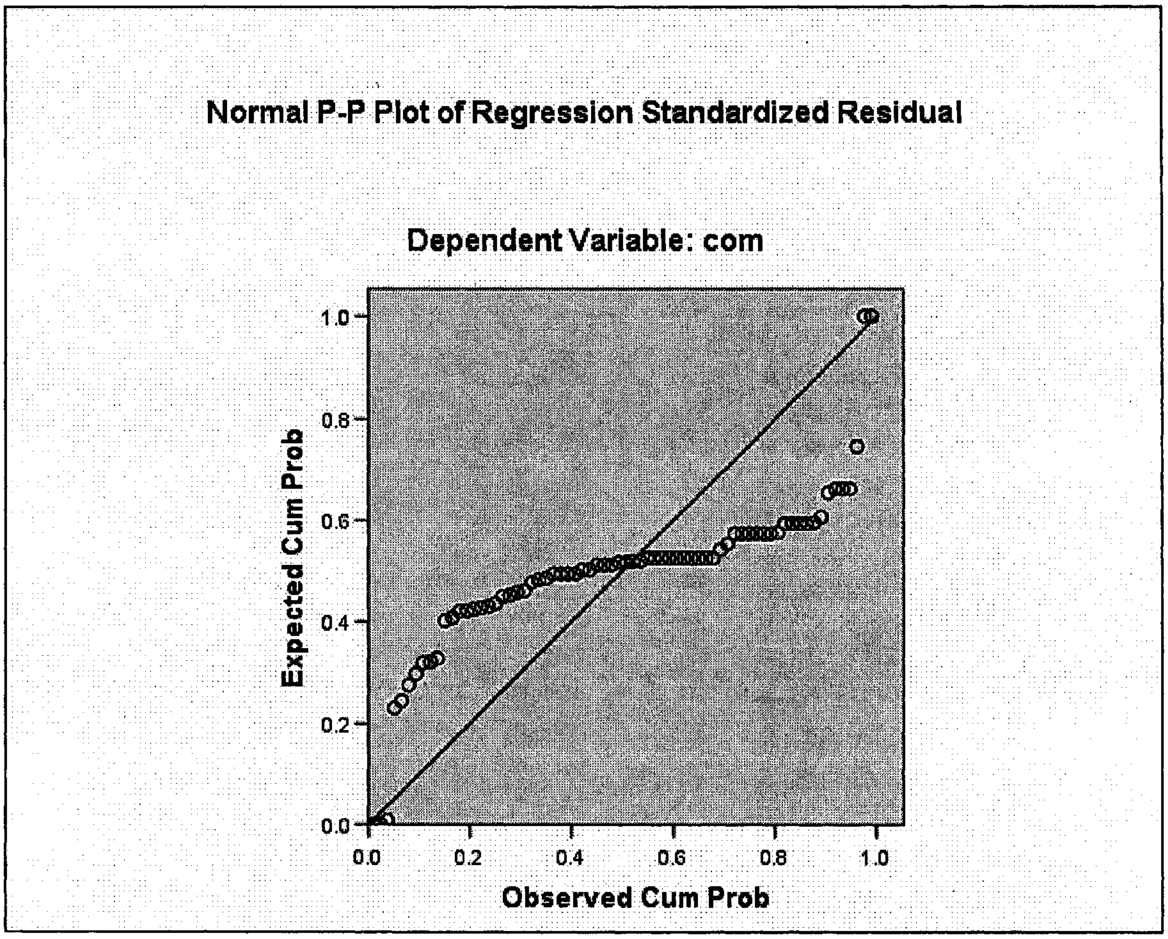

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Figure 26. Model IV: Standardized B Values Superimposed

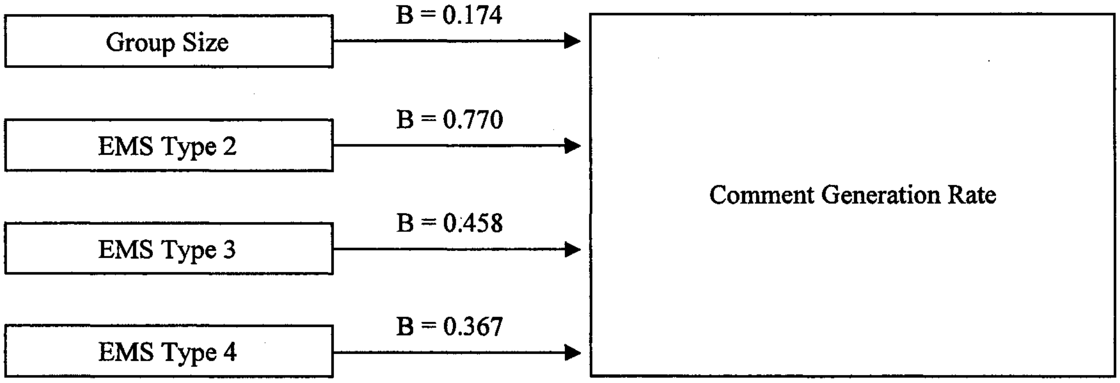

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Figure 27. Model V: Expected vs. Observed Values of Process Satisfaction

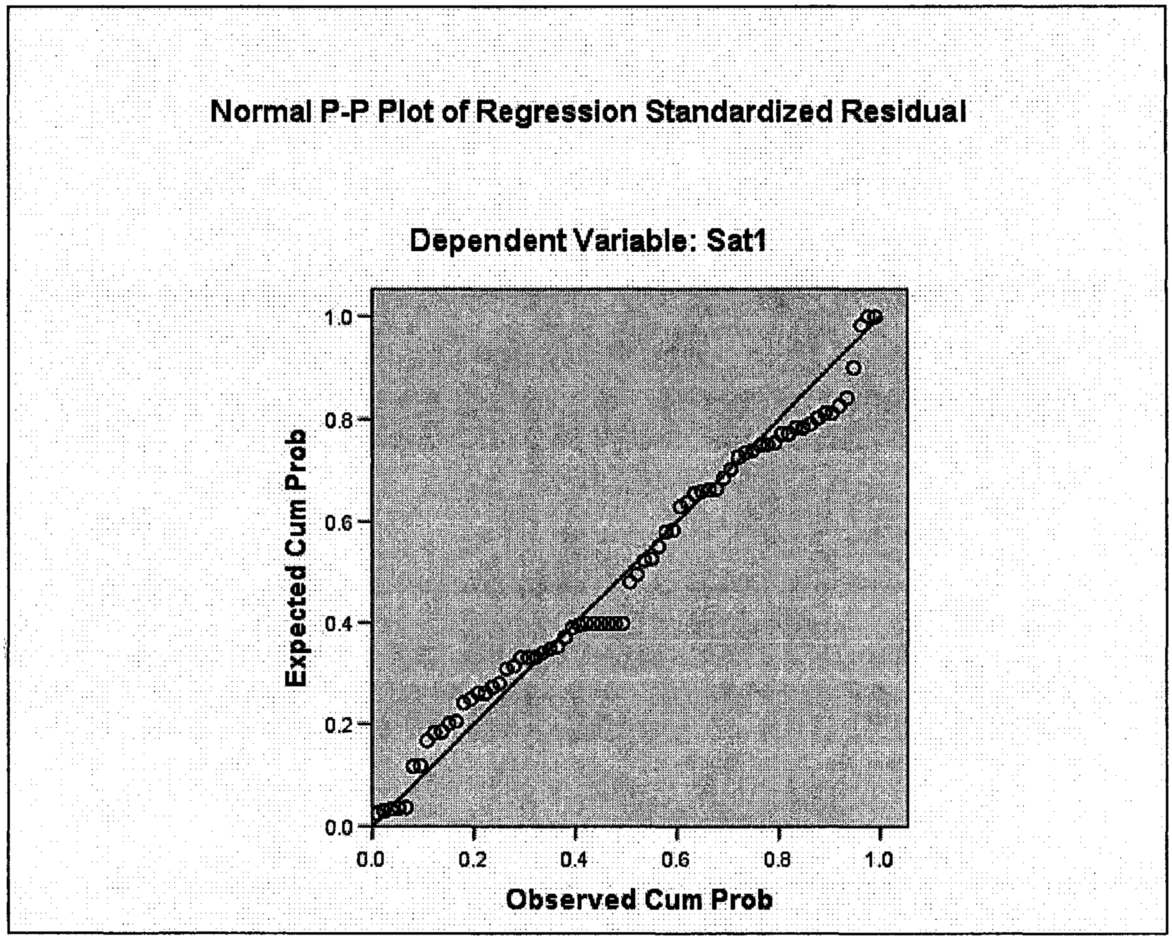

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Figure 28. Model V: Standardized B Values Superimposed

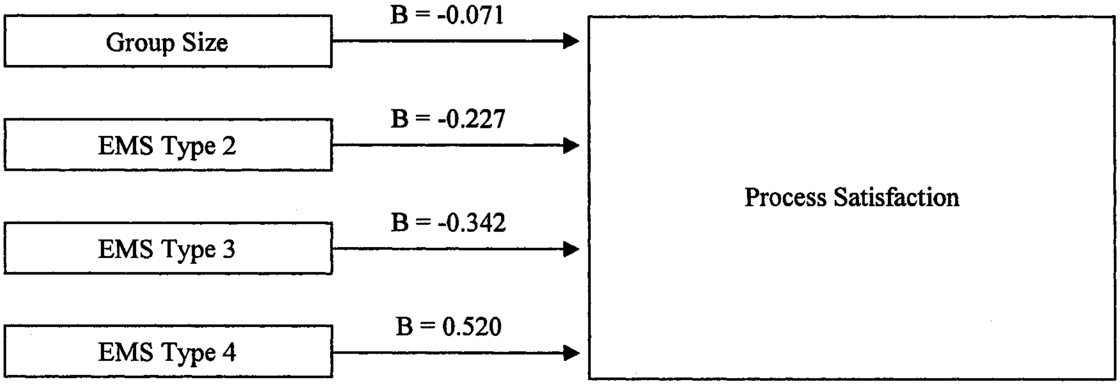

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Figure 29. Model VI: Expected vs. Observed Values of Production Blocking

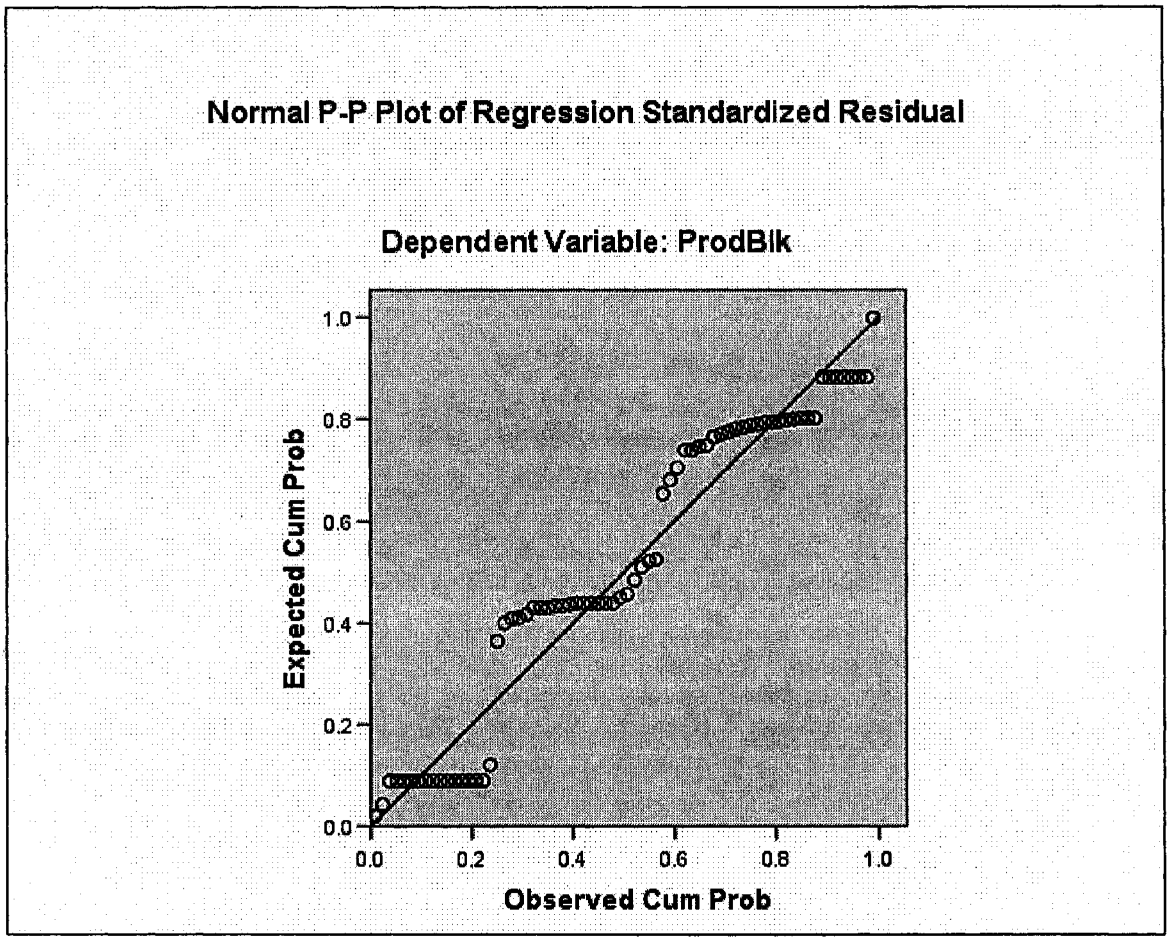

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Figure 30. Model VI: Standardized B Values Superimposed

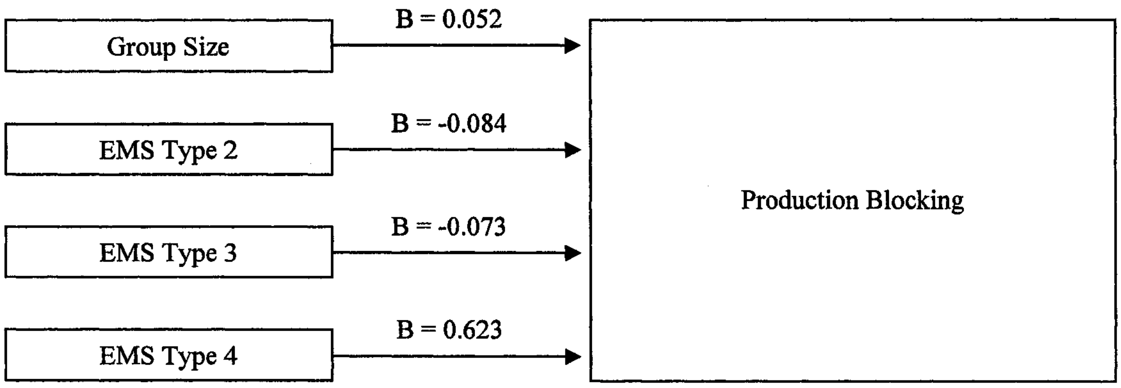

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Figure 31. Models III – VI Combined: Variable Significance Summary

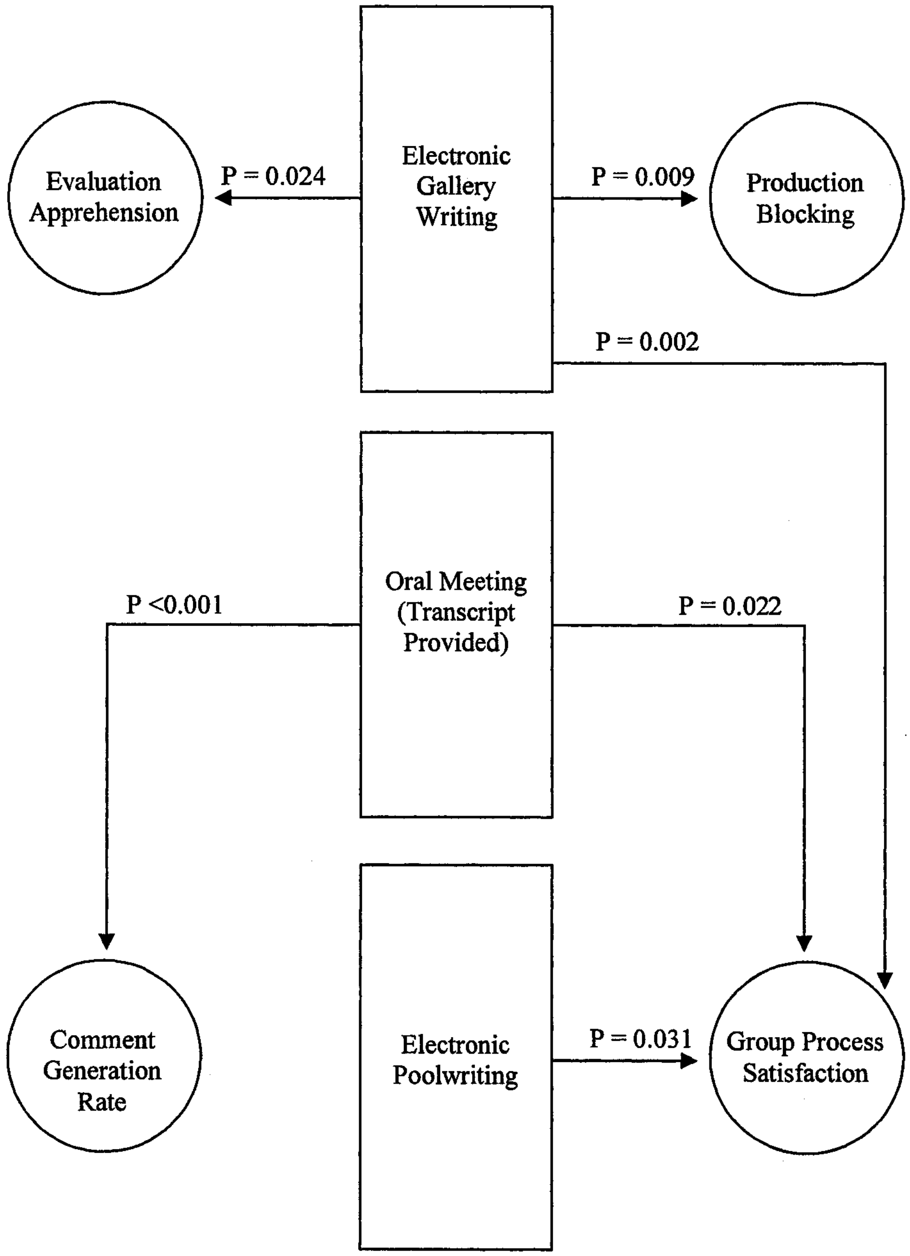

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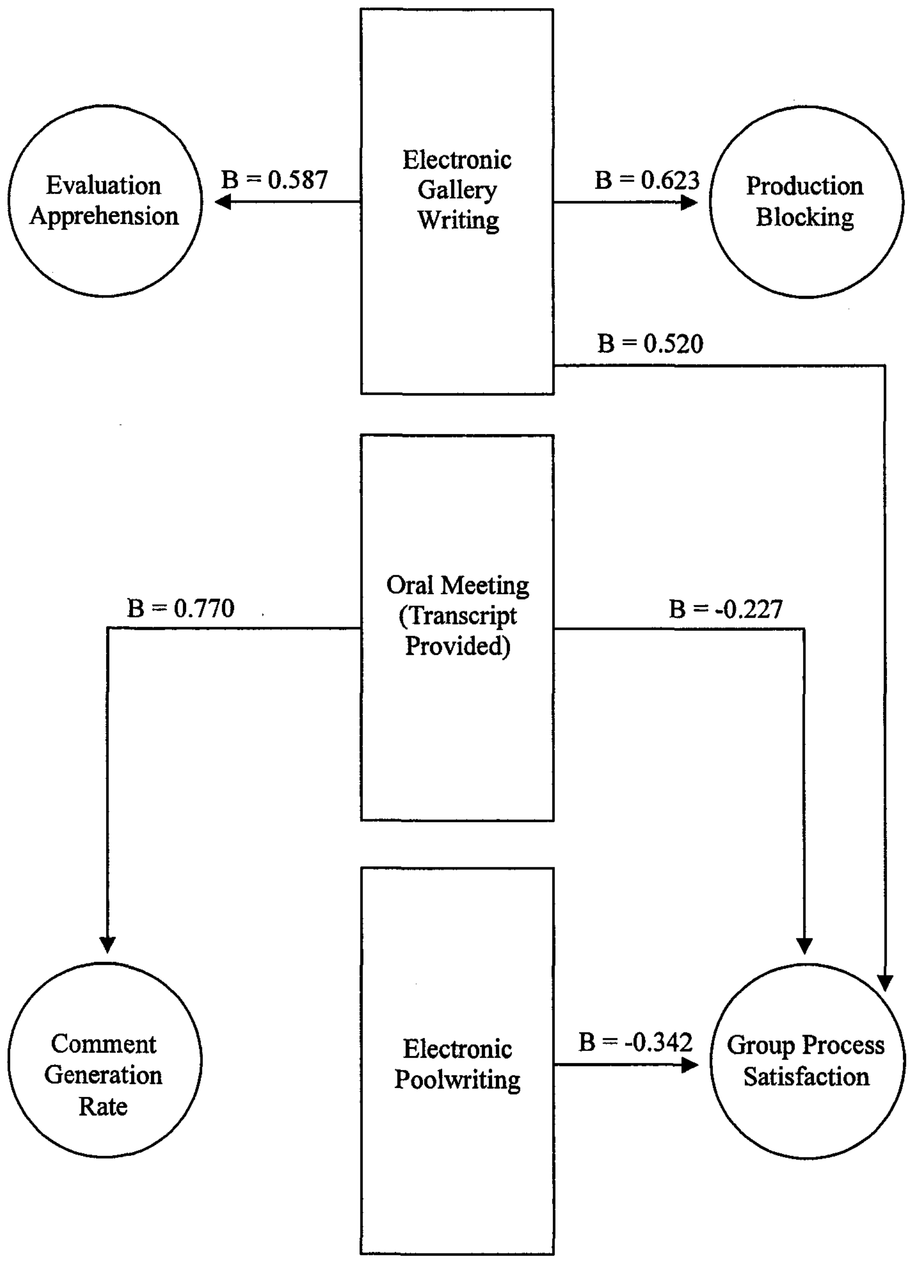
Figure 32. Models III – VI Combined: Significant Standardized B Values



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APPENDIX

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SPSS Output: Process Time

Variables Entered/Removed(b)			
Model	Variables Entered	Variables Removed	Method
1	Tool Experience, Prior Knowledge, Mood, Topic Familiarity, Group Size, Complexity, Organizational Rank, Prior History, Homogeneity(a)	.	Enter
a All requested variables entered.			
b Dependent Variable: Time			

Model Summary(b)										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.396(a)	.157	-.135	21.877	.157	.538	9	26	.834	1.595
a Predictors: (Constant), Tool Experience, Prior Knowledge, Mood, Topic Familiarity, Group Size, Complexity, Organizational Rank, Prior History, Homogeneity										
b Dependent Variable: Time										

ANOVA(b)						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2316.487	9	257.387	.538	.834(a)
	Residual	12443.402	26	478.592		
	Total	14759.889	35			
a Predictors: (Constant), Tool Experience, Prior Knowledge, Mood, Topic Familiarity, Group Size, Complexity, Organizational Rank, Prior History, Homogeneity						
b Dependent Variable: Time						

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Coefficients(a)							
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	81.439	41.246		1.974	.059
	Complexity	-1.032	4.390	-.057	-.235	.816
	Group Size	.175	.631	.059	.278	.783
	Homogeneity	-3.795	5.472	-.203	-.694	.494
	Mood	3.325	5.773	.145	.576	.570
	Organizational Rank	-5.657	5.886	-.278	-.961	.345
	Prior Knowledge	2.338	5.148	.127	.454	.653
	Prior History	1.624	4.319	.108	.376	.710
	Topic Familiarity	-6.962	5.962	-.303	-1.168	.253
	Tool Experience	4.139	4.054	.228	1.021	.317

a Dependent Variable: Time

Residuals Statistics(a)					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	30.42	66.22	48.06	8.135	36
Residual	-29.691	59.666	.000	18.855	36
Std. Predicted Value	-2.168	2.233	.000	1.000	36
Std. Residual	-1.357	2.727	.000	.862	36

a Dependent Variable: Time

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SPSS Output: Evaluation Apprehension

Variables Entered/Removed(b)			
Model	Variables Entered	Variables Removed	Method
1	Elec GW, Size, Verbal (Transcribed), Elec PW(a)	.	Enter
a All requested variables entered.			
b Dependent Variable: eval			

Model Summary(b)										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.641(a)	.411	.375	.4278	.411	11.361	4	65	.000	1.302
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW										
b Dependent Variable: eval										

ANOVA(b)						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.318	4	2.079	11.361	.000(a)
	Residual	11.898	65	.183		
	Total	20.215	69			
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW						
b Dependent Variable: eval						

Coefficients(a)						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.542	.306		11.577	.000
	Size	.004	.006	.072	.692	.491
	Verbal (Transcribed)	-.614	.322	-.294	-1.907	.061
	Elec PW	.233	.286	.201	.816	.418
	Elec GW	.638	.275	.587	2.319	.024
a Dependent Variable: eval						

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Residuals Statistics(a)					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.966	4.336	3.993	.3472	70
Residual	-.8361	1.2277	.0000	.4152	70
Std. Predicted Value	-2.957	.989	.000	1.000	70
Std. Residual	-1.954	2.870	.000	.971	70
a Dependent Variable: eval					

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SPSS Output: Comment Generation Rate

Variables Entered/Removed(b)			
Model	Variables Entered	Variables Removed	Method
1	Elec GW, Size, Verbal (Transcribed), Elec PW(a)	.	Enter
a All requested variables entered.			
b Dependent Variable: com			

Model Summary(b)										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.621(a)	.386	.348	.37000	.386	10.212	4	65	.000	2.073
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW										
b Dependent Variable: com										

ANOVA(b)						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.592	4	1.398	10.212	.000(a)
	Residual	8.899	65	.137		
	Total	14.491	69			
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW						
b Dependent Variable: com						

Coefficients(a)						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.159	.265		-.600	.550
	Size	.008	.005	.174	1.637	.106
	Verbal (Transcribed)	1.360	.278	.770	4.888	.000
	Elec PW	.449	.247	.458	1.815	.074
	Elec GW	.338	.238	.367	1.421	.160
a Dependent Variable: com						

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Residuals Statistics(a)					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-.0963	1.4669	.3896	.28469	70
Residual	-1.13699	1.61132	.00000	.35912	70
Std. Predicted Value	-1.707	3.784	.000	1.000	70
Std. Residual	-3.073	4.355	.000	.971	70
a Dependent Variable: com					

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SPSS Output: Group Process Satisfaction

Variables Entered/Removed(b)			
Model	**Variables Entered**	**Variables Removed**	**Method**
1	Elec GW, Size, Verbal (Transcribed), Elec PW(a)	.	Enter
a All requested variables entered.			
b Dependent Variable: Sat1			

Model Summary(b)										
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**					**Durbin-Watson**
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**	
1	.876(a)	.768	.753	.4639	.768	53.695	4	65	.000	2.335
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW										
b Dependent Variable: Sat1										

ANOVA(b)						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	46.219	4	11.555	53.695	.000(a)
	Residual	13.988	65	.215		
	Total	60.206	69			
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW						
b Dependent Variable: Sat1						

Coefficients(a)						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	**(Constant)**	3.481	.332		10.494	.000
	Size	-.007	.006	-.071	-1.095	.278
	Verbal (Transcribed)	-.818	.349	-.227	-2.344	.022
	Elec PW	-.683	.310	-.342	-2.205	.031
	Elec GW	.975	.298	.520	3.269	.002
a Dependent Variable: Sat1						

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Residuals Statistics(a)

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.440	4.429	3.666	.8184	70
Residual	-.9050	1.4321	.0000	.4502	70
Std. Predicted Value	-1.498	.932	.000	1.000	70
Std. Residual	-1.951	3.087	.000	.971	70

a Dependent Variable: Sat1

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SPSS Output: Production Blocking

Variables Entered/Removed(b)			
Model	**Variables Entered**	**Variables Removed**	**Method**
1	Elec GW, Size, Verbal (Transcribed), Elec PW(a)	.	Enter
a All requested variables entered.			
b Dependent Variable: ProdBlk			

Model Summary(b)										
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**Change Statistics**					**Durbin-Watson**
					R Square Change	**F Change**	**df1**	**df2**	**Sig. F Change**	
1	.709(a)	.503	.472	.489	.503	16.433	4	65	.000	1.321
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW										
b Dependent Variable: ProdBlk										

ANOVA(b)						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	15.748	4	3.937	16.433	.000(a)
	Residual	15.573	65	.240		
	Total	31.321	69			
a Predictors: (Constant), Elec GW, Size, Verbal (Transcribed), Elec PW						
b Dependent Variable: ProdBlk						

Coefficients(a)						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	**(Constant)**	3.153	.350		9.010	.000
	Size	.003	.006	.052	.549	.585
	Verbal (Transcribed)	-.219	.368	-.084	-.594	.555
	Elec PW	-.106	.327	-.073	-.324	.747
	Elec GW	.842	.315	.623	2.675	.009
a Dependent Variable: ProdBlk						

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Residuals Statistics(a)					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	2.97	4.14	3.64	.478	70
Residual	-1.009	1.419	.000	.475	70
Std. Predicted Value	-1.398	1.046	.000	1.000	70
Std. Residual	-2.061	2.899	.000	.971	70
a Dependent Variable: ProdBlk					

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VITA

Born in Union, Mississippi, in 1969, David Michael Williams has an unusually diverse scholarly career. He received a Bachelor of Arts in English from the University of Mississippi in 1991. After a career as a high school teacher of English, he returned to the University of Mississippi to pursue the study of law, receiving a Juris Doctor in 1999. During his tenure in law school, he further became interested in business and technology. He pursued this interest by entering the Doctoral program at the University of Mississippi in 1999, studying Management Information Systems and Operations Management.

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