THE EFFECTS OF DECISION AID STRUCTURAL
RESTRICTIVENESS ON DECISION-MAKING OUTCOMES

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ABSTRACT

This study examines the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes. Decision aids are often used to direct users’ attention to items prompted by the decision aid (Bonner, Libby, and Nelson, 1996; Butler, 1985); but, in most instances, it is impossible to prompt for all possible items that should be considered in making a decision (Glover, Prawitt, and Spilker, 1997). An aid can be designed to be more structurally-restrictive so that users are forced to consider each prompted item in a defined sequence; while a less structurally-restrictive aid would allow users to interact with the aid in any manner they desire. Structural restrictiveness is determined by the rules embedded within computerized decision aids that restrict how users interact with the decision aid (Lynch and Gomaa, 2003). For example, consider two computerized decision aids that prompt the same items. The structurally-restrictive aid forces users to sequentially consider the prompts (i.e. consider Prompt A before Prompt B). In contrast, a less structurally-restrictive decision aid would be designed so that users are free to consider Prompts A and B in whatever sequence they desire. The more structurally-restrictive design imposes more limits on users’ decision-making process because they are forced to adapt their decision-making process to match the decision aid. However, it is unclear whether restricting how users interact with decision aids affects their decision-making outcomes.

The Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981) from the psychology literature provides the theoretical framework for examining the impact of structurally-restrictive decision aids on decision-making. SAM theory argues that the probability of recalling an item from decision-makers’ long-term memory depends on the strength of association between the probe cue stored in short-term working memory and the image stored in long-term memory. Following the SAM theory, prompted items have a higher strength of association resulting in a higher probability of being elicited from long-term memory. Using a decision aid can induce decision-making biases
because users of decision aids are more likely to elicit images of prompted items rather than images of non-prompted items from their long-term memory (Raaijmakers and Shiffrin, 1981). This study posits that a more structurally-restrictive decision aid further increases the prominence of the prompts by forcing decision-makers to adapt their decision-making process to match the decision aid. Furthermore, the increased prominence is expected to induce a stronger decision-making bias for non-prompted items.

To examine this issue, ninety participants were randomly assigned to one of three experimental groups: no decision aid (control group), less structurally-restrictive decision aid or more structurally-restrictive decision aid. While both types of decision aids contained a checklist of items to be considered (prompted items), the more structurally-restrictive decision aid required that the participants consider and respond to each prompted item before proceeding to the next prompted item. Participants were given a case narrative of a company’s order entry/sales process and were required to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative. The context of internal control evaluation was selected because decision aids are often employed in evaluating internal control systems (Dowling and Leech, 2007; Hubbard, 2003).

Participants provided with either type of decision aid identified more items prompted by the decision aid than participants in the control group. However, participants provided with a decision aid identified fewer items that were not prompted by the decision aid than participants who did not have access to a decision aid. Importantly, participants in the more structurally-restrictive decision aid group did not identify any more prompted items than participants in the less structurally-restrictive decision aid group. However, those in the more structurally-restrictive decision aid group recalled fewer non-prompted items indicating that the aid increased the decision-making bias by causing users to focus more attention on the prompted items. Decision-making bias is an
important issue because decision aids are unlikely to prompt all unique items relevant to a particular situation (Dowling and Leech, 2007; Glover et al., 1997). The results contribute to the decision aid literature by showing that structurally-restrictive decision aids may actually impair the decision-making process and by highlighting the cost of increasing the degree of structural restrictiveness embedded within decision aids. The findings also enable organizations to make more-informed decisions about the design of decision aids by making them aware of the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes.
DECLARATION

This is to certify that

i. the thesis comprises only my original work towards the PhD,

ii. due acknowledgment has been made in the text to all other material used,

iii. the thesis is less than 100,000 words in length, exclusive of tables, maps, bibliographies and appendices.

Signed:

Date: 29 MAY 2008
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# TABLE OF CONTENTS

**LIST OF FIGURES** .................................................................................................................. x

**LIST OF TABLES** .................................................................................................................... xi

**CHAPTER ONE : INTRODUCTION** ......................................................................................... 1

1.0 INTRODUCTION .................................................................................................................. 1
1.1 RESEARCH OBJECTIVE .................................................................................................... 2
1.2 MOTIVATION ..................................................................................................................... 3
1.3 THEORETICAL FRAMEWORK .......................................................................................... 5
1.4 RESEARCH DESIGN .......................................................................................................... 6
1.5 FINDINGS ........................................................................................................................... 8
1.6 CONTRIBUTIONS ............................................................................................................... 9
  1.6.1 Contributions for practice ......................................................................................... 9
  1.6.2 Contributions for research ........................................................................................ 10
1.7 ORGANIZATION OF THESIS ......................................................................................... 11

**CHAPTER TWO : BACKGROUND** ....................................................................................... 12

2.0 INTRODUCTION .................................................................................................................. 12
2.1 DECISION AIDS .............................................................................................................. 12
  2.1.0 Introduction ............................................................................................................. 12
  2.1.1 Decision-making benefit caused by prompting from decision aids ....................... 14
  2.1.2 Decision-making bias caused by prompting from decision aids ......................... 15
  2.1.3 Summary ................................................................................................................. 16
2.2 OUTPUT INTERFERENCE .................................................................................................. 16
  2.2.0 Introduction ............................................................................................................. 16
  2.2.1 Search of associative memory (SAM) theory ......................................................... 17
    2.2.1.1 Memory-retrieval process ................................................................................. 18
    2.2.1.2 Application of SAM theory ............................................................................ 22
    2.2.1.3 Applicability of SAM theory .......................................................................... 23
  2.2.2 Summary ................................................................................................................. 24
2.3 SYSTEM RESTRICTIVENESS ............................................................................................. 25
  2.3.0 Introduction ............................................................................................................. 25
  2.3.1 Sources of system restrictiveness .......................................................................... 25
    2.3.1.1 Physical restrictiveness .................................................................................. 26
    2.3.1.2 Structural restrictiveness .............................................................................. 31
    2.3.1.3 Process restrictiveness .................................................................................. 35
CHAPTER FIVE : PRELIMINARY ANALYSES ........................................ 93

5.0 INTRODUCTION ................................................................................. 93
5.1 DATA PREPARATION ......................................................................... 93
5.2 BIOGRAPHICAL DETAILS OF PARTICIPANTS ................................. 94
5.3 KNOWLEDGE OF PARTICIPANTS ................................................. 96
5.4 DESCRIPTIVE STATISTICS OF THE DEPENDENT VARIABLES ....... 98
5.5 TESTING FOR NORMALITY ........................................................... 105
5.6 CORRELATIONS ............................................................................. 106
5.7 CHAPTER SUMMARY .................................................................... 109

CHAPTER SIX : RESULTS AND DATA ANALYSES .............................. 111

6.0 INTRODUCTION ................................................................................. 111
6.1 STATISTICAL METHOD ................................................................... 111
6.2 ANALYSES ...................................................................................... 113
   6.2.1 The effects of using decision aids on identification of internal control plans prompted by the decision aid (Hypothesis 1) ................. 115
       6.2.1.1 Present and missing internal control plans ................................. 118
   6.2.2 The effects of using decision aids on identification of internal control plans not prompted by the decision aid (Hypothesis 2) .............. 123
       6.2.2.1 Present and missing internal control plans ................................. 126
   6.2.3 The effects of structural restrictiveness on identification of internal control plans prompted by the decision aid (Hypothesis 3) ............ 130
       6.2.3.1 Present and missing internal control plans ................................. 132
   6.2.4 The effects of structural restrictiveness on identification of internal control plans not prompted by the decision aid (Hypothesis 4) ....... 133
       6.2.4.1 Present and missing internal control plans ................................. 134
   6.3 SENSITIVITY ANALYSES .......................................................... 135
   6.4 SUMMARY RESULTS OF HYPOTHESIS TESTING ......................... 136
6.5 CHAPTER SUMMARY .................................................................... 138

CHAPTER SEVEN : CONCLUSIONS .................................................. 140

7.0 INTRODUCTION ................................................................................. 140
7.1 MOTIVATION AND SUMMARY OF RESEARCH FINDINGS ............ 140
7.2 LIMITATIONS ................................................................................. 143
   7.2.1 Threats to statistical conclusion validity ..................................... 143
   7.2.2 Threats to internal validity ......................................................... 145
   7.2.3 Threats to construct validity ...................................................... 150
   7.2.4 Threats to external validity ....................................................... 150
7.3 IMPLICATIONS ........................................................................................................ 153
7.4 FUTURE RESEARCH OPPORTUNITIES ......................................................... 155
7.5 CHAPTER SUMMARY ....................................................................................... 157

BIBLIOGRAPHY ........................................................................................................ 158

APPENDICES ............................................................................................................. 168

Appendix 1: Summary of studies supporting the decision-making benefit of directing users’ attention to items prompted by the decision aids .................................................. 169
Appendix 2: Summary of studies supporting the decision-making bias of failing to identify items not prompted by the decision aids ............................................. 172
Appendix 3: Summary of accounting studies examining output interference .......................................................................................................................... 174
Appendix 4: Summary of studies examining system restrictiveness .................................................. 176
Appendix 5: Experimental cases and model solutions .............................................................................. 196
Appendix 6: List of control plans .......................................................................................... 212
Appendix 7: Checklist .................................................................................................................. 214
Appendix 8: Decision aids ...................................................................................................... 217
Appendix 9: Knowledge test ........................................................................................................ 223
Appendix 10: Comparison between main pilot study and revised pilot study .......... 228
Appendix 11: Recruitment handout .......................................................................................... 232
Appendix 12: Random allocation of participants .............................................................................. 233
Appendix 13: Plain language statement ....................................................................................... 234
Appendix 14: Consent form .......................................................................................................... 235
Appendix 15: Screen shots of computerized web-based software .................................................. 236
Appendix 16: Perceived task complexity ....................................................................................... 266
Appendix 17: Perceived reliance .............................................................................................. 267
Appendix 18: Coding guidelines for knowledge test ...................................................................... 268
LIST OF FIGURES

Figure 2.1: A generalized depiction of the various phases of retrieval in the SAM theory (Raaijmakers and Shiffrin, 1981, p. 97) ......................... 21
Figure 2.2: Physical restrictiveness of two decision support systems (DSS) for the same decision (Silver, 1988c, p. 55) ..................................... 30
Figure 2.3: Sources of system restrictiveness .................................................. 39
Figure 3.1: A flowchart for the memory-retrieval process of identifying items based upon the SAM theory (Raaijmakers and Shiffrin, 1981) ........................................................................... 45
Figure 3.2: A flowchart for the memory-retrieval process of identifying items with a decision aid based upon the SAM theory (Raaijmakers and Shiffrin, 1981) ................................................................. 47
Figure 4.1: Validation of cases and model solutions ........................................ 63
Figure 4.2: Checklist development ................................................................. 67
Figure 4.3: Experimental procedures .............................................................. 84
Figure 5.1: Comparison of “Prompted All” (Percentage of all internal control plans identified that were prompted by the decision aid) (n=90) .......................................................................................... 101
Figure 5.2: Comparison of “Non-Prompted All” (Percentage of all internal control plans identified that were not prompted by the decision aid) (n=90) ................................................................................. 101
Figure 5.3: Comparison of “Prompted Present” (Percentage of present internal control plans identified that were prompted by the decision aid) (n=90) .............................................................................. 103
Figure 5.4: Comparison of “Prompted Missing” (Percentage of missing internal control plans identified that were prompted by the decision aid) (n=90) .............................................................................. 103
Figure 5.5: Comparison of “Non-Prompted Present” (Percentage of present internal control plans identified that were not prompted by the decision aid) (n=90) .............................................................................. 104
Figure 5.6: Comparison of “Non-Prompted Missing” (Percentage of missing internal control plans identified that were not prompted by the decision aid) (n=90) .............................................................................. 104
LIST OF TABLES

Table 4.1: Experts’ validation of the case narratives ............................................... 62
Table 4.2: Experts’ validation of the model solutions ............................................... 62
Table 4.3: Participants’ feedback on the case narrative and task for main pilot study .................................................................................................................. 75
Table 4.4: Participants’ feedback on the checklist for main pilot study .................... 77
Table 4.5: Summary of dependent variables ............................................................. 88
Table 4.6: An example of the computation of dependent variables ....................... 88
Table 4.7: Kappa coefficients of inter-coder agreement for dependent variables .......................................................... 90
Table 4.8: Kappa coefficients of inter-coder agreement for knowledge test .......... 91
Table 5.1: Number of participants in the final usable sample .................................. 94
Table 5.2: Biographical details of participants ........................................................... 95
Table 5.3: Knowledge of participants (n=90) ............................................................ 97
Table 5.4: Analysis of variance for knowledge ....................................................... 98
Table 5.5: Descriptive statistics of dependent variables ......................................... 99
Table 5.6: Jacque-Bera (JB) statistics of dependent variables .................................. 106
Table 5.7: Spearman’s rho correlations between variables (n=90) ......................... 108
Table 6.1: Assumptions for analysis of covariance ................................................ 112
Table 6.2: Percentage of all internal control plans identified that were prompted by the decision aid (Prompted All) ....................................................... 116
Table 6.3: Percentage of present internal control plans identified that were prompted by the decision aid (Prompted Present) ............................................. 119
Table 6.4: Percentage of missing internal control plans identified that were prompted by the decision aid (Prompted Missing) ........................................... 120
Table 6.5: Percentage of all internal control plans identified that were not prompted by the decision aid (Non-Prompted All) ............................................ 124
Table 6.6: Percentage of present internal control plans identified that were not prompted by the decision aid (Non-Prompted Present) ...................... 127
Table 6.7: Percentage of missing internal control plans identified that were not prompted by the decision aid (Non-Prompted Missing) ...................... 128
Table 6.8: Spearman’s rho correlations for sensitivity analysis ............................. 136
Table 6.9: Summary results of hypothesis testing ................................................... 137
Table 7.1: Threats to statistical conclusion validity ............................................... 146
Table 7.2: Threats to internal validity ................................................................. 149
Table 7.3: Threats to construct validity ............................................................... 151
Table 7.4: Threats to external validity ................................................................. 152
CHAPTER ONE : INTRODUCTION

1.0 INTRODUCTION

The use of decision aids is widespread in accounting (Dowling and Leech, 2007; Mascha and Smedley, 2007), health care (Holbrook et al., 2007; Inger, 2007; McMaster University Evidence-based Practice Center, 2002; Miller, 1994), human-resource management (Lawler and Elliot, 1996; Sturman, Hannon, and Milkovich, 1996) and marketing (Haubl and Trifts, 2000; Olson and Widing II, 2002; Wierenga, Van Bruggen, and Staelin, 1999). Increasingly, computerized decision aids are developed to support human judgments (Bell, Bedard, Johnstone, and Smith, 2002; Brown and Eining, 1997; Dowling and Leech, 2007; Mascha and Smedley, 2007; Reneau and Blanthorne, 2001; Wheeler and Jones, 2006). Technology offers the opportunity to have more discretion regarding the design of computerized decision aids as compared with manual decision aids. For example, technology facilitates the choice to embed rules into a computerized decision aid to restrict how users interact with the decision aid. The “specific types of rules” embedded within a technology are described as structural features (DeSanctis and Poole, 1994, p. 126).

The structural features embedded within technologies determine the degree of structural restrictiveness\(^1\) that restrict how users interact with and employ the technologies (Anson, Bostrom, and Wynne, 1995; DeSanctis and Poole, 1994; Kim, Hiltz, and Turoff, 1998; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Vessey, Jarvenpaa, and Tractinsky, 1992; Wheeler and Valacich, 1996). For example, a decision aid can be designed to be more structurally-restrictive so that users are forced to employ the decision aid in a particular prescribed manner. In contrast, a less structurally-restrictive decision aid would be designed so that users are free to interact with the decision aid in any manner they desire. The more structurally-restrictive design imposes more limits on

\(^{1}\) Structural restrictiveness is one of the three predominant sources of system restrictiveness identified within the system restrictiveness literature. System restrictiveness was originally defined by Silver (1988b, p. 259) in the information systems literature as “the degree to which and the manner in which a Decision Support System restricts its users’ decision-making processes to a particular subset of all possible processes.”
users’ decision-making process because users are forced to adapt their decision-making process to match the decision aid.

1.1 RESEARCH OBJECTIVE

Prior research indicates that the use of decision aids results in decision-making benefits and biases (Arnold, Collier, Leech, and Sutton, 2004; Arnold and Sutton, 1998; Dowling and Leech, 2007; Rose, 2002; Sharda, Barr, and McDonnell, 1988). One benefit is that decision aids are often used to reduce the effects of cognitive constraints, for example, by directing users’ attention to items prompted by the decision aid (Bonner et al., 1996; Butler, 1985; Eining and Dorr, 1991; Lowe and Reckers, 2000). Although the use of decision aids is beneficial in assisting users to focus on certain items during the decision-making process, decision aids can induce decision-making biases whereby users focus only on the items prompted by the decision aid and fail to adequately consider items not prompted by the decision aid (Asare and Wright, 2004; Dube-Rioux and Russo, 1988; Fischhoff, Slovic, and Lichtenstein, 1978; Johnson and Kaplan, 1996; Pincus, 1989). Potentially, this bias may be exacerbated by designing decision aids that restrict and limit the decision-making process that a decision-maker uses to solve a particular problem. The objective of this study is to examine the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes.

In order to achieve the foregoing research objective, this study addresses the following research questions:

Does the degree of structural restrictiveness embedded within a decision aid affect the decision-making benefit by helping users to identify items prompted by the decision aid?

Does the degree of structural restrictiveness embedded within a decision aid affect the decision-making bias by causing users to miss items not prompted by the decision aid?
1.2 MOTIVATION

Prior research shows that the use of decision aids induces decision-making biases by comparing the performance of aided and unaided decision-makers (Arnold et al., 2004; Asare and Wright, 2004; Dube-Rioux and Russo, 1988; Fischhoff et al., 1978; Johnson and Kaplan, 1996; Pincus, 1989). But little has been done to investigate whether forcing aided decision-makers to employ a certain prescribed decision-making process by restricting how they interact with the decision aid affects decision-making biases. Technology facilitates the choice to embed high levels of structural restrictiveness within a computerized decision aid to restrict how users employ the decision aid. For example, a decision aid can be designed to be more structurally-restrictive so that users are forced to interact with the decision aid in a particular prescribed manner. As a result, users of a more structurally-restrictive decision aid face more limits on their decision-making process while interacting with the decision aid. Although evidence shows that the degree of structural restrictiveness embedded within a decision aid affects users’ decision-making process (Anson et al., 1995; DeSanctis and Poole, 1994; Kim et al., 1998; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Wheeler and Valacich, 1996), it is uncertain whether restricting how users interact with decision aids affects their decision-making outcomes.

Whether the degree of structural restrictiveness embedded within a decision aid affects the decision-making bias is an empirical question. Decision-making bias is an important issue because decision aids are not necessarily exhaustive and are unlikely to prompt all unique items relevant to a particular situation (Arnold and Sutton, 1998; Cushing and Loebbecke, 1986; Dowling and Leech, 2007; Eining, Jones, and Loebbecke, 1997; Gal and Steinbart, 1987; Glover et al., 1997; Pincus, 1989; Purvis, 1989). Decision aids used in practice “often do not capture all potentially relevant environmental features” (Glover et al., 1997, p. 242). Thus, it is important to examine the impacts of increasing the degree of structural restrictiveness within a decision aid on users’ decision-making outcomes.
In practice, substantial differences have been identified in the level of restrictiveness among the audit support systems\(^2\) used at five international audit firms\(^3\) (Dowling and Leech, 2007). Two of the five audit support systems were classified as having a high level of restrictiveness because the system “significantly restricts the extent to which a user is free to choose how the audit is performed and make certain judgments through influencing how a user interacts with the system” (Dowling and Leech, 2007, p. 95). Restrictive systems are designed such that the embedded decision aids automatically tailor the audit plans based on auditors’ responses to a set of standard questions (Dowling and Leech, 2007).

On the other hand, the other three audit support systems were classified as having a low level of restrictiveness because the system “does not significantly constrain users interaction with the system” (Dowling and Leech, 2007, p. 95). Instead of automatic tailoring, the less-restrictive systems are designed such that auditors need to tailor the audit plans using the checklists accessed from the audit support system (Dowling and Leech, 2007).

In summary, the audit support systems of the five international audit firms do not exhibit the same degree of restrictiveness. These observed differences raise the empirical question of whether different degrees of restrictiveness impact users’ performance. This study builds on the observed differences to examine the fundamental question of whether using a decision aid designed to be more structurally-restrictive affects users’ decision-making outcomes.

\(^2\) The audit support systems “include electronic workpapers, extensive help files, accounting and auditing standards, relevant legislation and decision aids” (Dowling and Leech, 2007, p. 92).
\(^3\) The five international audit firms include the Big 4 and one large mid-tier international audit firms. The firms were not identified individually due to confidentiality agreements (Dowling and Leech, 2007).
1.3 THEORETICAL FRAMEWORK

The Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981) from the psychology literature forms the conceptual basis around which the research hypotheses are developed. The SAM theory was developed by Raaijmakers and Shiffrin (1981) to explain the nature of the long-term memory-retrieval process. It is built upon a two-phase memory system: short-term working memory and long-term memory (Atkinson and Shiffrin, 1968). Short-term working memory temporarily stores information about newly-presented items and the information is transferred to the permanent long-term memory after processing (Raaijmakers and Shiffrin, 1981). SAM theory argues that the probability of recalling an item from an individual’s long-term memory depends on the strength of association between the probe cue stored in short-term working memory and the image stored in long-term memory (Raaijmakers and Shiffrin, 1981).

SAM theory suggests that prompted items have a higher strength of association resulting in a higher probability of being elicited from long-term memory (Raaijmakers and Shiffrin, 1981). Decision-makers who are prompted are more likely to elicit images of prompted items from their long-term memory rather than images of non-prompted items because their elicited images contain a smaller number of non-prompted items (Raaijmakers and Shiffrin, 1981). In contrast, decision-makers who are not prompted are not distracted by any prompting and hence are unbiased with respect to eliciting the images of prompted or non-prompted items (Raaijmakers and Shiffrin, 1981).

Therefore, if a decision aid is used in the memory-retrieval process, this study hypothesizes that decision-makers provided with a decision aid are likely to identify more items prompted by the decision aid than decision-makers who do not have access to a decision aid. On the other hand, decision-makers

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4 The distinction between short-term working memory and long-term memory relates to whether the newly-presented information has been coded and processed (Raaijmakers and Shiffrin, 1981). The distinction does not relate to items' length of duration in individuals' memory. After processing in the temporary short-term working memory, newly-presented information is transferred to the permanent long-term memory (Raaijmakers and Shiffrin, 1981).
provided with a decision aid are likely to identify fewer items not prompted by the decision aid than decision-makers who do not have access to a decision aid.

This study posits that the strength of the prompts in a decision-maker’s memory can be further differentiated by the degree of structural restrictiveness embedded within a decision aid. A greater degree of structural restrictiveness embedded within a decision aid further increases the prominence of the prompts by forcing decision-makers to adapt their decision-making process to match the decision aid. Due to the increased strength of association, decision-makers provided with a more structurally-restrictive decision aid are likely to identify more items prompted by the decision aid than decision-makers provided with a less structurally-restrictive decision aid. On the other hand, decision-makers provided with a more structurally-restrictive decision aid are expected to experience a stronger decision-making bias for non-prompted items. Thus, decision-makers provided with a more structurally-restrictive decision aid are likely to identify fewer items not prompted by the decision aid than decision-makers provided with a less structurally-restrictive decision aid.

1.4 RESEARCH DESIGN
An experiment was conducted using a 1 x 3 between-subjects design. Ninety participants were randomly assigned to one of three experimental groups: no decision aid (control group), less structurally-restrictive decision aid or more structurally-restrictive decision aid. This study utilized a computerized decision aid in the form of a computerized checklist embedded within web-based software. Checklists were selected because they are frequently used decision aids in the context of internal control evaluation (Abdolmohammadi and Usoff, 2001; Dowling and Leech, 2007).

This study focuses on the context of internal control evaluation because decision aids are often deployed by organizations in evaluating the strengths and weaknesses of internal control systems (Hubbard, 2003, 2005; McCuaig, 2005; Root, 1998; Sobel, 2006; Spencer, 1989). Audit firms also embed
decision aids within their computerized audit support systems to assist auditors in internal control evaluation during the planning phase of the audit process (Dowling and Leech, 2007). The importance of effective internal control evaluation was further increased with the introduction of the Sarbanes-Oxley Act (SOA) (2002). Section 404 of the SOA (2002) mandates organizations to include an internal control report in the annual report filed with the U.S. Securities and Exchange Commission (SEC).

In the less structurally-restrictive manipulation, participants were given access to a computerized checklist which contained a list of questions to consider when identifying internal control plans. Participants were not required to answer any of the questions and could view the questions in any order. The more structurally-restrictive checklist contained the same questions as the less structurally-restrictive checklist. However, in the more structurally-restrictive manipulation, participants were presented with each of the questions individually and they were required to provide a response to each question before they could proceed to the next question. The more structurally-restrictive decision aid actually restricts the decision-making process by imposing a rigid structure on the decision-maker.

For the experimental task, participants were given a case narrative of a company’s order entry/sales process. The case narrative described both internal control strengths and weaknesses. Participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative (i.e. areas requiring improvement in internal control in order to have effective overall control).

In order to ensure that the participants had sufficient and relatively homogeneous knowledge for assessing internal control procedures seeded within the case, participants were recruited from an accounting information systems subject that extensively exposed the participants to internal controls for
the order entry/sales process. Students were chosen as the participant group for this study because they are considered a homogenous group and their knowledge of internal control plans is less likely to differ than non-students because of the latters’ varied experiences (Frederick, 1991) and training (Tan, 2001).

1.5 FINDINGS
Participants provided with a decision aid identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid. Specifically, the findings indicate that prompting from a decision aid is beneficial for identifying missing internal control plans but not as beneficial for identifying present internal control plans. On the other hand, the findings provide evidence of the decision-making bias in recalling non-prompted items. Participants provided with a decision aid identified fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid.

The performances of participants provided with the less structurally-restrictive decision aid and participants provided with the more structurally-restrictive decision aid were comparable with respect to identifying internal control plans prompted by the decision aid. However, performance differed with respect to identifying internal control plans not prompted by the decision aid. Participants provided with the more structurally-restrictive decision aid identified fewer internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid.

The results show that although a greater degree of structural restrictiveness embedded within a decision aid does not assist participants to identify more internal control plans prompted by the decision aid, it increases users’ decision-making bias in that fewer non-prompted internal control plans are recalled.
1.6 CONTRIBUTIONS
This study contains lessons for both the research and practice communities. Section 1.6.1 discusses the practical contributions and Section 1.6.2 discusses the theoretical contributions.

1.6.1 Contributions for practice
This study informs practice about the effects of designing more structurally-restrictive or less structurally-restrictive decision aids on decision-making outcomes. It will be of interest to accounting practitioners as the use of decision aids is widespread in accounting (Dowling and Leech, 2007; Mascha and Smedley, 2007). The use of decision aids is also widespread in other domains, including human-resource management (Lawler and Elliot, 1996; Sturman et al., 1996), marketing (Haubl and Trifts, 2000; Olson and Widing II, 2002; Wierenga et al., 1999) and health care (Holbrook et al., 2007; Inger, 2007; McMaster University Evidence-based Practice Center, 2002; Miller, 1994). Thus, this study will also be of interest to other professions.

Specifically, this study utilized a computerized decision aid in the form of a computerized checklist embedded within web-based software. Checklists are frequently used decision aids employed extensively in diverse decision-making situations, including tax research (Wheeler and Arunachalam, 2008), software risk management (Keil, Li, Mathiassen, and Zheng, 2006; Wallace and Keil, 2004), marketing (Dibb, 2005; Sonja, 2006), human resources (Lievens, 1998; Yun, Donahue, Dudley, and McFarland, 2005) and quality management (Low and Wee, 2001; Van Der Wiele, Brown, Millen, and Whelan, 2000). Therefore, the results will also be of interest to other business disciplines.

The main finding was that the more structurally-restrictive decision aid did not assist participants to identify more items prompted by the decision aid. However, it increased the decision-making bias in recalling non-prompted items. Thus, the results highlight the cost of increasing the degree of structural restrictiveness embedded within a decision aid. An awareness of the effects of
structural restrictiveness embedded within a decision aid on users’ decision-making outcomes will enable organizations to make more-informed decisions about the design of decision aids.

The results show that a greater degree of structural restrictiveness exacerbates the decision-making bias of users failing to identify items not prompted by the decision aid. An increase in decision-making bias should be a concern to organizations that design structurally-restrictive decision aids because users are less likely to identify non-prompted items with the assistance of a structurally-restrictive decision aid. Depending on the consequences of failing to identify non-prompted items, an increase in decision-making bias may have effectiveness and efficiency implications. For example, if a user fails to identify a non-prompted item and ends up with a wrong judgment, it impacts the effectiveness of the decision-making process. On the other hand, if a user fails to identify a non-prompted item and requires more effort to reach a judgment, it impacts the efficiency of the decision-making process. Therefore, understanding the effects of the design of decision aids on users’ decision-making outcomes is important for practice because of the effectiveness and efficiency implications caused by the increase in decision-making bias.

1.6.2 Contributions for research
For the research community, this study contributes to the decision aid literature. Prior research has examined the effects of decision aid design on decision quality, including the orientation of decision aids (positive or negative) (Bedard and Graham, 2002), the information content of decision aids (more or less) (Johnson and Kaplan, 1996; Mascha and Smedley, 2007), the information sequence of decision aids (earlier or later during the decision-making process) (Reneau and Blanthorne, 2001) and match with users’ level of expertise (novice or expert) (Arnold et al., 2004). This study contributes by investigating another aspect of decision aid design in terms of the degree of structural restrictiveness embedded within a decision aid. Little has been done to examine whether restricting how users interact with decision aids affects decision-making
outcomes. The findings indicate that the degree of structural restrictiveness is an important aspect of the design of decision aids as a greater degree of structural restrictiveness embedded within a decision aid results in a greater decision-making bias of failing to identify items not prompted by the decision aid.

This study also provides new insights into the decision-making benefit of prompting by examining present and missing\textsuperscript{5} internal control plans separately. The results provide evidence that the decision-making benefit is dependent on the nature of the item prompted by the decision aid. The results show that although prompting from decision aids is beneficial for identifying both present and missing items, the positive effect is significant for identifying missing items but not significant for identifying present items.

1.7 ORGANIZATION OF THESIS
The remainder of this thesis is organized as follows. The next chapter reviews the prior literature on decision-making benefits and biases of using decision aids and examines structural restrictiveness. Chapter Two also discusses the Search of Associative Memory theory (Raaijmakers and Shiffrin, 1981) that provides the theoretical framework for this study. The hypotheses are developed in Chapter Three. Chapter Four describes the research design employed for this study. The results are presented in two chapters. Chapter Five presents the preliminary analyses of the data. The hypotheses are tested in Chapter Six. Finally, Chapter Seven summarizes the research findings and discusses the limitations of this study. The implications and opportunities for future research are also discussed.

\textsuperscript{5} This study focuses on the context of internal control evaluation. A key step in evaluating an internal control system is identifying the presence and absence of control plans (COSO, 1992, 2004; Gelinas, Sutton, and Hunton, 2005; Goodfellow and Willis, 2006). Therefore, the experimental task required participants to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative. Present internal control plans were stated in the case narrative whereas missing internal control plans were not stated in the case narrative and had to be recommended by the participant.
CHAPTER TWO : BACKGROUND

2.0 INTRODUCTION
This chapter is structured as follows. Section 2.1 discusses the decision-making benefits and biases of using decision aids as a prelude to the major investigation of whether the decision-making benefits and biases of using decision aids are affected by the degree of structural restrictiveness embedded within the decision aid. Section 2.2 reviews the Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981) to provide theoretical explanations for the decision-making benefits and biases. The SAM theory provides an understanding of the long-term memory-retrieval process.

Structural restrictiveness is one of the three predominant sources of system restrictiveness identified within the system restrictiveness literature. Accordingly, Section 2.3 discusses the three sources of system restrictiveness. Physical restrictiveness is discussed in section 2.3.1.1. Structural restrictiveness is discussed in section 2.3.1.2. Process restrictiveness is discussed in section 2.3.1.3. The last section provides a summary of the chapter.

2.1 DECISION AIDS

2.1.0 Introduction
Early studies in the decision aid literature focused on the characteristics of decision aids and categorized decision aids into three major types: deterministic aids, decision support systems and expert systems (Abdolmohammadi, 1987; Benbasat and Nault, 1990; Messier and Hansen, 1987). These categorizations map to the continuum of the levels of structure inherent in the problem domain (Abdolmohammadi, 1987; Benbasat and Nault, 1990; Messier and Hansen, 1987). Highly-structured problem domains relate to well-defined problems and highly-unstructured problem domains relate to ill-defined problems (Abdolmohammadi, 1987). Semi-structured problem domains fall in the middle
of the “structured-unstructured” continuum and relate to problems which are reasonably defined. Deterministic aids are designed to help users in highly-structured problem domains. Decision support systems are designed to help users apply judgment in semi-structured problem domains. Expert systems are designed to represent the expertise of experts in highly-unstructured problem domains (Abdolmohammadi, 1987).

However, this study does not confine itself under such categorization because it does not examine the type of decision aids per se. Rather, the research objective is to examine the effects of decision aid design on decision-making outcomes which can be applied to different types of decision aid. A better framework to understand the contributions of this study to the decision aid literature is obtained from Rose’s (2002) review of the decision aid literature that focuses on the effects of use of decision aids rather than the types of decision aids. Rose (2002) broadly categorized decision aid studies into three main research streams: decision quality, decision aid reliance and knowledge acquisition. This study maps to the “decision quality” research stream as the goal is to investigate whether using decision aids designed to be more structurally-restrictive affects users’ decision-making performance.

Prior studies in the “decision quality” stream compared the decision-making outcomes of aided and unaided decision-makers to demonstrate the usefulness of decision aids to improve decision quality (Arnold et al., 2004; Bonner et al., 1996; Butler, 1985). Prior studies also examined decision quality by investigating the effects of decision aid design on decision-making outcomes, including the orientation of decision aids (positive or negative) (Bedard and Graham, 2002), the information content of decision aids (more or less) (Johnson and Kaplan, 1996; Mascha and Smedley, 2007), the information sequence of decision aids (earlier or later during the decision-making process) (Reneau and Blanthorne, 2001) and match with users’ level of expertise (novice or expert) (Arnold et al., 2004). This study extends the “decision quality” stream by examining another aspect of decision aid design in terms of the degree of
As stated in Chapter One, the objective of this study is to examine the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes. As stated in Section 1.1, the first research question of this study examines whether the degree of structural restrictiveness embedded within a decision aid affects the decision-making benefit of identifying items prompted by the decision aid. The second research question investigates the effects of structural restrictiveness embedded within a decision aid on the decision-making bias of failing to identify items not prompted by the decision aid. To this end, the next two sections review the prior literature concerning the decision-making benefit and bias caused by prompting from decision aids.

2.1.1 Decision-making benefit caused by prompting from decision aids
A major decision-making benefit of using a decision aid is “to provide a structure for the task” as the prompting from the decision aid allows decision-makers to consider the task in a systematic manner (Abdolmohammadi and Usoff, 2001, p. 142). An important intangible benefit of using a decision aid is to assist users to facilitate their thoughts and focus on relevant items (Pieptea and Anderson, 1987). For example, audit firms responded to the issuance of Statement on Auditing Standards (SAS) No. 82, Consideration of Fraud in a Financial Statement Audit, by employing decision aids to focus auditors’ attention on identification of fraud-risk factors (Mock and Turner, 2005).

The above claims of positive attention-directing effects caused by the use of decision aids are empirically supported in the context of judging conditional probability (Bonner et al., 1996), assessing sampling risk (Butler, 1985), assessing inventory obsolescence (Lowe and Reckers, 2000), estimating unfamiliar scenarios (MacGregor, Lichtenstein, and Slovic, 1988), judging importance of tax cases (Wheeler and Arunachalam, 2008) and learning payroll
internal control systems (Eining and Dorr, 1991). These studies\(^6\) show that decision aids are beneficial during the decision-making process as users’ attention is directed to items prompted by the decision aid.

### 2.1.2 Decision-making bias caused by prompting from decision aids

Decision-making bias from using a decision aid arises because decision aids are not necessarily exhaustive and are unlikely to prompt all unique items relevant to a particular situation (Pincus, 1989; Purvis, 1989). Decision aids used in practice “often do not capture all potentially relevant environmental features” (Glover et al., 1997, p. 242). An audit partner interviewed by Dowling and Leech (2007, p. 100) commented that a decision aid “is limited in that the standard questions do not always cover all risks for a specific client. Therefore, users need to consider each client’s specific circumstances and whether other risks not covered by the decision aid need to be considered”.

Several studies confirm the existence of the decision-making bias of failing to identify items not prompted by the decision aid (Asare and Wright, 2004; Johnson and Kaplan, 1996; Pincus, 1989; Wheeler and Arunachalam, 2008). Auditors who had access to a fraud-risk assessment decision aid underestimated the possibility of fraud because they focused only on those risk factors covered by the decision aid and consequently failed to pick up other important risk factors that existed in the fraud-case material but were not listed in the decision aid (Asare and Wright, 2004; Pincus, 1989). Similarly, auditors provided with a list aid focused only on items included in the list and underestimated the probability of unspecified errors not included in the list aid (Johnson and Kaplan, 1996). Tax professionals provided with a checklist aid focused only on the individual factors included in the checklist and did not address other facts of the case (Wheeler and Arunachalam, 2008).

\(^6\) A summary of the above-mentioned empirical studies is provided in Appendix 1.
Decision-making bias has also been demonstrated in the psychology literature (Dube-Rioux and Russo, 1988; Fischhoff et al., 1978). Users of an incomplete decision aid identify problems highlighted explicitly by the decision aid but fail to recognize possible problems that are not addressed by the decision aid (Dube-Rioux and Russo, 1988; Fischhoff et al., 1978).

The above-mentioned studies show that the use of decision aids induces decision-making biases causing users to focus only on items prompted by the decision aid and inadequately consider other items not prompted by the decision aid.

2.1.3 Summary
The use of decision aids can improve users’ decision-making by encouraging the user to consider items that may otherwise not be considered (Bonner et al., 1996; Butler, 1985; Eining and Dorr, 1991; Lowe and Reckers, 2000; MacGregor et al., 1988). However, using a decision aid can lead to a decision-making bias whereby users focus only on the items prompted by the decision aid and fail to adequately consider items not prompted by the decision aid (Asare and Wright, 2004; Dube-Rioux and Russo, 1988; Fischhoff et al., 1978; Johnson and Kaplan, 1996; Pincus, 1989). The next section reviews the output interference literature to provide theoretical explanations for the decision-making benefits and biases associated with using decision aids.

2.2 OUTPUT INTERFERENCE

2.2.0 Introduction
Output interference occurs when the act of recalling some items inhibits recall of others (Brown, 1968; Frederick, 1991; Hoch, 1984; Nickerson, 1984; Raaijmakers and Shiffrin, 1981; Rundus, 1973; Slamecka, 1968). Slamecka (1968) was one of the first to report the output interference phenomenon known as the part-set cueing paradigm by demonstrating that when free recall of a list

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7 A summary of the above-mentioned empirical studies is provided in Appendix 2.
of words is cued by a random subset of words from the list, the probability of recalling any of the remaining words is less than if no cues were provided.

Similarly, Brown (1968) demonstrated the output interference phenomenon by asking participants to recall all the States in United States. Half of the participants were given a list of all the Eastern States to peruse for five minutes before performing the task and the other half were not given any study list. Participants who were exposed to the study list performed poorer in recalling the names of the Western States that were not included in the study list compared with those participants who had not been given the study list. The results show that experimenter-supplied items interfere with participants’ ability to recall the remaining items, resulting in output interference effects.

The output interference phenomenon in memory retrieval is argued to be responsible for the existence of the decision-making bias whereby users focus only on items prompted by the decision aid and fail to adequately consider other items that are not prompted by the decision aid (Frederick, 1991; Hoch, 1984). The next section introduces the Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981) to understand the output interference effects. The next section first describes the SAM theory then reviews the associated literature.

2.2.1 Search of associative memory (SAM) theory
Raaijmakers and Shiffrin (1980; 1981) developed the Search of Associative Memory (SAM) theory to explain the nature of the long-term memory-retrieval process. The long-term memory-retrieval process needs to be understood before the SAM theory can be used to explain the output interference phenomenon.
2.2.1.1 Memory-retrieval process

The SAM theory is built upon a two-phase memory system: short-term memory and long-term memory (Atkinson and Shiffrin, 1968). The role of the short-term memory is to serve as a working memory system to hold newly presented information temporarily in the mind so that decision-makers can process the information and store it in their long-term memory. The most important characteristic of short-term memory is its limited capacity. In contrast, the long-term memory acts as a permanent storage and contains all prior information and new information transferred from the short-term memory. The information is inter-connected in the long-term memory.

Raaijmakers and Shiffrin (1981) developed a simulation model to validate the SAM theory. The SAM theory proposes that the long-term memory-retrieval process is cue-dependent. The memory-retrieval process involves a series of discrete steps. It is first triggered by a question concerning some information stored in a decision-maker’s long-term memory. Next, a retrieval plan is generated to guide the search for the answer. Cues are then collected in the short-term memory based on the retrieval plan. The cues include context cues, item cues and category cues. The cues serve to probe the long-term memory, and thus, are known as probe cues.

After generating the probe cues, the next elements of the memory-retrieval process are the sampling and recovery phases. A localized set of information in the long-term memory is described as an image. When the probe cues are activated in the short-term memory, the images in the long-term memory are sampled. The probe cues activate the images to varying degrees.
The probability of sampling an image (Iᵢ), given a set of probe cues (Q₁, Q₂,…, Qₘ) can be quantified by the following equation:

\[
P_S(I_i \ \mid Q_1, Q_2, \ldots, Q_m) = \frac{\prod_{j=1}^{m} S(Q_j, I_i)^{w_j}}{\sum_{k=1}^{N} \prod_{j=1}^{m} S(Q_j, I_k)^{w_j}}
\]

where:

- \( P_S \) = Probability of sampling
- \( I_i \) = Image
- \( Q_j \) = Set of probe cues
- \( M \) = Number of cues
- \( N \) = Number of images
- \( S(Q_j, I_i) \) = Strength of association between the set of probe cues and the image (Iᵢ)
- \( S(Q_j, I_k) \) = Strength of association between the set of probe cues and all images
- \( W_j \) = Weight of the cues

The left-hand side of the equation represents the probability of sampling image Iᵢ given that the set of probe cues consist of Q₁,…,Qₘ. On the right-hand side of the equation, the numerator relates to the total activation for a given image (Iᵢ) and the denominator relates to the summed activation across all images. Based on the above probability-of-sampling equation, an image which has a higher strength of association with the probe cues is more likely to be sampled from the long-term memory due to the stronger activation. The probability of sampling an image is a function of the strength of association between the probe cues in the short-term memory and the various images in the long-term memory. The strength of association determines the likelihood that a given set of probe cues will elicit a given image.
Once an image has been sampled, the next step is to recall the information encoded in the sampled image. During the recovery phase, the probability of recalling the information encoded in the image can be quantified by the following recovery-rule equation:

\[ P_R(I_i \setminus Q_1, Q_2, ..., Q_M) = 1 - \exp\left(-\sum_{j=1}^{M} W_j S(Q_j, I_i)\right) \]

where:
- \( P_R \) = Probability of recall
- \( I_i \) = Image
- \( Q_j \) = Set of probe cues
- \( M \) = Number of cues
- \( S(Q_j, I_i) \) = Strength of association between the set of probe cues and the image \( I_i \)
- \( W_j \) = Weight of the cues

The above recovery-rule equation indicates that the probability of recalling the information encoded in the image increases as the strength of association between the probe cues and the image \( S(Q_j, I_i) \) increases. The probability of recall depends on the strength of association between the probe cues in the short-term memory and the image in the long-term memory. A higher strength of association results in stronger activation which subsequently lead to a higher probability of recall. After the sampling and recovery phases, the decision-maker conducts evaluations and makes an output decision. If the decision-maker decides to continue the search, the memory-retrieval process loops back to the retrieval plan. The memory-retrieval process repeats until the maximum number of search failures is reached. The series of discrete steps of the memory-retrieval process is illustrated in Figure 2.1.
Figure 2.1: A generalized depiction of the various phases of retrieval in the SAM theory\(^8\) (Raaijmakers and Shiffrin, 1981, p. 97)

Question

Retrieval Plan

Assemble probe cues in short term search

Search-Set Selection
(Restriction to relevant long-term search region)

Sampling of item
(Of aggregate of features)

Recovery
(Of context and item features)

SEARCH

Evaluation
(Context comparisons, Item decisions)

Output Decision

Termination Decision

Response Production

Automatic Retrieval Processes

(Yes)

(No)

(Yes)

Stop

\(^8\) Source: Raaijmakers and Shiffrin (1981, p. 97)
Raaijmakers and Shiffrin (1981) applied the SAM theory’s mathematical-simulation model to the context of a cued-recall task and found the presence of the output interference phenomenon. They compared the recall performance of a control group with no cueing assistance and a cued group supplied with a random subset of words from a list. The simulation results showed that when free recall of a list of words is cued by a random subset of words from the list, the probability of recalling any of the remaining words (target words) is lower for the cued group compared with the control group. Raaijmakers and Shiffrin (1981) argued that the cued group experiences a sampling bias as the cued group’s sampled images contain a greater number of cued words and a smaller number of target words.

2.2.1.2 Application of SAM theory

The SAM theory was extended to recognition memory in 1984 to explain the recognition process (Gillund and Shiffrin, 1984). In a typical recognition task, participants are first shown a list of items, following which they are presented with another list of items which contains some items from the original list. Items which are on the original list are known as “target” items and items which are not on the original list are labeled “distracter” items.

Participants are presented with the set of target and distracter items and are asked to respond “Yes or No” whether they recognize an item. Similar to the original SAM model for recall, the probability of recognizing an item depends on the strength of association between the probe cues in the short-term memory and the images in the long-term memory. The extended SAM model for recognition assumes that a target item results in stronger activation compared with a distracter item which leads to a higher sense of familiarity. Therefore the target item has a higher probability of being recognized by the participant than the distracter item.
The SAM theory was used to explain that as more items are added to a list, the probability of remembering the original items decreases, known as the list-length effect (Gillund and Shiffrin, 1984). The SAM theory was subsequently used to explain the list-strength effect (Ratcliff, Clark, and Shiffrin, 1990a, 1990b). The list-strength effect shows that strengthening or weakening some items on a list affects the retrieval of the remaining list items (Ratcliff et al. 1990a). The SAM theory was extended to allow the modeling of episodic recognition memory, which relates to memory of a specific event (Shiffrin and Steyvers, 1997).

2.2.1.3 Applicability of SAM theory

Earlier studies on output interference focus mainly on simple memory tasks such as the recall of words from a list of words (Nickerson, 1984; Slamecka, 1968). Since then, researchers have extended the study of output interference to more complex tasks, including investment decisions (Moser, 1989), analytical procedures judgment (Anderson, Kaplan, and Reckers, 1992), internal control judgment (Frederick, 1991) and hypothesis generation (Heiman-Hoffman, Moser, and Joseph, 1995; Hoch, 1984; Pei and Tuttle, 1999).

Nickerson (1984) reviewed several theoretical explanations for the output interference phenomenon and concluded that none completely explained the output interference phenomenon. Among the various theoretical explanations, Nickerson (1984, p. 550) suggests that the Search of Associative Memory (SAM) theory proposed by Raaijmakers and Shiffrin (1981) provides “the most adequate account of the inhibitory efforts of part-set cuing” and makes the “most precise predictions”. A strength of the SAM theory is its powerful mathematical model which explains the memory-retrieval process (Nickerson, 1984).

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9 A summary of the above-mentioned accounting-related output interference studies is provided in Appendix 3.
The SAM theory (Raaijmakers and Shiffrin, 1981) explains that the long-term memory-retrieval process is cue-dependent based on the strength of association between probe cues in short-term working memory and knowledge stored in long-term memory. This relationship resembles the cued-recall process in the presence of prompting from a decision aid. Decision aids are often used to direct users’ attention to items prompted by the decision aid (Bonner et al., 1996; Butler, 1985). However, output interference occurs as decision-makers are focusing on the items prompted by the decision aid because it is unlikely for a decision aid in most instances to prompt for all possible items that should be considered in making a decision (Glover et al., 1997).

2.2.2 Summary
Prior studies in the literature have demonstrated the presence of output interference. This section has reviewed the Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981) which provides a quantitative mathematical model for understanding the memory-retrieval process and the associated output interference effect. Images in the long-term memory which have greater strength of association with the probe cues in the short-term memory have a higher probability of being recalled. This study posits that the strength of association between the probe cues in the short-term memory and images in the long-term memory can be further differentiated by the degree of structural restrictiveness embedded within a decision aid.

As structural restrictiveness is the prime focus of the study and is one of the three sources of system restrictiveness, the next section reviews the system restrictiveness literature.
2.3 SYSTEM RESTRICTIVENESS

2.3.0 Introduction
This study examines an aspect of decision aid design in terms of the degree of structural restrictiveness embedded within the decision aid to investigate whether it affects the decision-making benefit of identifying items prompted by the decision aid and the decision-making bias of failing to identify items not prompted by the decision aid. A greater degree of structural restrictiveness embedded within a decision aid further increases the prominence of the prompts by forcing decision-makers to adapt their decision-making process to match the decision aid. Structural restrictiveness is one of the three predominant sources of system restrictiveness identified within the system restrictiveness literature. It is important to recognize that there are three different sources of restrictiveness so that the construct of structural restrictiveness is properly operationalized in this study.

2.3.1 Sources of system restrictiveness
System restrictiveness was originally defined by Silver (1988b, p. 259) in the information systems literature as “the degree to which and the manner in which a Decision Support System restricts its users’ decision-making processes to a particular subset of all possible processes.” The concept of system restrictiveness has been broadened in the subsequent literature (DeSanctis and Poole, 1994; Dowling and Leech, 2007; Kim et al., 1998; Vessey et al., 1992; Wheeler and Valacich, 1996). The system restrictiveness literature identifies three predominant sources of system restrictiveness: physical, structural and process restrictiveness. Physical and structural restrictiveness arise from the system itself while the sources of restriction for process restrictiveness are external to the system. Each of these sources of restrictiveness is now described and discussed.
2.3.1.1 Physical restrictiveness

Physical restrictiveness is derived from the physical limitations of a system caused by the finite functional capabilities it contains (Chu and Elam, 1990; Silver, 1988a, 1988b, 1988c, 1990) (i.e., the extent of decision support received by decision-makers when they are using a system). The functional capabilities of a system are determined by the number of physical features it possesses (Davern and Kamis, 2006; Speier and Morris, 2003) or the type of information display it provides (Tabatabaei, 2002).

Physical restrictiveness is innate within a system. Each system contains a finite set of features, which in turn determines its functional capabilities, that is, what the system can and cannot do. If a system does not offer a particular feature to support a certain decision-making process, system users will not be assisted if they try to employ this process. Also, if a system offers only one feature, then users will be compelled to employ the particular decision-making method associated with that sole feature. For example, if a system has the functional capabilities to support both “elimination by aspects (EBA)\(^{10}\)” and “additive-compensatory (AC)\(^{11}\)” decision-making methods, users will have a choice in their decision-making process. In contrast, for a more-restrictive system that provides only one feature to support either the EBA or AC method, users will be compelled to employ the supported method of making the decision.

Davern and Kamis (2006) adopted the above view of physical restrictiveness in their study and developed two decision-support tools that differed in terms of their functional capabilities: an eliminative tool (ELIM) and a parametric search (PS) tool. They argue that ELIM is a more-restrictive tool since it provides only a subset of the functional capabilities offered by PS. Decision-makers using PS can accomplish everything that ELIM can support and more but not vice versa.

\(^{10}\) The “elimination by aspects (EBA)” method is based on a comparison of attribute values across the alternatives. An alternative will be eliminated if any of the attribute values does not meet the threshold level (Todd and Benbasat, 2000).

\(^{11}\) Decision-makers using the “additive-compensatory (AC)” method will evaluate one alternative at a time across all relevant attributes. The alternative with the highest weighted attribute score will be chosen (Todd and Benbasat, 2000).
Thus, decision-makers using ELIM are more limited in their decision-making process than decision-makers using PS. These results show that the less-restrictive tool (PS) provides more opportunity to exert effort which indirectly results in a higher level of decision accuracy. However, the less-restrictive tool (PS) yields poorer performance for more-knowledgeable decision-makers.

Similarly, Speier and Morris (2003) viewed physical restrictiveness in terms of the number of physical features offered by a system. They compared the visual- versus text-based query interface design. The visual-based query interface can achieve all that the text-based query interface can support and yet offer additional physical features, including direct manipulation, immediate feedback and detail on demand. Thus, they argue that text-based query interface is more restrictive due to its smaller subset of physical features. Therefore, decision-makers using the text-based query interface are more limited in their decision-making process than decision-makers using the visual-based query interface. These findings demonstrate that when task complexity is high, decision accuracy is higher when the less-restrictive visual-based query interface is employed. This suggests that the additional physical features offered by the less-restrictive interface allow users to more-effectively deal with increased task complexity.

The above two studies illustrate how decision-makers can be limited in their decision-making process by the number of physical features offered by a system. Decision-makers can also be restricted by a system in terms of the type of information display it provides. Tabatabaei (2002) varied three levels of information display: (a) display of information by alternative, (b) display of information by attribute, and (c) display of the full-information matrix. Display by alternative or attribute are considered in the study as more restrictive than the full-information matrix because they display a smaller subset of information compared with the full-information matrix display. The full-information matrix display contains all the information available in the display by alternative or attribute and more. Thus, decision-makers using the display of information by
alternative or by attribute are more limited in their decision-making process than
decision-makers using the full-information matrix display due to the smaller
subset of information they receive.

Tabatabaei (2002) provides evidence that the less-restrictive full-information
matrix display treatment results in a choice of information processing and the
two more-restrictive information display treatments are successful in channeling
participants to employ the supported information-processing pattern. Participants who were assigned to the display by alternative (attribute)
treatment ended up exhibiting alternative-based (attribute-based) processing
behaviors. As hypothesized, information processing by alternative results in
higher decision accuracy than by attribute. Decision accuracy for the non-
channeled full-information matrix display group lies between the two more-
restrictive information display groups because participants in the full-information
matrix display group could follow either the alternative-based or attribute-based
information processing.

The foregoing studies\(^\text{12}\) demonstrate that the degree of physical restrictiveness
is an important design consideration for a decision tool as it affects the decision-
making process. However, the findings are mixed in terms of the effects of
physical restrictiveness on decision outcomes. In conclusion, the source of
physical restrictiveness is internal to a system as it is caused by its finite
functional capabilities. Users of a system are limited in their decision-making
process by what the system can and cannot do.

\(^{12}\) A summary of physical restrictiveness related studies is provided in Appendix 4 (Panel A).
In addition, physical restrictiveness is a relative concept: a system has to be an exact subset of another system in order to assess whether it is a more or less physically-restrictive system (Davern and Kamis, 2006; Silver, 1988a, 1988b, 1988c; Speier and Morris, 2003; Tabatabaei, 2002). If a system is not an exact subset of another system, we can only conclude that they differ in their physical restrictiveness but we cannot identify which is the more physically-restrictive DSS (Silver, 1988c).

This relative view of physical restrictiveness is portrayed schematically in Figure 2.2 (Silver, 1988c, p. 55). The outermost ellipse represents all possible decision-making processes for solving a problem, irrespective of any system. The two smaller inner ellipses represent those decision-making processes supported by the function capabilities of Decision Support System (DSS) A and B respectively. DSS B is viewed as more restrictive than DSS A only in Panel A of Figure 2.2 as the set of features available in DSS B is a proper subset of DSS A. DSS A contains all the features of DSS B and more. In other words, DSS A can provide all the supported decision-making processes of DSS B but not vice versa. Therefore, DSS B is viewed as more restrictive than DSS A. On the other hand, where DSS B is not an exact subset of DSS A (see Panels B and C of Figure 2.2), we can conclude only that DSS A and B differ in their physical restrictiveness but we cannot identify which is the more physically-restrictive DSS (Silver, 1988c).
Figure 2.2: Physical restrictiveness of two decision support systems (DSS) for the same decision\(^\text{13}\) (Silver, 1988c, p. 55)

Panel A: DSS B is a proper subset of DSS A

```
All possible processes

Processes supported by DSS A

Processes supported by DSS B
```

Panel B: DSS A and DSS B do not overlap

```
All possible processes

Processes supported by DSS A

Processes supported by DSS B
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Panel C: DSS B is not an exact subset of DSS A

```
All possible processes

Processes supported by DSS A

Processes supported by DSS B
```

\(^{13}\) Source: Silver (1988c, p. 55).
2.3.1.2 Structural restrictiveness

Another source of system restrictiveness is “structural restrictiveness”. Structural restrictiveness arises from the structural features embedded within a technology (DeSanctis and Poole, 1994; Lynch and Gomaa, 2003). DeSanctis and Poole (1994, p. 126) describe structural features as the “specific types of rules” embedded within the system. Lynch and Gomaa (2003, p. 304) consider structural features as a form of control and assert that a more-restrictive system tends to include “more embedded control mechanisms that limit the range of activities in which individuals can engage”. McLeod and Liker (1992, p. 195) regard structural features as the “explicit rules and procedures embedded in the software”.

Similar to physical restrictiveness, structural restrictiveness assumes that the source of restrictiveness is internal to the system. However, instead of focusing on the functional capabilities of the system, structural restrictiveness focuses on the structural features embedded within the system that restrict how users interact with the physical features of the system (Anson et al., 1995; DeSanctis and Poole, 1994; Kim et al., 1998; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Vessey et al., 1992; Wheeler and Valacich, 1996).

The following analogy differentiates physical and structural restrictiveness. As discussed in section 2.3.1.1, physical restrictiveness is related to the number of physical features offered by the system; the more features the less restrictive a system is. For example, a system that only offers two physical features (Features A and B) will limit a user’s decision-making process more than a system that offers these two features plus an additional feature (i.e. Features A, B and C). The absence of the functional capabilities offered by the additional Feature C hinders users of the system that only offers Features A and B from engaging the process of decision-making supported by Feature C.
In contrast, structural restrictiveness is how a system is designed to restrict the interaction between users and the physical features included in the system. For example, consider two systems that offer the same number of physical features (Features A, B and C), but differ in how freely users can interact with these features. The interaction between users and physical features will determine the manner in which the system limits a user’s decision-making process. For example, a system can be designed to be more structurally-restrictive so that users are forced to use only Features A, B and C in a particular sequence as compared with a less-restrictive manner where users are free to use physical features in any sequence they desire. The more-restrictive design will force users to use the system in a prescribed manner, thus affecting their decision-making processes.

The foregoing view of structural restrictiveness is adopted in the computer-aided software engineering (CASE) tool literature for CASE-tool classification studies. Vessey et al. (1992) developed an independent restrictive, guided or flexible classification scheme and classified twelve commercially available CASE tools accordingly. The twelve CASE tools all offered the same functional capabilities but differed in the degree of structural restrictiveness embedded within the tool. Restrictive CASE tools are designed so as to force system developers to use a prescribed system-development methodology, for example, a top-down approach, to data flow diagrams. If the system developer does not follow the top-down approach, the restrictive CASE tool will display error messages and will not permit the system developer to continue. In comparison, guided CASE tools are designed to encourage but not to enforce system developers to use tools in a prescribed way. As for flexible CASE tools, there are no structural features embedded within the tools to enforce a prescribed system-development methodology. Therefore, users of a flexible CASE tool are not restricted by any structural feature and have complete freedom in using the tool. They can choose to use either the top-down or bottom-up approach to data flow diagrams. Vessey et al. (1992) suggest that the difference in degree
of structural restrictiveness embedded within the CASE tool restricts how system developers interact with the tool.

In the group decision support system (GSS) literature, researchers claim that the use of a GSS provides structure for a group’s decision-making process through the rules and procedures embedded within the GSS (Anson et al., 1995; McLeod and Liker, 1992). However, the results have been mixed.

Anson et al. (1995, p. 193) argued that the decision-making process of groups with access to a GSS are more restricted than unaided groups, given that there is “a limited set of structured procedures” embedded within a GSS. Due to the “structured procedures” of the GSS, they hypothesized that the GSS groups will achieve better decision outcomes than unaided groups. However, these results show that the use of a GSS does not significantly improve task performance, even though the use of a GSS does affect the groups’ decision-making processes.

Similarly, McLeod and Liker (1992) argued that groups with access to a GSS experience a greater structuring intervention caused by the interaction with the GSS compared with groups who are not using a GSS. These findings illustrate that the use of a GSS leads to better performance in a well-known item-ranking evaluative task but leads to worse performance for an ambiguous response-generative task. These results suggest that it is important to consider the characteristics of the GSS and the task. The public non-anonymous nature of the GSS utilized in the experiment appears to suit the well-known evaluative task more than the ambiguous generative task.

McLeod and Liker (1992, p. 195) also discussed the differences between a high-structure and low-structure GSS. They assert that a high-structure system contains “explicit rules and procedures” to change a group’s pre-existing structures and govern users’ interaction and decision-making process. In contrast, there is no particular structure that is inherent in a low-structure
system as it is not designed specifically to change group structure and processes. The high-structure GSS is viewed in the study as more restrictive than the low-structure GSS because the embedded rules and procedures limit users’ interaction with the system and thus, govern the group decision-making process. However, it is uncertain whether a greater degree of structural restrictiveness affects the decision-making outcomes as McLeod and Liker (1992) only utilized a low-structure GSS in their study.

Other researchers have tested two versions of the same GSS that differ only in the degree of structural restrictiveness embedded within them (Kim et al., 1998; Wheeler and Valacich, 1996). Kim et al. (1998) tested two versions of a distributed group support system (DGSS). Both versions contained the same functional capabilities but differed in terms of structural features embedded within the system. Both versions ultimately allowed users to view all the discussion topics but the presentation format of the topics differed. One version of the DGSS supported parallel-coordination mode where the complete discussion topics were presented at the beginning of the experiment and participants could discuss any topic at any time. On the other hand, the other version of the DGSS supported the sequential-coordination mode where the discussion topics were presented sequentially one at a time. Kim et al. (1998) argued that the sequential-coordination mode is more restrictive than the parallel-coordination mode because of its pre-defined and inflexible interaction pattern. The less-restrictive parallel-coordination mode group had higher objective and perceived decision quality and satisfaction measures than the more-restrictive sequential-coordination mode group.

The results of Wheeler and Valacich (1996) conflict with Kim et al. (1998). Wheeler and Valacich (1996) found that groups using the more-restrictive GSS configuration followed the structure of the heuristic more closely than the less-restrictive group, resulting in higher decision quality. In their study, structural restrictiveness was operationalized by manipulating the GSS configuration. Half of the groups used a more-restrictive GSS configuration that displayed a
sequenced agenda. The agenda items were presented in a sequential manner, one item at a time. The other half of the groups used a less-restrictive GSS configuration where users were free to employ the GSS features in any manner they choose.

In summary, structural restrictiveness is determined by the internal structural features embedded within a system that restrict how users interact with the physical features of the system. Users of a system have to adapt their decision-making process to match the way the structural features embedded in the system restrict its use. However, the findings\textsuperscript{14} are inconclusive in terms of the effects of structural restrictiveness on decision-making outcomes. In addition, the above studies relate to a group’s decision-making process. It is unclear whether the findings will generalize to an individual’s decision-making process.

2.3.1.3 Process restrictiveness

In contrast to physical and structural restrictiveness which arise from within a system, process restrictiveness arises from the heuristics\textsuperscript{15} imposed by sources external to the system such as instructions imposed on users (DeSanctis, D’Onofrio, Sambamurthy, and Poole, 1989), the presence of a facilitator (Anson et al., 1995; Dickson, Partridge, and Robinson, 1993; Kim et al., 1998; Wheeler and Valacich, 1996) and training (Wheeler and Valacich, 1996). Similar to the other two sources of system restrictiveness, process restrictiveness restricts how users interact with and employ the system. A greater degree of process restrictiveness means that users face greater restriction from external sources to interact with the physical features of the system in a particular manner.

\textsuperscript{14} A summary of structural restrictiveness related studies is provided in Appendix 4 (Panel B).

\textsuperscript{15} Heuristics consist of structures which “describe a particular activity, specify a sequence of activities or describe a philosophy for communication” (Wheeler and Valacich, 1996, p. 431). Heuristics provide rules and describe the subset of possible activities to which the decision-making process will be restricted (Wheeler and Valacich, 1996).
As mentioned above, one of the external sources of process restrictiveness arises from the instructions imposed on users to govern their interaction with a system. DeSanctis et al. (1989) manipulated the high-restrictive treatment by instructing half of the groups to use all the available features of a system in a sequential manner. In contrast, the other half of the groups in the low-restrictive treatment were told that they were free to use, or not use, any feature and could apply the selected features in any sequence. DeSanctis et al. (1989) argued that the second treatment is less restrictive as the participants are left on their own accord in an open-ended manner when there are no instructions, whereas the participants in the first treatment are given a structure to their execution as they are told explicitly what to do. However, the results of this study show that greater restrictiveness does not result in greater group consensus and faster decision time as hypothesized.

Another external source of process restrictiveness is the presence of a human facilitator to govern users’ interaction with the system. This source is commonly studied in the group decision support system literature and the findings have been mixed. Wheeler and Valacich (1996) investigated the facilitator effect on decision accuracy by assigning participants to facilitated or un-facilitated groups. Facilitated groups were subjected to greater process restrictiveness as the facilitator enforced a level of structure on their decision-making that was not enforced for the groups with no facilitator. The role of the facilitator is to monitor users to ensure they use the system in a particular manner. These results show that the more-restrictive facilitated groups follow the structure of the heuristic more closely than the less-restrictive un-facilitated groups, resulting in higher decision accuracy. Similarly, Anson et al. (1995) also hypothesized that facilitated groups will outperform un-facilitated groups due to the structure imposed on the decision-making process. However, these results show that the presence of a facilitator does not improve group performance but does significantly improve group relationships and the perceived quality of the group interaction process.
The above two studies compared facilitated and un-facilitated groups. Dickson et al. (1993) and Kim et al. (1998) extended the literature by investigating other roles of a facilitator. Dickson et al. (1993) manipulated two GSS support modes: facilitator-driven and chauffeur-driven. In a facilitator-driven mode, the facilitator plays an active role in directing the group members on what GSS features to use, and when and how to use them. In a chauffeur-driven mode, the facilitator plays a passive role by merely acting as a chauffeur in implementing the features of the GSS upon directions from the group. They argue that the degree of process restrictiveness is lower for the chauffeur-driven mode as the chauffeur does not affect the group decision-making process. Dickson et al. (1993) found that the less-restrictive chauffeur-driven support mode achieved higher levels of post-meeting consensus than the more-restrictive facilitator-driven support mode. These results highlight that imposing structure on a group’s decision-making process does not necessarily lead to greater consensus as expected. The study by Dickson et al. (1993) examines group consensus as the performance measure and the effects on decision-making outcomes are unclear.

Kim et al. (1998) examined the role of the facilitator as a group leader. In their experiment, groups without leaders were asked to respond to procedures imposed by the GSS and were not allowed to modify any procedures. On the other hand, leaders were given freedom to modify procedures imposed by the GSS. Kim et al. (1998) argued that groups with leaders are considered less restrictive as a group leader has the flexibility not to follow the procedures imposed by the GSS and choose to create new procedures for the group. These results showed that the less-restrictive groups with a leader achieve higher objective and perceived decision quality and satisfaction measures than the more-restrictive groups without leaders.
Training is another external source of process restrictiveness. Investigating this phenomenon, Wheeler and Valacich (1996) assigned participants to trained or un-trained groups. The trained groups received training in how and why to use the activities, sequences and philosophy of the decision heuristic. They argued that training provides a passive form of process restrictiveness as users are influenced by the training to interact with a system in a particular manner. These results show that the more-restrictive trained groups achieved higher decision quality because they followed the structure of the heuristic more closely than the less-restrictive untrained group.

In summary, process restrictiveness arises from sources external to the system such as instructions imposed on users, the presence of a facilitator and specialized training, that all restrict how users interact with the physical features of a system. These external sources restrict how much freedom a user has during interaction with a system. As these external sources of restriction are capable of enforcing structure during the decision-making process, users are affected by these external sources to interact with systems in a particular manner. The findings are mixed in terms of the effects of process restrictiveness on decision outcomes.

2.3.2 Summary
The degree of system restrictiveness embedded within technologies restricts how users interact with the technology. The foregoing discussion has identified three predominant sources of system restrictiveness: physical, structural and process restrictiveness (see Figure 2.3). The restriction on users’ decision-making process can be achieved in two ways by focusing on the number of physical features (physical restrictiveness) or focusing on users’ interaction with the physical features (structural and process restrictiveness).

\[16\] A summary of process restrictiveness related studies is provided in Appendix 4 (Panel C).
Figure 2.3: Sources of system restrictiveness

- **Physical features**
  - **Physical Restrictiveness**
    - Extent of functional capabilities supported by the system.
  - **Internal to System**
  - **External to System**

- **Interaction with the physical features**

- **Structural Restrictiveness**
  - Design of the structural features embedded within the system that restricts how users interact with the physical features of the system.

- **Process Restrictiveness**
  - External sources of restriction such as specific instructions imposed on users, presence of a facilitator and training that restrict how users interact with the physical features of the system.
The difference between structural and process restrictiveness lies in the source of restriction. For structural restrictiveness, the source arises from the structural features embedded internally within the system whereas for process restrictiveness, the source arises externally to the system such as instructions imposed on users, the presence of a facilitator and training.

Although the sources of physical, structural and process restrictiveness are different, they overlap to restrict how users interact with a technology. This study investigates the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes. Assuming that the optimal physical features have been included in a decision aid, the next important step is to consider the extent to which structural restrictiveness determines how users interact with and use the physical features of a decision aid.

Moreover, the effects of physical restrictiveness on an individual’s decision-making have been examined in prior research. For example, Eining et al. (1997) examined how three different types of decision aids (checklists, logit statistical models and expert systems) affect auditors’ fraud assessment, and Bonner et al. (1996) compared the conditional-probability judgment of auditors provided either with a checklist or a decomposition and mechanical-aggregation decision aid. Such studies focus on the effects of the different functional capabilities of a decision aid on an individual’s decision-making.

Process restrictiveness is a passive form of restrictiveness because the sources of restriction for process restrictiveness are not administered at the exact instances when users are interacting with decision aids during their decision-making phase (DeSanctis et al., 1989; Wheeler and Valacich, 1996). In addition, the use of a facilitator as a form of process restrictiveness is more applicable in a group decision-making context. Therefore, this study does not focus on investigating the effects of process restrictiveness.
2.4 CHAPTER SUMMARY

This chapter reviewed the prior literature on decision-making benefits and biases caused by prompting from decision aids as the research questions examine the effects of structural restrictiveness embedded within a decision aid on users' decision-making outcomes. The chapter also introduced the Search of Associative Memory (SAM) theory (Raaijmakers and Shiffrin, 1981). The SAM theory provides insights into decision-makers’ long-term memory-retrieval process and helps to understand how decision aids may cause output interference, resulting in decision-making biases. Structural restrictiveness is one of the three predominant sources of system restrictiveness identified within the system restrictiveness literature. The chapter has discussed the three sources of system restrictiveness: physical, structural and process restrictiveness. The next chapter develops the hypotheses from the theory presented in the current chapter.
CHAPTER THREE : HYPOTHESES DEVELOPMENT

3.0 INTRODUCTION
This chapter draws on the review of the theory and prior research in Chapter Two to develop the hypotheses. The chapter is structured as follows. Section 3.1 develops the hypotheses related to the effects of using decision aids on decision-makers’ performance. Section 3.2 develops the hypotheses related to the effects of structural restrictiveness embedded within a decision aid on decision-makers’ performance. Section 3.3 explains the need to control for the effects of task-specific knowledge. The last section provides a summary of the hypotheses.

Hypothesis 1 relates to the effects of using decision aids on identification of items prompted by the decision aid. Hypothesis 2 relates to the effects of using decision aids on identification of items not prompted by the decision aid. Hypothesis 3 relates to whether a greater degree of structural restrictiveness embedded within a decision aid affects the identification of items prompted by the decision aid. Hypothesis 4 relates to whether a greater degree of structural restrictiveness embedded within a decision aid affects the identification of items not prompted by the decision aid.

3.1 THE EFFECTS OF USING DECISION AIDS ON DECISION-MAKERS’ PERFORMANCE
As discussed in Sections 2.1, although decision aids can improve users’ decision-making performance (Arnold et al., 2004; Bonner et al., 1996; Butler, 1985; Eining and Dorr, 1991; Lowe and Reckers, 2000; MacGregor et al., 1988), it also has the potential to induce decision-making biases (Arnold et al., 2004; Asare and Wright, 2004; Pincus, 1989). Section 3.1.1 hypothesizes the effects of using decision aids on identification of items prompted by the decision aid and Section 3.1.2 hypothesizes the effects of using decision aids on identification of items not prompted by the decision aid.
3.1.1 The effects of using decision aids on identification of items prompted by the decision aid

The Search of Associative Memory (SAM) theory\textsuperscript{17} explains the nature of the long-term memory-retrieval process (Raaijmakers and Shiffrin, 1981). Applying the SAM theory (Raaijmakers and Shiffrin, 1981) to a generic decision-making context, decision-makers’ knowledge of items is encoded and stored in their long-term memory as images. Decision-makers need to retrieve the images of items stored in their long-term memory in order to make a decision.

As discussed in Section 2.2.1.1, the SAM theory proposes that the long-term memory-retrieval process is cue-dependent. Based on SAM theory (Raaijmakers and Shiffrin, 1981), decision-makers collect case-specific probe cues in their short-term working memory while making a decision for a specific case. After picking up case-specific probe cues in their short-term working memory, the next phases of the memory-retrieval process for decision-makers are the sampling and recovery phases. The issue during the sampling and recovery phase is whether decision-makers can recall images of items from their long-term memory and identify all items in the case by relating case-specific probe cues stored in their short-term working memory to knowledge of items stored in their long-term memory.

During the sampling and recovery phases, the case-specific probe cues gathered in decision-makers’ short-term working memory activate images of items in their long-term memory to varying degrees. According to the SAM theory (Raaijmakers and Shiffrin, 1981), the degree of activation depends on the strength of association between case-specific probe cues stored in decision-makers’ short-term working memory and images of items stored in their long-term memory.

\textsuperscript{17} The Search of Associative Memory (SAM) theory was described in Section 2.2.1.
Moreover, following the SAM theory's probability of sampling\(^{18}\), an item which has a higher strength of association has a higher probability of being elicited from long-term memory of a decision-maker due to the stronger activation. After the image of the item has been sampled, the next recovery step is to recall the name of the item encoded in the sampled image. The probability of recalling\(^{19}\) the name of the item for decision-makers also depends on the strength of association between case-specific probe cues stored in their short-term working memory and images of the items stored in their long-term memory.

As a result, an item which has a higher strength of association has a higher probability of being elicited from long-term memory and thus it is more likely to be identified by a decision-maker. The memory-retrieval process when no decision aid is used is illustrated in Figure 3.1.

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\(^{18}\) The probability of sampling an image was discussed in Section 2.2.1.1.

\(^{19}\) The probability of recalling the information encoded in the image was discussed in Section 2.2.1.1.
Figure 3.1: A flowchart for the memory-retrieval process of identifying items based upon the SAM theory (Raaijmakers and Shiffrin, 1981)

- Question
- Collect probe cues in the short-term memory
- Let \( S \) = Strength of association between probe cues in short-term memory and images of the items in long-term memory
  - No
    - Is \( S \) High?
      - Yes: Higher probability of eliciting the image of the item from long-term memory
      - More likely to identify the item
      - Lower probability of eliciting the image of the item from long-term memory
      - Less likely to identify the item
  - Yes: Lower probability of eliciting the image of the item from long-term memory
  - Lower probability of identifying the item
  - Sampling Phase
  - Recovery Phase
Using a decision aid affects the memory-retrieval process by highlighting case-specific items that decision-makers should focus on (Eining and Dorr, 1991; Piepelea and Anderson, 1987; Pincus, 1989). Prior studies support the positive attention-directing effects of using decision aids on decision-makers’ performance (Bonner et al., 1996; Butler, 1985; Lowe and Reckers, 2000). Bonner et al. (1996) demonstrated that a decision aid is useful in prompting auditors to recall potential errors, resulting in better judgments. Butler (1985) found that using a decision aid can focus auditors’ attention to consider possibly underutilized information which lead to more-accurate sampling risk assessments. Lowe and Reckers (2000) demonstrated that a decision aid is effective in directing auditors to consider other potential outcomes.

Using a decision aid directs the attention of the decision-makers to case-specific items that decision-makers should consider, focusing decision-makers’ attention on the prompted items (Bonner et al., 1996; Butler, 1985; Lowe and Reckers, 2000). Thus, when using a decision aid, the memory-retrieval process resembles a cued-recall process. As decision-makers focus on the items prompted by the decision aid, the focused attention results in an increase in the strength of association between the prompted case-specific probe cues stored in their short-term working memory and the knowledge stored in their long-term memory (Nickerson, 1984; Pei and Tuttle, 1999; Ratcliff et al., 1990a). The memory-retrieval process when using a decision aid is illustrated in Figure 3.2.
Figure 3.2: A flowchart for the memory-retrieval process of identifying items with a decision aid based upon the SAM theory (Raaijmakers and Shiffrin, 1981)

1. **Question**
   - Collect probe cues in the short-term memory

2. **Let $S$ = Strength of association between probe cues in short-term memory and images of the items in long-term memory**

3. **Prompting from a decision aid?**
   - **No (Non-prompted Items)**
     - **Decrement of the strength of association ($S$)**
     - **Lower probability of eliciting the image of the item from long-term memory**
     - **Less likely to identify the item**
   - **Yes (Prompted Items)**
     - **Increment of the strength of association ($S$)**
     - **Higher probability of eliciting the image of the item from long-term memory**
     - **More likely to identify the item**

**Sampling Phase**
- Increment of the strength of association ($S$)

**Recovery Phase**
- Decrement of the strength of association ($S$)

**Is $S$ High?**
- **No**
  - Lower probability of eliciting the image of the item from long-term memory
  - Less likely to identify the item
- **Yes**
  - Higher probability of eliciting the image of the item from long-term memory
  - More likely to identify the item
Prompting strengthens the association between case-specific probe cues stored in a decision-maker’s short-term working memory and knowledge of the items stored in their long-term memory (Nickerson, 1984; Pei and Tuttle, 1999; Ratcliff et al., 1990a). Following the SAM theory (Raaijmakers and Shiffrin, 1981), an item which has a higher strength of association has a higher probability of being elicited from long-term memory and thus it is more likely to be identified by a decision-maker. Therefore, if a decision aid is used in the memory-retrieval process, decision-makers are better able to identify items as compared with a memory-retrieval process without the aid of prompting from the decision aid. This suggests the following hypothesis.

$$H_1 : \text{Decision-makers who use a decision aid that prompts them to consider specific items will correctly identify more of the prompted items than decision-makers who do not have access to a decision aid.}$$

3.1.2 The effects of using decision aids on identification of items not prompted by the decision aid

Although using decision aids can improve decision-makers’ performance by encouraging the decision-maker to consider items that they may otherwise not consider, using decision aids can also induce decision-making biases of failing to consider items not prompted by the decision aid (Asare and Wright, 2004; Dube-Rioux and Russo, 1988; Fischhoff et al., 1978; Johnson and Kaplan, 1996; Pincus, 1989). For example, Pincus (1989) and Asare and Wright (2004) illustrated that auditors provided with a decision aid under-assessed the possibility of fraud risk because they focused only on factors prompted by the decision aid and did not adequately consider other factors that were not prompted by the decision aid.
Prior studies in the psychology literature have also found that using a decision aid can induce decision-making biases. Fischhoff et al. (1978) and Dube-Rioux and Russo (1988) demonstrated that decision-makers identified only problems that were highlighted explicitly in a fault tree and overlooked problems that were not addressed by the fault tree, resulting in an underestimation decision-making bias.

Decision-making bias induced by using a decision aid has been examined in the output interference literature. Prior studies show that the act of recalling the prompted items interferes with participants’ ability to recall the non-prompted items (Brown, 1968; Frederick, 1991; Hoch, 1984; Nickerson, 1984; Raaijmakers and Shiffrin, 1981; Rundus, 1973; Slamecka, 1968). For example, Brown (1968) demonstrated the output interference effect by asking participants to recall all the States in the United States. The participants given a study list that included only the name of all the Eastern States to peruse for five minutes before performing the recall task were less able to recall the name of the excluded Western States compared with those participants who were not given a study list.

As stated in Section 2.1.2, a decision aid is unlikely to prompt for all possible items that should be considered in making a decision (Dowling and Leech, 2007; Glover et al., 1997). Certain case-specific information may not be prompted by the decision aid, thus, the use of a decision aid does not ensure that a decision-maker will consider all possible items for each case.

Based on *SAM* theory (Raaijmakers and Shiffrin, 1981), the prompting from a decision aid results in a sampling bias for decision-makers when they are trying to elicit images of items from their long-term memory. The *SAM* theory suggests that the sampled images of a decision-maker who uses a decision aid will contain a greater number of items prompted by the decision aid due to the stronger strength of association and thus contain a smaller number of non-prompted items. In contrast, a decision-maker who does not use a decision aid
is not distracted by any prompting and hence is unbiased with respect to sampling the images of items. Due to the sampling bias, decision-makers who use decision aids are more likely to elicit images of prompted items from their long-term memory rather than images of non-prompted items. This suggests the following hypothesis.

\[ H_2 \] : Decision-makers who use a decision aid that prompts them to consider specific items will correctly identify fewer items not prompted by the decision aid than decision-makers who do not have access to a decision aid.

3.2 THE EFFECTS OF STRUCTURAL RESTRICTIVENESS ON DECISION-MAKERS’ PERFORMANCE

The previous two hypotheses focus on the effects of using decision aids in the identification of items. Prompted items have a higher degree of activation from a decision-maker’s long-term memory compared with non-prompted items because prompting strengthens the association between case-specific probe cues stored in a decision-maker’s short-term working memory and knowledge of the items stored in their long-term memory (Nickerson, 1984; Pei and Tuttle, 1999; Ratcliff et al., 1990a).

In addition, this study posits that the strength of the prompts in a decision-maker’s memory can be further differentiated by the degree of structural restrictiveness embedded within a decision aid. This section examines the effects of structural restrictiveness embedded within a decision aid on identification of items. Section 3.2.1 hypothesizes the effects of structural restrictiveness on identification of items prompted by the decision aid and Section 3.2.2 hypothesizes the effects of structural restrictiveness on identification of items not prompted by the decision aid.
3.2.1 The effects of structural restrictiveness on identification of items prompted by the decision aid

Structural restrictiveness\(^{20}\) is determined by the structural features embedded within a system that restrict how a user interacts with the system (Anson et al., 1995; DeSanctis and Poole, 1994; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Vessey et al., 1992). DeSanctis and Poole (1994, p. 126) describe structural features as the “specific types of rules” embedded within a system. The rules limit a user’s decision-making process (Lynch and Gomaa, 2003; McLeod and Liker, 1992; Wheeler and Valacich, 1996).

Increasing the degree of structural restrictiveness within a decision aid forces more limitations on a user’s decision-making process. For example, a more structurally-restrictive decision aid only allows users to use the decision aid in a particular manner whereas a less structurally-restrictive decision aid allows users to use the decision aid in any manner they desire.

A more structurally-restrictive decision aid restricts a user’s decision-making process by restraining how the user interacts with and employs the decision aid. In contrast, users of a less structurally-restrictive decision aid have more freedom in their interaction with the decision aid. By restricting how a user interacts with a decision aid, the degree of structural restrictiveness is expected to affect the extent to which using a decision aid prompts a user’s memory. A more structurally-restrictive decision aid that limits users’ decision-making process by forcing users to interact with the decision aid in a particular manner is expected to strengthen the extent to which the prompt affects the recall of prompted items in their memory.

\(^{20}\) Structural restrictiveness was discussed in Section 2.3.1.2.
According to the *SAM* theory (Raaijmakers and Shiffrin, 1981), the probability of recalling an item depends on the strength of association between probe cues in short-term working memory and images of the items in long-term memory. A higher strength of association results in a higher probability of recall. It is expected that a greater degree of structural restrictiveness embedded within a decision aid results in a higher strength of association because a more structurally-restrictive decision aid increases the prominence of the prompts by forcing users to adapt their decision-making process to match the decision aid.

Due to the higher strength of association, the probability of recalling a prompted item for a decision-maker using a more structurally-restrictive decision aid is higher compared with a decision-maker using a less structurally-restrictive decision aid. Following the *SAM* theory, an item which has a higher probability of recall is more likely to be identified by a decision-maker.

Decision-makers who are using a more structurally-restrictive decision aid are forced to follow the structure imposed on their decision-making process (Lynch and Gomaa, 2003). Therefore, decision-makers who are using a more structurally-restrictive decision aid are more likely to consider all the prompted items compared with decision-makers who are using a less structurally-restrictive decision aid. This suggests the following hypothesis.

$$H_3 : \text{Decision-makers who use a more structurally-restrictive decision aid will correctly identify more of the prompted items than decision-makers who use a less structurally-restrictive decision aid.}$$

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21 The probability of recalling the information encoded in the image was discussed in Section 2.2.1.1.
3.2.2 The effects of structural restrictiveness on identification of items not prompted by the decision aid

As discussed previously in Section 2.2, the output interference literature suggests that the prompting from decision aids produces interference effects in recalling non-prompted items (Frederick, 1991; Nickerson, 1984; Raaijmakers and Shiffrin, 1981). When the items within a decision aid are held constant, the degree of structural restrictiveness embedded within the decision aid is expected to affect the strength of the interference effect. Hypothesis 4 argues that a greater degree of structural restrictiveness embedded within the decision aid increases the interference effect.

As discussed in Section 3.2.1, the case-specific probe cues prompted by a more structurally-restrictive decision aid have an increased prominence in decision-makers' short-term working memory because decision-makers are forced to adapt their decision-making process to match the decision aid. It is expected that the increased prominence of the prompting induced by a more structurally-restrictive design results in a higher strength of association between the prompts stored in decision-makers' short-term working memory and the knowledge of items stored in their long-term memory.

Based on \textit{SAM} theory (Raaijmakers and Shiffrin, 1981), the prompting from a decision aid results in a sampling bias for decision-makers when they are trying to elicit images of items from their long-term memory. As the probability of sampling a prompted case-specific probe cue is higher for a decision-maker using a more structurally-restrictive decision aid, the sampling bias for non-prompted items is expected to be stronger.

Due to the stronger sampling bias, the sampled images of a decision-maker who uses a more structurally-restrictive decision aid is expected to contain more items prompted by the decision aid and fewer non-prompted items compared with a decision-maker using a less structurally-restrictive decision aid. Consequently, decision-makers who use a more structurally-restrictive decision
aid are more likely than decision-makers using a less structurally-restrictive decision aid to elicit images of prompted items from their long-term memory than images of non-prompted items. This suggests the following hypothesis.

\[ H_4 \] Decision-makers who use a more structurally-restrictive decision aid will correctly identify fewer items not prompted by the decision aid than decision-makers who use a less structurally-restrictive decision aid.

3.3 THE EFFECTS OF KNOWLEDGE ON DECISION-MAKERS’ PERFORMANCE
An important determinant of judgment performance is task-specific knowledge (Bonner and Lewis, 1990; Libby and Luft, 1993). Prior research shows that task-specific knowledge significantly affects performance (Bonner, 1990; Choo and Trotman, 1991; Frederick, 1991; Roberts, 1998). Therefore, participants’ pre-existing task-specific knowledge will be used as a covariate in testing the foregoing hypotheses.

3.4 CHAPTER SUMMARY
This chapter developed the hypotheses to be tested in Chapter Six. Hypotheses 1 and 2 compare the decision-making outcomes of aided and unaided decision-makers. Hypothesis 1 predicts that the use of decision aids is beneficial in assisting decision-makers to identify items prompted by the decision aid. However, using decision aids can induce decision-making biases. Hypothesis 2 predicts that the use of decision aids leads to a decision-making bias in identifying items not prompted by the decision aid.

These hypotheses were followed by an examination of the effects of varying the degree of structural restrictiveness embedded within a decision aid to develop Hypotheses 3 and 4. Hypothesis 3 proposes that a greater degree of structural restrictiveness embedded within a decision aid increases the decision-making benefit of using decision aids. Therefore, decision-makers who use a more
structurally-restrictive decision aid identify more items prompted by the decision aid than decision-makers who use a less structurally-restrictive decision aid. On the other hand, Hypothesis 4 proposes that a greater degree of structural restrictiveness embedded within a decision aid increases the decision-making bias. Therefore, decision-makers who use a more structurally-restrictive decision aid identify fewer items not prompted by the decision aid than decision-makers who use a less structurally-restrictive decision aid.

The next chapter presents the research design employed for this study.
CHAPTER FOUR : RESEARCH DESIGN

4.0 INTRODUCTION
This chapter describes the experimental research design employed to test the hypotheses developed in Chapter Three. The chapter is structured as follows. Section 4.1 discusses the rationale for the choice of participants. Section 4.2 describes the development of the experimental cases. Section 4.3 reports the validation process of the experimental cases and model solutions by experts. Section 4.4 details the development of the checklist that was used to develop two versions of a computerized decision aid differing in the degree of structural restrictiveness embedded in their design. The decision aids are described in Section 4.5. Section 4.6 describes the testing process of the experimental materials, including the pre-pilot validation studies, the main pilot study and the revised pilot study. The recruitment of participants and the experimental procedures for the experiment are presented in Section 4.7. The variables are explained in Section 4.8. Section 4.9 describes the coding process. The last section provides a summary of the research design.

4.1 PARTICIPANTS
To test the hypotheses developed in Chapter Three, participants will be required to identify internal control plans in a case narrative. This study focuses on the context of internal control evaluation because decisions aids are often deployed by organizations in evaluating the strengths and weaknesses of internal control systems (Hubbard, 2003, 2005; McCuaig, 2005; Root, 1998; Sobel, 2006; Spencer, 1989). Audit firms also embed decision aids within their computerized audit support systems to assist auditors in internal control evaluation during the planning phase of the audit process (Dowling and Leech, 2007). The importance of effective internal control evaluation was further increased with the introduction of the Sarbanes-Oxley Act (SOA) (2002). Section 404 of the SOA (2002) mandates organizations to include an internal control report in the annual report filed with the U.S. Securities and Exchange Commission (SEC).
Therefore, in choosing the target participants to participate in this study, it is important that the participants have sufficient knowledge of internal control plans to complete the experimental task. One option was to use practising auditors. However, the practising auditors’ level of knowledge of internal control plans is likely to differ because of their varied levels of learning opportunities in an audit setting (Tan, 2001) and experiences (Frederick, 1991). On the other hand, the significant advantage of selecting students over practising auditors is that students are considered a homogenous group and their knowledge of internal control plans is unlikely to differ significantly. Moreover, this study focuses on the fundamental question of whether restricting how users interact with a decision aid affects the user’s ability to identify items prompted and not prompted by the decision aid. Students were therefore used as participants.

In order to ensure that the participants had sufficient and relatively homogenous knowledge to identify present and missing internal control plans, participants were recruited from an accounting information systems subject at the undergraduate level. The accounting information systems subject extensively exposed the students to internal controls for core business processes. The cases were developed specifically based on the order entry/sales process to test the participants’ knowledge of internal control plans. The order entry/sales process was the first business process taught in the accounting information systems subject from which the participants were recruited.

In addition, participants had to complete two major semester assignments based on the order entry/sales process. The first assignment related to documentation of an order entry/sales process using the data flow diagram technique. For the second assignment, the participants were required to analyze the order entry/sales process given in the first assignment and submit a report discussing the internal control strengths and weaknesses of the process.

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22 The two major semester assignments were submitted before the experiments. The first assignment was submitted in Week 8 of the semester and the second assignment was submitted in Week 11. The experiments were conducted in Week 12.
The two assignments constitute 40 per cent of the total assessment for the accounting information systems subject. The first assignment constitutes 15 per cent and the second assignment constitutes 25 per cent. Because of this emphasis on the order entry/sales process in their studies and assessment, participants were expected to have the knowledge to identify present and missing internal control plans for an order entry/sales process.

4.2 EXPERIMENTAL CASE
The experimental cases used were developed following an iterative procedure. The first version of the case narrative was based on the revenue cycle. The revenue cycle was chosen because it was emphasized more than the expenditure cycle in the accounting information systems subject from which the participants were recruited. Participants were taught both the revenue cycle and the expenditure cycle in that subject. Participants spent six lessons on the revenue cycle as compared with three lessons on the expenditure cycle. In addition, when participants were learning about business-process documentation techniques (data flow diagrams and system flowcharts) during the early part of the subject, the process narratives used were based on the revenue cycle.

After the development of the first version of the case narrative and the checklist (described in Section 4.4) based on the revenue cycle, the entire revenue cycle was considered too lengthy for the participants to attempt in an experimental setting. The revenue cycle includes the order entry/sales process and billing/accounts receivable and cash receipts processes (Gelinas et al., 2005). Due to concerns about the duration of the experiment, a decision was made to focus on the order entry/sales process and drop the billing/accounts receivable and cash receipts processes.
Subsequently, three cases and model solutions were developed based on the order entry/sales process (provided in Appendix 5). Case 1 was used as a training case because individuals may not understand how to perform the task well in their first attempt (Awasthi and Pratt, 1990; Sprinkle, 2000). Individuals require prior experience with a decision aid to be sufficiently familiar with it to complete the task (Arnold and Sutton, 1998; Hampton, 2005; Noga and Arnold, 2002; Todd and Benbasat, 1992; Wheeler and Jones, 2003). Cases 2 and 3 were used as the actual experimental cases.

The first part of each case narrative provided background information for a hypothetical company. A detailed narrative of the company’s order entry/sales process was described in the second part. The case narrative described both internal control strengths and weaknesses. Participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative (i.e. areas requiring improvement in internal control in order to have effective overall control). This is because a key step in evaluating an internal control system is identifying the presence and absence of internal control plans (COSO, 1992, 2004; Gelinas et al., 2005; Goodfellow and Willis, 2006). Internal control plans help ensure management’s objectives are achieved (COSO, 2004; Gelinas et al., 2005; Kinney, 2000; Maijoor, 2000; Spira and Page, 2003). If existing internal control plans are not identified, an organization could end up with costly, redundant internal control plans because there are costs associated with these plans (COSO, 2004). On the other hand, missing internal control plans is an indication of weaknesses in the internal control system (COSO, 2004; Gelinas et al., 2005; Goodfellow and Willis, 2006). Participants were taught the same approach in the accounting information systems subject to identify present internal control plans and recommend missing internal control plans for various business processes.

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23 Case 3 was subsequently dropped after the pilot study to keep the duration of the entire experiment within a reasonable timeframe to increase participants’ engagement.
4.3 VALIDATION OF CASES AND MODEL SOLUTIONS

The validation of the three cases and model solutions was conducted over three stages. The model solutions provide the normative solutions against which participants' answers were assessed. During the first stage, five internal control experts\(^{24}\) provided feedback on the cases and model solutions. In the second stage, three independent experts\(^{25}\) completed the three cases without access to the model solutions. The model solutions were not provided so as not to influence their answers. The checklist was also not provided as the purpose of this validation study is to assess the cases and model solutions. Based on the experts' responses, the cases and model solutions were refined.

A further three independent experts\(^{26}\) validated the three cases and model solutions during the last stage. These experts were given the three cases and model solutions and rated the cases and the model solutions by completing some feedback questions (provided in Appendix 5, Part D).

The three experts evaluated the clarity and complexity of each case. The three experts rated the clarity for each case narrative on a seven-point Likert measurement scale anchored at 1=Very Confusing and 7=Very Clear. All three experts rated the level of clarity of all three cases as very clear (mean of Case 1 = 6.67, mean of Case 2 = 6.33 and mean of Case 3 = 6.67). The high means for all the three cases provide strong assurance that the case narratives are very clear to the readers. They also rated the complexity for each case narrative on a seven-point Likert measurement scale anchored at 1=Very Easy and 7=Very Complex. All three experts rated the complexity of all three cases as fairly complex (mean of Case 1 = 5.33, mean of Case 2 = 5.33 and mean of Case 3 = 5.00). The responses of the experts for each case are provided in Table 4.1.

\(^{24}\) The experts are academics with teaching experience of internal control evaluation.

\(^{25}\) The experts were not involved during the first stage. One of them was the lecturer in charge of the accounting information systems subject the participants were recruited from and the other two experts were teaching assistants in this subject.

\(^{26}\) The experts are academics with teaching experience of internal control evaluation and they were not involved during the two earlier stages of validating the cases.
In addition, the three experts rated the level of similarity among the three cases in terms of the level of complexity on a seven-point Likert measurement scale anchored at 1=Very Different and 7=Very Similar. One rated 7 and the other two rated 6 (mean = 6.33). The validation of the experts provides strong assurance that the three cases are similar in terms of task complexity.

For the model solutions, the three experts evaluated the completeness and accuracy of the model solutions. They rated the completeness of the model solutions on a seven-point Likert measurement scale anchored at 1=Very Incomplete and 7=Very Complete. All three experts rated the level of completeness of all three model solutions as very complete (mean of Case 1 = 6.67, mean of Case 2 = 7.00 and mean of Case 3 = 6.67).

The three experts also rated the accuracy of the model solutions on a seven-point Likert measurement scale anchored at 1=Very Inaccurate and 7=Very Accurate. All three experts rated the level of accuracy of all three model solutions as very accurate (mean of Case 1 = 6.67, mean of Case 2 = 6.67 and mean of Case 3 = 7.00). The validation of the experts provides strong assurance that the model solutions are complete and accurate. This validation is important as the model solutions provide the normative solutions against which participants’ answers were assessed. The responses of the experts for each model solution are provided in Table 4.2. A summary of the validation of cases and model solutions is illustrated in Figure 4.1.
<table>
<thead>
<tr>
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<th>Clarity of Case</th>
<th>Complexity of Case</th>
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<td></td>
<td>(1=Very Confusing and 7=Very Clear)</td>
<td>(1=Very Easy and 7=Very Complex)</td>
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<td></td>
<td>Case 1</td>
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<td>Expert 1</td>
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<td>Expert 2</td>
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<td>Mean</td>
<td>6.67</td>
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|                      | Completeness of Solutions | Accuracy of Solutions |
|                      | (1=Very Incomplete and 7=Very Complete) | (1=Very Inaccurate and 7=Very Accurate) |
|                      | Case 1 | Case 2 | Case 3 | Case 1 | Case 2 | Case 3 |
| Expert 1             | 7     | 7     | 7     | 7     | 6     | 7     |
| Expert 2             | 6     | 7     | 7     | 6     | 7     | 7     |
| Expert 3             | 7     | 7     | 6     | 7     | 7     | 7     |
| Mean                 | 6.67  | 7.00  | 6.67  | 6.67  | 6.67  | 7.00  |
Figure 4.1: Validation of cases and model solutions

Original version of cases and model solutions

Validation Stage 1
Five experts provided feedback on cases and model solutions.

Validation Stage 2
Three experts\(^a\) completed cases without model solutions.

Validation Stage 3
Three experts\(^b\) rated clarity, complexity, and similarity of cases. They also rated completeness and accuracy of model solutions.

Final validated version of cases and model solutions

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\(a\). The experts were not involved during the first stage.

\(b\). The experts were not involved during the two earlier stages.
4.4 CHECKLIST DEVELOPMENT

At the time of the experimental case development, a checklist used in the experiment was also developed. Checklists were selected because they are frequently used decision aids in the context of internal control evaluation (Abdolmohammadi and Usoff, 2001; Dowling and Leech, 2007). The initial phase was to develop a standard checklist that could be implemented in a more and a less structurally-restrictive manner. The first step involved compiling a list of internal control plans and administrating a questionnaire based on the initial list to get feedback from internal control experts.

Since participants required knowledge to complete the experimental task, it was important that they had been previously exposed to the internal control plans used in the experimental cases. The initial list of internal control plans was therefore compiled based on the course materials of the accounting information systems subject from which the participants were recruited, the prescribed textbook (Gelinas et al., 2005) and the supplementary references (Boockholdt, 1999; Considine, Razeed, Lee, and Collier, 2005; Hall, 2004; Romney and Steinbart, 2005; Wilkinson, Cerullo, Raval, and Wong-On-Wing, 2000).

After the compilation of the initial list of internal control plans, a questionnaire was sent to five internal control experts. For each internal control plan, the experts rated the extent to which they believed a participant will be able to identify the internal control plan if it is present or missing in a case narrative. The ratings obtained from the experts were used to short-list the internal control plans the participants are expected to know and be able to identify from a case narrative. The questionnaire utilized a seven-point Likert measurement scale anchored at 1=Not Likely and 7=Very Likely.

27 The experts are academics with teaching experience of internal control evaluation. An expert was involved during the first stage of validation of cases and model solutions as described in Section 4.3. Another expert was involved during the second stage of validation of cases and model solutions. Two other experts were involved during the third stage of validation of cases and model solutions.
Internal control plans that were rated with a mean of less than 3.5 or with a standard deviation of more than 1.5 were discussed with the five experts. Four out of the 20 initial internal control plans were dropped as the participants are not expected to have the knowledge to identify them (provided in Appendix 6). The validation of the experts provides assurance that the participants are expected to have the knowledge to identify the short-listed internal control plans.

The next step of the checklist development process was to exclude some short-listed internal control plans from the checklist so that it prompted only a subset of the internal control plans in the case narrative. This is because the research questions relate to the decision-making benefit of identifying items prompted by the decision aid and decision-making bias of failing to identify items not prompted by the decision aid. Specifically, Hypothesis 1 predicts that decision-makers who use a decision aid will identify more items prompted by the decision aid than decision-makers who do not have access to a decision aid. Hypothesis 2 predicts that decision-makers who use a decision aid will identify fewer items not prompted by the decision aid than decision-makers who do not have access to a decision aid.

Half of the 16 short-listed internal control plans were excluded from the checklist to represent the non-prompted items to test Hypothesis 2. The remaining eight internal control plans included in the checklist represent the prompted items to test Hypothesis 1. In terms of the rating by the five experts of the extent to which they believe a participant will likely be able to identify the internal control plan if it is present in the case, the mean of the eight prompted internal control plans (included in the checklist) is 5.75 and the mean of the remaining eight non-prompted internal control plans (not included in the checklist) is 5.40 (see Appendix 6, Part A). The comparison suggests that the expected knowledge of participants with respect to prompted and non-prompted present internal control plans is similar.
In terms of the rating by the five experts of the extent to which they believe a participant will likely be able to identify the internal control plan if it is missing in the case, the mean of the eight prompted internal control plans (included in the checklist) is 4.75\textsuperscript{28} and the mean of the remaining eight non-prompted internal control plans (not included in the checklist) is 4.58 (see Appendix 6, Part B). The similar means suggest that the expected knowledge of participants with respect to prompted and non-prompted missing internal control plans is comparable.

The included internal control plans were used as a basis for developing the checklist questions. The final version of the checklist (provided in Appendix 7) consists of 16 questions\textsuperscript{29} in total. The internal control plans were categorized into two parts\textsuperscript{30}. Part one consisted of ten questions relating to data input accuracy, completeness and validity, and part two consisted of six questions relating to security of resources.

The validation of the checklist was done concurrently with the validation of the cases and model solutions as described in Section 4.3. The three experts rated how clear they found the checklist on a seven-point Likert measurement scale anchored at 1=Very Confusing and 7=Very Clear. All three experts\textsuperscript{31} rated 7 for the level of clarity of the checklist. The validation of the experts provides strong assurance that the checklist questions are worded in a clear manner. A summary of the checklist development is illustrated in Figure 4.2.

\textsuperscript{28}The means of the missing internal control plans were lower than the present internal control plans, indicating that students are expected to be more capable of identifying present internal control plans than missing internal control plans.

\textsuperscript{29}Checklists developed for use across multiple situations are likely to include items that are not applicable for a specific situation (Johnson, Wardle, and Griffith, 2002). Thus, the checklist includes several questions which are not applicable for the order entry/sales process described in the case narrative.

\textsuperscript{30}Participants were taught in the accounting information systems subject the same approach to categorize internal control plans.

\textsuperscript{31}Two experts were involved during the earlier questionnaire stage of the checklist development.
Figure 4.2: Checklist development

- **Initial list of internal control plans**

- Five experts rated the extent to which they believe a participant will likely be able to identify each internal control plan.

- **Short-listed internal control plans after discussion with the five experts.**

- Excluded some short-listed internal control plans so that the checklist only prompted a subset of the internal control plans in the case narrative.

- **Developed checklist questions based on the included short-listed internal control plans.**

- **Three experts\(^a\) rated clarity of checklist questions and provided feedback.**

- **Final validated checklist**

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\(a\) Two experts were involved during the earlier rating stage of the checklist development.
4.5 DECISION AID

The next step was to incorporate the validated checklist questions into two computerized decision aids that took the form of computerized checklists. To test Hypotheses 3 and 4, two versions of a computerized checklist that differ in structural restrictiveness are required. In the less structurally-restrictive manipulation (provided in Appendix 8, Part A), participants are given access to a computerized checklist which contains a list of questions to consider when identifying the present and missing internal control plans. The checklist is embedded in the middle frame of the screen and participants can scroll up and down to examine the checklist in any manner they desire before they submit their answers. The checklist serves as a reference list; participants do not have to answer and complete the checklist. There are no embedded structural features which restrict how a participant interacts with and uses the checklist.

The more structurally-restrictive checklist contains the same questions in the same order as the less structurally-restrictive checklist. Ensuring that the information content of the checklist is equivalent across treatment conditions reduces the potential for any bias (Johnson and Kaplan, 1996). The checklists across the two treatment conditions only differ in terms of the way in which the questions are presented to participants. In the less structurally-restrictive condition discussed previously, all questions are presented on the one page and participants can scroll through the items and are not required to answer any of the questions. In contrast, in the more structurally-restrictive condition, participants are presented with each of the questions individually and they are required to provide a response to each question.

If a participant selects “Yes”, the screen expands and prompts the participant to state the present internal control plan (provided in Appendix 8, Part B-1). On the other hand, if a participant selects “No”, the screen expands and prompts the participant to state the missing internal control plan (provided in Appendix 8, Part B-2). Lastly, if a participant selects “Not Applicable”, the screen expands and prompts the participant to explain why the prompted internal control plan is
not applicable (provided in Appendix 8, Part B-3). Participants are not allowed to skip any question and are only allowed to proceed to the next question after they have answered each question. After answering all the prompted questions, a list of internal control plans that the participant stated as present by selecting “Yes” or missing by selecting “No” is presented (provided in Appendix 8, Part B-4). Participants have the opportunity to alter the list before submitting their answer.

The two versions of the computerized checklist were embedded within web-based software. Participants who were assigned to the “no decision aid” control group also logged on to the web-based software to complete the experimental task but they did not see any computerized checklist (provided in Appendix 8, Part C).

4.6 TESTING OF EXPERIMENTAL MATERIALS

Two further validation studies were conducted in order to test the experimental materials and prepare for the main pilot study. Section 4.6.1 describes the first pre-pilot validation, and the second pre-pilot validation is discussed in Section 4.6.2. The main pilot study is reported in Section 4.6.3, and the revised pilot study is presented in Section 4.6.4.

4.6.1 First pre-pilot validation

The first pre-pilot validation was a paper-based experiment which was conducted before the development of the computerized decision aid. At that point, only Case 1 was developed. The purpose was to gather initial feedback regarding the paper-based checklist, the manipulation of structural restrictiveness and the first version of Case 1. Three students and another teaching assistant from the accounting information systems subject participated in this validation and were compensated A$20 for their participation time. The paper-based experiment was administered to resemble the structural restrictiveness manipulation.
For the less structurally-restrictive treatment, the two participants (both students) were given the case narrative and checklist in separate documents. The checklist document consists of a list of questions to consider when identifying the present and missing internal control plans. The checklist document serves more as a reference list as the participants did not have to answer and complete the checklist. Both participants wrote their answers on a separate answer-sheet document.

On the other hand, the other two participants (a student and the teaching assistant) in the more structurally-restrictive treatment were exposed to the same list of questions individually on separate sheets of paper. Just like the final computerized decision aid (described in Section 4.5), each question was presented individually. In the paper-based version, each sheet of paper contained one question from the checklist. The participants were required to circle “Yes/No/Not Applicable” on each sheet for each question. If the participants selected “Yes”, they were required to describe the present internal control plans. If the participants selected “No”, they were required to describe the missing internal control plans. The participants could only proceed to a new sheet of paper after answering each question and were not allowed to return to previous questions. The researcher was present to ensure that the participants did not return to previous questions.

The four participants completed the paper-based experiment in four separate sessions. After each session, an interview was conducted with participants. All four participants commented that the case narrative was similar to the case narratives that they were exposed to in the subject in terms of the level of clarity and complexity. All four participants found the checklist useful in assisting them identifying the present and missing internal control plans. Both the more structurally-restrictive and the less structurally-restrictive manipulations were described to them and all agreed that the more structurally-restrictive treatment would result in a higher level of restrictiveness during the decision-making process. Both participants in the more structurally-restrictive treatment
suggested that the questions should ask participants to justify their answer if they select “Not Applicable”, otherwise it may encourage participants to circle “Not Applicable” in order to speed through the questions. This suggestion was adopted to refine the checklist for the second pre-pilot validation. Two additional case narratives were also developed for the second pre-pilot validation.

4.6.2 Second pre-pilot validation

The purpose of the second pre-pilot validation was to test the computerized decision aid and manipulate different experimental procedures in order to finalize the administration of the main pilot study. Fifty-two participants enrolled in the accounting information systems subject from which the final participants were recruited participated in this validation, held over four sessions. Each session lasted around two hours. Participants were compensated A$30 for their participation time.

First, a paper-based knowledge test\textsuperscript{32} was administered. As discussed in Section 3.3, participants’ pre-existing task-specific knowledge will be included as a covariate in data analysis. The knowledge test consisted of five internal control failure scenarios. The five scenarios were adapted from discussion questions\textsuperscript{33} in the prescribed textbook for the course completed by the experiment participants (Gelinas et al., 2005). The solutions for the knowledge test were obtained from the solutions manual of the prescribed textbook. Each scenario was described in a short paragraph. For each scenario, the participants were required to provide a three-part answer. All participants were required to briefly describe the internal control problem, state one internal control plan that would best prevent the control problem from occurring and briefly explain how the recommended internal control plan works to prevent the internal control problem from occurring (provided in Appendix 9).

\textsuperscript{32} The ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. Therefore, a knowledge test needs to be administered to measure participants’ pre-existing knowledge of internal control plans.

\textsuperscript{33} The discussion questions were not used as tutorial questions.
The five scenarios were printed on separate sheets of paper. The participants were instructed not to turn over the question sheet until they were given the signal to do so. The question sheets were color coded. During the knowledge test, the researcher walked around the experimental laboratory to ensure that the participants did not proceed to the next scenario until they were instructed to do so. The color coding of the question sheet facilitated the visual monitoring. Participants were given three minutes to answer each scenario and were informed when they had a minute left. The question sheets were collected after each scenario, and the participants were then instructed to move on to the next question.

After the knowledge test, participants completed a paper-based “Group Embedded Figures Test (GEFT)” test (Witkin, Oltman, Raskin, and Karp, 2002) to assess their cognitive style. The original intention was to examine the fit between cognitive style and structural restrictiveness. However, the test required half an hour, resulting in a time pressure. Since the GEFT test was not the main focus of this study, it was dropped for the main pilot study. The priority was to free up more experimental time so that the participants would have sufficient time to complete the experimental task.

After the GEFT test, participants logged into the web-based software to complete the experimental task of identifying present and missing internal control plans for the three cases. Participants were randomly assigned to one of three experimental groups: no decision aid\(^{34}\) (control group), less structurally-restrictive decision aid or more structurally-restrictive decision aid.

In order to finalize the administration of the main pilot study, different experimental procedures were tested over the four sessions. After each session, changes were incorporated in the next session based on the feedback.

\(^{34}\) Participants who were assigned to the “no decision aid” experiment group also logged on to the web-based software to complete the experimental task but they did not see any computerized checklist.
given by the participants. Sixteen participants were involved in the first session. During the first session, participants were given three minutes to complete each question of the knowledge test. The knowledge test consisted of five questions and the answer sheets were collected by the researcher before proceeding to the next question. After the first session, several participants commented that the allocated three minutes was not enough time to complete each question. The collected answer sheets also showed that several participants did not finish writing their answers. As a result, the allocated time was increased from three minutes to four minutes for the subsequent three sessions. In addition, several participants asked for clarification on some instructions of the computerized decision aid during the first session. As a result, some instructions of the computerized decision aid were rephrased to improve their clarity for the subsequent three sessions.

The second and third sessions were identical. Fifteen participants were involved in the second session and ten participants were involved in the third session. During these two sessions, several participants in the more structurally-restrictive treatment group were rushing through the third case because they felt the time pressure to complete the three case narratives during the experiment. They added that the two-hour experiment was too lengthy and their concentration dropped for the third case.

Eleven participants were involved in the fourth and final session. Due to time-pressure concerns raised during the previous two sessions, participants in the more structurally-restrictive treatment group attempted only two instead of three case narratives in order to investigate whether they could better allocate their time if they completed only two cases. The results indicated that participants spent more time on each case when they only had to complete two cases. This suggests that participants in the previous two sessions were rushing through the third case because of time pressure.
4.6.3 Main pilot study

Thirty-two participants from the accounting information systems subject participated in this main pilot study. In order to motive participation, participants were compensated A$30 for their participation time. In addition, each participant was entered into a draw to win an A$150 book voucher if their performance was among the top 25 per cent. There were 16 participants in each session. They were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid. Two participants from the “no decision aid” group were excluded from the pilot sample because they did not complete the task. The number of participants in the final usable sample was: 8 in the no decision aid group, 11 in the less structurally-restrictive decision aid group and 11 in the more structurally-restrictive decision aid group.

During the pilot study, each participant completed the three cases in the same order. After the pilot study, a decision was made to drop Case 3 from the actual experiment due to confounding factors associated with the case. Many participants commented that it was repetitive to attempt three case narratives and they were less engaged by the time they got to the third case. As a result, many participants admitted spending the least effort on Case 3. Some participants spent too much time on the first two cases and rushed through Case 3 because of time pressure. Case 3 was dropped to keep the duration of the entire experiment within a reasonable timeframe to increase participants’ engagement. In addition, the knowledge test’s number of internal control failure scenarios was reduced from five to three in order to free up more experimental time.

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35 The 32 participants who attended the main pilot study were not involved in the earlier validation studies.

36 Questions 4 and 5 of the knowledge test were dropped. As the average score for Questions 4 and 5 were much lower than Questions 1, 2 and 3, the researcher examined the answers for Question 4 and 5 individually. The researcher observed that many participants wrote a similar wrong answer which suggests a possible ambiguity in the wording of the questions.
In addition to completing the experimental tasks, the pilot study's participants provided feedback on the case narrative. All participants evaluated the level of clarity of Cases 1 and 2 narratives on a seven-point Likert measurement scale anchored at 1=Very Confusing and 7=Very Clear. Their responses suggest that participants found both case narratives clear (mean for Case 1=4.47 and mean for Case 2=4.83, n=30).

All participants also rated their perceived difficulty of the task on a seven-point Likert measurement scale anchored at 1=Very Difficult and 7=Very Easy. Lastly, all participants rated the level of confidence in their answers on a seven-point Likert measurement scale anchored at 1=Not Confident and 7=Very Confident. The feedback demonstrated that participants found the task slightly easy (mean=4.17, n=30) and were slightly confident about their answers (mean=4.13, n=30). This information suggests that the difficulty level of the task was within the capability of the participants and they had the expected knowledge to complete the task. Their feedback is summarized in Table 4.3 below.

<table>
<thead>
<tr>
<th></th>
<th>Group 1 No Decision Aid (n=8)</th>
<th>Group 2 Less Structurally-Restrictive Decision Aid (n=11)</th>
<th>Group 3 More Structurally-Restrictive Decision Aid (n=11)</th>
<th>Combined Groups (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarity of Case 1 narrative (1=Very Confusing and 7=Very Clear)</td>
<td>4.25</td>
<td>4.82</td>
<td>4.27</td>
<td>4.47</td>
</tr>
<tr>
<td>Clarity of Case 2 narrative (1=Very Confusing and 7=Very Clear)</td>
<td>4.13</td>
<td>5.09</td>
<td>5.09</td>
<td>4.83</td>
</tr>
<tr>
<td>Difficulty level of task (1=Very Difficult and 7=Very Easy)</td>
<td>3.63</td>
<td>4.36</td>
<td>4.36</td>
<td>4.17</td>
</tr>
<tr>
<td>Confidence level (1=Not At All and 7=Very Confident)</td>
<td>4.00</td>
<td>4.73</td>
<td>3.64</td>
<td>4.13</td>
</tr>
</tbody>
</table>
In order to assess the manipulation of structural restrictiveness, the 22 participants in the two computerized decision aid treatment conditions (more and less structurally-restrictive decision aid) rated the extent to which they perceived using the decision aid constrained their decision-making process. Participants in the two computerized decision aid treatment conditions rated their response on a seven-point Likert measurement scale anchored at 1=Not Restricted and 7=Very Restricted. The mean for the less structurally-restrictive decision aid group is 3.00 (n=11) and the mean for the more structurally-restrictive decision aid group is 4.50 (n=11). This suggests that participants in the more structurally-restrictive decision aid group perceived a higher level of constraint in their decision-making process than participants in the less structurally-restrictive decision aid group.

In addition, the 22 participants evaluated the usefulness of the checklist they were provided with on a seven-point Likert measurement scale anchored at 1=Not At All and 7=Very Useful. They also rated the level of satisfaction with the checklist on a seven-point Likert measurement scale anchored at 1=Very Unsatisfied and 7=Very Satisfied. It appears that participants found the checklist useful during their decision-making process (mean=4.75, n=22) and were satisfied with it (mean=4.70, n=22). It is important that the participants view the checklist credibly so that they will use the checklist during the task (Parasuraman and Riley, 1997). Their feedback is summarized in Table 4.4.
Table 4.4: Participants’ feedback on the checklist for main pilot study

<table>
<thead>
<tr>
<th></th>
<th>Group 2 Less Structurally-Restrictive Decision Aid (n=11)</th>
<th>Group 3 More Structurally-Restrictive Decision Aid (n=11)</th>
<th>Combined Groups (n=22)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restrictiveness of checklist</td>
<td>3.00</td>
<td>4.50</td>
<td>3.75</td>
</tr>
<tr>
<td>(1=Not Restricted and 7=Very Restricted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Usefulness of checklist</td>
<td>4.60</td>
<td>4.90</td>
<td>4.75</td>
</tr>
<tr>
<td>(1=Not At All and 7=Very Useful)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Satisfaction with checklist</td>
<td>4.60</td>
<td>4.80</td>
<td>4.70</td>
</tr>
<tr>
<td>(1=Very Unsatisfied and 7=Very Satisfied)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.6.4 Revised pilot study

After the main pilot study, a revised pilot study was conducted. The purpose was to test the order effects of the two remaining case narratives (Case 1 and Case 2)\(^{37}\). The experimental procedures for the revised pilot study were identical to the main pilot study except that the order of the cases was reversed. For the main pilot study, Case 1 was used as the first case while Case 2 was used as the second case. The order of the two cases was reversed for the revised pilot study. Seven participants\(^{38}\) were involved in the revised pilot study and were randomly assigned to one of three experimental groups: two in the no decision aid group, two in the less structurally-restrictive decision aid group and three in the more structurally-restrictive decision aid group.

The performance of the revised pilot study was compared with the main pilot study to determine the presence of any order effects. Due to the small sample size of the revised pilot study, a visual comparison of the trend was conducted. Appendix 10, Part A provides the mean percentage of all prompted internal control plans identified by the participants across the three groups. For both cases, the charts exhibit a similar increasing trend regardless of the order of the

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\(^{37}\) As discussed previously in Section 4.6.3, Case 3 was dropped after the main pilot study to keep the duration of the entire experiment within a reasonable timeframe to increase participants’ engagement.

\(^{38}\) The seven participants who attended the revised pilot study were not involved in the earlier main pilot study.
case. Participants who did not have access to a decision aid identified the lowest percentage and participants provided with the more structurally-restrictive decision aid identified the highest percentage.

Appendix 10, Part B provides the mean percentage of all non-prompted internal control plans identified by the participants across the three groups. For Case 2, both charts exhibit a similar decreasing trend regardless of the case order with participants who did not have access to a decision aid identifying the highest percentage and participants provided with the more structurally-restrictive decision aid identifying the lowest percentage (see Appendix 10, Part B, Panels A and B). For Case 1, participants who did not have access to a decision aid outperformed the other two groups regardless of the case order (see Appendix 10, Part B, Panels C and D). However, the more structurally-restrictive decision aid group performed slightly better than the less structurally-restrictive decision aid group for the revised pilot study.

The results suggest that the order of the case does not affect the performance variables. The mean percentages of all prompted and non-prompted internal control plans identified by the participants across the three groups were similar regardless of the order of the case. In addition, the performance trend across the three experiment groups was in the same direction.

4.7 EXPERIMENT
This section describes the experiment. Section 4.7.1 describes the participants’ recruitment process while the experimental procedures are presented in Section 4.7.2.

4.7.1 Recruitment of participants
The experiment was only open to students enrolled in the current semester of the accounting information systems subject. Recruitment announcements were made at the beginning of the lecture and handouts and reply slips were

39 The students were not involved in the earlier testing of the experimental materials as described in Section 4.6.
distributed to the attending students. The handout contains information about the experiment such as the schedule of experimental sessions and the venue of the experiment. The handout was approved by the University’s ethics committee. A copy is provided in Appendix 11.

Two incentives were provided to motivate participation. First, participants were compensated A$20 for their participation time. Second, each participant was entered into a draw to win one of three A$150 book vouchers if their performance was among the top 25 per cent. Interested participants provided their contact information and the top three preferred sessions on the reply slips, which were collected at the end of the lecture. A recruitment email was also sent to the mailing list of the accounting information systems subject, containing the same information as the handout.

After the compilation of the participants’ list, emails were sent out asking participants who signed up\(^{40}\) for the experiment to confirm their assigned session. A week before the experiment, reminder announcements were made during the lecture. Reminder emails\(^{41}\) were also sent out a few days before the experiment.

4.7.2 Experimental procedures
The experiment adopts a 1 x 3 between-subjects design and the participants were randomly\(^{42}\) assigned to one of three experimental groups (no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid) on a first-come-first-serve basis (see Appendix 12).

The participants were asked to read the plain language statement of the purpose and procedures of the experiment and sign a consent form. This is an ethical requirement of the University where the study was conducted. The plain

\(^{40}\) One hundred and twelve participants signed up for the experiment.  
\(^{41}\) Eighteen participants did not turn up for the experiment. The initial sample size of 94 participants represents 84 per cent of the participants who signed up for the experiment.  
\(^{42}\) Randomization is effective in controlling for all possible extraneous variables (Cook and Campbell, 1979; Kerlinger and Lee, 2000).
language statement and the consent form were approved by the ethics committee and a copy is provided in Appendices 13 and 14.

The experiment proceeded after ensuring that all the participants had signed the consent form. In order to ensure the consistency of instructions across all of the experimental sessions, the same researcher was present for all sessions and followed a written script when providing verbal instructions during the experiment. The researcher was present in the experimental laboratory for the entire duration of the experiment to answer any query43.

In the first part of the session, the paper-based knowledge test44 was conducted. The knowledge test was administered in the first part of the experiment to obtain a measure of the participants’ pre-existing knowledge of internal control plans. It was necessary to obtain this measure before the participants attempted the experimental task in case the pre-existing knowledge level of the participants assigned to the two decision aid treatment groups was confounded by learning transfer from using the decision aid (Eining and Dorr, 1991).

The knowledge test consisted of three internal control failure scenarios, each printed on a separate sheet of color-coded paper. For each scenario, participants were required to answer three parts. All participants were required to briefly describe the internal control problem, state one internal control plan that would best prevent the control problem from occurring and briefly explain how the recommended internal control plan works to prevent the internal control problem from occurring. The three scenarios focus specifically on knowledge of internal control plans because the experimental task relates to identification of internal control plans. Participants were given four minutes to answer each scenario and they were informed when they had a minute left. During the

43 The researcher only answered queries relating to the administration of the experiment and did not answer any query relating to the experimental task.
44 The ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. Therefore, a knowledge test needs to be administered to measure participants’ pre-existing knowledge of internal control plans.
knowledge test, the researcher walked around the experimental laboratory to ensure that the participants did not proceed to the next scenario until they were instructed to do so. The color coding of the question sheet facilitated the visual monitoring. The researcher collected the answer sheets before proceeding to the next scenario.

After the knowledge test, participants were given instructions regarding the two envelopes on their table. Each envelope contained a case narrative. Participants were told to open the respective envelope only when they were instructed by the web-based software. All participants completed the two cases in the same order. The first case was used as a training case and the results of the second case were used to test the hypotheses. All participants were told to log into the web-based software with the User ID and password written on the top right corner of Envelope 1. The decision aid was embedded within the web-based software. The screen shots of the web-based software are provided in Appendix 15.

After logging into the software, participants completed several tasks before they proceeded with the first case. First, participants self-rated their knowledge about internal control plans for an order entry/sales process on a seven-point Likert measurement scale anchored at 1=Very Low and 7=Very High. The next task was to attempt five multiple-choice questions. The multiple-choice questions differ from the knowledge test’s questions as they focus on the participants’ broader general internal control knowledge rather than on specific knowledge of internal control plans. After that, participants entered their personal details so that their demographic profiles were collected.

After submitting their personal details, the software presented participants with a familiarization session before they started the experimental task of identifying present and missing internal control plans. The purpose was to familiarize participants with the screen layout that they would see during the experiment. The screen layouts differed across the three groups because the familiarization
sessions were tailored for each group. Therefore, the software presented participants in different experimental groups with different familiarization screens.

After the familiarization session, participants proceeded with the last part of the experiment which involved them completing the two cases. At this point, the participants were instructed by the software to open Envelope 1, which contained the narrative for Case 1. Participants were instructed to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative. After reading the case narrative, the participants were required to enter their answers into the software. The decision aid was embedded within the software. Therefore, participants experienced different screens based on their assigned experimental group.

After submitting their answers, the participants completed feedback questions on their perceived complexity of the task. There was a risk that participants’ perceived task complexity affected their reliance on the decision aid (Arnold and Sutton, 1998; Hampton, 2005). The perceived task complexity questions were adapted from Hampton’s (2005) study (provided in Appendix 16).

Participants repeated the same procedures for Envelope 2, which contained the narrative for Case 2. In addition, after completing Case 2, participants completed the feedback questions on their perceived reliance on the decision aid and the manipulation-check question. As discussed previously in Section 4.5, participants could interact with the less structurally-restrictive decision aid in any manner because there were no embedded structural features embedded within the decision aid to restrict participants’ use. Therefore, there was a risk that participants provided with the less structurally-restrictive decision aid might not rely on the decision aid. Thus, feedback on perceived reliance was collected to determine the extent of reliance on the decision aid. The perceived
reliance questions were adapted from Hampton’s (2005) study (provided in Appendix 17).

For the manipulation-check question, participants were asked whether the web-based software provided them with a checklist of internal control questions to assist them in identifying the present and missing internal control plans. Participants who answered “Yes” when a checklist was not provided and those who answered “No” when a checklist was provided were considered to have not understood the experimental manipulation.

Participants were not allowed to leave if they completed the experiment early. It was observed during the pilot study that participants may rush to complete the experiment once they notice that people are leaving the computer laboratory after completing the experiment. In order to hold back participants until everyone had completed Case 2, the last part of the software consisted of multiple-choice questions adopted from the Graduate Record Examinations (GRE) test. Participants were not informed earlier of this test so that the slower participants would think that the other participants are still attempting Case 2. After completing the GRE questions, the last screen of the software prompted the participants to stay in their workstation and surf the Internet to wait for the remaining participants to complete Case 2.

During the experiment, the researcher was present in the experimental laboratory. When the researcher observed that all participants had completed the feedback questions after Case 2, he announced the end of the experiment. The participants collected A$20 after signing the payment acknowledgment slip and were instructed not to discuss the experiment with other participants as there would be other later experimental sessions during the week. A summary of the experimental procedures for the experiment described above is illustrated in Figure 4.3.
Figure 4.3: Experimental procedures

1. Start
2. Read plain language statement and sign consent form
3. Complete knowledge test (paper-based)
4. Log in web-based software with assigned User ID and password
5. Self rate knowledge on internal control
6. Complete five MCQ on general internal control knowledge
7. Next Page
Fill in personal details

Complete familiarization session

No Decision Aid (Control Group)  Less Structurally-Restrictive Decision Aid  More Structurally-Restrictive Decision Aid

Open Envelope 1 (Training Case)

Complete task for Case 1

No Decision Aid (Control Group)  Less Structurally-Restrictive Decision Aid  More Structurally-Restrictive Decision Aid

Complete feedback questions for Case 1

Next Page
Open Envelope 2 (Experimental Case)

Complete task for Case 2

No Decision Aid (Control Group)
Less Structurally-Restrictive Decision Aid
More Structurally-Restrictive Decision Aid

Complete feedback questions for Case 2

Complete manipulation-check questions and feedback questions on decision aid

Attempt holding task until the end of the experiment

End
4.8 VARIABLES
The validated model solutions as described in Section 4.3 were used as the normative solution to assess the number of present and missing internal control plans identified by the participants. Based on the model solutions, a point was awarded for each present or missing\textsuperscript{45} internal control plan identified correctly by the participant. Each point related to either prompted or non-prompted variables: Prompted Present, Non-Prompted Present, Prompted Missing or Non-Prompted Missing. In addition, the points in the “Prompted Present” and “Prompted Missing” variables were combined to represent the number of all prompted internal control plans identified. On the other hand, the points in the “Non-Prompted Present” and “Non-Prompted Missing” variables were combined to represent the number of all non-prompted internal control plans identified. The absolute points were then converted to a percentage. A summary of the dependent variables is provided in Table 4.5.

The experimental case contained a total of 17 internal control plans, of which eight were prompted by the decision aid and the remaining nine were not prompted. Four of the eight prompted internal control plans related to internal control plans that were present in the case narrative. The other four prompted plans were missing in the case narrative. As for the nine non-prompted internal control plans, five plans were present in the case narrative and the remaining four plans were missing in the case narrative. As an illustration, if a participant identifies four prompted present, three prompted missing, two non-prompted present and one non-prompted missing internal control plans, the dependent variables will be computed as follows in Table 4.6.

\textsuperscript{45} As discussed previously in Section 4.2, a key step in evaluating an internal control system is identifying the presence and absence of control plans (COSO, 1992, 2004; Gélinas et al., 2005; Goodfellow and Willis, 2006). Thus, participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that are missing and should be present in the case narrative. In addition, students were taught the same approach in the accounting information systems subject to identify present internal control plans and recommend missing internal control plans.
### Table 4.5: Summary of dependent variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompted All ^a</td>
<td>Percentage of all internal control plans identified that were prompted by the decision aid</td>
</tr>
<tr>
<td>Non-Prompted All ^a</td>
<td>Percentage of all internal control plans identified that were not prompted by the decision aid</td>
</tr>
<tr>
<td>Prompted Present</td>
<td>Percentage of “present” internal control plans identified that were prompted by the decision aid</td>
</tr>
<tr>
<td>Non-Prompted Present</td>
<td>Percentage of “present” internal control plans identified that were not prompted by the decision aid</td>
</tr>
<tr>
<td>Prompted Missing</td>
<td>Percentage of “missing” internal control plans identified that were prompted by the decision aid</td>
</tr>
<tr>
<td>Non-Prompted Missing</td>
<td>Percentage of “missing” internal control plans identified that were not prompted by the decision aid</td>
</tr>
</tbody>
</table>

^a. The number of all internal control plans identified was the total sum of the number of “present” and “missing” internal control plans identified:

Number of Prompted All = Number of Prompted Present + Number of Prompted Missing
Number of Non-Prompted All = Number of Non-Prompted Present + Number of Non-Prompted Missing

The numbers were all converted to percentage.

### Table 4.6: An example of the computation of dependent variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Computation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompted All</td>
<td>((4^a\text{ prompted present} + 3^a\text{ prompted missing}) / 8^b = 87.5%)</td>
</tr>
<tr>
<td>Non-Prompted All</td>
<td>((2^c\text{ non-prompted present} + 1^c\text{ non-prompted missing}) / 9^d = 33.3%)</td>
</tr>
<tr>
<td>Prompted Present</td>
<td>(4^a\text{ prompted present} / 4^b = 100%)</td>
</tr>
<tr>
<td>Prompted Missing</td>
<td>(3^a\text{ prompted missing} / 4^b = 75%)</td>
</tr>
<tr>
<td>Non-Prompted Present</td>
<td>(2^c\text{ non-prompted present} / 5^d = 40%)</td>
</tr>
<tr>
<td>Non-Prompted Missing</td>
<td>(1^c\text{ non-prompted missing} / 4^d = 25%)</td>
</tr>
</tbody>
</table>

^a. Assuming a participant identifies four prompted “present” and three prompted “missing” internal control plans

^b. The experimental case contains eight internal control plans prompted by the decision aid. Four of them relate to “present” internal control plans and the remaining four relate to “missing” internal control plans.

^c. Assuming a participant identifies two non-prompted present and one non-prompted missing internal control plans.

^d. The experimental case contains nine internal control plans not prompted by the decision aid. Five of them relate to “present” internal control plans and the remaining four relate to “missing” internal control plans.
Participants’ knowledge of internal control plans was used as a covariate in the data analysis because participants who were more knowledgeable about internal control plans were expected to perform better (Frederick, 1991). A knowledge test was conducted to measure the participants’ knowledge of internal control plans. The knowledge test consisted of three internal control failure scenarios (provided in Appendix 9). Each scenario was allocated four marks. For each scenario, participants were required to answer three parts. All participants were required to briefly describe the internal control problem (one mark), state one internal control plan that would best prevent the control problem from occurring (one mark) and briefly explain how the recommended internal control plan works to prevent the internal control problem from occurring (two marks). The maximum score for the knowledge test is 12 (four marks X three scenarios). The score of the knowledge test was converted to percentage and used as a covariate in data analysis. For example, if a participant scores eight marks for the knowledge test, the participant’s score of the knowledge test will be 66.67 per cent [8/12 X 100 per cent].

4.9 CODING PROCESS

The responses of each participant were extracted from the web-based software and printed on individual answer sheet. An independent graduate student who was not involved in this study assisted to randomly assign a coding identification code for each answer sheet. This step ensured that the coders were unable to identify the assigned experimental group of each answer sheet.

The researcher and an independent expert were involved in the coding process of the dependent variables. The expert was not aware of the research questions, other than that the study investigates the effects of the use

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46 The ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. Therefore, a knowledge test needs to be administered to measure participants’ pre-existing knowledge of internal control plans.

47 The expert is an academic with teaching experience of internal control evaluation and was not involved with the validation of the cases, model solutions and checklist.

48 Two independent coders were involved in the coding exercise because the assessment of participants’ answers is a qualitative exercise which requires coders’ judgment (Choo and Trotman, 1991).
of decision aids on users’ decision-making outcomes. First, a trial coding was conducted. Both coders independently coded the responses of the four participants who failed the manipulation check based on the validated model solutions (provided in Appendix 5). After that, a discussion was held to clarify any coding differences before both coders proceeded separately with the main round of coding for the remaining responses. Coding was performed by each coder in their respective office over a period of three days.

The two coded data sets were analyzed for inter-coder agreement using Cohen’s Kappa statistic, which controls for chance agreement (Cohen, 1960). The Kappa coefficients are reported in Table 4.7 and range from 0.927 to 0.958. The high Kappa coefficient values indicate that the coders achieved a very high degree of agreement⁴⁹ (Landis and Koch, 1977). Coding differences were resolved before analyzing the data in Chapter Six.

### Table 4.7: Kappa coefficients of inter-coder agreement for dependent variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>Kappa Coefficient</th>
<th>Standard Error</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompted Present</td>
<td>0.956</td>
<td>0.025</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Non-Prompted Present</td>
<td>0.958</td>
<td>0.024</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Prompted Missing</td>
<td>0.944</td>
<td>0.028</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Non-Prompted Missing</td>
<td>0.927</td>
<td>0.031</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

a. The Kappa coefficients were calculated based on a sample size of 90 participants. Kappa coefficient = \( \frac{\text{Observed agreement} - \text{Expected agreement}}{1 - \text{Expected agreement}} \)

b. Percentage of “present” internal control plans identified that were prompted by the decision aid
c. Percentage of “present” internal control plans identified that were not prompted by the decision aid
d. Percentage of “missing” internal control plans identified that were prompted by the decision aid
e. Percentage of “missing” internal control plans identified that were not prompted by the decision aid

⁴⁹ Values of Kappa coefficient greater than 0.80 indicate “almost perfect” agreement; between 0.61 and 0.80, substantial; between 0.41 and 0.60, moderate; between 0.21 and 0.40, fair; between 0 and 0.20, slight and below 0, poor (Landis and Koch, 1977, p. 165).
Another expert was employed for the coding process of the knowledge test. The expert was not aware of the research objectives, other than that the study related to the researcher’s PhD research. As stated earlier in Section 4.7.2, the participants completed the three scenarios of the knowledge test on separate sheets of paper. Two sets of answer sheets were photocopied and the original set was kept aside. The researcher provided and explained the coding guidelines to the expert (provided in Appendix 18). Both coders independently coded the responses.

The two coded data sets were analyzed for inter-coder agreement using Cohen’s Kappa statistic, which controls for chance agreement (Cohen, 1960). As reported in Table 4.8, the high Kappa coefficient values (Scenario 1=0.911, Scenario 2=0.927 and Scenario 3=0.941) indicate that the coders achieved a very high degree of agreement (Landis and Koch, 1977). Coding differences were resolved before analyzing the data in Chapter Six.

### Table 4.8: Kappa coefficients of inter-coder agreement for knowledge test

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Kappa Coefficient</th>
<th>Standard Error</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario 1</td>
<td>0.911</td>
<td>0.035</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>0.927</td>
<td>0.035</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>0.941</td>
<td>0.029</td>
<td>p&lt;0.001</td>
</tr>
</tbody>
</table>

**a.** The Kappa coefficients were calculated based on a sample size of 90 participants. Kappa coefficient = \( \frac{\text{Observed agreement} - \text{Expected agreement}}{1 - \text{Expected agreement}} \)

50 The expert who was involved in the coding process of the dependent variables was not available to continue with the coding process of the knowledge test. The expert who was involved in the coding process of the knowledge test was a teaching assistant of the accounting information systems subject.

51 Two independent coders were involved in the coding exercise because the assessment of participants’ answers is a qualitative exercise which requires coders’ judgment (Choo and Trotman, 1991).

52 Values of Kappa coefficient greater than 0.80 indicate “almost perfect” agreement; between 0.61 and 0.80, substantial; between 0.41 and 0.60, moderate; between 0.21 and 0.40, fair; between 0 and 0.20, slight and below 0, poor (Landis and Koch, 1977, p. 165).
4.10 CHAPTER SUMMARY
This chapter has described the research design for the study. In order to ensure that the participants had sufficient and relatively homogenous knowledge to identify internal control plans, participants were recruited from an accounting information systems subject that extensively exposed the participants to internal controls for the order entry/sales process. The experimental cases and model solutions used in the experiment were developed following an iterative procedure and were validated by internal control experts. The checklist was also developed concurrently and the finalized questions were incorporated into the design of a computerized decision aid in the form of a computerized checklist. Two versions of a computerized checklist that differ in the degree of structural restrictiveness embedded in their design were developed and embedded in web-based software.

Two rounds of pilot study were conducted to test the experimental materials. Two validation studies were conducted before the pilot studies. The experiment adopted a 1 x 3 between-subjects design and the participants were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid. Participants were instructed to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative. The responses of each participant were extracted from the web-based software and coded by two independent coders. An inter-rate agreement test was performed and the coders achieved a very high degree of agreement. The next chapter presents the preliminary analyses of the data. This step is followed by the hypotheses testing provided in Chapter Six.
CHAPTER FIVE : PRELIMINARY ANALYSES

5.0 INTRODUCTION
The aim of this chapter is to provide an overview of the data collected and the preliminary analyses conducted. This chapter is structured as follows. Section 5.1 explains the data preparation steps which were conducted to obtain the final sample. Section 5.2 presents the biographical details of the participants. Section 5.3 discusses the results of the knowledge test. Section 5.4 reports the descriptive statistics of the dependent variables and Section 5.5 tests for normality. Section 5.6 reports the correlations between the research variables. The last section provides a summary of the preliminary analyses.

5.1 DATA PREPARATION
Data preparation was necessary before the hypothesis testing could be performed in the next chapter. Ninety-four participants were recruited from an accounting information systems subject that extensively exposed the students to internal controls. As discussed previously in Section 4.7.2, the initial sample of 94 participants were randomly assigned to one of three experimental groups: 29 in the no decision aid group, 34 in the less structurally-restrictive decision aid group and 31 in the more structurally-restrictive decision aid group.

Participants who failed the manipulation check were excluded from the final sample. Participants were asked whether the software provided them with a checklist of internal control questions to assist them in identifying the present and missing internal control plans. Four participants failed the manipulation as they answered “No” to the manipulation-check question when a checklist was provided. All participants who were not provided with a checklist answered the manipulation-check question correctly. The four participants who failed the manipulation check were excluded from the final useable sample53.

53 As discussed in Section 4.9, the responses of the four participants who failed the manipulation check were used to conduct the trial coding before the coding process of the dependent variables. Thus, a sensitivity check of including the four participants who failed the manipulation check was not conducted.
The number of participants in the final usable sample\textsuperscript{54} is provided in Table 5.1 below.

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Initial Sample</th>
<th>Failed Manipulation</th>
<th>Final Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1 - No Decision Aid (Control)</td>
<td>29</td>
<td>0</td>
<td>29</td>
</tr>
<tr>
<td>Group 2 - Less Structurally-Restrictive Decision Aid</td>
<td>34</td>
<td>3</td>
<td>31</td>
</tr>
<tr>
<td>Group 3 - More Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>1</td>
<td>30</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>94</strong></td>
<td><strong>4</strong></td>
<td><strong>90</strong></td>
</tr>
</tbody>
</table>

5.2 BIOGRAPHICAL DETAILS OF PARTICIPANTS

The biographical details are based on the final usable sample of 90 participants as described in Section 5.1. The participants were enrolled in an accounting information systems subject and the majority of them were commerce students [93.4 per cent]. Eight-nine per cent of the participants were first year students. The age of the participants ranges from 18 to 25 with the majority of them in the 18 to 21 age group [95.6 per cent]. More than half of the participants [57.8 per cent] had working experience. A summary of the biographical details of the participants is shown in Table 5.2.

\textsuperscript{54} Box plots of the dependent variables were prepared to identify outliers for the remaining 90 participants. A positive outlier was identified for the dependent variable of “Non-Prompted Missing” in the more structurally-restrictive decision aid group. The outlier was included in the final usable sample since it would bias against finding a result for Hypothesis 4. Nonetheless, a sensitivity check was conducted by excluding the outlier (n=89) and it did not affect the results of the hypothesis testing presented in Chapter 6.
<table>
<thead>
<tr>
<th>Table 5.2: Biographical details of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Gender a:</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Age b:</td>
</tr>
<tr>
<td>18</td>
</tr>
<tr>
<td>19</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>21</td>
</tr>
<tr>
<td>Over 21 years</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Degree c:</td>
</tr>
<tr>
<td>Commerce</td>
</tr>
<tr>
<td>Commerce and Law</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Year of Degree d:</td>
</tr>
<tr>
<td>Year 1</td>
</tr>
<tr>
<td>Year 2</td>
</tr>
<tr>
<td>Year 3</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Working Experience e:</td>
</tr>
<tr>
<td>Yes</td>
</tr>
<tr>
<td>No</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

a. Not significantly different among the three groups [Pearson Chi-Square=3.499, p=0.174]
b. Not significantly different among the three groups [Kruskal-Wallis Chi-Square=4.574, p=0.102]
c. Not significantly different among the three groups [Pearson Chi-Square=2.038, p=0.729]
The 3 other degrees include Commerce and Science, Commerce and Arts and Education.
d. Not significantly different among the three groups [Pearson Chi-Square=2.913, p=0.573]
e. Not significantly different among the three groups [Pearson Chi-Square=0.763, p=0.683]
5.3 KNOWLEDGE OF PARTICIPANTS

The participants’ pre-existing knowledge of internal control plans was collected through a paper-based knowledge test as described in Section 4.7.2. The knowledge test consists of three internal control failure scenarios and focuses specifically on knowledge of internal control plans. Each scenario is allocated four marks. Thus, the maximum score for the knowledge test is twelve (four marks X three scenarios). The scores of the knowledge test were converted to percentage. The mean value of the specific knowledge of internal control plans is 55.93 per cent [Standard Deviation=24.96].

In addition, two other knowledge measures were collected. In their self-evaluation of knowledge about internal control plans for an order entry/sales process, the mean rating is 4.26 [Standard Deviation=1.19] (on a seven-point Likert measurement scale anchored at 1=Very Low and 7=Very High). Participants also completed five internal control multiple-choice questions. The multiple-choice questions differ from the knowledge test’s internal control failure scenarios as they focus on attaining a participant’s general internal control knowledge rather than on specific knowledge of internal control plans. The mean value of the general knowledge of internal control is 67.33 per cent [Standard Deviation=21.51].

The specific knowledge of internal control plans captured by the knowledge test correlates significantly with the self-evaluation of knowledge of internal control plans [Spearman’s rho correlation=0.482, p<0.001]. The specific knowledge of internal control plans also correlates significantly with the general knowledge of internal control captured by the multiple-choice questions [Spearman’s rho correlation=0.236, p=0.025]. The significant correlations provide some assurance that the knowledge test adequately captures the participants’ pre-existing knowledge of internal control plans. In subsequent data analyses, the knowledge variable refers to the results of the knowledge test that

55 Participants completed the knowledge test before the self-evaluation, thus, their self-evaluation of knowledge may be influenced by their performance during the earlier knowledge test.
specifically captures participants’ pre-existing knowledge of internal control plans.

Participants’ knowledge of internal control is summarized in Table 5.3 below. The results in Table 5.3 indicate that the participants have a sufficient level of pre-existing knowledge of internal control plans to complete the experimental task.

**Table 5.3: Knowledge of participants (n=90)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific knowledge of internal control plans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Knowledge test (Percentage)</td>
<td>55.93</td>
<td>24.96</td>
<td>58.33</td>
</tr>
<tr>
<td>Self-evaluation of knowledge of internal control plans</td>
<td>4.26</td>
<td>1.19</td>
<td>4.00</td>
</tr>
<tr>
<td>(1=Very Low and 7=Very High)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General knowledge of internal control</td>
<td>67.33</td>
<td>21.51</td>
<td>60.00</td>
</tr>
<tr>
<td>- Multiple-choice questions (Percentage)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The analysis of variance (ANOVA) results reported in Table 5.4 show that the participants’ pre-existing knowledge of internal control plans is not significantly different among the three experimental groups \[F(2, 87)=0.936, p=0.396\]. The results provide evidence that the participants were randomly assigned to the three experimental groups in term of pre-existing knowledge of internal control plans.
Table 5.4: Analysis of variance for knowledge

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition</th>
<th>n</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>51.72</td>
<td>26.76</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>60.48</td>
<td>25.18</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>55.28</td>
<td>22.90</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>55.93</td>
<td>24.96</td>
</tr>
</tbody>
</table>

Panel B: ANOVA Results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F(2, 87)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>1168.62</td>
<td>2</td>
<td>584.31</td>
<td>0.936</td>
<td>0.396</td>
</tr>
<tr>
<td>Error</td>
<td>54281.99</td>
<td>87</td>
<td>623.93</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).

b. Levene’s test of homogeneity of variances p=0.734

5.4 DESCRIPTIVE STATISTICS OF THE DEPENDENT VARIABLES

Descriptive statistics of the dependent variables were compiled to provide an overview of the data. Table 5.5 reports the descriptive statistics of the dependent variables for the three different experimental groups: no decision aid, less structurally-restrictive decision aid and more structurally-restrictive decision aid.
Table 5.5: Descriptive statistics of dependent variables
Mean (Standard Deviation) [Median]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1 No Decision Aid (n=29)</th>
<th>Group 2 Less Structurally-Restrictive Decision Aid (n=31)</th>
<th>Group 3 More Structurally-Restrictive Decision Aid (n=30)</th>
<th>Combined Groups (n=90)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promoted All a</td>
<td>40.52 (16.67)</td>
<td>62.70 (26.44)</td>
<td>58.33 (24.14)</td>
<td>54.10 [37.50] [62.50] [50.00]</td>
</tr>
<tr>
<td>Non-Prompted All b</td>
<td>46.55 (20.33)</td>
<td>40.50 (21.24)</td>
<td>27.22 (20.29)</td>
<td>38.02 [50.00] [44.44] [22.22]</td>
</tr>
<tr>
<td>Prompted Present c</td>
<td>60.34 (22.92)</td>
<td>72.18 (25.76)</td>
<td>63.33 (30.78)</td>
<td>65.42 [50.00] [75.00] [56.25]</td>
</tr>
<tr>
<td>Prompted Missing d</td>
<td>20.69 (20.12)</td>
<td>53.23 (38.59)</td>
<td>53.33 (26.04)</td>
<td>42.78 [25.00] [50.00] [30.00]</td>
</tr>
<tr>
<td>Non-Prompted Present e</td>
<td>56.55 (24.54)</td>
<td>52.90 (27.10)</td>
<td>34.67 (25.15)</td>
<td>48.00 [60.00] [60.00] [40.00]</td>
</tr>
<tr>
<td>Non-Prompted Missing f</td>
<td>34.05 (23.60)</td>
<td>25.00 (24.37)</td>
<td>17.92 (24.27)</td>
<td>25.56 [25.00] [25.00] [0.00]</td>
</tr>
</tbody>
</table>

a. Percentage of all internal control plans identified that were prompted by the decision aid
b. Percentage of all internal control plans identified that were not prompted by the decision aid
c. Percentage of “present” internal control plans identified that were prompted by the decision aid
d. Percentage of “missing” internal control plans identified that were prompted by the decision aid
e. Percentage of “present” internal control plans identified that were not prompted by the decision aid
f. Percentage of “missing” internal control plans identified that were not prompted by the decision aid
Table 5.5 compares the mean, standard deviation and median of the dependent variables among the three groups. Participants without a decision aid identified the lowest percentage of all internal control plans prompted by the decision aid [Mean=40.52, Standard Deviation=16.67]. On the other hand, participants provided with the less structurally-restrictive decision aid identified the highest percentage of all internal control plans prompted by the decision aid [Mean=62.70, Standard Deviation=26.44]. Participants in the third group using the more structurally-restrictive decision aid group were second-best, identifying a mean value of 58.33 per cent [Standard Deviation=24.14] (See Figure 5.1).

Although participants without a decision aid identified the lowest percentage of all internal control plans prompted by the decision aid, they identified the highest percentage of all internal control plans not prompted by the decision aid [Mean=46.55, Standard Deviation=20.33]. On the other hand, participants provided with the more structurally-restrictive decision aid identified the lowest percentage of all internal control plans not prompted by the decision aid [Mean=27.22, Standard Deviation=20.29]. Participants in the third group using the less structurally-restrictive decision aid group were second-best, identifying a mean value of 40.50 per cent [Standard Deviation=21.24] (See Figure 5.2).
Figure 5.1: Comparison of “Prompted All” (Percentage of all internal control plans identified that were prompted by the decision aid) (n=90)

Figure 5.2: Comparison of “Non-Prompted All” (Percentage of all internal control plans identified that were not prompted by the decision aid) (n=90)
The trend is the same for the identification of prompted present and missing internal control plans. Participants without a decision aid identified the lowest percentage of present internal control plans prompted by the decision aid [Mean=60.34, Standard Deviation=22.92] (See Figure 5.3). They also identified the lowest percentage of missing internal control plans prompted by the decision aid [Mean=20.69, Standard Deviation=20.12] (See Figure 5.4). Participants provided with the less structurally-restrictive decision aid identified the highest percentage of present internal control plans prompted by the decision aid [Mean=72.18, Standard Deviation=25.76] (See Figure 5.3). Participants provided with the more structurally-restrictive decision aid identified the highest percentage of missing internal control plans prompted by the decision aid [Mean=53.33, Standard Deviation=26.04] (See Figure 5.4).

In terms of identification of non-prompted present and missing internal control plans, participants without a decision aid identified the highest percentage of present internal control plans not prompted by the decision aid [Mean=56.55, Standard Deviation=24.54] (See Figure 5.5). They also identified the highest percentage of missing internal control plans not prompted by the decision aid [Mean=34.05, Standard Deviation=23.60] (See Figure 5.6). Similarly, participants provided with the more structurally-restrictive decision aid identified the lowest percentage of present internal control plans not prompted by the decision aid [Mean=34.67, Standard Deviation=25.15] (See Figure 5.5). They also identified the lowest percentage of missing internal control plans not prompted by the decision aid [Mean=17.92, Standard Deviation=24.27] (See Figure 5.6).
Figure 5.3: Comparison of “Prompted Present” (Percentage of present internal control plans identified that were prompted by the decision aid) (n=90)

Figure 5.4: Comparison of “Prompted Missing” (Percentage of missing internal control plans identified that were prompted by the decision aid) (n=90)
Figure 5.5: Comparison of “Non-Prompted Present”
(Percentage of present internal control plans identified that were not
prompted by the decision aid) (n=90)

Figure 5.6: Comparison of “Non-Prompted Missing”
(Percentage of missing internal control plans identified that were not
prompted by the decision aid) (n=90)
In summary, participants provided with a decision aid identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid. However, participants provided with a decision aid identified fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid. Participants provided with the more structurally-restrictive decision aid identified fewer internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. The trend is consistent for the identification of present and missing internal control plans.

5.5 TESTING FOR NORMALITY
The testing of normality of the dependent variables is reported in this section. The purpose of the normality tests is to ensure that a major assumption regarding the use of parametric statistics is met (Kerlinger and Lee, 2000).

The Jacque-Bera test for normality is a formal test used to examine whether the dependent variables are normally distributed (Hill, Griffiths, and Judge, 2001). The Jacque-Bera (JB) statistics are reported in Table 5.6. A five percent significance level is used to test the null hypothesis that the variable is normally distributed. The JB statistics indicate that four out of the six dependent variables: “Prompted All” [JB statistics=2.85, p=0.24], “Non-Prompted All” [JB statistics=4.39, p=0.11], “Prompted Present” [JB statistics=3.24, p=0.20] and “Non-Prompted Present” [JB statistics=4.39, p=0.11] are normally distributed. The JB statistic for “Prompted Missing” is marginally significant [JB statistics=5.18, p=0.08]. As for the last dependent variable, “Non-Prompted Missing”, the JB statistic is significant [JB statistics=7.65, p=0.02] indicating that the data are not normally distributed. Although parametric statistical tests are relatively robust to violations of the assumption of normality (Kerlinger and Lee,

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The Jarque-Bera test for normality is based on the skewness and kurtosis measures (Hill et al., 2001). The Jacque-Bera (JB) statistics is defined as:

\[ JB = \frac{T}{6} \left( S^2 + \frac{(k - 3)^2}{4} \right) \]

where T is the number of observations, S is skewness and k is kurtosis.

---

56 The Jarque-Bera test for normality is based on the skewness and kurtosis measures (Hill et al., 2001). The Jacque-Bera (JB) statistics is defined as:
2000), additional non-parametric Kruskal-Wallis tests that do not assume normality (Kerlinger and Lee, 2000) were conducted for “Prompted Missing” and “Non-Prompted Missing”.

Table 5.6: Jacque-Bera (JB) statistics of dependent variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>JB</th>
<th>p-value</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prompted All</td>
<td>2.85</td>
<td>0.24</td>
<td>0.09</td>
<td>2.15</td>
</tr>
<tr>
<td>Non-Prompted All</td>
<td>4.39</td>
<td>0.11</td>
<td>0.02</td>
<td>1.92</td>
</tr>
<tr>
<td>Prompted Present</td>
<td>3.24</td>
<td>0.20</td>
<td>-0.24</td>
<td>2.21</td>
</tr>
<tr>
<td>Prompted Missing</td>
<td>5.18</td>
<td>0.08</td>
<td>0.28</td>
<td>1.96</td>
</tr>
<tr>
<td>Non-Prompted Present</td>
<td>4.39</td>
<td>0.11</td>
<td>-0.13</td>
<td>1.95</td>
</tr>
<tr>
<td>Non-Prompted Missing</td>
<td>7.65</td>
<td>0.02</td>
<td>0.65</td>
<td>2.40</td>
</tr>
</tbody>
</table>

- **a.** Percentage of all internal control plans identified that were prompted by the decision aid
- **b.** Percentage of all internal control plans identified that were not prompted by the decision aid
- **c.** Percentage of “present” internal control plans identified that were prompted by the decision aid
- **d.** Percentage of “missing” internal control plans identified that were prompted by the decision aid
- **e.** Percentage of “present” internal control plans identified that were not prompted by the decision aid
- **f.** Percentage of “missing” internal control plans identified that were not prompted by the decision aid

### 5.6 CORRELATIONS

Table 5.7 reports the Spearman’s rho correlations\(^{57}\) between the variables. The decision aid condition variable is significantly positively correlated with “Prompted All” (percentage of all internal control plans identified prompted by the decision aid) \([\text{Spearman’s rho correlation} = 0.294, \ p=0.005]\). This result shows that participants provided with a decision aid identified a higher percentage of internal control plans prompted by the decision aid than participants who did not have access to a decision aid.

In contrast, the decision aid condition variable is significantly negatively correlated with “Non-Prompted All” (percentage of all internal control plans identified that were not prompted by the decision aid) \([\text{Spearman’s rho correlation} = -0.357, \ p=0.001]\). This result shows that participants provided with a decision aid identified a lower percentage of internal control plans not

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\(^{57}\) Spearman’s rho correlations were conducted as decision aid condition is a categorical variable. Participants were randomly assigned to one of three experimental groups: no decision aid (coded as 1), less structurally-restrictive decision aid (coded as 2) or more structurally-restrictive decision aid (coded as 3).
prompted by the decision aid than participants who did not have access to a decision aid.

For present internal control plans, the decision aid condition variable is not significantly positively correlated with “Prompted Present” [Spearman’s rho correlation=0.061, p=0.566] but significantly negatively correlated with “Non-Prompted Present” [Spearman’s rho correlation=-0.334, p=0.001]. For missing internal control plans, the decision aid condition variable is significantly positively correlated with “Prompted Missing” [Spearman’s rho correlation=0.415, p<0.001] and significantly negatively correlated with “Non-Prompted Missing” [Spearman’s rho correlation=-0.298, p=0.004].

Knowledge is significantly positively correlated with all of the dependent variables. This result shows that participants who performed better for the knowledge test also performed better for the experimental task. Participants who had a higher pre-existing knowledge of internal control plans identified a higher percentage of present and missing internal control plans from the case narrative. The significant correlation with all of the dependent variables validates the inclusion of knowledge as a covariate\(^58\) in subsequent data analyses conducted in the next chapter.

---

\(^58\) A variable is included as a covariate in an ANCOVA model only if it has a significant effect on the dependent variable (Field, 2005).
Table 5.7: Spearman’s rho correlations between variables (n=90)

<table>
<thead>
<tr>
<th></th>
<th>Decision Aid Condition</th>
<th>Prompted</th>
<th>Non-Prompted</th>
<th>Prompted</th>
<th>Non-Prompted</th>
<th>Non-Prompted</th>
<th>Knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>All</td>
<td>All</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td></td>
</tr>
<tr>
<td>Decision Aid</td>
<td>1</td>
<td>.294(**)</td>
<td>-.357(**)</td>
<td>0.061</td>
<td>.415(**)</td>
<td>-.334(**)</td>
<td>-.298(**)</td>
</tr>
<tr>
<td>Condition</td>
<td></td>
<td>.005</td>
<td>.001</td>
<td>0.566</td>
<td>.000</td>
<td>.001</td>
<td>.004</td>
</tr>
<tr>
<td>Prompted</td>
<td>.294(**)</td>
<td>1</td>
<td>0.203</td>
<td>.772(**)</td>
<td>.859(**)</td>
<td>0.179</td>
<td>0.130</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>.005</td>
<td>.055</td>
<td>.000</td>
<td>.000</td>
<td>.091</td>
<td>.223</td>
</tr>
<tr>
<td>Non-Prompted</td>
<td>-.357(**)</td>
<td>.203</td>
<td>1</td>
<td>.292(**)</td>
<td>0.064</td>
<td>.890(**)</td>
<td>.787(**)</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td>.001</td>
<td>.055</td>
<td>.005</td>
<td>.549</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>Prompted Present</td>
<td>0.061</td>
<td>.772(**)</td>
<td>.292(**)</td>
<td>1</td>
<td>.349(**)</td>
<td>.215(*)</td>
<td>.285(**)</td>
</tr>
<tr>
<td>Prompted Missing</td>
<td>0.566</td>
<td>0.000</td>
<td>0.000</td>
<td>0.005</td>
<td>0.001</td>
<td>0.042</td>
<td>0.006</td>
</tr>
<tr>
<td>Prompted</td>
<td>.415(**)</td>
<td>.859(**)</td>
<td>0.064</td>
<td>.349(**)</td>
<td>1</td>
<td>.075</td>
<td>-0.019</td>
</tr>
<tr>
<td>Missing</td>
<td>0.000</td>
<td>0.000</td>
<td>.549</td>
<td>0.001</td>
<td>0.481</td>
<td>0.859</td>
<td>0.000</td>
</tr>
<tr>
<td>Non-Prompted</td>
<td>-.334(**)</td>
<td>0.179</td>
<td>.890(**)</td>
<td>.215(*)</td>
<td>0.075</td>
<td>1</td>
<td>.437(**)</td>
</tr>
<tr>
<td>Present</td>
<td>0.001</td>
<td>0.091</td>
<td>0.000</td>
<td>0.042</td>
<td>.481</td>
<td>1</td>
<td>0.000</td>
</tr>
<tr>
<td>Non-Prompted</td>
<td>-.298(**)</td>
<td>0.130</td>
<td>.787(**)</td>
<td>.285(**)</td>
<td>-.019</td>
<td>.437(**)</td>
<td>1</td>
</tr>
<tr>
<td>Missing</td>
<td>0.004</td>
<td>0.223</td>
<td>0.000</td>
<td>0.006</td>
<td>0.859</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.064</td>
<td>.550(**)</td>
<td>.482(**)</td>
<td>.467(**)</td>
<td>.433(**)</td>
<td>.407(**)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.552</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid (coded as 2), a more structurally-restrictive decision aid (coded as 3) or no decision aid (control) (coded as 1).
b. Percentage of all internal control plans identified that were prompted by the decision aid
c. Percentage of all internal control plans identified that were not prompted by the decision aid
d. Percentage of “present” internal control plans identified that were prompted by the decision aid
e. Percentage of “missing” internal control plans identified that were prompted by the decision aid
f. Percentage of “present” internal control plans identified that were not prompted by the decision aid
g. Percentage of “missing” internal control plans identified that were not prompted by the decision aid
h. Score of knowledge test in percentage
5.7 CHAPTER SUMMARY

This chapter reported the preliminary analyses of the data, based on the final usable sample of 90 participants. The final usable sample did not include the four participants who failed the manipulation check. Based on the results of the knowledge test, the participants have a sufficient level of pre-existing knowledge of internal control plans to complete the experimental task. In addition, the ANOVA results show that the participants’ pre-existing knowledge of internal control plans is not significantly different among the three experimental groups.

Descriptive statistics of the dependent variables show that participants without a decision aid identified the lowest percentage of all internal control plans prompted by the decision aid. However, they identified the highest percentage of all internal control plans not prompted by the decision aid. Participants who were provided with the less structurally-restrictive decision aid identified the highest percentage of all internal control plans prompted by the decision aid. At the same time, they were second-best among the three groups in identifying the percentage of all internal control plans not prompted by the decision aid. Participants in the third group using the more structurally-restrictive decision aid group identified the lowest percentage of all internal control plans not prompted by the decision aid. They were second-best in identifying the percentage of all internal control plans prompted by the decision aid. The trend was consistent for the identification of present and missing internal control plans.

The Jacque-Bera test for normality indicated all the dependent variables were normally distributed except for “Non-Prompted Missing” and “Prompted Missing”. Although parametric statistical tests are relatively robust to violations of the assumption of normality (Kerlinger and Lee, 2000), additional non-parametric Kruskal-Wallis tests that do not assume normality (Kerlinger and Lee, 2000) were conducted for “Prompted Missing” and “Non-Prompted Missing”. 
A Spearman’s rho correlation analysis was conducted and the decision aid condition variable was significantly positively correlated with “Prompted All” but significantly negatively correlated with “Non-Prompted All”. In addition, knowledge was significantly positively correlated with all of the dependent variables.

The next chapter analyses the results of the hypothesis testing.
CHAPTER SIX : RESULTS AND DATA ANALYSES

6.0 INTRODUCTION
This chapter presents the results of the experiment and data analyses. The results first examine the effects of using a decision aid on the identification of internal control plans prompted and not prompted by the decision aid in order to test Hypotheses 1 and 2. The results then assess the effects of structural restrictiveness embedded within a decision aid on the identification of internal control plans prompted and not prompted by the decision aid in order to test Hypotheses 3 and 4. The chapter is structured as follows. Section 6.1 explains the data analysis. Section 6.2 discusses the results of the data analyses conducted to test the hypotheses as developed in Chapter Three. Section 6.3 assesses factors that may affect the results of this study. Section 6.4 provides a summary of the results of the hypotheses. The last section provides a summary of the results.

6.1 STATISTICAL METHOD
The primary statistical test used to test the data was the one-way Analysis of Covariance (ANCOVA) statistical procedure. A one-way ANCOVA is a statistical technique to analyze the effect of an independent variable on a dependent variable, after controlling for the effects of covariates (Field, 2005; Tabachnick and Fidell, 2001). ANCOVA is similar to Analysis of Variance (ANOVA) except that the covariate serves as a control variable to reduce the error variances in the model and more-accurately assess the effect of the independent variable on the dependent variable (Field, 2005; Tabachnick and Fidell, 2001). The assumptions for ANCOVA (Field, 2005) are discussed in Table 6.1.

The multivariate extension of ANCOVA is Multivariate Analysis of Covariance (MANCOVA). ANCOVA was used as the primary statistical test instead of MANCOVA because the correlation between the dependent variables (Prompted All and Non-Prompted All) is low (Pearson correlation = 0.198). Separate ANCOVAs on each dependent variable should be used over MANCOVA if the correlation between the dependent variables is low (Kerlinger and Lee, 2000; Tabachnick and Fidell, 2001).
<table>
<thead>
<tr>
<th>Assumptions</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal distribution of dependent variables</td>
<td>In this study, this assumption is tested by the Jacque-Bera (JB) statistic (Hill et al., 2001) as reported in Section 5.5. Four of the six dependent variables: “Prompted All”, “Non-Prompted All”, “Prompted Present” and “Non-Prompted Present” are normally distributed. The JB statistic for “Non-Prompted Missing” is significant indicating that the data are not normally distributed and the JB statistic for “Prompted Missing” is marginally significant. Although parametric statistical tests are relatively robust to violations of the assumption of normality (Kerlinger and Lee, 2000), additional non-parametric Kruskal-Wallis tests that do not assume normality (Kerlinger and Lee, 2000) were conducted for “Non-Prompted Missing” and “Prompted Missing”.</td>
</tr>
<tr>
<td>Homogeneity of variances</td>
<td>In this study, this assumption is tested by the Levene’s test (Kerlinger and Lee, 2000). The Levene’s test is significant for “Prompted All” and “Prompted Missing”. Thus, additional non-parametric Kruskal-Wallis tests that do not assume homogeneity of variances (Kerlinger and Lee, 2000) were conducted.</td>
</tr>
<tr>
<td>Homogeneity of regression</td>
<td>In this study, this assumption is tested by adding an interaction term between the covariate and the independent variable to the ANCOVA model (Field, 2005). Any significant interaction effects indicate that the assumption of homogeneity of regression has been violated (Field, 2005). All the interaction terms are not significant.</td>
</tr>
</tbody>
</table>
6.2 ANALYSES

As discussed in Chapter Four, a 1 x 3 between-subjects experiment was conducted. Participants were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid. Participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative.

The first stage of data analyses focused on all internal control plans identified. The dependent variables included in the first round of ANCOVA analysis were participants’ percentage of all internal control plans identified prompted by the decision aid (Prompted All) and percentage of all internal control plans identified not prompted by the decision aid (Non-Prompted All). The second stage of data analyses focused on the present and missing internal control plans separately because the number of all such plans identified was the total sum of the number of present and missing internal control plans identified.

For present internal control plans, the two dependent variables were participants’ percentage of present internal control plans identified prompted by the decision aid (Prompted Present) and percentage of present internal control plans identified not prompted by the decision aid (Non-Prompted Present). On the other hand, the two dependent variables related to missing internal control plans were participants’ percentage of missing internal control plans identified prompted by the decision aid (Prompted Missing) and percentage of missing internal control plans identified not prompted by the decision aid (Non-Prompted Missing).

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60 SPSS Version 15 was used to run the statistical tests shown in the following sections.
61 The dependent variables were discussed in Section 4.8.
62 As discussed previously in Section 4.2, a key step in evaluating an internal control system is identifying the presence and absence of control plans (COSO, 1992, 2004; Gelinas et al., 2005; Goodfellow and Willis, 2006). Thus, participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that are missing and should be present in the case narrative. In addition, participants were taught in the accounting information systems subject the same approach to identify present internal control plans and recommend missing internal control plans.
As for the covariate, this study used the results of the specific-knowledge test as the covariate in the ANCOVA analyses. Participants who have a higher pre-existing knowledge of internal control plans are expected to perform better for the experimental task of identifying internal control plans from the experimental case narrative (Frederick, 1991). As shown in Section 5.6, the knowledge variable is significantly positively correlated with all of the dependent variables. The significant positive correlation with all of the dependent variables validates the inclusion of knowledge as a covariate in the ANCOVA analyses conducted in the following sections.

This section contains four sub-sections. The first two sub-sections assess the effects of using a decision aid on a decision-maker’s performance. Section 6.2.1 reports the test of Hypothesis 1. Hypothesis 1 predicted that participants provided with a decision aid will identify more items prompted by the decision aid than participants who did not have access to a decision aid. Section 6.2.2 reports the test of Hypothesis 2. Hypothesis 2 proposed that participants provided with a decision aid will identify fewer items not prompted by the decision aid than participants who did not have access to a decision aid.

The next two sub-sections further assess the effects of structural restrictiveness. Section 6.2.3 reports the test of Hypothesis 3. Hypothesis 3 predicted that participants provided with a more structurally-restrictive decision aid will identify more items prompted by the decision aid than participants provided with a less structurally-restrictive decision aid. Section 6.2.4 reports the test of Hypothesis 4. Hypothesis 4 proposed that participants provided with a more structurally-

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63 A variable is included as a covariate in an ANCOVA model only if it has a significant effect on the dependent variable (Field, 2005). The results of subsequent ANCOVA analyses show that knowledge has a significant effect on all the dependent variables, which validates the inclusion of knowledge as a covariate in the ANCOVA analyses.

64 Although the participants’ pre-existing knowledge of internal control plans was not significantly different among the three experimental groups [F(2,87)=0.936, p=0.396], it was included as a covariate in the ANCOVA models to reduce the error variance and more accurately assess the effect of the independent variable (Field, 2005). As a sensitivity check, ANOVA models (not tabulated) that did not include knowledge as a covariate were conducted and the results are consistent with the ANCOVA models. All ANOVA models have lower adjusted $R^2$ values than the respective ANCOVA models.
restrictive decision aid will identify fewer items not prompted by the decision aid than participants provided with a less structurally-restrictive decision aid.

6.2.1 The effects of using decision aids on identification of internal control plans prompted by the decision aid (Hypothesis 1)

The primary analysis was conducted using an ANCOVA with planned contrast tests. The results are reported in Table 6.2. The ANCOVA results (Table 6.2, Panel B) show that after adjusting for pre-existing knowledge, there is a significant difference among the three different experimental groups in the percentage of all internal control plans identified prompted by the decision aid (Prompted All) \(F(2,86)=7.511, p=0.001\). Knowledge also has a significant effect on the percentage of all internal control plans identified prompted by the decision aid (Prompted All) \(F(1,86)=36.65, p<0.001\).

In order to test Hypothesis 1, planned contrast tests were performed as shown in Table 6.2, Panel C. As shown in Table 6.2 (Panel C), the mean “Prompted All” percentage for participants provided with a decision aid is 16.91 per cent higher than for participants who did not have access to a decision aid. The contrast test indicates that the mean difference between participants provided with a decision aid and participants who did not have access to a decision aid is significant \(F(1,86)=14.898, p<0.001\), therefore supporting Hypothesis 1.
Table 6.2: Percentage of all internal control plans identified that were prompted by the decision aid (Prompted All)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>40.52</td>
<td>16.67</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>62.70</td>
<td>26.44</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>58.33</td>
<td>24.14</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>54.10</td>
<td>24.60</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>5592.11</td>
<td>2</td>
<td>2796.05</td>
<td>7.511</td>
<td>0.001</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>13643.77</td>
<td>1</td>
<td>13643.77</td>
<td>36.65</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>32015.44</td>
<td>86</td>
<td>372.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: No Decision Aid vs. Combined Decision Aid (Less and More Structurally-Restrictive)</td>
<td>-16.91</td>
<td>4.38</td>
<td>14.898</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>H3: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid</td>
<td>1.76</td>
<td>4.96</td>
<td>0.126</td>
<td>0.724</td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).
b. $R^2 = 0.405, \text{Adjusted } R^2 = 0.385$
   Levene's test of homogeneity of variances $p=0.018^{65}$
   Test of homogeneity of regression (Decision Aid Condition x Knowledge) $p=0.273$
c. The non-parametric Kruskal-Wallis Test is also significant [Kruskal-Wallis Chi-Square=14.205, df=2, p=0.001].
d. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also significant [F(1.55)=14.96, p<0.001].
e. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)

---

65 The homogeneity of variances assumption is violated as the Levene’s Test is significant (p=0.018). However, ANCOVA was found to be robust for groups of similar size (Glass, Peckham, and Sanders, 1972). The sample size was approximately equal under the three experimental groups: n=29 under the “No Decision Aid” group, n=31 under the “Less Structurally-Restrictive Decision Aid” group and n=30 under the “More Structurally-Restrictive Decision Aid” group. The approximately equal sample size under all conditions lowers the risk of Type I errors (i.e., the error of rejecting a null hypothesis when it is actually true) (Glass et al., 1972). In addition, the non-parametric Kruskal-Wallis Test is also significant [Kruskal-Wallis Chi-Square=14.205, df=2, p=0.001].

116
The findings support the positive attention-directing effects of prompting from a decision aid on a decision-maker’s performance. Support for Hypothesis 1 provides evidence that participants provided with a decision aid identified a higher percentage of all items prompted by the decision aid than participants who did not have access to a decision aid. The results corroborate the findings of prior research which shows that users’ attention is directed to items prompted by the decision aid in the context of judging conditional probability (Bonner et al., 1996), assessing sampling risk (Butler, 1985), assessing inventory obsolescence (Lowe and Reckers, 2000), estimating unfamiliar scenarios (MacGregor et al., 1988), judging importance of tax cases (Wheeler and Arunachalam, 2008) and learning payroll internal control systems (Eining and Dorr, 1991).

Post hoc pairwise comparisons (adjusted for Bonferroni correction\textsuperscript{66}) were conducted to compare the performances of participants who did not have access to a decision aid and participants provided with either the less structurally-restrictive or the more structurally-restrictive decision aid respectively. The mean difference between participants who did not have access to a decision aid and participants provided with the less structurally-restrictive decision aid is significant [\(p(\text{Bonferroni adjusted})(\text{one-tailed})=0.001\)]. The mean difference between participants who did not have access to a decision aid and participants provided with the more structurally-restrictive decision aid is also significant [\(p(\text{Bonferroni adjusted})(\text{one-tailed})=0.003\)].

The next section examines the present and missing internal control plans separately because the number of all such plans identified was the total sum of the number of present and missing internal control plans identified.

\textsuperscript{66} Bonferroni correction is necessary to protect against familywise Type 1 errors when multiple post hoc comparisons are performed (Field, 2005).
6.2.1.1 Present and missing internal control plans

This section examines the effects of using a decision aid on the percentage of present internal control plans identified prompted by the decision aid (Prompted Present) and the percentage of missing internal control plans identified prompted by the decision aid (Prompted Missing). Table 6.3 reports the results for “Prompted Present” and Table 6.4 reports the results for “Prompted Missing”.

The ANCOVA results (Table 6.3, Panel B) show that after adjusting for pre-existing knowledge, there is no significant difference among the three different experimental groups in the percentage of present internal control plans identified prompted by the decision aid (Prompted Present) \( [F(2,86)=0.849, p=0.431] \). In contrast for the percentage of missing internal control plans identified prompted by the decision aid (Prompted Missing), the ANCOVA results (Table 6.4, Panel B) show that after adjusting for pre-existing knowledge, there is a significant difference among the three different experimental groups \([F(2,86)=11.818, p<0.001]\).

Knowledge has a significant effect on both the percentage of present internal control plans identified prompted by the decision aid (Prompted Present) \([F(1,86)=23.354, p<0.001]\) (Table 6.3, Panel B) and the percentage of missing internal control plans identified prompted by the decision aid (Prompted Missing) \([F(1,86)=19.573, p<0.001]\) (Table 6.4, Panel B).

---

67 As discussed in Section 5.5, the Jacque-Bera (JB) statistics for “Prompted Missing” is marginally significant \([JB \text{ statistics}=5.18, p=0.08]\). Thus, additional non-parametric tests that do not assume normality (Kerlinger and Lee, 2000) were conducted.
Table 6.3: Percentage of present internal control plans identified that were prompted by the decision aid (Prompted Present)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>60.34</td>
<td>22.92</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>72.18</td>
<td>25.76</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>63.33</td>
<td>30.78</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>65.42</td>
<td>26.90</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>963.94</td>
<td>2</td>
<td>481.97</td>
<td>0.849</td>
<td>0.431</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>13261.93</td>
<td>1</td>
<td>13261.93</td>
<td>23.354</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>48835.57</td>
<td>86</td>
<td>567.86</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: No Decision Aid vs. Combined Decision Aid (Less and More Structurally-Restrictive) c</td>
<td>-4.37</td>
<td>5.41</td>
<td>0.651</td>
<td>0.422</td>
</tr>
<tr>
<td>H3: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid d</td>
<td>6.27</td>
<td>6.13</td>
<td>1.048</td>
<td>0.309</td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).

b. R² = 0.242, Adjusted R² = 0.215

Levene’s test of homogeneity of variances p=0.108

Test of homogeneity of regression (Decision Aid Condition x Knowledge) p=0.774

c. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also not significant [F(1,55)=1.356, p=0.249].

d. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)
Table 6.4: Percentage of missing internal control plans identified that were prompted by the decision aid (Prompted Missing)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>20.69</td>
<td>20.12</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>53.23</td>
<td>38.59</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>53.33</td>
<td>26.04</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>42.78</td>
<td>32.94</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>16943.55</td>
<td>2</td>
<td>8471.77</td>
<td>11.818</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>14031.03</td>
<td>1</td>
<td>14031.03</td>
<td>19.573</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>61649.27</td>
<td>86</td>
<td>716.85</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1: No Decision Aid vs. Combined Decision Aid (Less and More Structurally-Restrictive)</td>
<td>-29.46</td>
<td>6.08</td>
<td>23.472</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>H3: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid</td>
<td>-2.75</td>
<td>6.88</td>
<td>0.16</td>
<td>0.69</td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).
b. \( R^2 = 0.362, \text{Adjusted } R^2 = 0.339 \)
   Levene’s test of homogeneity of variances \( p=0.001 \)
   Test of homogeneity of regression (Decision Aid Condition x Knowledge) \( p=0.072 \)
c. The non-parametric Kruskal-Wallis Test is also significant (Kruskal-Wallis Chi-Square=19.28, df=2, \( p<0.001 \)).
d. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also significant [\( F(1,55)=21.971, p<0.001 \)].
e. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)

68 The homogeneity of variances assumption is violated as the Levene’s Test is significant \( (p<0.001) \). However, ANCOVA was found to be robust for groups of similar size (Glass et al., 1972). The sample size was approximately equal under the three experimental groups: n=29 under the “No Decision Aid” group, n=31 under the “Less Structurally-Restrictive Decision Aid” group and n=30 under the “More Structurally-Restrictive Decision Aid” group. The approximately equal sample size under all conditions lowers the risk of Type I errors (i.e., the error of rejecting a null hypothesis when it is actually true) (Glass et al., 1972). In addition, the non-parametric Kruskal-Wallis Test is also significant [Kruskal-Wallis Chi-Square=19.28, df=2, \( p<0.001 \)].
The planned contrast tests were examined to provide further insight into Hypothesis 1. The mean “Prompted Present” percentage for participants provided with a decision aid is only 4.37 per cent higher than for participants who did not have access to a decision aid and the difference is not significant \[F(1,86)=0.651, \ p=0.422\] (Table 6.3, Panel C). In contrast, the mean “Prompted Missing” percentage for participants provided with a decision aid is 29.46 per cent higher than for participants who did not have access to a decision aid and the difference is significant \[F(1,86)=23.472, \ p<0.001\] (Table 6.4, Panel C).

The findings show that the results for “Prompted All” are driven primarily by “Prompted Missing”\textsuperscript{69}. The difference between “Prompted Present” and “Prompted Missing” provides further insight into Hypothesis 1. The findings suggest that the positive attention-directing effects of prompting from a decision aid is only beneficial for identifying missing internal control plans and not as useful for identifying present internal control plans. Present internal control plans were stated in the case narrative whereas missing internal control plans were not stated in the case narrative and had to be recommended by the participant. Therefore, as participants read through the case narrative, present internal control plans are more likely to be picked up as case-specific probe cues in their short-term working memory compared with the missing internal control plans. As a result, the initial strength of association without the prompting from a decision aid between the unstated missing plans in the short-term memory and knowledge of the internal control plan in the long-term memory is expected to be lower compared with the stated present plans.

According to the \textit{SAM} theory (Raaijmakers and Shiffrin, 1981) as discussed in Chapter Three, prompting further strengthens the association between case-specific probe cue stored in decision-makers’ short-term working memory and knowledge of the internal control plan stored in their long-term memory.

\textsuperscript{69}As discussed previously in Section 4.4, the five academics who were involved in the validation of the checklist indicated participants are more likely to identify an internal control plan when it is present in a case narrative than when it is missing in a case narrative.
Following the SAM theory, an internal control plan which has a higher strength of association has a higher probability of being elicited from long-term memory and thus it is more likely to be identified by a decision-maker. The findings show that prompting results in a substantial increment of strength of association for the missing internal control plans. The mean “Prompted Missing” percentage for participants provided with a decision aid is significantly 29.46 per cent higher than for participants who did not have access to a decision aid (Table 6.4, Panel C). The results provide evidence that prompting from the decision aid directs the attention of the participants to case-specific probe cues that they may otherwise not consider, focusing participants’ attention on the prompted items.

Post hoc pairwise comparisons (adjusted for Bonferroni correction\(^70\)) were conducted to compare the performances of participants who did not have access to a decision aid and participants who used either the less structurally-restrictive or the more structurally-restrictive decision aid respectively. For “Prompted Missing”, the mean difference between participants who did not have access to a decision aid and participants provided with the less structurally-restrictive decision aid is significant \([p(\text{Bonferroni adjusted})(\text{one-tailed})<0.001]\). The mean difference between participants who did not have access to a decision aid and participants provided with the more structurally-restrictive decision aid is also significant \([p(\text{Bonferroni adjusted})(\text{one-tailed})<0.001]\).

In summary, Hypothesis 1 was supported as participants provided with a decision aid identified significantly more internal control plans prompted by the decision aid than participants who did not have access to a decision aid. However, further testing shows that the difference was driven primarily by identification of missing internal control plans prompted by the decision aid. Although participants provided with a decision aid identified more present and missing internal control plans prompted by the decision aid than participants

\(^{70}\) Bonferroni correction is necessary to protect against familywise Type 1 errors when multiple post hoc comparisons are performed (Field, 2005).
who did not have access to a decision aid, the difference is only significant for missing internal control plans.

The next section tests Hypothesis 2 related to the identification of items not prompted by the decision aid.

6.2.2 The effects of using decision aids on identification of internal control plans not prompted by the decision aid (Hypothesis 2)
The primary analysis was conducted using an ANCOVA with planned contrast tests. The results are reported in Table 6.5. The ANCOVA results (Table 6.5, Panel B) show that after adjusting for pre-existing knowledge, there is a significant difference among the three different experimental groups in the percentage of all internal control plans identified not prompted by the decision aid (Non-Prompted All) \([F(2,86)=10.356, p<0.001]\). Knowledge has a significant effect on the percentage of all internal control plans identified not prompted by the decision aid (Non-Prompted All) \([F(1,86)=33.415, p<0.001]\).

In order to test Hypothesis 2, planned contrast tests were performed as shown in Table 6.5, Panel C. As shown in Table 6.5 (Panel C), the mean “Non-Prompted All” percentage for participants provided with a decision aid is 15.38 per cent lower than for participants who did not have access to a decision aid. The planned contrast test indicates that the mean difference between participants provided with a decision aid and participants who did not have access to a decision aid is significant \([F(1,86)=14.787, p<0.001]\), therefore supporting Hypothesis 2.
Table 6.5: Percentage of all internal control plans identified that were not prompted by the decision aid (Non-Prompted All)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition a</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>46.55</td>
<td>20.33</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>40.50</td>
<td>21.24</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>27.22</td>
<td>20.29</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>38.02</td>
<td>21.94</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results b

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>6213.63</td>
<td>2</td>
<td>3211.81</td>
<td>10.356</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>10363.06</td>
<td>1</td>
<td>10363.06</td>
<td>33.415</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>26671.34</td>
<td>86</td>
<td>310.13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2: No Decision Aid vs. Combined Decision Aid</td>
<td>15.38</td>
<td>4.00</td>
<td>14.787</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>(Less and More Structurally-Restrictive)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4: Less Structurally-Restrictive Decision Aid vs.</td>
<td>11.01</td>
<td>4.53</td>
<td>5.909</td>
<td>0.017</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).
b. $R^2 = 0.377$, Adjusted $R^2 = 0.356$
Levene's test of homogeneity of variances $p=0.602$
Test of homogeneity of regression (Decision Aid Condition x Knowledge) $p=0.734$
c. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also significant \([F(1,55)=13.342, p=0.001]\).
d. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)
Support for Hypothesis 2 provides evidence of the decision-making bias in recalling non-prompted items as participants provided with a decision aid did not adequately consider other items not prompted by the decision aid. As a result, although using a decision aid improved participants' performance as they were able to identify more internal control plans prompted by the decision aid, participants ended up identifying fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid.

The results corroborate the findings of prior research which shows that the use of decision aids induces decision-making biases causing users to focus only on items prompted by the decision aid and inadequately consider other items not prompted by the decision aid in the context of assessing fraud risk (Asare and Wright, 2004; Pincus, 1989), assessing error probability (Johnson and Kaplan, 1996) and judging failure probability (Dube-Rioux and Russo, 1988; Fischhoff et al., 1978).

*Post hoc* pairwise comparisons (adjusted for Bonferroni correction\(^{71}\)) were conducted to compare the performances of participants who did not have access to a decision aid and participants who used either the less structurally-restrictive or the more structurally-restrictive decision aid respectively. The mean difference between participants who did not have access to a decision aid and participants provided with the more structurally-restrictive decision aid is significant \[p(\text{Bonferroni adjusted})(\text{one-tailed})<0.001\]. The mean difference between participants who did not have access to a decision aid and participants provided with the less structurally-restrictive decision aid is marginally significant \[p(\text{Bonferroni adjusted})(\text{one-tailed})=0.052\].

The next section examines the present and missing internal control plans separately because the number of all such plans identified was the total sum of the number of present and missing internal control plans identified.

---

\(^{71}\) Bonferroni correction is necessary to protect against familywise Type 1 errors when multiple post hoc comparisons are performed (Field, 2005).
6.2.2.1 Present and missing internal control plans

This section examines the effects of using a decision aid on the percentage of present internal control plans identified not prompted by the decision aid (Non-Prompted Present) and the percentage of missing internal control plans identified not prompted by the decision aid (Non-Prompted Missing). Table 6.6 reports the results for “Non-Prompted Present” and Table 6.7 reports the results for “Non-Prompted Missing”.

The results for “Non-Prompted Present” and “Non-Prompted Missing” are similar to the results for “Non-Prompted All”. The ANCOVA results (Table 6.6, Panel B) show that after adjusting for pre-existing knowledge, there is a significant difference among the three different experimental groups in the percentage of present internal control plans identified not prompted by the decision aid (Non-Prompted Present) \[F(2,86)=7.81, p=0.001\]. Table 6.7, Panel B also shows that there is a significant difference among the three different experimental groups in the percentage of missing internal control plans identified not prompted by the decision aid (Non-Prompted Missing) \[F(2,86)=5.207, p=0.007\].

Knowledge also has a significant effect on both the percentage of present internal control plans identified not prompted by the decision aid (Non-Prompted Present) \[F(1,86)=19.219, p<0.001\] (Table 6.6, Panel B) and the percentage of missing internal control plans identified not prompted by the decision aid (Non-Prompted Missing) \[F(1,86)=21.899, p<0.001\] (Table 6.7, Panel B).

\[72\] As discussed in Section 5.5, the Jacke-Bera (JB) statistics for “Non-Prompted Missing” is significant \[JB statistics=7.65, p=0.02\] indicating that the data are not normally distributed. Thus, additional non-parametric tests that do not assume normality (Kerlinger and Lee, 2000) were conducted.
Table 6.6: Percentage of present internal control plans identified that were not prompted by the decision aid (Non-Prompted Present)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>56.55</td>
<td>24.54</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>52.90</td>
<td>27.10</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>34.67</td>
<td>25.15</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>48.00</td>
<td>27.12</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>8496.97</td>
<td>2</td>
<td>4248.49</td>
<td>7.81</td>
<td>0.001</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>10455.59</td>
<td>1</td>
<td>10455.59</td>
<td>19.219</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>46784.96</td>
<td>86</td>
<td>544.01</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2: No Decision Aid vs. Combined Decision Aid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Less and More Structurally-Restrictive)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H4: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid</td>
<td>15.47</td>
<td>5.30</td>
<td>8.528</td>
<td>0.004</td>
</tr>
<tr>
<td>H4: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid</td>
<td>15.95</td>
<td>6.00</td>
<td>7.077</td>
<td>0.009</td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).
b. $R^2 = 0.285$, Adjusted $R^2 = 0.260$
   Levene's test of homogeneity of variances $p=0.243$
   Test of homogeneity of regression (Decision Aid Condition x Knowledge) $p=0.304$
c. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also significant $[F(1,55)=9.163, p=0.004]$.
d. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)
Table 6.7: Percentage of missing internal control plans identified that were not prompted by the decision aid (Non-Prompted Missing)

Panel A: Descriptive Statistics

<table>
<thead>
<tr>
<th>Decision Aid Condition a</th>
<th>n</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (Control)</td>
<td>29</td>
<td>34.05</td>
<td>23.60</td>
</tr>
<tr>
<td>Less Structurally-Restrictive Decision Aid</td>
<td>31</td>
<td>25.00</td>
<td>24.37</td>
</tr>
<tr>
<td>More Structurally-Restrictive Decision Aid</td>
<td>30</td>
<td>17.92</td>
<td>24.27</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>25.56</td>
<td>24.71</td>
</tr>
</tbody>
</table>

Panel B: Analysis of Covariance Results b

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>4873.80</td>
<td>2</td>
<td>2436.90</td>
<td>5.207</td>
<td>0.007</td>
</tr>
<tr>
<td>Knowledge (Covariate)</td>
<td>10247.98</td>
<td>1</td>
<td>10247.98</td>
<td>21.899</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Error</td>
<td>40245.73</td>
<td>86</td>
<td>467.97</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Panel C: Planned Contrast Pairwise Comparisons

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Mean Difference</th>
<th>Std. Error</th>
<th>F(1, 86)</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2: No Decision Aid vs. Combined Decision Aid (Less and More Structurally-Restrictive) d</td>
<td>15.27</td>
<td>4.91</td>
<td>9.658</td>
<td>0.003</td>
</tr>
<tr>
<td>H4: Less Structurally-Restrictive Decision Aid vs. More Structurally-Restrictive Decision Aid e</td>
<td>4.82</td>
<td>5.56</td>
<td>0.752</td>
<td>0.388</td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid, a more structurally-restrictive decision aid or no decision aid (control).
b. R² = 0.259, Adjusted R² = 0.234
   Levene's test of homogeneity of variances p=0.565
   Test of homogeneity of regression (Decision Aid Condition x Knowledge) p=0.761
   c. The non-parametric Kruskal-Wallis Test is also significant (Kruskal-Wallis Chi-Square=7.920, df=2, p=0.019).
   d. Based on the contrast coefficients: No Decision Aid (1) vs. Less Structurally-Restrictive Decision Aid (-0.5) vs. More Structurally-Restrictive Decision Aid (-0.5). The size of the combined decision aid group is 61, consisting of the 31 participants from the less structurally-restrictive decision aid group and the 30 participants from the more structurally-restrictive decision aid group. In addition to the planned contrast test, 29 participants were randomly selected from the Combined Decision Aid group using SPSS in order to achieve equal number of participants for the No Decision Aid group (n=29) and the Decision Aid group (n=29). The ANCOVA results (not tabulated) are also significant [F(1,55)=7.148, p=0.01].
e. Based on the contrast coefficients: No Decision Aid (0) vs. Less Structurally-Restrictive Decision Aid (1) vs. More Structurally-Restrictive Decision Aid (-1)
The planned contrast tests were examined to provide further insight into Hypothesis 2. The mean “Non-Prompted Present” percentage for participants provided with a decision aid is 15.47 per cent lower than for participants who did have access to a decision aid and the difference is significant \([F(1,86)=8.528, p=0.004]\) (Table 6.6, Panel C). Similarly, the mean “Non-Prompted Missing” percentage for participants provided with a decision aid is 15.27 per cent lower than for participants who did not have access to a decision aid and the difference is also significant \([F(1,86)=9.658, p=0.003]\) (Table 6.7, Panel C).

Participants provided with a decision aid identified both fewer present and missing internal control plans not prompted by the decision aid than participants who did not have access to a decision aid. The findings indicate that prompting from a decision aid interferes with participants’ ability to recall the non-prompted internal control plans, regardless of whether the plan was present or missing in the case narrative.

*Post hoc* pairwise comparisons (adjusted for Bonferroni correction\(^{73}\)) were conducted to compare the performances of participants who did not have access to a decision aid and participants who used either the less structurally-restrictive or the more structurally-restrictive decision aid respectively. For “Non-Prompted Present”, the mean difference between participants who did not have access to a decision aid and participants provided with the more structurally-restrictive decision aid is significant \([p(\text{Bonferroni adjusted}) \text{ (one-tailed)}<0.001]\). But the mean difference between participants who did not have access to a decision aid and participants provided with the less structurally-restrictive decision aid is not significant \([p(\text{Bonferroni adjusted}) \text{ (one-tailed)}=0.333]\).

\(^{73}\) Bonferroni correction is necessary to protect against familywise Type 1 errors when multiple post hoc comparisons are performed (Field, 2005).
As for “Non-Prompted Missing”, the mean difference between participants who did not have access to a decision aid and participants provided with the more structurally-restrictive decision aid is significant \(p(\text{Bonferroni adjusted})\) (one-tailed)=0.004. The mean difference between participants who did not have access to a decision aid and participants provided with the less structurally-restrictive decision aid is also significant \(p(\text{Bonferroni adjusted})(\text{one-tailed})=0.038\).

In summary, Hypothesis 2 was supported as participants provided with a decision aid identified significantly fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid. Further testing shows that participants provided with the more structurally-restrictive decision aid identified significantly fewer both present and missing internal control plans not prompted by the decision aid than participants who did not have access to a decision aid. However, participants provided with the less structurally-restrictive decision aid only identified significantly fewer missing internal control plans not prompted by the decision aid than participants who did not have access to a decision aid.

The next section tests Hypothesis 3 related to the identification of items prompted by the decision aid between participants who use the less structurally-restrictive decision aid and participants who use the more structurally-restrictive decision aid.

6.2.3 The effects of structural restrictiveness on identification of internal control plans prompted by the decision aid (Hypothesis 3)

This section compares the performances of participants provided with the less structurally-restrictive decision aid and participants provided with the more structurally-restrictive decision aid in order to test Hypothesis 3. Hypothesis 3 predicted that participants provided with a more structurally-restrictive decision aid will identify more items prompted by the decision aid than participants provided with a less structurally-restrictive decision aid.
As discussed in Chapter Three, structural restrictiveness is determined by the structural features embedded within a system that restrict how users interact with the system (Anson et al., 1995; DeSanctis and Poole, 1994; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Vessey et al., 1992). DeSanctis and Poole (1994, p. 126) describe structural features as the “specific types of rules” embedded within a system which determine the degree and manner in which the decision aid limits a user’s decision-making process.

Increasing the degree of structural restrictiveness within a decision aid forces more limitations on a user’s decision-making process by restraining how the user interacts with and employs the decision aid. Two versions of a computerized decision aid that differ in the degree of structural restrictiveness embedded in their design were developed for this study (discussed in Section 4.5).

The primary analysis was conducted using an ANCOVA with planned contrast tests between participants provided with the less structurally-restrictive decision and participants provided with the more structurally-restrictive decision (Table 6.2 as reported in Section 6.2.1).

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74 The 61 participants in the two decision aid treatment conditions (less and more structurally-restrictive decision aid) rated the extent to which they perceived using the decision aid constrained their decision-making process. Participants rated their response on a seven-point Likert measurement scale anchored at 1=Not Restricted and 7=Very Restricted. Participants in the more structurally-restrictive decision aid group (n=30, Mean=4.20, Std. Dev.=1.10) perceive a higher level of constraint in their decision-making process as compared with participants in the less structurally-restrictive decision aid group (n=31, Mean=3.87, Std. Dev.=1.544). However, the difference is not significant [t(1, 59)=−0.962, p(one-tailed)=0.17]. Silver (1988c) demonstrated that users’ perceptions of restrictiveness differed from the absolute viewpoint of restrictiveness because users’ perceptions vary from one to another. Besides, participants provided with a decision aid in this study were only provided with one version of the decision aid (either the less structurally-restrictive decision aid or the more structurally-restrictive decision aid). Thus, participants rated their perception of restrictiveness without having an idea of the other version of decision aid. Without knowing the other version, participants’ rating does not capture the relative concept of restrictiveness (Silver, 1988c).
Hypothesis 3 predicted that participants provided with a more structurally-restrictive decision aid will identify more items prompted by the decision aid than participants provided with a less structurally-restrictive decision aid. However, the mean “Prompted All” percentage for participants provided with the more structurally-restrictive decision aid is 1.76 per cent lower than for participants provided with the less structurally-restrictive decision aid (Table 6.2, Panel C). The planned contrast test performed in Table 6.2, Panel C indicates that the mean difference is not significant \(F(1,86)=0.126, p=0.724\). Thus, Hypothesis 3 is not supported.

The findings suggest that a greater degree of structural restrictiveness embedded within a decision aid does not provide significant incremental benefits in terms of identifying internal control plans prompted by the decision aid. This finding, interpreted in conjunction with the results discussed in Section 6.2.1 suggests that the more important factor is whether a decision aid is provided. As long as a decision aid was provided, participants identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid.

The next section examines the present and missing internal control plans separately because the number of all such plans identified was the total sum of the number of present and missing internal control plans identified.

6.2.3.1 Present and missing internal control plans

The mean “Prompted Present” percentage for participants provided with the more structurally-restrictive decision aid is 6.27 per cent lower than for participants provided with the less structurally-restrictive decision aid and the difference is not significant \(F(1,86)=1.048, p=0.309\) (Table 6.3, Panel C). As for “Prompted Missing”, the difference between participants provided with the more structurally-restrictive decision aid and participants provided with the less structurally-restrictive decision aid is only 2.75 per cent and is also not significant \(F(1,86)=0.16, p=0.69\) (Table 6.4, Panel C).
Both differences for “Prompted Present” and “Prompted Missing” are not significant which are consistent with the results for “Prompted All”. The findings provide evidence that a greater degree of structural restrictiveness embedded within a decision aid does not provide significant incremental benefits in terms of identifying internal control plans prompted by the decision aid, regardless of whether the plan was present or missing in the case narrative.

The next section tests Hypothesis 4 related to the identification of items not prompted by the decision aid between participants provided with the less structurally-restrictive decision aid and participants provided with the more structurally-restrictive decision aid.

6.2.4 The effects of structural restrictiveness on identification of internal control plans not prompted by the decision aid (Hypothesis 4)

This section compares the performances of participants who use the less structurally-restrictive decision aid and participants who use the more structurally-restrictive decision aid in order to test Hypothesis 4. Hypothesis 4 predicted that participants provided with a more structurally-restrictive decision aid will identify fewer items not prompted by the decision aid than participants provided with a less structurally-restrictive decision aid.

The primary analysis was conducted using an ANCOVA with planned contrast tests between participants provided with the less structurally-restrictive decision aid and participants provided with the more structurally-restrictive decision aid (Table 6.5 as reported in Section 6.2.2). As shown in Table 6.5 (Panel C), the mean “Non-Prompted All” percentage for participants provided with the more structurally-restrictive decision aid is 11.01 per cent lower than for participants provided with the less structurally-restrictive decision aid. The planned contrast test shown in Table 6.5, Panel C indicates that the mean difference is significant [F(1,86)=5.909, p=0.017], therefore supporting Hypothesis 4.
The results show that a greater degree of structural restrictiveness does not assist participants to identify more internal control plans prompted by the decision aid as discussed in Section 6.2.3. On the other hand, a greater degree of structural restrictiveness significantly affects participants’ ability to identify internal control plans not prompted by the decision aid. Increasing the degree of structural restrictiveness increases the decision-making bias in recalling non-prompted items, thus participants provided with the more structurally-restrictive decision aid are less likely to consider non-prompted internal control plans. As a result, participants provided with the more structurally-restrictive decision aid identified significantly fewer internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid.

The next section examines the present and missing internal control plans separately because the number of all such plans identified was the total sum of the number of present and missing internal control plans identified.

**6.2.4.1 Present and missing internal control plans**

Participants provided with the more structurally-restrictive decision aid identified both fewer present and missing internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. The mean “Non-Prompted Present” percentage for participants provided with the more structurally-restrictive decision aid is 15.95 per cent lower than for participants provided with the less structurally-restrictive decision aid (Table 6.6, Panel C). The mean “Non-Prompted Missing” percentage for participants provided with the more structurally-restrictive decision aid is also 4.82 per cent lower than for participants provided with the less structurally-restrictive decision aid (Table 6.7, Panel C).

However, only the difference for “Non-Prompted Present” is significant \[F(1,86)=7.077, \ p=0.009\] (Table 6.6, Panel C). The difference for “Non-Prompted Missing” is not significant \[F(1,86)=0.752, p=0.388\] (Table 6.7, Panel C). The findings show that the decision-making bias in recalling
non-prompted items arises in relation to identifying present internal control plans but not for missing internal control plans. The next section discusses factors that may affect the results of this study.

6.3 SENSITIVITY ANALYSES

First, participants’ demographic profiles were examined to assess whether the three experimental groups varied in terms of demographic variables. As reported in Section 5.2, there is no significant difference among the three experimental groups in terms of gender [Pearson Chi-Square=3.499, p=0.174], age [Kruskal-Wallis Chi-Square=4.574, p=0.102], degree enrolled [Pearson Chi-Square=2.038, p=0.729], year of degree [Pearson Chi-Square=2.913, p=0.573] and working experience [Pearson Chi-Square=0.763, p=0.683].

In addition, the demographic variables (gender, age, degree enrolled, year of degree and working experience) were separately included as a covariate in additional ANCOVA analyses (not tabulated) and the results indicate that the variables do not have a significant effect on the dependent variables. A variable is included as a covariate in an ANCOVA model only if it has a significant effect on the dependent variable (Field, 2005). Therefore, the demographic variables were not considered as covariates.

Second, Spearman’s rho correlations were conducted to assess whether time spent on the experimental task, participants’ perceived reliance on the decision aid and perceived task complexity varied significantly among the groups. Participants were provided a less structurally-restrictive decision aid (coded as 2), a more structurally-restrictive decision aid (coded as 3) or no decision aid (control) (coded as 1). Time spent by participants in answering the case narrative was automatically captured by the web-based software as a proxy for effort (Wheeler and Jones, 2006).

As discussed in Section 4.7.2, there was a risk that participants provided with the less structurally-restrictive decision aid might not rely on the decision aid because there were no embedded structural features embedded within the less structurally-restrictive decision aid to restrict how participants use it. The perceived reliance questions were adapted from Hampton’s (2005) study and the Cronbach’s Alpha was 0.729.

There was a risk that participants’ perceived task complexity affected their reliance on the decision aid (Arnold and Sutton, 1998; Hampton, 2005). The perceived task complexity questions were adapted from Hampton’s (2005) study and the Cronbach’s Alpha was 0.738.

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75 Spearman’s rho correlations were conducted as decision aid condition is a categorical variable. Participants were provided a less structurally-restrictive decision aid (coded as 2), a more structurally-restrictive decision aid (coded as 3) or no decision aid (control) (coded as 1).

76 Time spent by participants in answering the case narrative was automatically captured by the web-based software as a proxy for effort (Wheeler and Jones, 2006).

77 As discussed in Section 4.7.2, there was a risk that participants provided with the less structurally-restrictive decision aid might not rely on the decision aid because there were no embedded structural features embedded within the less structurally-restrictive decision aid to restrict how participants use it. The perceived reliance questions were adapted from Hampton’s (2005) study and the Cronbach’s Alpha was 0.729.

78 There was a risk that participants’ perceived task complexity affected their reliance on the decision aid (Arnold and Sutton, 1998; Hampton, 2005). The perceived task complexity questions were adapted from Hampton’s (2005) study and the Cronbach’s Alpha was 0.738.
three experimental groups. There are no significant correlations among the three experimental groups (see Table 6.8). Furthermore, the variables were separately included as a covariate in additional ANCOVA analyses (not tabulated) and the results indicate that the variables do not have a significant effect on the dependent variables. A variable is included as a covariate in an ANCOVA model only if it has a significant effect on the dependent variable (Field, 2005). Therefore, time spent on the experimental task, participants’ perceived reliance on the decision aid, and perceived task complexity were not considered as covariates.

Table 6.8: Spearman’s rho correlations for sensitivity analysis

<table>
<thead>
<tr>
<th></th>
<th>Decision Aid Condition a</th>
<th>Time b</th>
<th>Perceived reliance c</th>
<th>Perceived task complexity d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision Aid Condition</td>
<td>1</td>
<td>0.097</td>
<td>0.141</td>
<td>-0.023</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.097</td>
<td>1</td>
<td>0.047</td>
<td>0.114</td>
<td></td>
</tr>
<tr>
<td>0.362</td>
<td></td>
<td>0.718</td>
<td>0.286</td>
<td></td>
</tr>
<tr>
<td>Perceived reliance</td>
<td>0.141</td>
<td>0.047</td>
<td>1</td>
<td>0.119</td>
</tr>
<tr>
<td>Perceived task complexity</td>
<td>0.278</td>
<td>0.718</td>
<td></td>
<td>0.359</td>
</tr>
<tr>
<td>Perceived task complexity</td>
<td>-0.023</td>
<td>-0.114</td>
<td>0.119</td>
<td>1</td>
</tr>
<tr>
<td>Perceived task complexity</td>
<td>0.830</td>
<td>0.286</td>
<td>0.359</td>
<td></td>
</tr>
</tbody>
</table>

a. Decision Aid Condition: Participants were provided a less structurally-restrictive decision aid (n=31), a more structurally-restrictive decision aid (n=30) or no decision aid (control) (n=29).
b. Time spent on the experimental task (n=90)
c. Participants’ perceived reliance on the decision aid (n=61): Only the 61 participants in the two decision aid treatment conditions rated the extent of their perceived reliance on the decision aid.
d. Participants’ perceived task complexity on the experimental task (n=90)

6.4 SUMMARY RESULTS OF HYPOTHESIS TESTING

The hypotheses tested in this chapter were developed in Chapter Three. Table 6.9 presents an overall summary of the results of the hypothesis testing performed in Section 6.2. The results support all the hypotheses, except for Hypothesis 3. The results are mixed for present and missing internal control plans.
Table 6.9: Summary results of hypothesis testing

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>All&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Present&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Missing&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₁: Decision-makers who use a decision aid that prompts them to consider specific items will correctly identify more of the prompted items than decision-makers who do not have access to a decision aid.</td>
<td>Supported</td>
<td>Not Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>H₂: Decision-makers who use a decision aid that prompts them to consider specific items will correctly identify fewer items not prompted by the decision aid than decision-makers who do not have access to a decision aid.</td>
<td>Supported</td>
<td>Partially Supported</td>
<td>Supported</td>
</tr>
<tr>
<td>H₃: Decision-makers who use a more structurally-restrictive decision aid will correctly identify more of the prompted items than decision-makers who use a less structurally-restrictive decision aid.</td>
<td>Not Supported</td>
<td>Not Supported</td>
<td>Not Supported</td>
</tr>
<tr>
<td>H₄: Decision-makers who use a more structurally-restrictive decision aid will correctly identify fewer items not prompted by the decision aid than decision-makers who use a less structurally-restrictive decision aid.</td>
<td>Supported</td>
<td>Supported</td>
<td>Not Supported</td>
</tr>
</tbody>
</table>

<sup>a</sup> The first round of analyses was conducted based on all (present and missing) internal control plans identified. The number of all internal control plans identified is the total sum of the number of present and missing internal control plans identified.

<sup>b</sup> Subsequent analyses were conducted based on present and missing internal control plans separately.
6.5 CHAPTER SUMMARY

This chapter reported the results of the experiment. Participants were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid.

The results supported Hypothesis 1. Participants provided with a decision aid identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid. Specifically, the findings indicate that prompting from a decision aid is beneficial for identifying missing internal control plans but not as beneficial for identifying present internal control plans. Hypothesis 2 was also supported. Participants provided with a decision aid identified fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid.

The effect of structural restrictiveness was only significant for the identification of items not prompted by the decision aid, thereby supporting Hypothesis 4. Participants provided with the more structurally-restrictive decision aid identified significantly fewer internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. The results were driven by the present internal control plans, indicating that the decision-making bias in recalling non-prompted items arises in relation to identifying present internal control plans but not for missing internal control plans.

On the other hand, participants provided with the more structurally-restrictive decision aid did not identify more internal control plans prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. Thus, Hypothesis 3 was not supported.
The results show that although a greater degree of structural restrictiveness embedded within a decision aid does not assist participants to identify more internal control plans prompted by the decision aid, it increases users’ decision-making bias in that less non-prompted internal control plans are recalled.

The next chapter summarizes the research findings and discusses the limitations of this study. The implications and opportunities for future research are also discussed.
CHAPTER SEVEN : CONCLUSIONS

7.0 INTRODUCTION
The final chapter in this thesis is structured as follows. Section 7.1 highlights the motivation and summarizes the research findings of this study. The limitations of the research findings are discussed in Section 7.2. Section 7.3 outlines the implications of this study. Several areas for future research are discussed in Section 7.4. The last section summarizes the chapter.

7.1 MOTIVATION AND SUMMARY OF RESEARCH FINDINGS
The motivation of this study was to examine the effects of structural restrictiveness embedded within a decision aid on users’ decision-making outcomes. Although evidence shows that the degree of structural restrictiveness affects users’ decision-making process (Anson et al., 1995; DeSanctis and Poole, 1994; Kim et al., 1998; Lynch and Gomaa, 2003; McLeod and Liker, 1992; Wheeler and Valacich, 1996), it is uncertain whether the degree of structural restrictiveness embedded within a decision aid affects users’ decision-making outcomes. The goal was to investigate whether using decision aids that are designed to be more structurally-restrictive affects users’ decision-making outcomes because technology facilitates the choice to embed high levels of structural restrictiveness within computerized decision aids so that users can only interact with the decision aid in a particular prescribed manner.

An experiment was conducted using a 1 x 3 between-subjects design. Ninety participants were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid. For the experimental task, participants were given a case narrative of a company’s order entry/sales process. The case narrative described both internal control strengths and weaknesses. Participants were required to identify all internal control plans present in the case narrative and recommend internal control plans that were missing and should be present in the case narrative (i.e. areas requiring improvement in internal control in order
to have effective overall control). The participants were recruited from an accounting information systems subject that extensively exposed the participants to internal controls for the order entry/sales process.

Analysis of covariance statistical technique was used to test the hypotheses. Participants more knowledgeable about internal control plans were expected to perform better for the experimental task (Frederick, 1991). Thus, participants’ pre-existing knowledge of internal control plans was used as a covariate in the ANCOVA analyses. A paper-based knowledge test was administered to measure the pre-existing knowledge of the participants. The knowledge test consisted of three internal control failure scenarios that focused specifically on knowledge of internal control plans. After adjusting for pre-existing knowledge, the results support all the hypotheses, except for Hypothesis 3. The results are mixed for present and missing internal control plans separately.

Hypothesis 1 was supported. Participants provided with a decision aid identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid. This result means that prompting from a decision aid has a positive attention-directing effect on a decision-maker’s performance. The findings specifically indicate that prompting from a decision aid is more beneficial for identifying missing internal control plans than for identifying present internal control plans. The results corroborate the findings of prior research which shows that users’ attention is directed to items prompted by the decision aid in the context of judging conditional probability (Bonner et al., 1996), assessing sampling risk (Butler, 1985), assessing inventory obsolescence (Lowe and Reckers, 2000), estimating unfamiliar scenarios (MacGregor et al., 1988), judging importance of tax cases (Wheeler and Arunachalam, 2008) and learning payroll internal control systems (Eining and Dorr, 1991).

The ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. Therefore, a knowledge test needs to be administered to measure participants’ pre-existing knowledge of internal control plans.
Hypothesis 2 related to the decision-making bias of prompting from a decision aid on a user’s ability to identify non-prompted items, was supported. Participants provided with a decision aid identified fewer internal control plans not prompted by the decision aid than participants who did not have access to a decision aid. This result means that prompting from a decision aid induces a decision-making bias in identifying non-prompted items.

Prior research shows that the use of decision aids induces decision-making biases in the context of assessing fraud risk (Asare and Wright, 2004; Pincus, 1989), assessing error probability (Johnson and Kaplan, 1996) and judging failure probability (Dube-Rioux and Russo, 1988; Fischhoff et al., 1978). However, these studies only compare the performances of aided and unaided decision-makers. This current study compares two versions of a computerized decision aid differing in the degree of structural restrictiveness embedded in their design. The results suggest that the performances of participants who used the less structurally-restrictive decision aid and participants who used the more structurally-restrictive decision aid differ with respect to identifying non-prompted internal control plans.

Hypothesis 3 was not supported as participants provided with the more structurally-restrictive decision aid did not identify more items prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. This result means that a greater degree of structural restrictiveness embedded within a decision aid does not provide significant incremental benefits in terms of identifying internal control plans prompted by the decision aid. The more important factor is whether a participant is provided with a decision aid as shown by the results for Hypothesis 1. The findings show that as long as a decision aid was provided, regardless of whether the decision aid was less or more structurally-restrictive, participants identified more internal control plans prompted by the decision aid than participants who did not have access to a decision aid.
Hypothesis 4 related to the research question of whether the degree of structural restrictiveness embedded within a decision aid affects the decision-making bias of failing to identify items not prompted by the decision aid. The hypothesis was supported as participants provided with the more structurally-restrictive decision aid identified significantly fewer internal control plans not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid. The findings specifically show that the decision-making bias in recalling non-prompted items applies to present internal control plans but not to missing internal control plans.

The results for Hypotheses 3 and 4 show that although a greater degree of structural restrictiveness embedded within a decision aid does not assist participants to identify more internal control plans prompted by the decision aid, it increases users’ decision-making bias in that less non-prompted internal control plans are recalled.

7.2 LIMITATIONS
This section assesses limitations of the study based on the four threats to validity identified by Cook and Campbell (1979). The four threats are (a) statistical conclusion validity, (b) internal validity, (c) construct validity of putative causes and effects, and (d) external validity. The following sub-sections discuss the implications of each threat for the research results.

7.2.1 Threats to statistical conclusion validity
Statistical conclusion validity refers to “inferences about whether it is reasonable to presume covariation given a specified $\alpha$ level and the obtained variances” (Cook and Campbell, 1979, p. 41). The main types of statistical conclusion validity threats are described and discussed in Table 7.1. Two potential threats to statistical conclusion validity in this study were identified.
The first threat relates to the violations of assumptions of parametric statistical tests in some instances. First, the Jacque-Bera (JB) tests for normality, as reported in Section 5.5, indicate that the JB statistic for “Non-Prompted Missing” is significant indicating that the data are not normally distributed and the JB statistic for “Prompted Missing” is marginally significant. Nonetheless, parametric statistical tests are relatively robust to violations of the assumption of normality (Kerlinger and Lee, 2000). In addition, non-parametric tests that do not assume normality (Kerlinger and Lee, 2000) were conducted for “Non-Prompted Missing” and “Prompted Missing”. The results of the non-parametric tests are consistent with the parametric tests.

Second, the Levene’s tests for ANCOVA indicate that the homogeneity of variances assumption was violated for two variables (Prompted All and Prompted Missing). Nonetheless, ANCOVA was found to be robust for groups of similar size (Glass et al., 1972). The sample size was approximately equal under the three experimental groups: n=29 under the “No Decision Aid” group, n=31 under the “Less Structurally-Restrictive Decision Aid” group and n=30 under the “More Structurally-Restrictive Decision Aid” group. The approximately equal sample size under all conditions lowers the risk of Type I errors (Glass et al., 1972). In addition, non-parametric tests that do not assume normality (Kerlinger and Lee, 2000) were conducted for “Prompted All” and “Prompted Missing”. The results of the non-parametric tests are consistent with the parametric tests.

The other threat to statistical conclusion validity deals with the reliability of the knowledge covariate. The knowledge covariate was measured by a paper-based knowledge test because the ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. The significant correlations between participants’ specific knowledge of internal control plans captured by the knowledge test and their self-evaluation of knowledge of internal control plans and general knowledge of internal control
provide assurance that the knowledge measure is reliable. However, participants’ self-evaluation of knowledge may be influenced as the knowledge test was completed before the self-evaluation.

7.2.2 Threats to internal validity

Internal validity refers to “the validity with which statements can be made about whether there is a causal relationship from one variable to another in the form in which the variables were manipulated or measured” (Cook and Campbell, 1979, p. 38). Table 7.2 discusses the main threats to internal validity.

Randomization is effective in controlling for all possible extraneous variables (Cook and Campbell, 1979; Kerlinger and Lee, 2000). As discussed in Section 4.7.2, participants were randomly assigned to one of three experimental groups: no decision aid (control group), less structurally-restrictive decision aid or more structurally-restrictive decision aid. The results show that there are no significant differences among the three experimental groups in terms of pre-existing knowledge of internal control plans, gender, age, degree enrolled, year of degree and working experience. Therefore, the randomization process was effective.

Although randomization is effective in dealing with many threats to internal validity, it does not rule out other threats, including diffusion or imitation of treatments, compensatory equalization, compensatory rivalry and demoralization in groups receiving less-desirable treatments (Cook and Campbell, 1979). Only the threat of diffusion or imitation of treatments is applicable for this study. The threat of diffusion or imitation of treatment arises because the eight experimental sessions were conducted over six consecutive working days. Thus, it was possible that participants in the earlier sessions communicated with participants in the later sessions. This limitation was handled by asking participants not to communicate with other participants until all the experimental sessions had been conducted.
<table>
<thead>
<tr>
<th>Threats to Statistical Conclusion Validity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low statistical power</td>
<td>Statistical power is low when the sample size is small (Cook and Campbell, 1979). This study has a sample size of 90, thus the results are unlikely to be threatened by low statistical power (Cohen, 1988).</td>
</tr>
<tr>
<td>Violated assumptions of statistical tests</td>
<td>The Jacque-Bera tests for normality indicate that the data for “Non-Prompted Missing” are not normally distributed and the JB statistic for “Prompted Missing” is marginally significant. The Levene’s tests for ANCOVA indicate that the homogeneity of variances assumption was violated for two variables (Prompted All and Prompted Missing). Nonetheless, parametric statistical tests are relatively robust to violations of the assumption of normality (Kerlinger and Lee, 2000). ANCOVA was also found to be robust for groups of similar size (Glass et al., 1972). For this study, the sample size was approximately equal under the three experimental groups: n=29 under the “No Decision Aid” group, n=31 under the “Less Structurally-Restrictive Decision Aid” group and n=30 under the “More Structurally-Restrictive Decision Aid” group. In addition, non-parametric tests that do not make the parametric test assumption (Kerlinger and Lee, 2000) were also conducted and the results are consistent with the parametric tests.</td>
</tr>
<tr>
<td>Threats to Statistical Conclusion Validity</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Fishing and the error rate problem</td>
<td>The risk of inflated Type I errors (i.e., the error of rejecting a null hypothesis when it is actually true) is small as only four planned contrast tests were conducted in testing the hypotheses. Eight additional planned contrast tests were conducted for examining present and missing internal control plans separately. The additional post hoc tests conducted to compare the performances of participants who did not have access to a decision aid and participants provided with either the less structurally-restrictive or the more structurally-restrictive decision aid respectively were adjusted for Bonferroni correction to protect against familywise Type I errors (Field, 2005).</td>
</tr>
<tr>
<td>The reliability of measures</td>
<td>The assessment of participants’ answers against the validated model solutions and the assessment of the knowledge test were both qualitative exercises. Thus, two independent coders were involved for each coding exercise and the two coded data sets were analyzed for inter-coder agreement using Cohen’s Kappa statistic (Cohen, 1960). The high Kappa coefficient values indicate that the coders achieved a very high degree of agreement (Landis and Koch, 1977). The knowledge covariate was measured by a paper-based knowledge test because the ethical rules of the University where the study was conducted do not permit the researcher to obtain the results of the accounting information systems subject from which the participants were recruited. As participants’ specific knowledge of internal control plans captured by the knowledge test correlates significantly with participants’ self-evaluation of knowledge of internal control plans and general knowledge of internal control, it provides assurance that the knowledge measure is reliable. However, participants’ self-evaluation of knowledge may be influenced as the knowledge test was completed before the self-evaluation.</td>
</tr>
<tr>
<td>Threats to Statistical Conclusion Validity</td>
<td>Comments</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Random irrelevancies in experimental settings</td>
<td>Experimental settings were held as constant as possible. All experimental sessions were held in the same experimental laboratory. In order to ensure the consistency of instructions across all of the experimental sessions, the same researcher was present for all sessions and followed a written script when providing verbal instructions during the experiment. The results are unlikely to be threatened by random irrelevancies in experimental settings.</td>
</tr>
<tr>
<td>Random heterogeneity of respondents</td>
<td>Although the experiment was only open to students enrolled in the current semester of the accounting information systems subject so that the participants would have similar experience and training, there exists the possibility that “respondents in any of the treatment groups of an experiment can differ on factors that are correlated with the major dependent variables” (Cook and Campbell, 1979, p. 44). Notwithstanding this, the sample appears to be homogenous as 88.9 per cent of the participants are first year students and 95.6 per cent belong to the 18 to 21 age group. Furthermore, participants were randomly assigned to one of three experimental groups: no decision aid, less structurally-restrictive decision aid or more structurally-restrictive decision aid.</td>
</tr>
<tr>
<td>Threats to Internal Validity</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>History, maturation, testing, instrumentation, statistical regression and mortality</td>
<td>These threats are not applicable in the single between-subjects experiment conducted in this study (Campbell and Stanley, 1966).</td>
</tr>
<tr>
<td>Selection</td>
<td>This threat is controlled by randomization (Campbell and Stanley, 1966). Participants were randomly assigned to one of three experimental groups: no decision aid (control group), less structurally-restrictive decision aid or more structurally-restrictive decision aid.</td>
</tr>
<tr>
<td>Ambiguity about the direction of causal inference</td>
<td>This threat is not applicable in a laboratory experimental setting as the order of temporal precedence between variables was controlled by the researcher (Cook and Campbell, 1979).</td>
</tr>
<tr>
<td>Diffusion or imitation of treatments</td>
<td>As the eight experimental sessions were conducted over six consecutive working days, it was possible that participants in the earlier sessions communicated with participants in the later sessions. This limitation was handled by asking participants not to communicate with other participants until all the experimental sessions had been conducted.</td>
</tr>
<tr>
<td>Compensatory equalization of treatment, compensatory rivalry and demoralization in groups receiving less-desirable treatments</td>
<td>These threats are not applicable as participants were not aware of the different treatments.</td>
</tr>
</tbody>
</table>
7.2.3 Threats to construct validity

Construct validity refers to “the possibility that the operations which are meant to represent a particular cause or effect construct can be construed in terms of more than one construct” (Cook and Campbell, 1979, p. 59). Table 7.3 identifies the two main threats to construct validity in this study. First, the construct of structural restrictiveness has not been tested before. Thus, it may not totally capture the construct as conceived. In addition, the construct of structural restrictiveness is subjected to the mono-operation and mono-method bias, resulting in lower construct validity.

7.2.4 Threats to external validity

External validity relates to generalizing the results “to particular target persons, settings, and time” and “across types of persons, settings, and times” (Cook and Campbell, 1979, p. 71). Table 7.4 identifies a number of threats in generalizing the findings of this study to other decision-making environments. First, one should be cautious in generalizing the findings to all users of decision aids as only one type of decision aid in the form of a computerized checklist was examined in this study.

Second, the setting chosen for this study related to internal control evaluation. In the experimental setting of this study, participants were given a written case narrative and were required to identify the present and missing internal control plans in the narrative. However, internal control evaluation is more complex in an actual field setting within an organization. Besides examining documentations, decision-makers also observe the actual business processes and interview people to evaluate the internal control strengths and weaknesses. In addition, students were chosen as the participant group for this study. Students are less experienced in the context of internal control evaluation than practising auditors, thus one should be prudent in generalizing the findings to the more experienced practising auditors.
<table>
<thead>
<tr>
<th>Threats to Construct Validity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate preoperational explication of constructs</td>
<td>The construct of structural restrictiveness is conceptually derived from a review of the literature. As the construct has not been tested before, it may not totally capture the construct as conceived.</td>
</tr>
<tr>
<td>Mono-operation bias</td>
<td>As this experiment was “designed to have only one exemplar of a particular possible cause” and “one measure to represent each of the possible effect constructs (Cook and Campbell, 1979, p. 65), the construct validity will be lower “than in research where each construct is multiply operationalized in order to triangulate on the referent” (Cook and Campbell, 1979, p. 65).</td>
</tr>
<tr>
<td>Mono-method bias</td>
<td>This study adopts a single experimental research method. Thus, the construct of structural restrictiveness is subjected to mono-method bias.</td>
</tr>
</tbody>
</table>
Table 7.4: Threats to external validity

<table>
<thead>
<tr>
<th>Threats to External Validity</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction of selection and treatment</td>
<td>Care should be taken to generalize the findings to all users of decision aids as only one type of decision aid was examined in this study. This study utilized a computerized decision aid in the form of a computerized checklist because the use of checklist is common in the context of internal control evaluation (Abdolmohammadi and Usoff, 2001; Dowling and Leech, 2007). However, it is unclear whether the results can be generalized to all types of decision aid. The results should also be generalized with care to practising auditors. Students are less experienced in the context of internal control evaluation than practising auditors, thus one should be careful in generalizing the findings to the more experienced practising auditors.</td>
</tr>
<tr>
<td>Interaction of setting and treatment</td>
<td>The setting chosen for this study related to internal control evaluation. Care should be taken when generalizing the findings to other settings. In the experimental setting, participants were given a written case narrative and were required to identify the present and missing internal control plans in the narrative. Internal control evaluation is more complex in an actual setting within an organization. Besides examining documentations, decision-makers also observe the actual business processes and interview people to evaluate the internal control system’s strengths and weaknesses.</td>
</tr>
</tbody>
</table>
7.3 IMPLICATIONS

Technology facilitates the choice to embed high levels of structural restrictiveness within computerized decision aids so that users can only interact with the decision aid in a particular prescribed manner. However, little has been done to examine the effects of designing more structurally-restrictive or less structurally-restrictive decision aids. This study has developed two versions of a computerized decision aid that differ in the degree of structural restrictiveness embedded in their design to investigate whether using a decision aid that is more structurally-restrictive affects users’ decision-making outcomes.

The main research findings indicate that the performances of participants provided with the less structurally-restrictive decision aid and participants provided with the more structurally-restrictive decision aid were comparable with respect to identifying items prompted by the decision aid. However, performance differed with respect to identifying items not prompted by the decision aid. The results show that a greater degree of structural restrictiveness does not assist participants to identify more items prompted by the decision aid. However, it increases the decision-making bias in recalling non-prompted items, causing participants provided with the more structurally-restrictive decision aid to identify fewer items not prompted by the decision aid than participants provided with the less structurally-restrictive decision aid.

By highlighting the cost of increasing the degree of structural restrictiveness embedded within a decision aid, these findings have implications for organizations that use decision aids. The findings indicate that the degree of structural restrictiveness is an important aspect of the design of a decision aid as a greater degree of structural restrictiveness exacerbates the decision-making bias of failing to consider items not prompted by a decision aid. Decision-making bias is an important issue because decision aids are not necessarily exhaustive and are unlikely to prompt all unique items relevant to a particular situation (Cushing and Loebbecke, 1986; Dowling and Leech, 2007;
An increase in decision-making bias should be a concern to organizations that design structurally-restrictive decision aids because users are less likely to identify non-prompted items with the assistance of a structurally-restrictive decision aid. Depending on the consequences of failing to identify non-prompted items, an increase in decision-making bias may have effectiveness and efficiency implications. For example, if a user fails to identify a non-prompted item and ends up with a wrong judgment, it impacts the effectiveness of the decision-making process. On the other hand, if a user fails to identify a non-prompted item and requires more effort to reach a judgment, it impacts the efficiency of the decision-making process. Therefore, understanding the effects of the design of decision aids on users’ decision-making outcomes is important for practice because of the effectiveness and efficiency implications caused by the increase in decision-making bias.

The findings also suggest that the decision-making benefit caused by prompting from the decision aid is dependent on the nature of the item prompted by the decision aid. There was a difference in performance with respect to identification of present and missing internal control plans. Present internal control plans were stated in the case narrative whereas missing internal control plans were not stated in the case narrative and had to be recommended by the participant. Participants provided with a decision aid identified significantly more missing internal control plans prompted by the decision aid than participants who did not have access to a decision aid. However, for present internal control plans, the difference between participants provided with a decision aid and participants who did not have access to a decision aid is not significant. The research findings indicate that prompting from a decision aid is beneficial for identifying missing internal control plans but not as beneficial for identifying present internal control plans. By being aware of this new insight into the decision-making benefit caused by prompting from decision aids as
identified in prior research, organizations may be able to better deploy decision aids in appropriate decision-making situations.

This study also has implications for a large number of business disciplines in which checklists are frequently used decision aids employed by other professions extensively in diverse decision-making situations, including tax research (Wheeler and Arunachalam, 2008), software risk management (Keil et al., 2006; Wallace and Keil, 2004), marketing (Dibb, 2005; Sonja, 2006), human resources (Lievens, 1998; Yun et al., 2005) and quality management (Low and Wee, 2001; Van Der Wiele et al., 2000).

This study has made a theoretical contribution to the decision aid literature. Prior research has examined the effects of decision aid design on decision quality, including the orientation of decision aids (positive or negative) (Bedard and Graham, 2002), the information content of decision aids (more or less) (Johnson and Kaplan, 1996; Mascha and Smedley, 2007) and the information sequence of decision aids (earlier or later during the decision-making process) (Reneau and Blanthorne, 2001). This study contributes by investigating another aspect of decision aid design in terms of the degree of structural restrictiveness embedded within a decision aid. The findings indicate that the degree of structural restrictiveness is an important aspect of the design of decision aids as a greater degree of structural restrictiveness embedded within a decision aid results in a greater decision-making bias of failing to identify items not prompted by the decision aid.

7.4 FUTURE RESEARCH OPPORTUNITIES
There are several areas for future research. First, while this study provides evidence that a greater degree of structural restrictiveness embedded within a decision aid increases the decision-making bias in recalling non-prompted internal control plans, it did not examine strategies to reduce the decision-making bias. The focus of this study was the effects of decision aid structural restrictiveness on users’ decision-making outcomes. Future research could
examine users’ decision-making processes to gain insights into how users interact with either more structurally-restrictive decision aids or less structurally-restrictive decision aids. Such a study could contribute to a better understanding of the decision-making bias of failing to consider items not prompted by the decision aid. This work would enable researchers to devise strategies to mitigate the decision-making bias. This result could be achieved by using the verbal-protocol methodology to examine decision-making processes (Biggs and Mock, 1983; Bouwman, 1985).

Second, this study focuses on a homogenous group of participants in which participants are unlikely to differ in terms of experience and training in internal control plans. Thus, the decision-making expertise of the participants is held constant. Future research could examine decision-making expertise as an experimental factor. This work could be undertaken by including practising auditors in the study. Practising auditors are more experienced than students in the context of internal control evaluation. Such a study could investigate whether the degree of structural restrictiveness has differential effects on expert and novice decision-makers.

Third, this study examined only one type of decision aid in the form of a computerized checklist. Future research is required to test the degree to which the findings can be generalized to all users of checklists. Besides internal control evaluation, future research could extend to other areas where checklists are used such as software risk management (Keil et al., 2006), marketing (Sonja, 2006), human resources (Yun et al., 2005) and quality management (Low and Wee, 2001).
Future research could also examine a variety of decision aids to test the generalizability of the findings. Besides examining individual decision aids, future research could examine entire systems such as the audit support systems\textsuperscript{80} deployed in audit firms that embed decision aids within a system (Dowling and Leech, 2007). Such a study is timely as substantial differences in the level of restrictiveness among the audit support systems used at five international audit firms have been identified\textsuperscript{81} (Dowling and Leech, 2007). Although the audit support systems are of a much larger scale than the decision aid utilized in this study, the findings of this study should be of a concern to the two audit firms classified as having audit support systems with high levels of system restrictiveness.

Lastly, future research could examine the effects of structural restrictiveness embedded within a decision aid on users’ experiential learning. Such a study would be of interest to practice as decision aids are deployed in practice to develop professional expertise (Eining and Dorr, 1991; Rose, 2002).

\textbf{7.5 CHAPTER SUMMARY}

This chapter summarized the research findings and discussed the limitations of the research findings. The chapter also discussed the implications of this study and concluded with suggestions for future research opportunities.

\textsuperscript{80} Dowling and Leech (2007, p. 92) examined the audit support systems which “include electronic workpapers, extensive help files, accounting and auditing standards, relevant legislation and decision aids”.

\textsuperscript{81} Two of the five audit support systems were classified as having a high level of system restrictiveness because the system “significantly restricts extent to which user is free to choose how the audit is performed and make certain judgments through influencing how user interacts with the system” (Dowling and Leech, 2007, p. 95). On the other hand, the other three audit support systems were classified as having a low level of system restrictiveness as the system “does not significantly constrain users interaction with the system” (Dowling and Leech, 2007, p. 95).
BIBLIOGRAPHY


### Appendix 1: Summary of studies supporting the decision-making benefit of directing users’ attention to items prompted by the decision aids

<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Decision Aid</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonner et al. (1996)</td>
<td>Judging conditional probability</td>
<td>Checklist aid and decomposition-and-mechanical-aggregation aid</td>
<td>105 auditors</td>
<td>Prompting from the decision aid enhances auditor judgments and reflects better error frequencies. The decomposition-and-mechanical-aggregation aid provided greater judgment improvement compared with the checklist aid.</td>
</tr>
<tr>
<td>Butler (1985)</td>
<td>Assessing sampling risk</td>
<td>Decision rules</td>
<td>144 auditors</td>
<td>Prompting from the decision aid results in risk assessments that were nearer to a statistically-evaluated risk assessment. It also results in more correct accept/reject decisions about an account balance.</td>
</tr>
<tr>
<td>Eining &amp; Dorr (1991)</td>
<td>Evaluating payroll internal control systems</td>
<td>Questionnaire, expert system with no explanatory capability and expert system with explanatory capability</td>
<td>191 undergraduate accounting students</td>
<td>The two expert system groups were significantly more accurate and efficient than the unaided control group in the post-test. However, there was no significant difference between the questionnaire group and the unaided control group.</td>
</tr>
</tbody>
</table>

82 Studies are in alphabetical order. They are all experiment.
<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Decision Aid</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowe &amp; Reckers (2000)</td>
<td>Assessing inventory obsolescence</td>
<td>Questions to consider a single potential negative outcome and questions to consider multiple positive and negative outcomes</td>
<td>131 auditors</td>
<td>The use of a decision aid that prompts the consideration of a single potential negative outcome was effective in mitigating hindsight-bias effects. The use of a decision aid that prompts the consideration of multiple positive and negative outcomes was moderately effective in mitigating hindsight-bias effects.</td>
</tr>
<tr>
<td>MacGregor et al. (1988)</td>
<td>Estimating answer to unfamiliar scenarios</td>
<td>Algorithm with specific instruction, algorithm without specific instruction, self-generated algorithm with estimation and, self-generated algorithm without estimation</td>
<td>514 students</td>
<td>The group provided with specific-instruction algorithm received the most decision support and their estimations were the most accurate and consistent among the participants.</td>
</tr>
<tr>
<td>Study</td>
<td>Task</td>
<td>Decision Aid</td>
<td>Participants</td>
<td>Findings</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------------</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Wheeler and Arunachalam (2008)</td>
<td>Judging importance of tax cases</td>
<td>Checklist aid and justification requirement decision aid</td>
<td>142 tax professionals</td>
<td>The justification requirement aid that prompts users to evaluate and weight factors in a balanced manner had a significant effect in reducing confirmation bias. On the other hand, the checklist aid that prompts users to evaluate factors individually in a narrow manner increased the confirmation bias.</td>
</tr>
</tbody>
</table>
Appendix 2: Summary of studies supporting the decision-making bias of failing to identify items not prompted by the decision aids

<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Decision Aid</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asare and Wright (2004)</td>
<td>Assessing fraud risk</td>
<td>Checklist</td>
<td>69 auditors</td>
<td>Corroborates the findings of Pincus (1989). Auditors who were provided with a decision aid made poorer fraud-risk assessments compared with the unaided auditors.</td>
</tr>
<tr>
<td>Dube-Rioux (1988)</td>
<td>Estimating probability of restaurant failure</td>
<td>Fault tree</td>
<td>60 managers in the hospitality industry</td>
<td>Corroborates the findings of Fischhoff et al. (1978). Managers who were assigned to the pruned-tree group underestimate the probability of unspecified failure compared with those assigned to the full-tree group.</td>
</tr>
<tr>
<td>Fischhoff et al. (1978)</td>
<td>Estimating probability of car failure</td>
<td>Fault tree</td>
<td>148 persons who responded to the University student newspaper</td>
<td>Participants who were assigned to the pruned-tree treatment overestimate the probability of specified failures and underestimate the probability of unspecified failure.</td>
</tr>
</tbody>
</table>

Studies are in alphabetical order. They are all experiment.
<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Decision Aid</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnson and Kaplan (1996)</td>
<td>Analytical procedures</td>
<td>Checklist</td>
<td>77 auditors</td>
<td>Auditors who were assigned to the shorter checklist group overestimated the likelihood of the specified errors included in the list and underestimated the likelihood of the unspecified errors not included in the list compared with those assigned to the longer checklist group.</td>
</tr>
<tr>
<td></td>
<td>(probability assessment)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pincus (1989)</td>
<td>Assessing fraud risk</td>
<td>Checklist</td>
<td>137 auditors</td>
<td>Prompting from the decision aid increased comprehensiveness and uniformity in data acquisition but did not improve fraud-risk assessment. In fact, auditors who were provided with a decision aid made poorer fraud-risk assessments compared with the unaided auditors as the aided auditors failed to pick up other important risk factors that existed in the fraud-case material but were not listed in the decision aid.</td>
</tr>
<tr>
<td>Wheeler and Arunachalam (2008)</td>
<td>Judging importance of tax cases</td>
<td>Checklist aid and justification requirement decision aid</td>
<td>142 tax professionals</td>
<td>The justification-requirement aid that prompts users to evaluate and weight factors in a balanced manner significantly reduced confirmation bias. On the other hand, the checklist aid that prompts users to evaluate factors individually in a narrow manner increased the confirmation bias.</td>
</tr>
</tbody>
</table>
## Appendix 3: Summary of accounting studies examining output interference

<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Participants</th>
<th>Dependent Variables(s)</th>
<th>Independent Variables(s) * = significant</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson et al. (1992)</td>
<td>Analytical procedures judgments</td>
<td>38 audit managers</td>
<td>Number of error and non-error explanations generated</td>
<td>Order of explanations* (errors first vs. non-errors first)</td>
<td>Audit managers generate significantly fewer error explanations if errors are generated second compared with first. However, there was no significant difference for non-error explanations.</td>
</tr>
<tr>
<td>Frederick (1991)</td>
<td>Recall of internal control</td>
<td>113 auditors and 97 undergraduate accounting students</td>
<td>Number of internal control recalled Percentage of non-cued controls recalled</td>
<td>Expertise* (E) Knowledge organization (O) (Schematic vs. taxonomic) Recall condition* (R) (Free recall vs. cued recall) Type of cue (C) (Category cued vs. part-category cued)</td>
<td>Auditors performed better than students in all treatment conditions. When cues were provided, both experts and novices suffer output interference and recall a lower percentage of non-cued items within both knowledge organizations. In the taxonomic organization, both category and part-category cueing produced output interference. However, in the schematic organization, only part-category cueing produced output interference.</td>
</tr>
</tbody>
</table>

*Studies are in alphabetical order. They are all experiment.*
<table>
<thead>
<tr>
<th>Study</th>
<th>Task</th>
<th>Participants</th>
<th>Dependent Variables(s)</th>
<th>Independent Variables(s) * = significant</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heiman-Hoffman et al. (1995)</td>
<td>Hypothesis generation</td>
<td>54 auditors</td>
<td>Percentage of participants who identified correctly the actual error after they received the additional information</td>
<td>Type of error* (frequent vs. infrequent)</td>
<td>Auditors’ performance in identifying an actual error was mediated by their reluctance to switch from their initial hypothesis. Auditors who generated a frequent error as the initial hypothesis performed best when it was the actual error but performed worst when the infrequent error was the actual error, demonstrating a reluctance to switch behavior.</td>
</tr>
<tr>
<td>Moser (1989)</td>
<td>Investment task (predictive earnings judgment)</td>
<td>58 investors from 7 investment clubs</td>
<td>Number of reasons generated Earnings probability judgment</td>
<td>Information condition (I) Order of reason generation* (pro-con vs. con-pro) I X O</td>
<td>Existence of output interference. Participants who were assigned to the pro-con group generate more pro than con reasons and make higher-probability judgments. On the other hand, participants who were assigned to the con-pro group generate more con than pro reasons and make lower probability judgments.</td>
</tr>
<tr>
<td>Pei and Tuttle (1999)</td>
<td>Hypothesis generation</td>
<td>Expt 1: 44 auditors Expt 2: 73 auditors Expt 3: 90 auditors Separate auditors for each experiment.</td>
<td>Number of hypotheses recalled</td>
<td>Hypothesis plausibility* (No prompt vs. high vs. low vs. mixed plausibility prompt) Hypothesis severity*</td>
<td>Prompting with high-plausibility hypotheses had no effect. Output interference occurs for the low-plausibility and mixed-plausibility prompt groups. For the low-plausibility prompt group, there is an interaction with hypothesis severity. Prompting results in inhibition when hypothesis severity is high but results in facilitation when hypothesis severity is low.</td>
</tr>
</tbody>
</table>
### Appendix 4: Summary of studies examining system restrictiveness

#### Panel A: Physical Restrictiveness

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design</th>
<th>Participants</th>
<th>Definition (Theoretical)</th>
<th>Definition (Operational)</th>
<th>Task</th>
<th>Dependent Variables(s)</th>
<th>Independent Variables(s)</th>
<th>* = significant</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chu and Elam (1990)</td>
<td>Experiment (Between subjects)</td>
<td>24 graduate business students</td>
<td>It is defined as the extent of constraints and limitations place by a system on the decision-making process. It introduces the idea of “induced restrictiveness”, which manifests itself when the users of the DSS predominantly employ a particular decision process even though the system also physically permits a complementary process or an array of other decision processes.</td>
<td>Half of the participants complete the task using Lotus 1-2-3 while the other half do not have access to any system.</td>
<td>Demand forecast</td>
<td>Decision process</td>
<td>System use* (use vs. nonuse)</td>
<td></td>
<td>The results demonstrate the existence of induced restrictiveness as Lotus users tend to adopt a decision process encouraged by the tool.</td>
</tr>
</tbody>
</table>

*Studies are in alphabetical order.*
<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design</th>
<th>Participants</th>
<th>Definition (Theoretical)</th>
<th>Definition (Operational)</th>
<th>Task</th>
<th>Dependent Variables(s)</th>
<th>Independent Variables(s) * = significant</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davern and Kamis (2006)</td>
<td>Experiment (Between subjects)</td>
<td>56 undergraduate information systems students</td>
<td>This study adopts Silver's (1988b) definition that system restrictiveness is the degree to which and the manner in which a decision support system limits its users' decision-making processes to a subset of all possible processes.</td>
<td>This study develops two tools: an eliminative tool (ELIM) and a parametric search tool (PS). The physical features offered by ELIM are an exact subset of PS. Thus, ELIM is a more restrictive tool than PS as PS can do everything ELIM can, and more.</td>
<td>Preferential choice task (printer purchase)</td>
<td>Accuracy</td>
<td>Decision tool (PS) Effort* Knowledge (K) PS X Effort* PS X K Effort X K PS X Effort X K</td>
<td>The effect of decision tool design (restrictiveness) on performance is contingent on both the effort and the form or content of the domain knowledge of the user.</td>
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<tr>
<td>Study</td>
<td>Research Design</td>
<td>Participants</td>
<td>Definition (Theoretical)</td>
<td>Definition (Operational)</td>
<td>Task</td>
<td>Dependent Variables(s)</td>
<td>Independent Variables(s) * = significant</td>
<td>Findings</td>
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<tr>
<td>Silver (1988b) (1988a) (1990)</td>
<td>Analytical</td>
<td>NA</td>
<td>It is defined as the degree to which and the manner in which a Decision Support System (DSS) restricts its users' decision-making processes to a particular subset of all possible processes.</td>
<td>DSS can limit decision-making processes by restricting:  - the set of operators  - the inputs to the operators, in particular, access to data  - the parametrization of the operators  - the use of operators with non-trivial sequencing rules  - the adaptors that allow modification/creation of operators</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>The finite functional capabilities of a system restrict users' decision-making processes. There are objectives that favor either greater or lesser restrictiveness. The two set of objectives are traded off against one another in designing a DSS.</td>
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<tr>
<td>Study</td>
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<tr>
<td>Silver (1988c)</td>
<td>Experiment (Within subjects)</td>
<td>50 MBA students</td>
<td>It is defined as the degree to which and the manner in which a Decision Support System (DSS) restricts its users’ decision-making processes to a particular subset of all possible processes.</td>
<td>Compared three DSS: Lotus 1-2-3, Multi-Attribute software system (MASS) and Elimination by Aspector (EBA). The decision-making processes supported by EBA are an exact subset of MASS, which are themselves an exact subset of Lotus 1-2-3. Thus, EBA is the most restrictive DSS and Lotus 1-2-3 is the least restrictive DSS.</td>
<td>Preferential choice task (list of 5 preferred cities to live)</td>
<td>Ranking of system restrictiveness among the three DSS</td>
<td>Decision support system</td>
<td>Users' perceived system restrictiveness differs from one to another and from the absolute viewpoint.</td>
</tr>
<tr>
<td>Study</td>
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<td>Definition (Theoretical)</td>
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<td>Speier and Morris (2003)</td>
<td>Experiment (Within subjects and Between subjects)</td>
<td>372 undergraduate students</td>
<td>It is defined as the extent to which the type of query interface employed can enforce a particular type of decision strategy.</td>
<td>The study manipulates text-based vs. visual query interface. The text-based query interface is more restrictive than the visual query interface because it offers a smaller subset of physical features.</td>
<td>Real estate acquisition task</td>
<td>Decision accuracy</td>
<td>Decision time Mental workload</td>
<td>Query interface (QI)* Task complexity (TC)* Spatial ability (SA) QI X TC* QI X SA* When task complexity is low, decision accuracy is higher with text-based query interface (more restrictive) but when task complexity is high, decision accuracy is higher with visual query interface (less restrictive).</td>
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<td>Study</td>
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<td>Tabatabaei (2002)</td>
<td>Experiment (Between subjects)</td>
<td>111 undergraduate business administration students</td>
<td>It is defined as the extent of channeling the decision-maker to adopt a particular information processing pattern.</td>
<td>The information display is manipulated on three levels: - display of information by alternative (matrix row) - display of information by attribute (matrix column) - display of the full-information matrix</td>
<td>Truck scheduling</td>
<td>Decision accuracy</td>
<td>Information display type* Time pressure*</td>
<td>The non-channeled full-information display results in decision accuracy level between the two restrictively channeled information display conditions (by alternative and by attribute) but requires significantly less time for participants to reach their decisions.</td>
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</table>
### Panel B: Structural Restrictiveness

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<tr>
<th>Study</th>
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<th>Participants</th>
<th>Definition (Theoretical)</th>
<th>Definition (Operational)</th>
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<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anson et al. (1995)</td>
<td>Experiment (Between subjects)</td>
<td>319 undergraduate students recruited from an introductory communication subject organized into 48 groups</td>
<td>This study examines both structural (SR) and process restrictiveness (PR). SR is defined as the extent of external structuring intervention by a group decision support system (GSS). PR is defined as the extent of structuring intervention by a third party facilitator.</td>
<td>Four treatment conditions: no external intervention (control), only GSS, only facilitator and combined GSS and facilitator.</td>
<td>Strategy design and implementation</td>
<td>Group meeting outcomes (performance) Group maintenance and relationships (cohesion) Perceived quality of group interaction processes (process)</td>
<td>Group decision support system (GSS) Facilitator(F)* GSS X F*</td>
<td>Groups provided structures by a GSS do not achieve better performance, cohesion and process outcomes than groups without a GSS. However, an additive relationship is found to exist between the facilitator and GSS for cohesion and process outcomes.</td>
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</tbody>
</table>

Anson et al. (1995) conducted an experiment between subjects. They recruited 319 undergraduate students from an introductory communication subject, organized into 48 groups. The study examines both structural (SR) and process restrictiveness (PR). Structural restrictiveness is defined as the extent of external structuring intervention by a group decision support system (GSS). Process restrictiveness is defined as the extent of structuring intervention by a third party facilitator. The study uses four treatment conditions: control (no external intervention), GSS only, facilitator only, and GSS and facilitator combined. The dependent variables include group meeting outcomes (performance), group maintenance and relationships (cohesion), and perceived quality of group interaction processes (process). The independent variables are group decision support system (GSS), facilitator (F), and their interaction (GSS X F). The findings indicate that groups provided structures by a GSS do not achieve better performance, cohesion, and process outcomes than groups without a GSS. However, an additive relationship is found between the facilitator and GSS for cohesion and process outcomes.
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<tr>
<th>Study</th>
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<th>Participants</th>
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<th>Dependent Variables(s)</th>
<th>Independent Variables(s)</th>
<th>* = significant</th>
<th>Findings</th>
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</thead>
</table>
| DeSanctis and Poole (1994) | Analytical      | NA           | This paper adopts Adaptive Structuration Theory (AST) to argue how the advanced information technologies affect the structure in human actions in two ways:  
- Structural features of the given technology, which relates to the specific types of rules and resources or capabilities offered by the system  
- Spirit of this feature set, which relates to the general intent with regards to values and goals underlying a given set of structural features.                                                                                      | NA                        | NA   | NA                     | NA                        | NA                      | AST provides a model that explains how the structure inherent in an advanced information technologies affect the structures in human action that emerge as people interact with the technologies, which in turn determine decision efficiency, quality and consensus. |
<table>
<thead>
<tr>
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<td>Kim et al. (1998)</td>
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<td>212 students organized into 47 groups</td>
<td>This study examines both structural (SR) and process restrictiveness (PR). SR is defined as the extent of procedural order arising from the coordination structure provided through Distributed Group Support Systems (DGSS). PR is defined as the extent of procedural order arising from the coordination structure provided through the presence of a group leader.</td>
<td>SR is operationalized in terms of the type of coordination mode supported by the DGSS. The sequential mode is more restrictive than the parallel mode due to its pre-defined and inflexible procedural order where groups are asked to discuss one topic at a time and not allowed to discuss previous topics once a new topic is introduced. PR is operationalized by the presence of a group leader. A group with a leader is considered less restrictive because the group leader is allowed to modify a given coordination structure. In contrast, a group without a leader is asked to restrictively respond to procedures imposed by the DGSS.</td>
<td>Investment club task, selecting 1-3 stocks from 15stocks to be held for at least six months</td>
<td>Decision quality</td>
<td>Perceived decision quality</td>
<td>Satisfaction with decision making process</td>
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The less-restrictive parallel-coordination mode results in higher objective and perceived decision quality and satisfaction measures compared with the more-restrictive sequential-coordination mode.

The less-restrictive coordination structure caused by the presence of a group leader also results in higher objective and perceived decision quality and satisfaction measures compared with the more-restrictive coordination structure without a group leader.
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<th>Findings</th>
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<tbody>
<tr>
<td>Lynch and Gomaa (2003)</td>
<td>Analytical</td>
<td>NA</td>
<td>It is defined as the extent of limiting the range of activities in which an individual can engage.</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>It asserts that highly-restrictive technology tends to include more embedded control mechanisms that limit the range of activities in which individuals can engage. It proposes a negative relationship between the perceived level of system restrictiveness and intentions to commit computer fraud.</td>
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<td>Study</td>
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<tr>
<td>McLeod and Liker (1992)</td>
<td>Experiment (Between subjects)</td>
<td>34 groups (10 groups of undergraduate engineering students, 10 groups of undergraduate business students and 14 groups of graduate business students)</td>
<td>It is defined as the extent of influence exerted by the system to change a group’s structure. High-structure (restrictive) systems are described as those that are designed specifically to change a group’s preexisting structures by offering specific methods. In contrast, low-structure (flexible) systems are described as those that are not designed to change group structure in any specific way.</td>
<td>This study uses a low-structure GSS called Capture Lab. Participants are assigned to either the GSS supported group or the manually supported group.</td>
<td>Expt. 1: Project planning item ranking evaluative task Expt. 2: In-basket response generative task</td>
<td>Equality of participation Degree of task focus Decision quality Member assessments of group performance and satisfaction</td>
<td>System* (GSS supported or manually supported)</td>
<td>It is important to consider the characteristic of the GSS and the task. The GSS leads to better performance for a well-known evaluative task but leads to worse performance for an ambiguous generative task.</td>
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<tr>
<td>Study</td>
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<tr>
<td>Vessey et al. (1992)</td>
<td>Analytical</td>
<td>NA</td>
<td>It is defined as the extent to which the system allows users to choose their preferred methodology. This study examines system restrictiveness in the context of computer-aided software engineering (CASE) tools. A restrictive CASE tool is designed to encourage the user to use it in a normative manner. A guided CASE tool is designed to encourage, but not to enforce, the user to use it in a normative way. A flexible CASE tool is designed to allow the user complete freedom in using it.</td>
<td>A restrictive CASE tool enforces the levelling of data-flow diagrams using a top-down partitioning process. A guided CASE tool suggests, but does not enforce a top-down partitioning process. With a flexible CASE tool, users can choose their own preferred process.</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>This study classifies 12 commercially available CASE tools according to the restrictive, guided or flexible classification.</td>
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<tr>
<td>Study</td>
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<tr>
<td>Wheeler and Valacich (1996)</td>
<td>Experiment (Between subjects)</td>
<td>480 students organized into 96 five members groups</td>
<td>This study examines both structural (SR) and process restrictiveness (PR). SR is defined as the set of rules embedded within the GSS to parallel the heuristics structure. PR is defined as the manner of limiting a group’s interaction to the activities, sequences, and philosophies specified by a heuristics.</td>
<td>SR is operationalized in terms of the GSS configuration. Half of the groups used a more restrictive GSS configuration that displayed a sequenced agenda. The agenda items were presented in a sequential manner, one item at a time. The other half of the groups used a less-restrictive GSS configuration where users are free to employ the GSS features in any manner they choose. PR is operationalized by the presence of a process group facilitator and training to enforce the structure of the heuristic.</td>
<td>Hidden-profile school of business policy task</td>
<td>Appropriation of the heuristic’s activity and sequence Decision quality</td>
<td>GSS configuration* (GSS) Facilitation* (F) Training* (T) GSS X F* GSS X T F X T* GSS X F X T</td>
<td>Groups using the more-restrictive GSS configuration follow the heuristic’s structure more closely than the less-restrictive group, resulting in higher decision quality. GSS configuration and facilitation interacted significantly. The more-restrictive facilitated groups follow the heuristic’s structure more closely than the less-restrictive un-facilitated group, resulting in higher decision quality. The more-restrictive trained...</td>
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<td>groups follow the heuristic’s structure more closely than the less-restrictive untrained group, resulting in higher decision quality. Facilitation and training also interacted significantly.</td>
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### Panel C: Process Restrictiveness

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<th>Research Design</th>
<th>Participants</th>
<th>Definition (Theoretical)</th>
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<td>Anson et al. (1995)</td>
<td>Experiment (Between subjects)</td>
<td>319 undergraduate students recruited from an introductory communication subject organized into 48 groups</td>
<td>This study examines both structural (SR) and process restrictiveness (PR). SR is defined as the extent of external structuring intervention by a group decision support system (GSS). PR is defined as the extent of structuring intervention by a third party facilitator.</td>
<td>Four treatment conditions: no external intervention (control), only GSS, only facilitator and combined GSS and facilitator.</td>
<td>Strategy design and implementation</td>
<td>Group meeting outcomes (performance) Group maintenance and relationships (cohesion) Perceived quality of group interaction processes (process)</td>
<td>Group decision support system (GSS) Facilitator(F)* GSS X F*</td>
<td>* = significant Groups provided structures by a GSS do not achieve better performance, cohesion and process outcomes than groups without a GSS. The presence of a facilitator significantly influenced cohesion and process outcomes but not performance outcomes However, an additive relationship is found to exist between the facilitator and GSS for cohesion and process outcomes.</td>
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<td>DeSanctis et al. (1989)</td>
<td>Experiment</td>
<td>239 graduate business students organized into 56 groups</td>
<td>It is defined as the extent that the group-decision heuristics limits, or channels, the group’s use of the resources inherent in the heuristics. The heuristics is highly restrictive if the instruction is given on their execution. It is confined to refer to the manner of resource use, given that a set of resources is available to the decision-maker.</td>
<td>It is operationalized by instructing groups to either: - use all of the available features and apply them in a sequential fashion until a decision was reached (higher restrictiveness) or - select the features that seemed most useful and apply them in any meaningful order (lower restrictiveness).</td>
<td>Philanthropic fund allocation among six competing projects</td>
<td>Task consensus Decision time</td>
<td>Restrictiveness (R) Comprehensive-ness* (C) R X C</td>
<td>Restrictiveness does not result in greater group consensus and faster decision time as hypothesized.</td>
</tr>
<tr>
<td>Study</td>
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<td>Dickson et al. (1993)</td>
<td>Experiment (Between subjects)</td>
<td>36 groups of MBA students</td>
<td>It is defined as the amount of freedom users have in choosing what feature to use whenever they want.</td>
<td>This study manipulates two GSS support mode:  - Facilitator-driven: It is a more-restrictive mode as the facilitator directs the group members on what GSS features to use, when to use them and how to use them.  - Chauffeur-driven: It is less restrictive than the facilitator-driven mode as the chauffeur does not affect the group process. The chauffeur merely implements the features of the technology upon directions from the group.</td>
<td>Philanthropic fund allocation among six competing projects</td>
<td>Consensus</td>
<td>Decision support* Guide Decision support X Guide</td>
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<td>Kim et al.</td>
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<td>Investment club task, selecting 1-3 stocks from 15 stocks to be held for at least six months</td>
<td>Decision quality Perceived decision quality Satisfaction with decision Satisfaction with decision-making process</td>
<td>* = significant</td>
<td>The less-restrictive parallel-coordination mode results in higher objective and perceived decision quality and satisfaction measures compared with the more-restrictive sequential-coordination mode. The less-restrictive coordination structure caused by the presence of a group leader also results in higher objective and perceived decision quality and satisfaction measures compared with the more-restrictive coordination structure without a group leader.</td>
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</table>
| Wheeler and Valacich (1996)  | Experiment (Between subjects) | 480 students organized into 96 five members groups | This study examines both structural (SR) and process restrictiveness (PR). SR is defined as the set of rules embedded within the GSS to parallel the heuristics structure. PR is defined as the manner of limiting a group’s interaction to the activities, sequences, and philosophies specified by a heuristics. | SR is operationalized in terms of the GSS configuration. Half of the groups used a more restrictive GSS configuration that displayed a sequenced agenda. The agenda items were presented in a sequential manner, one item at a time. The other half of the groups used a less-restrictive GSS configuration where users are free to employ the GSS features in any manner they choose. PR is operationalized by the presence of a process group facilitator and training to enforce the structure of the heuristic. | Hidden-profile school of business policy task | Appropriation of the heuristic’s activity and sequence Decision quality | GSS configuration* (GSS) Facilitation* (F) Training* (T) GSS X F* GSS X T F X T* GSS X F X T | Groups using the more-restrictive GSS configuration follow the heuristic’s structure more closely than the less-restrictive group, resulting in higher decision quality. GSS configuration and facilitation interacted significantly. The more-restrictive facilitated groups follow the heuristic’s structure more closely than the less-restrictive un-facilitated group, resulting in higher decision quality. The more-restrictive trained
<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design</th>
<th>Participants</th>
<th>Definition (Theoretical)</th>
<th>Definition (Operational)</th>
<th>Task</th>
<th>Dependent Variables(s)</th>
<th>Independent Variables(s)</th>
<th>* = significant</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>groups follow the heuristic’s structure more closely than the less-restrictive untrained group, resulting in higher decision quality. Facilitation and training also interacted significantly.</td>
</tr>
</tbody>
</table>
Appendix 5: Experimental cases and model solutions

Part A: Case 1 - Redpool Office Supplies (Training Case)

Background Information
Redpool Office Supplies is a medium sized business-to-business provider of office supplies. The product range includes stationery, computer supplies, office machines, office furniture and related items. It is 100 percent owned by the 2 founding directors and employs 30 people. All of Redpool’s current sales are made to local customers in Melbourne. Customers are provided with an updated product catalogue every three months. They can only place their orders by calling the Sales Department. All customers are allowed to buy on credit. The credit terms range from 15 to 30 days depending on the customer’s credit worthiness and strategic importance.

Narrative of the Order Entry/Sales Process at Redpool Office Supplies
Breana, the Sales Manager, is supported by a team of Sales Officers (SO). Only Breana has the authority to approve new customers. After deciding on their credit limit, she adds them to the customer master data file in the information system. The SO is responsible for processing the orders of existing customers. When taking a phone order, the SO first asks for the customer’s name. After keying in the customer’s name, the SO selects the customer from the displayed list. This triggers the computer to display the sales order screen with the customer’s details (such as name, customer ID, address, contact number, sales history and credit balance).

The SO first checks the displayed credit balance. Once satisfied that the customer has available credit, the SO proceeds with the sales order by keying in the product code. All product code follows a 6 digit format. The computer displays an input error message if the SO does not enter a 6 digit format product code. If the product is available, the computer displays the product information (such as description and price) on a read-only basis. At the same time, the computer automatically jumps the input cursor to the “order quantity” field to facilitate the SO in entering the order quantity. Once the SO clicks on the
“Submit” button of the sales order screen, the order is processed and the sales order and inventory master data file are updated.

At the same time, the computer prints four copies of the pre-numbered sales order. The SO files Copy 1 in the “Sales Order” file in numeric sequence and places the other three copies in the “Out-Tray” of the Sales Department. Billy, the Office Boy, goes on his dispatch round around the office three times a day. Billy picks up the documents and arranges to fax Copy 3 of the sales order to Justin, the Warehouse Supervisor and Copy 4 of the sales order to Ian, the Shipping Supervisor. During the next dispatch round, Billy places the faxed sales orders in the Sales Department’s “In-Tray”. At the end of each working day, the SO on duty attaches the faxed Copy 3 and 4 to Copy 1 in the “Sales Order” file and ensures that the sales orders are filed in numeric sequence with no missing sales order. As for Copy 2, Billy places it in the “In-Tray” of May, the Billing Clerk who is in the same building. May does the billing every Monday for all the shipments in the previous week.

Justin and his team of four Warehouse Clerks use the faxed Copy 3 of the sales order as the picking ticket to assemble the customer’s order. Once the items are picked, the Warehouse Clerk on duty delivers the goods and Copy 3 of the sales order to the shipping department which is situated in the adjacent building. On occasions when the warehouse team is busy, the Shipping Clerk on duty enters the warehouse to collect the picked items from the Warehouse Clerk.

On receipt of the faxed Copy 4 of the sales order at the shipping department, the Shipping Clerk on duty files it in the “Outstanding Sales Order” file. Once the shipping department receives the goods and Copy 3 of the sales order from the warehouse, the Shipping Clerk on duty retrieves the matching Copy 4. The Shipping Clerk compares the physical count of the product with the quantities indicated on Copy 3 and 4 of the sales order. If the items are in order, the Shipping Clerk calls up the sales order from the information system and advances the status from “Outstanding” to “Standby for Shipment”. This triggers
the computer to print a copy of the pre-numbered shipping notice and three copies of the pre-numbered bill of lading. The Shipping Clerk faxes the shipping notice and Copy 1 of the bill of lading to May, the Billing Clerk. After faxing, the Shipping Clerk attaches the documents to the twofaxed sales orders (Copy 3 and 4). The Shipping Clerk stamps “Shipped” on each document and places them in Ian’s “In-Tray”. Lastly, the Shipping Clerk attaches the remaining two copies of the bill of lading to the goods for the carrier and customer. The order is placed in the dispatch area of the shipping department. At 9am every morning, a courier picks up the goods and delivers them to the customer.

Ian, the Shipping Supervisor, is responsible for updating the status of the sales order. At the end of each working day, Ian calls up all sales orders with the status of “Standby for Shipment” and updates the shipped sales orders to “Shipped”. This triggers the computer to update the stock level in the inventory master data file. Ian then files the documents in numeric sequence in the “Shipped” file.
**Suggested model solutions for Redpool Office Supplies**

**Part 1: List of present control plans**

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter customer order close to where the order is received</td>
<td>The Sales Officer keys the order directly into the system while talking to the customer over the phone.</td>
</tr>
<tr>
<td>2</td>
<td>Populate inputs with master data</td>
<td>The system retrieves the details of customer and product based on the customer name and product code.</td>
</tr>
<tr>
<td>3</td>
<td>Preformatted screen</td>
<td>The sales order screen guides the Sales Officer during the data entry process. The computer automatically jumps the input cursor to the “order quantity” field to facilitate the SO in entering the order quantity.</td>
</tr>
<tr>
<td>4</td>
<td>Independent pricing data maintenance</td>
<td>The system retrieves the product price information on a read-only basis. The Sales Officer cannot change the price.</td>
</tr>
<tr>
<td>5</td>
<td>Programmed edit checks</td>
<td>The system displays an input error message if the Sales Officer does not enter a 6 digit format product code.</td>
</tr>
<tr>
<td>6</td>
<td>Independent shipping authorization</td>
<td>A copy of sales order is sent directly to the shipping department which will be matched with the picking ticket (Copy 3 of the sales order) from the warehouse.</td>
</tr>
<tr>
<td>7</td>
<td>One-for-one checking of goods with picking ticket and sales order at the shipping department</td>
<td>The shipping clerk compares the physical count with the quantities indicated on the picking ticket (Copy 3 of the sales order) and Copy 4 of the sales order before shipment.</td>
</tr>
<tr>
<td>8</td>
<td>Document number is assigned automatically by the system in sequence followed by sequence check</td>
<td>The computer prints pre-numbered sales order, bill of lading and shipping notice. All the documents are filed in numeric sequence. The Sales Office on duty ensures that the sales orders are filed in numeric sequence with no missing sales order in the “Sales Order” file.</td>
</tr>
</tbody>
</table>
## Part 2: List of missing control plans

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Customer credit check</td>
<td>Although the Sales Officer checks the credit balance before proceeding with the sales order, the information is not updated as the billing is only done once a week. As a result, the customer credit check is not effective due to the periodic updating of the credit balance.</td>
</tr>
<tr>
<td>2</td>
<td>Online prompting</td>
<td>The system does not prompt the Sales Officer to accept/edit/reject the sales order at the end of the sales order entry after clicking on the “Submit” button.</td>
</tr>
<tr>
<td>3</td>
<td>Interactive feedback checks</td>
<td>The system does not display an acknowledgment message to inform the Sales Officer that the sales order has been successfully recorded after the officer clicks on the “Submit” button.</td>
</tr>
<tr>
<td>4</td>
<td>Independent customer master data maintenance</td>
<td>Approval and addition of new customers to the system should not be done by Breana, the Sales Manager. It should be handled by an independent person such as the Credit Manager.</td>
</tr>
<tr>
<td>5</td>
<td>One-for-one checking of picking ticket with the goods at the warehouse</td>
<td>At the warehouse, there is no check that the items picked by the warehouse clerk match the items listed in the picket ticket (Copy 3 of the sales order) before forwarding to the shipping department.</td>
</tr>
<tr>
<td>6</td>
<td>Prevent theft of inventory</td>
<td>Only authorized employees are allowed into the warehouse. The shipping clerk should not be allowed inside the warehouse.</td>
</tr>
<tr>
<td>7</td>
<td>Review open sales orders</td>
<td>Although the Shipping Clerk files Copy 4 of the sales order in an “Outstanding Sales Order” file, there is no mention of reviewing and following up on outstanding sales orders.</td>
</tr>
</tbody>
</table>
Part B: Case 2 - Lion Sporting Goods (Experimental Case)

Background Information
Lion Sporting Goods (LSG) is a wholesaler supplying sporting goods such as sports apparel, cricket and soccer gear to sports retailers in Australia. The Head Office is in Melbourne and the branch office is in Sydney. LSG was awarded the Victoria Business Excellence Award under the Small and Medium Enterprise category in 2006. Customers visit the company’s website for product information. Currently, customers can either call or email the Sales Department to place their orders.

Narrative of the Order Entry/Sales Process at Lion Sporting Goods
The sales team is managed by Matthew, the Sales Manager. The Sales Officers are responsible for taking phone orders from customers. They write down the details of the customer’s order on the sales order form. The sales order form is designed to assist the sales team in capturing all relevant information while talking to customers over the phone. In addition, the Sales Officer on duty is responsible for processing customers’ orders submitted through email. The Sales Officer on duty prints out customers’ email and completes a sales order form.

For new customers, the sales order forms are sent to Samantha, the Credit Manager. Only Samantha has the authority to approve new customers and add them to the information system. Samantha also has to decide the credit terms for each customer as the company offers credit to all its customers. For existing customers, the sales order forms are forwarded to Lily, the Operations Manager. Lily is supported by two Data Entry Clerks who are in charge of entering the customers’ orders into the information system. After adding the new customers to the system, Samantha forwards the sales order forms to Lily.
The Data Entry Clerk keys in the customer’s name and selects the customer from a list of possible customers. The computer then displays the sales order screen with the customer’s details (such as name, customer ID, address and contact number). The screen input cursor jumps to the product description field to facilitate the Data Entry Clerk in the next step of the data entry process. Once the Data Entry Clerk enters the product description and clicks on the “Next” button, the computer displays a list of possible products that match the description. The Data Entry Clerk selects the appropriate product and enters the quantity required and the agreed selling price as written on the sales order form by the sales team.

Once the Data Entry Clerk clicks on the “Submit” button at the bottom of the sales order screen, the computer prompts to accept, change or cancel the sales order. If the Data Entry Clerk clicks on the “Accept” button, the computer updates the sales order and inventory master data file and prints three copies of the sales order. Otherwise, it goes back to the sales order screen. Copy 1 is attached to the sales order form and filed together in the “Sales Order” file. Copy 2 is forwarded to Sarah, the Billing Clerk. Copy 3 is sent to the Shipping Department. On receipt of Copy 3 of the sales order, the Shipping Clerk on duty files it in the “Outstanding Sales Order” file.

At the same time, the computer prints two copies of the picking ticket in the warehouse. The Warehouse Clerk on duty uses the picking tickets to assemble the customer’s order. Once the items are picked, the Warehouse Clerk approaches Ernie, the Warehouse Supervisor to check the picked items. Ernie checks the picked goods against the picking ticket. If the items are in order, Ernie signs both copies of the picking ticket. He attaches Copy 1 to the goods and files Copy 2. The Warehouse Clerk then delivers the goods to the Shipping Department. Only warehouse personnel are allowed access into the warehouse.
Once the Shipping Department receives the goods from the warehouse, the Shipping Clerk on duty uses the attached Copy 1 of the picking ticket to retrieve the matching Copy 3 of the sales order from the “Outstanding Sales Order” file. The Shipping Clerk ensures that the items and quantities agree on both documents and conducts a physical count of the products.

If the items are in order, the Shipping Clerk calls up the sales order from the information system and advances the status from “Outstanding” to “Shipped”. This triggers the computer to update the stock level in the inventory master data file and to print three copies of the shipping notice. After signing the shipping notices, the Shipping Clerk attaches Copy 1 to the goods and sends Copy 2 to Sarah, the Billing Clerk. Copy 3 is attached to the other two documents (Copy 1 of the picking ticket and Copy 3 of the sales order) and filed together in the “Shipped” file. The order is placed in the dispatch area of the Shipping Department. The courier picks up the goods every morning and delivers them to the customer.
### Suggested model solutions for Lion Sporting Goods

#### Part 1: List of present control plans

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Populate inputs with master data</td>
<td>The system retrieves the details of customer based on the customer’s name.</td>
</tr>
<tr>
<td>2</td>
<td>Preformatted screen</td>
<td>The sales order screen guides the Data Entry Clerk during the data entry process. The mouse cursor automatically moves to the next input field to facilitate the Data Entry Clerk in the next step of the data entry process.</td>
</tr>
<tr>
<td>3</td>
<td>Online prompting</td>
<td>The system prompts the Data Entry Clerk to accept/change/cancel the sales order at the end of the sales order entry after clicking on the “Submit” button.</td>
</tr>
<tr>
<td>4</td>
<td>Independent customer master data maintenance</td>
<td>Addition of new customer to the system is handled by an independent person, Samantha, the Credit Manager.</td>
</tr>
<tr>
<td>5</td>
<td>Independent shipping authorization</td>
<td>A copy of sales order is sent directly to the Shipping Department which will be matched with the picking ticket from the warehouse.</td>
</tr>
<tr>
<td>6</td>
<td>One-for-one checking of picking ticket with the goods at the warehouse</td>
<td>At the warehouse, Ernie the Warehouse Supervisor checks that the items picked by the Warehouse Clerk match the items listed in the picking ticket before forwarding to the Shipping Department.</td>
</tr>
<tr>
<td>7</td>
<td>One-for-one checking of goods with picking ticket and sales order at the shipping department</td>
<td>The Shipping Clerk compares the physical count with the quantities indicated on the picking ticket and sales order before shipment.</td>
</tr>
<tr>
<td>8</td>
<td>Prevent theft of inventory</td>
<td>Only authorized employees are allowed into the warehouse.</td>
</tr>
<tr>
<td>9</td>
<td>Document Design</td>
<td>The sales order form is designed to assist the sales team in capturing all relevant information while talking to customers over the phone.</td>
</tr>
</tbody>
</table>
### Part 2: List of missing control plans

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter customer order close to where the order is received</td>
<td>The sales team does not enter the customer’s order directly into the system. It is done by the Data Entry Clerk.</td>
</tr>
<tr>
<td>2</td>
<td>Customer credit check</td>
<td>There is no mention of a credit check done on customers’ order.</td>
</tr>
<tr>
<td>3</td>
<td>Independent pricing data maintenance</td>
<td>The system does not retrieve the product price information on a read-only basis. The Data Entry Clerk relies on the prices written on the sales order form by the Sales Officer.</td>
</tr>
<tr>
<td>4</td>
<td>Programmed edit checks</td>
<td>The system does not perform data input validation checks during the data entry process.</td>
</tr>
<tr>
<td>5</td>
<td>Calculate batch totals</td>
<td>There is no mention of the Data Entry Clerk conducting a batch total to verify the data entry process.</td>
</tr>
<tr>
<td>6</td>
<td>Interactive feedback checks</td>
<td>The system does not display an acknowledgment message to inform the Data Entry Clerk that the sales order has been successfully recorded after the clerk clicks the “Accept” button at the end of the sales order screen.</td>
</tr>
<tr>
<td>7</td>
<td>Document number is assigned automatically by the system in sequence followed by sequence check</td>
<td>There is no mention of pre-numbered documents and there is no sequence check of the documents.</td>
</tr>
<tr>
<td>8</td>
<td>Review open sales orders</td>
<td>Although the Shipping Clerk files Copy 3 of the sales order in an “Outstanding Sales Order” file, there is no mention of reviewing and following up on outstanding sales orders.</td>
</tr>
</tbody>
</table>
Part C: Case 3 - Patches Pet Supplies
(Note: Dropped for the experiment after the pilot study)

Background Information
Patches Pet Supplies (PPS) is a pet supplies wholesaler. It supplies pet food, cages, pet toys and other accessories to pet shops in Australia. PPS only has an electronic commerce presence. Customers can only place their sales orders through the company’s website. Every month, the Sales Manager emails the company’s electronic newsletter to all its customers. The newsletter highlights the products on special monthly promotion and invites customers to check out the company's website for more information on its entire product range.

Narrative of the Order Entry/Sales Process at Patches Pet Supplies
Sales orders are received through the Internet. Customers need to obtain a customer ID number before they can place their sales order online. New customers need to click on the “Account Application” link on the website to submit their details. The information system routes the application details to John, the Credit Manager. Only John has the authority to approve new customers and add them to the customer master data file in the information system. At the same time, John has to decide the credit terms as all customers are allowed to buy on credit. On average, most customers are given two weeks to settle their outstanding balance. All approved new customers will receive their customer ID number through email.

After logging on with their customer ID number and password, customers are directed to their respective customer portal site. They can view their account details such as address, contact number and sales history. Customers can click on the various product categories to browse through the products. Alternatively, they can search for their requested products through the search engine. Based on the customer’s input in the search box, the information system displays a list of possible products that match the description. The customer clicks on the appropriate product in the search listing to view more information (such as the detailed description, price and availability).
Customers need to click on the “Buy It Now” button to proceed with the sales order. The screen input cursor automatically moves to the product quantity field for the customer to enter the requested quantity. The selling price is fixed and John, the Credit Manager is responsible for updating the selling price master data file in the information system. At the same time, the computer performs a credit check and displays an error message if the customer exceeds the credit limit.

Once the customer clicks on the “Done” button at the bottom of the sales order screen, the computer prompts to confirm, edit or cancel the sales order. If the customer clicks on the “Confirm” button, the computer updates the sales order and inventory master data files. At the same time, the computer prints two copies of the picking ticket in the warehouse.

The warehouse is monitored by security cameras and only warehouse personnel are allowed access into the warehouse. Every morning, Luke, the Warehouse Supervisor collects the picking tickets and distributes the picking tickets to his team of Warehouse Assistants. Each Warehouse Assistant uses the picking ticket to assemble the customer’s order. Once the items are picked, the Warehouse Assistant signs both copies of the picking ticket, attaches Copy 1 to the goods and delivers them to the shipping department. Copy 2 is filed in the Warehouse.

Once the shipping department receives the goods from the warehouse, the Shipping Clerk on duty retrieves the sales order from the information system. The next step is to compare the physical count of the product with the quantities indicated on the picking ticket and the sales order display screen. If the items are in order, the Shipping Clerk advances the status of the sales order in the information system from “Outstanding” to “Shipped”. This triggers the computer to update the stock level in the inventory master data file and to print three copies of the shipping notice.
Copy 1 is attached to the goods as the delivery order. Copy 2 is sent to Josephine, the Billing Clerk who does the billing on a weekly basis for all the shipments in the previous week. Copy 3 is attached to Copy 1 of the picking ticket. The Shipping Clerk stamps “Shipped” on both document and files them in the “Shipped” file. The order is placed in the dispatch area of the shipping department for the courier to deliver them to the customer.
### Suggested model solutions for Patches Pet Supplies

#### Part 1: List of present control plans

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Enter customer order close to where the order is received</td>
<td>The customer logs onto the website and enters the order online directly into the system.</td>
</tr>
<tr>
<td>2</td>
<td>Populate inputs with master data</td>
<td>The system retrieves the details of customer and product based on the customer’s ID number and product description.</td>
</tr>
<tr>
<td>3</td>
<td>Preformatted screen</td>
<td>The sales order screen guides the customer during the data entry process. The mouse cursor automatically moves to the next input field.</td>
</tr>
<tr>
<td>4</td>
<td>Online prompting</td>
<td>The system prompts the customer to confirm/edit/cancel the sales order at the end of the sales order entry after clicking on the “Done” button.</td>
</tr>
<tr>
<td>5</td>
<td>Independent pricing data maintenance</td>
<td>The system retrieves the product price information on a read-only basis. The pricing file is maintained by John, the Credit Manager whom is an independent party.</td>
</tr>
<tr>
<td>6</td>
<td>Independent customer master data maintenance</td>
<td>Addition of new customers to the system is handled by an independent person, John, the Credit Manager.</td>
</tr>
<tr>
<td>7</td>
<td>Independent shipping authorization</td>
<td>The Shipping Clerk retrieves the sales order directly from the system to check against the picking ticket from the warehouse.</td>
</tr>
<tr>
<td>8</td>
<td>One-for-one checking of goods with picking ticket and sales order at the shipping department</td>
<td>The shipping clerk compares the physical count with the quantities indicated on the picking ticket and sales order before shipment.</td>
</tr>
<tr>
<td>9</td>
<td>Prevent theft of inventory</td>
<td>The warehouse is monitored by security cameras. Only authorized employees are allowed into the warehouse.</td>
</tr>
</tbody>
</table>
### Part 2: List of missing control plans

<table>
<thead>
<tr>
<th>S/N</th>
<th>Control Plan</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Customer credit check</td>
<td>Although the computer performs a credit check, the information is not updated in real time as the billing is only done once a week.</td>
</tr>
<tr>
<td>2</td>
<td>Programmed edit checks</td>
<td>The system does not perform data validation checks during the data entry process.</td>
</tr>
<tr>
<td>3</td>
<td>Interactive feedback checks</td>
<td>The system does not display an acknowledgment message to inform the customer that the sales order has been successfully recorded after the customer clicks the “Confirm” button at the end of the sales order screen.</td>
</tr>
<tr>
<td>4</td>
<td>One-for-one checking of picking ticket with the goods at the warehouse</td>
<td>At the warehouse, Luke, the Warehouse Supervisor does not check that the items picked by the Warehouse Assistant match the items listed in the picking ticket before forwarding to the shipping department.</td>
</tr>
<tr>
<td>5</td>
<td>Document number is assigned automatically by the system in sequence followed by sequence check</td>
<td>There is no mention of pre-numbered documents and there is no sequence check of the documents.</td>
</tr>
<tr>
<td>6</td>
<td>Review open sales orders</td>
<td>Although the system captures outstanding status for sales order, there is no mention of reviewing and following up on outstanding sales order.</td>
</tr>
</tbody>
</table>
Part D: Expert feedback questions for the cases and model solutions

1. On a scale of 1 to 7, with 1=Very Confusing and 7=Very Clear, circle the number which best reflects how clear you found the narrative for Case 1 (Redpool Office Supplies).

   1  2  3  4  5  6  7

2. On a scale of 1 to 7, with 1=Very Easy and 7=Very Complex, circle the number which best reflects the level of complexity for Case 1 (Redpool Office Supplies).

   1  2  3  4  5  6  7

3. On a scale of 1 to 7, with 1=Very Incomplete and 7=Very Complete, circle the number which best reflects how complete you found the suggested solutions for Case 1 (Redpool Office Supplies).

   1  2  3  4  5  6  7

4. On a scale of 1 to 7, with 1=Very Inaccurate and 7=Very Accurate, circle the number which best reflects how accurate you found the suggested solutions for Case 1 (Redpool Office Supplies).

   1  2  3  4  5  6  7

5. Please list down any other present and/or missing control plans that should be included in the suggested solutions.

6. Please list down any part of the suggested solutions that you do not agree with.

7. Any other comments?
Appendix 6: List of control plans

For each internal control plan, the five experts rated the extent to which they believe a student will likely be able to identify the internal control plan if it is present or missing in a case narrative. The questionnaire utilized a seven-point Likert measurement scale anchored at 1=Not Likely and 7=Very Likely.

**Part A: Comparison between prompted and non-prompted internal control plans (If present in the case)**

<table>
<thead>
<tr>
<th>Prompted Control Plans</th>
<th>Mean</th>
<th>Non-Prompted Control Plans</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.2</td>
<td>9</td>
<td>5.2</td>
</tr>
<tr>
<td>2</td>
<td>6.4</td>
<td>10</td>
<td>5.6</td>
</tr>
<tr>
<td>3</td>
<td>5.0</td>
<td>11</td>
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<td>5.6</td>
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<tr>
<td>6</td>
<td>5.6</td>
<td>14</td>
<td>6.4</td>
</tr>
<tr>
<td>7</td>
<td>5.6</td>
<td>15</td>
<td>5.0</td>
</tr>
<tr>
<td>8</td>
<td>4.4</td>
<td>16</td>
<td>5.2</td>
</tr>
</tbody>
</table>

Mean of prompted control plans | 5.75  | Mean of non-prompted control plans | 5.40

**Part B: Comparison between prompted and non-prompted internal control plans (If missing in the case)**

<table>
<thead>
<tr>
<th>Prompted Control Plans</th>
<th>Mean</th>
<th>Non-Prompted Control Plans</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.6</td>
<td>9</td>
<td>4.6</td>
</tr>
<tr>
<td>2</td>
<td>5.4</td>
<td>10</td>
<td>4.2</td>
</tr>
<tr>
<td>3</td>
<td>3.6</td>
<td>11</td>
<td>5.6</td>
</tr>
<tr>
<td>4</td>
<td>6.4</td>
<td>12</td>
<td>3.8</td>
</tr>
<tr>
<td>5</td>
<td>5.4</td>
<td>13</td>
<td>5.0</td>
</tr>
<tr>
<td>6</td>
<td>4.8</td>
<td>14</td>
<td>5.8</td>
</tr>
<tr>
<td>7</td>
<td>4.8</td>
<td>15</td>
<td>3.4</td>
</tr>
<tr>
<td>8</td>
<td>3.0</td>
<td>16</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Mean of prompted control plans | 4.75  | Mean of non-prompted control plans | 4.58
Notes:

a. There are eight prompted control plans included in the checklist. The list is as follows:

1. Enter customer order close to where the order is received
2. Preformatted screen
3. Online prompting
4. Customer credit check
5. Programmed edit check
6. One-for-one checking of picking tickets with the goods at the warehouse
7. One-for-one checking of goods with picking ticket and sales order at the shipping department
8. Review open sales orders

b. There are eight non-prompted control plans not included in the checklist. The list is as follows:

9. Interactive feedback check
10. Independent pricing
11. Populate inputs with master data
12. Independent shipping authorization
13. Independent customer master data maintenance
14. Prevent theft of inventory
15. Cumulative sequence check of pre-numbered documents
16. Compare inputs with master data

c. Out of the 20 initial internal control plans, four are dropped from the final checklist. They are as follows:

1. Check legitimacy of customer orders
2. Procedures for rejected inputs
3. Receive and input turnaround document
4. Review back orders
Appendix 7: Checklist

Checklist
This checklist is designed to assist you in identifying present and missing control plans for the revenue cycle. Since the checklist may not include all control plans associated with a particular business process, you should be alert for any other control plans. The checklist may also include control plans that are not applicable for a particular business process.

Part 1 (Information Process)
Ensure data input accuracy, completeness and validity

1. Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

2. Does the system perform programmed edit checks such as data input validation checks? For example, does the system display an input error message if an invalid format for a field is entered?

3. Does the system prompt the data entry person to confirm the data entry? For example, does the system prompt the data entry person to check and then accept the inputs at the end of the data entry process?

4. Does the person taking the customer order enter the order into the system directly without delay?

5. Are open sales orders monitored on a regular basis to ensure that all sales orders are shipped to customers?

6. Does the person responsible for depositing cheques total the number of cheques before banking? Is a deposit slip used to verify the deposit of cheques?
7. Are there policies and procedures in place to prevent unauthorized billing? For example, does the billing clerk ensure that each shipment is supported by an approved sales order and valid shipping notifications?

8. Are customers’ account confirmed regularly? For example, do customers receive monthly statements?

9. Is the bank account reconciled regularly? Is bank reconciliation performed after receiving the monthly bank statement?

10. This is the end of Part 1 of the checklist. Are there other control plans to ensure data input accuracy, completeness and validity?

Part 2 (Operations Process)
Ensure security of resources (inventory and data)

1. Are there policies and procedures in place to ensure a credit check is performed for all credit sales before the goods are shipped? Does the person performing the credit check have access to all the necessary and updated information to perform an effective credit check?

2. Do personnel at the warehouse check the physical count of picked items before sending to the shipping department? Does the warehouse supervisor compare the physical count with the quantities indicated on the supporting picking ticket?

3. Do personnel at the shipping department check the physical count of items to be shipped? Does the shipping clerk compare the physical count with the quantities indicated on the supporting picking ticket and sales order?
4. Are incoming cheques endorsed immediately? Are incoming cheques stamped with “Company payee only” upon receipt?

5. Are deposit slips filed in a deposit slip file to provide an audit trail? Is the deposit slip file monitored on a regular basis to protect deposits from misappropriation?

6. This is the end of Part 2 of the checklist. Are there other control plans to ensure security of resources (inventory and data)?
Appendix 8: Decision aids

Part A: Screenshot of less structurally-restrictive manipulation of decision aid

Notes:

1. For the less structurally-restrictive manipulation, the decision aid presents the checklist in the middle frame of the screen. Participants can click on the scroll bar to view the entire checklist as provided in Appendix 7.

2. Participants type in their answers for “Present” control plans in this text box.

3. Participants type in their answers for “Missing” control plans in this text box.

4. Participants click on the “Submit” button to submit their answers.
Part B-1: Screenshot of more structurally-restrictive manipulation of decision aid (When participant selects “Yes”)

TASK
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

CHECKLIST
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

Part 1 (Information Process)
Ensure data input accuracy, completeness and validity

Question 1
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

Note 1

Note 2

You have selected 'Yes', please STATE the present control plan.

Notes:

1. For the more structurally-restrictive manipulation, the decision aid presents each checklist question individually. The number of questions is the same as the less structurally-restrictive manipulation.

2. Participants need to select “Yes/No/Not Applicable” in response to the question.

3. In this case, the participant selects “Yes”, therefore the decision aid prompts the participant to state the “Present” control plan in the text box.

4. Participants click on the “Next” button to proceed to the next question. They are not allowed to go back to the previous question.
Part B-2: Screenshot of more structurally-restrictive manipulation of decision aid (When participant selects “No”)

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

*Part 1 (Information Process)*
Ensure data input accuracy, completeness and validity

*Question 1*
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

- [X] Yes
- [ ] No
- [ ] Not Applicable

You have selected 'No', please STATE the missing control plan.

![Note 1](image)

**Note:**

1. This is the same question as the previous screen shot. In this case, the participant selects “No”, therefore the decision aid prompts the participant to state the “Missing” control plan in the text box.
Part B-3: Screenshot of more structurally-restrictive manipulation of decision aid (When participant selects “Not Applicable”)

**Note:**
1. This is the same question as the two previous screen shots. In this case, the participant selects “Not Applicable”, therefore the decision aid prompts the participant to explain why the question is not applicable.
Part B-4: Screenshot of more structurally-restrictive manipulation of decision aid (Display of earlier inputs after the last prompted question)

**Notes:**

1. After the participant answered the last question of the checklist, the decision aid automatically retrieves all the earlier inputs entered by the participant. The left text box presents all the “Present” control plans stated by the participant. The right text box presents all the “Missing” control plans stated by the participant.

2. Participants click on the “Submit” button to submit their answers.
Part C: Screenshot of no decision aid manipulation

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

<table>
<thead>
<tr>
<th>List of Present Control Plans</th>
<th>List of Missing Control Plans</th>
</tr>
</thead>
</table>

**Note 1**

Note:

1. Participants do not see any computerized checklist.
Appendix 9: Knowledge test

Scenario 1

The mailroom clerk date-stamps all customers’ orders received by fax. All sales order form received after 3pm will be keyed into the information system in the next morning. For the “Date of Sales” field, the data entry clerk has to type in the date of receipt of the sales order form, using the date format of MM/DD/YYYY. A recent audit of the order entry process discovered invalid date of sales such as 13/22/2006 and 06/39/2007.

**BRIEFLY** describe the control problem.

State **ONE** control plan that would **BEST** prevent the control problem from occurring.

**BRIEFLY** explain how your recommended control plan works to prevent the control problem from occurring.
Scenario 2

Customer sales officers at Straits Company enter customer orders received in the mail. For each mail order, officers have to enter customer's details such as customer ID, name, address and contact number into the computer system. A recent audit of the order entry process determined that the officers were making many errors in entering data. For example, the address entered for a specific sales order does not match the address record in the customer data file.

**BRIEFLY** describe the control problem.

State **ONE** control plan that would **BEST** prevent the control problem from occurring.

**BRIEFLY** explain how your recommended control plan works to prevent the control problem from occurring.
Scenario 3

At Tiger Company, the warehouse delivers goods to the shipping department, accompanied by the picking ticket. If the items tally with the picking ticket, the shipping clerk prepares a three-part shipping notice, one copy of which serves as the packing slip. A recent audit discovered that a dishonest warehouse employee had been forging picking ticket documents, allowing him to have goods shipped to an accomplice.

**BRIEFLY** describe the control problem.

State **ONE** control plan that would **BEST** prevent the control problem from occurring.

**BRIEFLY** explain how your recommended control plan works to prevent the control problem from occurring.
Scenario 4 (Note: Dropped for the experiment after the pilot study)

Clerks in the shipping department at Mary, Inc., scan all picking tickets to bring up the appropriate open sales order from the enterprise system. If the items tally with the picking ticket and sales order, the clerk clicks on the “Submit” button. This triggers the computer to advance the status of the sales order from “Open” to “Shipped”. The clerk then puts the box on the conveyer to the loading dock for shipping to the customer. A recent review of open sales orders discovered that some shipments are not being recorded by the system.

**BRIEFLY** describe the control problem.

State **ONE** control plan that would **BEST** prevent the control problem from occurring.

**BRIEFLY** explain how your recommended control plan works to prevent the control problem from occurring.
**Scenario 5 (Note: Dropped for the experiment after the pilot study)**

Millennium Inc has a centralized data processing department based in Melbourne which is responsible for entering customers’ orders into the computer system. Millennium Inc.’s field sales representatives across Australia are required to email customer's orders to the data processing department. Upon receiving an email, the data processing clerk have to key in the sales order immediately. John Williams, one of Millennium’s sales representatives in the Sydney branch office, discovered that the order that he emailed last week was not captured in the system.

**BRIEFLY** describe the control problem.

**State ONE control plan that would BEST prevent the control problem from occurring.**

**BRIEFLY** explain how your recommended control plan works to prevent the control problem from occurring.
Appendix 10: Comparison between main pilot study and revised pilot study

Part A: Comparison between main pilot study and revised pilot study for “Prompted All” variable

Panel A: Main pilot study (n=30) (Case 2 was used as the second case)

Panel B: Revised pilot study (n=7) (Case 2 was used as the first case)
Panel C: Main pilot study (n=30) (Case 1 was used as the first case)

- No Decision Aid (n=8): 39.06%
- Less Structurally-Restrictive Decision Aid (n=11): 52.27%
- More Structurally-Restrictive Decision Aid (n=11): 64.20%

Panel D: Revised pilot study (n=7) (Case 1 was used as the second case)

- No Decision Aid (n=2): 43.75%
- Less Structurally-Restrictive Decision Aid (n=2): 50.00%
- More Structurally-Restrictive Decision Aid (n=3): 62.50%
Part B: Comparison between main pilot study and revised pilot study for “Non-Prompted All” variable

Panel A: Main pilot study (n=30) (Case 2 was used as the second case)

Panel B: Revised pilot study (n=7) (Case 2 was used as the first case)
Panel C: Main pilot study (n=30) (Case 1 was used as the first case)

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<tr>
<th>Decision Aid Type</th>
<th>% of &quot;Non-Prompted All&quot; Identified</th>
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</thead>
<tbody>
<tr>
<td>No Decision Aid (n=8)</td>
<td>41.96</td>
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<tr>
<td>Less Structurally-Restrictive</td>
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<tr>
<td>More Structurally-Restrictive</td>
<td>22.08</td>
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</tbody>
</table>

Panel D: Revised pilot study (n=7) (Case 1 was used as the second case)

<table>
<thead>
<tr>
<th>Decision Aid Type</th>
<th>% of &quot;Non-Prompted All&quot; Identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Decision Aid (n=2)</td>
<td>35.71</td>
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<tr>
<td>Less Structurally-Restrictive</td>
<td>21.43</td>
</tr>
<tr>
<td>More Structurally-Restrictive</td>
<td>23.81</td>
</tr>
</tbody>
</table>
WANT TO EARN EXTRA CASH? WANT TO EARN EXTRA CASH? WANT TO EARN EXTRA CASH? WANT TO EARN EXTRA CASH?

PARTICIPATE IN AN EXPERIMENT!!!

* This is ONLY open to students enrolled in 306-106 Business Process Analysis (BPA) for Semester 2, 2007

Be part of an exciting research project examining human judgment and decision aid use!

WHAT IS IN IT FOR ME?

• Opportunity to apply the knowledge you have gained from 306-106 Business Process Analysis.
• Be paid $20 for approximately 1 hour 15 minutes of your time
• A chance to win a $150 Melbourne University Bookshop voucher (3 vouchers to give away) – save money on buying textbooks next semester

All necessary materials required to complete this experiment will be provided. Participation is completely voluntary.

SESSIONS:

• 19th October 2007, Fri, 10:15am to 11:30am
• 22nd October 2007, Mon, 3:30pm to 4:45pm
• 23rd October 2007, Tues, 9:15am to 10:30am or 1:15pm to 2:30pm
• 24th October 2007, Wed, 10:15am to 11:30am or 3:30pm to 4:45pm
• 25th October 2007, Thurs, 10:15am to 11:30am or 1:15pm to 2:30pm
• 26th October 2007, Fri, 10:15am to 11:30am or 1:15pm to 2:30pm

Email your preferred sessions to Poh-Sun at psseow@unimelb.edu.au now to reserve your preferred slot!!

Venue: Experimental Research Laboratory (Room 729, Level 7 Alan Gilbert Building)

For more information please contact:

Poh-Sun Seow
Department of Accounting and BIS
The University of Melbourne
Ph: (03) 8344-3178 or 0433-553-626
Email: psseow@unimelb.edu.au

Professor Colin Ferguson
Department of Accounting and BIS
The University of Melbourne
Ph: (03) 8344-4482
Email: colinf@unimelb.edu.au
Appendix 12: Random allocation of participants

Group 1 – No Decision Aid
Group 2 – Less Structurally-Restrictive Decision Aid
Group 3 – More Structurally-Restrictive Decision Aid

<table>
<thead>
<tr>
<th>Participant 1</th>
<th>Participant 2</th>
<th>Participant 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 3</td>
<td>Group 2</td>
<td>Group 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant 4</th>
<th>Participant 5</th>
<th>Participant 6</th>
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<tbody>
<tr>
<td>Group 2</td>
<td>Group 3</td>
<td>Group 1</td>
</tr>
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</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Group 3</td>
<td>Group 1</td>
<td>Group 2</td>
</tr>
</tbody>
</table>

<table>
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<tr>
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<th>Participant 11</th>
<th>Participant 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Group 2</td>
<td>Group 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant 13</th>
<th>Participant 14</th>
<th>Participant 15</th>
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<tbody>
<tr>
<td>Group 2</td>
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<td>Group 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant 16</th>
<th>Participant 17</th>
<th>Participant 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Group 3</td>
<td>Group 2</td>
</tr>
</tbody>
</table>
Appendix 13: Plain language statement

Research Project: The Effects of the Use of Decision Aids on Internal Control Evaluation

Mr Poh-Sun Seow and Professor Colin Ferguson
Department of Accounting and Business Information Systems
The University of Melbourne, Victoria 3010
Telephone: 03 8344 3178; Email: psseow@unimelb.edu.au

Purpose
The purpose of this study is to examine the effects of the use of decision aids on a user’s decision making outcomes. This study forms part of Poh-Sun Seow’s PhD research at The University of Melbourne.

Procedures and Use
You have been invited to participate in this project. Participation involves completing an experiment. The experiment will take approximately 1 hour and 15 minutes and you will be paid $20 for your time. You are required to work through two cases. Your task is to identify all the control plans that are present in the cases and recommend the control plans that are missing and should be present. There will be several questionnaires which you will have to complete before and after the tasks. You will qualify for a lucky draw to win a $150 Melbourne University Bookshop voucher if your average score for the two cases ranks among the top 25%.

We intend to protect your anonymity and confidentiality of your responses to the fullest extent possible, within the limits of the law. The data will be kept securely in the Department of Accounting and Business Information Systems for a minimum of five years. The data will be destroyed subsequently.

Participation
Participation in this research is entirely voluntary. Neither participation nor non-participation will affect the grade in your subjects. Participants can withdraw at any time and withdraw any unprocessed data previously supplied.

Consent
The completion of the experiment implies that you have read the above information, you have agreed to participate in this project and you understand that you may withdraw at any time without prejudice.

Queries or Concerns
If you have any queries or concerns about the research, please contact either of the above named investigators. This project has received ethics clearance by the HREC. If you have concerns of an ethical nature, please contact The Executive Officer, Human Research Ethics, The University of Melbourne, telephone 8344 2073 or fax 9347 6739.
Appendix 14: Consent form

CONSENT FORM

THE UNIVERSITY OF MELBOURNE

DEPARTMENT OF ACCOUNTING AND BUSINESS INFORMATION SYSTEMS

Consent form for persons participating in research projects

PROJECT TITLE:
The Effects of the Use of Decision Aids on Internal Control Evaluation

Name of participants: __________________________________________

Name of investigators: Mr Poh-Sun Seow and Professor Colin Ferguson

1. I consent to participate in the project named above. A written copy of the plain language statement has been given to me to keep.

2. I authorize the researchers to retain the consent form.

3. I acknowledge that:
   (a) The possible effects of the task have been explained to me to my satisfaction;
   (b) I have been informed that participation is voluntary and I am free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied;
   (c) The project is for the purpose of research;
   (d) I have been informed that the confidentiality of the information I provide will be safeguarded subject to any legal requirements.

Signature: ___________________________ Date: ________________

(Participant)
Appendix 15: Screen shots of computerized web-based software
Thank you for participating in this research project.

On a scale of 1 to 7 with 1=Very Low to 7=Very High, please rate your knowledge about control plans for an order entry/sales process.

Very Low 1 2 3 4 5 6 7 Very High

Next
Knowledge Test

1. Which of the following statements regarding internal controls systems is false?
   - OA. Effective internal control systems provide absolute assurance against the occurrence of material frauds and embezzlements.
   - OB. Internal control systems depend largely on the competency and honesty of people.
   - OC. Because internal control systems have a cost, management should evaluate the cost/benefit of each control plan.
   - OD. A major reason to exercise control over an organization’s business processes is to provide reasonable assurance that the company is in compliance with applicable legal and regulatory obligations

2. Who is legally responsible for establishing and maintaining an adequate system of internal control?
   - OA. The board of directors
   - OB. Stakeholders
   - OC. Investors
   - OD. Management

3. _______ sets the tone of the organization, influencing the control consciousness of its people.
   - OA. Risk assessment
   - OB. Control environment
   - OC. Monitoring
   - OD. Control activities

4. Control plans that relate to a multitude of goals and applications are called:
   - OA. Business process control plans
   - OB. Internal control systems
   - OC. Pervasive control plans
   - OD. Management control systems

5. A control that involves reprocessing transactions that are rejected during initial processing is an example of:
   - OA. Preventive controls
   - OB. Detective controls
   - OC. Corrective controls
   - OD. Programmed controls

Next
Personal Details

1. Name: 

2. E-Mail: 

3. Gender:  
   
4. Nationality: 

5a. Degree: 

5b. Year:  
   
5c. Majors: 

6a. In which country did you complete your last year of pre-university education (e.g., VCE, Year 12, HSC, STPM, GCE): 

6b. How many years have you studied in Australia? 

7. Age: 

8a. What is your first language? 

8b. What language(s) are you fluent in? 

9. Do you have any working experience?  
   
9a. If YES, number of months of working experience:  
    months 

10. If you have working experience, have you work before as an auditor or accountant dealing with internal control system?  
   
10a. If YES, number of months of such experience:  
    months
You are about to start your experiment.
Before you start your experiment, you will go through a familiarization session.

Click here to start the familiarization session
The familiarization session is specific to each of the three different experimental groups: no decision aid, less structurally-restrictive decision aid and more structurally-restrictive decision aid.

Below is the familiarization session for the no decision aid group.
Below is the familiarization session for the less structurally-restrictive decision aid group.

FAMILIARIZATION SESSION
The purpose of the familiarization session is to let you get used to the screen layout. You will see similar screens later when you are completing the experiment.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
During the experiment, you will be provided a checklist in this section. You can use the vertical scroll bar at the slide to scroll down the checklist.

The checklist is designed to assist you in identifying present and missing control plans for the revenue cycle. Since the checklist may not include all control plans associated with a particular business process, you should be alert for any other control plans. The checklist may also include control plans that are not applicable for a particular business process.

---

List of **Present** Control Plans
Write down your answers in this column if it is a 'present' control plan. Start each control plan with a number.

For example:
(1) Present Control plan A
(2) Present Control plan B
(3) Try typing something in this column.

List of **Missing** Control Plans
Write down your answers in this column if it is a 'missing' control plan. Start each control plan with a number.

For example:
(1) Missing Control plan A
(2) Missing Control plan B
(3) Try typing something in this column.

When you are confident, click the ‘Submit’ button on the top right to end the familiarization session.
Below is the familiarization session for the more structurally-restrictive decision aid group. It consists of four screens.

**FAMILIARIZATION SESSION**

The purpose of the familiarization session is to let you get used to the screen layout. You will see similar screens later when you are completing the experiment.

**TASK**

Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**

During the experiment, you will be asked specific questions which serve as the checklist. Please consider and answer each checklist question carefully. You are not allowed to return to the previous checklist question. The checklist is designed to assist you in identifying present and missing control plans for the revenue cycle. Since the checklist may not include all control plans associated with a particular business process, you should be alert for any other control plans. The checklist may also include control plans that are not applicable for a particular business process.

**EXAMPLE CHECKLIST QUESTION**

1. Is the purchase of the good authorized?  
   (For this particular familiarization screen, please select *Yes* for this screen.)

   - Yes
   - No
   - Not Applicable

   You have selected "Yes", please STATE the present control plan.

   **For example:** Present Control Plan A
   After stating the present control plan in the text box, click the "Next" button below to proceed.

   Please click the 'Next' button to proceed to the next question.
Below is the second screen of the familiarization session for the more structurally-restrictive decision aid group.

FAMILIARIZATION SESSION
The purpose of the familiarization session is to let you get used to the screen layout. You will see similar screens later when you are completing the experiment.

TASK
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

CHECKLIST
During the experiment, you will be asked specific questions which serve as the checklist. Please consider and answer each checklist question carefully. You are not allowed to return to the previous checklist question. The checklist is designed to assist you in identifying present and missing control plans for the revenue cycle. Since the checklist may not include all control plans associated with a particular business process, you should be alert for any other control plans. The checklist may also include control plans that are not applicable for a particular business process.

EXAMPLE CHECKLIST QUESTION
2. Is the purchase of the good authorized?
(For this particular familiarization screen, please select "No" for this screen.)

O Yes
@ No
O Not Applicable

You have selected "No", please STATE the missing control plan.

For example: Missing Control Plan A
After stating the missing control plan in the text box, click the "Next" button below to proceed.

Please click the 'Next' button to proceed to the next question.
Below is the third screen of the familiarization session for the more structurally-restrictive decision aid group.

FAMILIARIZATION SESSION
The purpose of the familiarization session is to let you get used to the screen layout.
You will see similar screens later when you are completing the experiment.

TASK:
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

CHECKLIST
During the experiment, you will be asked specific questions which serve as the checklist. Please consider and answer each checklist question carefully. You are not allowed to return to the previous checklist question. The checklist is designed to assist you in identifying present and missing control plans for the revenue cycle. Since the checklist may not include all control plans associated with a particular business process, you should be alert for any other control plans. The checklist may also include control plans that are not applicable for a particular business process.

EXAMPLE CHECKLIST QUESTION
3. Is the purchase of the good authorized?
(For this particular familiarization screen, please select "Not Applicable" for this screen.)

O Yes
O No
O Not Applicable

You have selected "Not Applicable", please explain why it is not applicable.

Write your reason in the text box and click the "Next" button below to proceed.

Please click the 'Next' button to proceed to the next question.
Below is the last screen of the familiarization session for the more structurally-restrictive decision aid group.

**FAMILIARIZATION SESSION**

*The purpose of the familiarization session is to let you get used to the screen layout. You will see similar screens later when you are completing the experiment.*

**TASK:**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

You have reached the end of the checklist. Below are your earlier inputs.

**List of Present Control Plans**

*This column will list your earlier stated PRESENT control plans. For example: Present Control Plan A & Present Control Plan B. You can edit or add on to your earlier inputs.*

**List of Missing Control Plans**

*This column will list your earlier stated MISSING control plans. For example: Missing Control Plan A & Missing Control Plan B. You can edit or add on to your earlier inputs.*

When you are confident, click the 'Submit' button on the top right to end the familiarization session.
Thank you for going through the familiarization session.

Please click the button below when you are ready to start the experiment.

Click here to start the first case
Participants proceed to complete the training case (Case 1).

Experiment Case 1

Please open Envelope 1 on your table. Envelope 1 contains instructions for the task, background information of the company and a narrative of the order entry/sales process. After reading the materials, please enter the case name and click the button below to enter your solutions.

Please enter the case name of the company:

[Button: Click here to enter your solutions for the first case]
The solution screen is specific to each of the three different experimental groups: no decision aid, the less structurally-restrictive decision aid and the more structurally-restrictive decision aid.

Below is the solution screen for the no decision aid group.
Below is the solution screen for the less structurally-restrictive decision aid group. The checklist is embedded in the middle frame of the screen. Participants can click on the scroll bar on the right to view all the question of the checklist (as provided in Appendix 7).
Below is the solution screen for the more structurally-restrictive decision aid group. The more structurally-restrictive decision aid contains the same questions in the same order as the less structurally-restrictive decision aid. Ensuring that the information content of the checklist is equivalent across treatment conditions reduces the potential for any bias. Participants are prompted with each question of the checklist individually and they have to select “Yes/No/Not Applicable” for each question.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

**Part 1 (Information Process)**
Ensure data input accuracy, completeness and validity

**Question 1**
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

- Yes
- No
- Not Applicable
If the participant selects “Yes”, the screen prompts the participant to state the present control plan. After that, the participant clicks the “Next” button to proceed to the next question.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

**Part 1 (Information Process)**
Ensure data input accuracy, completeness and validity

**Question 1**
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

- Yes
- No
- Not Applicable

You have selected 'Yes', please STATE the present control plan.

[Next]
If the participant selects “No”, the screen prompts the participant to state the missing control plan. After that, the participant clicks the “Next” button to proceed to the next question.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

**Part 1 (Information Process)**
Ensure data input accuracy, completeness and validity

**Question 1**
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

- O Yes
- O No
- O Not Applicable

You have selected ‘No’, please STATE the missing control plan.

**Next**
If the participant selects “Not Applicable”, the screen prompts the participant to explain the reason. After that, the participant clicks the “Next” button to proceed to the next question.

Task
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

Checklist
Note: Please consider and answer each question carefully. You are not allowed to return to the previous question.

Part 1 (Information Process)
Ensure data input accuracy, completeness and validity

Question 1
Is the input screen preformatted to guide the data entry process? For example, does the input cursor move to the next field after the data entry person completes a previous field?

- Yes
- No
- Not Applicable

You have selected 'Not Applicable', please explain why it is not applicable.
After clicking on the “Next Button” in the previous screen, the more structurally-restrictive decision aid prompts the next question (Question 2). The procedure repeats until the participant answers all the questions in the checklist (as provided in Appendix 7). The more structurally-restrictive decision aid contains the same questions in the same order as the less structurally-restrictive decision aid.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**

**Part 1 (Information Process)**
Ensure data input accuracy, completeness and validity

**Question 2**

Does the system perform programmed edit checks such as data input validation checks? For example, does the system display an input error message if an invalid format for a field is entered?

- Yes
- No
- Not Applicable
Below is the last question prompted by the more structurally-restrictive decision aid.

**TASK**
Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

**CHECKLIST**
Part 2 (Operations Process)
Ensure security of resources (inventory and data)

Question 6
This is the end of Part 2 of the checklist. Are there other control plans to ensure security of resources (inventory and data)?

☑ Yes ☐ No

You have selected 'Yes', please STATE other present and/or missing control plans below.

<table>
<thead>
<tr>
<th>Other Present Control Plans</th>
<th>Other Missing Control Plans</th>
</tr>
</thead>
</table>

Next
After answering all the prompted questions, a list of controls plans that the participant stated as present by selecting “Yes” or missing by selecting “No” is presented. Participants have the opportunity to alter these lists before submitting their answers.

**TASK**

Please (1) identify all control plans that are present in the narrative and (2) recommend control plans that are missing and should be present in this order entry/sales process. Please assume that a control plan is missing if it is not specifically mentioned in the narrative.

You have reached the end of the checklist. Below are your earlier inputs:

**List of Present Control Plans**
- Present Control Plan A
- Present Control Plan B
- Present Control Plan C
- Present Control Plan D
- Present Control Plan E
- Present Control Plan F

**List of Missing Control Plans**
- Missing Control Plan A
- Missing Control Plan B
- Missing Control Plan C
- Missing Control Plan D
- Missing Control Plan E
- Missing Control Plan F
After the participant clicks on the “Submit” button, the software presents the feedback questions for Case 1.

Thank you for completing the first case. Please put all the materials back into Envelope 1.

Please answer the following questions:

1. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I found this task challenging.
   1 2 3 4 5 6 7

2. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   This task was difficult for me to complete.
   1 2 3 4 5 6 7

3. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I consider this task complex.
   1 2 3 4 5 6 7

4. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   Most people would consider this task simple.
   1 2 3 4 5 6 7

5. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I am confident with my answers.
   1 2 3 4 5 6 7

[Click here to start the second case]
Participants proceed to complete the experimental case (Case 2).

Experiment Case 2

Please open Envelope 2 on your table. Envelope 2 contains instructions for the task, background information of the company and a narrative of the order entry/sales process. After reading the materials, please enter the case name and click the button below to enter your solutions.

Please enter the case name of the company:

[Blank field]

Click here to enter your solutions for the second case.

The subsequent solution screens for Case 2 are the same as Case 1.
After the participant clicks on the “Submit” button, the software presents the feedback questions for Case 2. The feedback questions are the same as Case 1.

Thank you for completing the second case. Please put all the materials back into Envelope 2.

Please answer the following questions:

1. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I found this task challenging.
   1 2 3 4 5 6 7 0

2. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   This task was difficult for me to complete.
   1 2 3 4 5 6 7 0

3. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I consider this task complex.
   1 2 3 4 5 6 7 0

4. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   Most people would consider this task simple.
   1 2 3 4 5 6 7 0

5. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I am confident with my answers.
   1 2 3 4 5 6 7 0
Manipulation-check question

Please answer the following questions.

1. When you were completing the case, did the software provide you with a checklist of internal control questions to assist you in identifying the present and missing control plans?

   Yes ☐ No ☐
If the participant selects “No”, the participant clicks on the “Next” button to proceed.

Please answer the following questions.

1. When you were completing the case, did the software provide you with a checklist of internal control questions to assist you in identifying the present and missing control plans?

   Yes  No
If the participant selects “Yes”, the screen expands and asks more feedback questions relating to the checklist.

Please answer the following questions:

1. When you were completing the case, did the software provide you with a checklist of internal control questions to assist you in identifying the present and missing control plans?
   Yes ☐ No ☐

2. Did the software provided internal control checklist include ALL control plans associated with the order entry/sales process?
   Yes ☐ No ☐

3. Did the software provided internal control checklist include any control plans NOT APPLICABLE for the order entry/sales process?
   Yes ☐ No ☐

4. On a scale of 1 to 7, with 1=Not Restricted and 7=Very Restricted, select the number which best reflects how constrained your decision making process was using the checklist to complete the task.
   1 2 3 4 5 6 7

5. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I agree with the checklist’s questions in identifying control plans for an order entry/sales process.
   1 2 3 4 5 6 7

6. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I would prefer to identify the control plans without using the checklist.
   1 2 3 4 5 6 7

7. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I found the checklist useful in identifying the control plans.
   1 2 3 4 5 6 7

8. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I relied on the checklist when identifying the control plans.
   1 2 3 4 5 6 7

9. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   I am satisfied with the checklist.
   1 2 3 4 5 6 7

[Next]
Below are the GRE questions to hold the faster participants in the laboratory until all the participants have completed Case 2.

Use the following information to answer questions 1 to 3
P, Q, R, S, and T are five computers in the five overseas offices of a large multinational corporation. The computers are linked in an unshared manner in order to provide increased security for the data in certain offices. Data can be directly requested only:

- from P by Q
- from S by Q
- from P by T
- from Q by T
- from Q by R
- from T by R
- from R by P

Question 1
If computers Q, R, S, and T are the only ones operating, which of the following requests for data can be made, either directly or through one or more of the other computers?

- a request by Q for data from T
- a request by T for data from R
- a request by R for data from Q
- a request by K for data from S

Question 2
Which of the following computers CANNOT request data from any of the other four computers?
- O
- Q
- R
- S

Question 3
Which of the following is a complete and accurate list of computers that can request data from S through exactly one other computer?
- O and Q
- O and R
- Q and R
- O and T

For questions 4 and 5, choose the analogous pair of words.

Question 4

Hustle : severe
Commute : available
Creatures : rare
Contribute : charitable
Qualify : general

Question 5

Babble : talk
Ortho : sculpt
Charmingly : sing
Cowardly : write
Chint : imply

Use the following information to answer questions 6 to 8

Last week's total hours worked and hourly wages for the cashiers at Market X:

<table>
<thead>
<tr>
<th>Cashier</th>
<th>Hourly Wage</th>
<th>Total Hours Worked</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>$4.75</td>
<td>40</td>
</tr>
<tr>
<td>Q</td>
<td>$4.75</td>
<td>32</td>
</tr>
<tr>
<td>R</td>
<td>$4.50</td>
<td>25</td>
</tr>
<tr>
<td>S</td>
<td>$5.00</td>
<td>20</td>
</tr>
<tr>
<td>T</td>
<td>$5.50</td>
<td>22</td>
</tr>
</tbody>
</table>

Note: Last week no more than two cashiers worked at any one time, no cashier worked more than 12 hours on the same day, and on each day, each cashier worked continuously.

Question 6
What was the average (arithmetic mean) number of hours that the five cashiers worked last week?
- 0:25
- 0:36
- 0:27
- 0:29
- 0:30

Question 7
On Saturday of last week, Market X was open for 13 hours and exactly four cashiers worked. What was the greatest possible amount that the market could have paid in cashiers' wages for that day?
- $132.00
- $157.50
- $161.25
- $163.00
- $165.00

Question 8
If Market X is open 96 hours per week, for how many hours last week were two cashiers working at the same time?
- 0:40
- 0:48
- 0:30
- 0:24
- 0:12
Below is the last screen of the software.

Thank you for your time.

Please wait in your seat till the end of the experiment session as other participants are still completing the experiment.

You may press 'Alt+Tab' to switch to a new Internet Explorer window and surf the Internet.

You will be informed shortly once it is time to go.
Appendix 16: Perceived task complexity

The perceived task complexity scale adds up the rating for each of the following four questions. Question 4 is reversed coded. The maximum score for the perceived reliance scale is 28 and the minimum score is four. A higher score represents a higher degree of perceived task complexity.

1. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I found this task challenging.”
   1 2 3 4 5 6 7

2. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “This task was difficult for me to complete.”
   1 2 3 4 5 6 7

3. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I consider this task complex.”
   1 2 3 4 5 6 7

4. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “Most people would consider this task simple.”
   1 2 3 4 5 6 7
Appendix 17: Perceived reliance

The perceived reliance scale adds up the rating for each of the following five questions. Question 2 is reversed coded. The maximum score for the perceived reliance scale is 35 and the minimum score is five. A higher score represents a higher degree of perceived reliance.

1. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I agree with the checklist’s questions in identifying control plans for an order entry/sales process.”
   1 2 3 4 5 6 7

2. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I would prefer to identify the control plans without using the checklist.”
   1 2 3 4 5 6 7

3. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I found the checklist useful in identifying the control plans.”
   1 2 3 4 5 6 7

4. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I relied on the checklist when identifying the control plans.”
   1 2 3 4 5 6 7

5. On a scale of 1 to 7, with 1=Strongly Disagree and 7=Strongly Agree, select your response to this statement:
   “I am satisfied with the checklist.”
   1 2 3 4 5 6 7
Appendix 18: Coding guidelines for knowledge test

Scenario 1

The mailroom clerk date-stamps all customers’ orders received by fax. All sales order form received after 3pm will be keyed into the information system in the next morning. For the “Date of Sales” field, the data entry clerk has to type in the date of receipt of the sales order form, using the date format of MM/DD/YYYY. A recent audit of the order entry process discovered invalid date of sales such as 13/22/2006 and 06/39/2007.

Control Problem : The data entry clerk can make data entry errors by entering invalid/inaccurate dates into the system as it is a manual data entry process. It has nothing to do with the time delay of data entry. It has nothing to do with the date format of MM/DD/YYYY.

Control Plan : Programmed edit checks (reasonableness check/limit check)

Explanation : The risk relates to data entry errors. The day (DD) and month (MM) value of the “Date of Sales” field needs to fall within a range depending on the month. A limit check will be able to pick up that the input for the month value (“13”) and the day value (“39”) are not within an acceptable range.

In order to get the full 2 marks for the explanation section, participants must mention specifically about the idea of “limit check or reasonableness check or out of range or invalid number”. If a participant only mentions “check format/input”, it is considered a vague explanation and shall only be awarded 1 mark.
Scenario 2

Customer sales officers at Straits Company enter customer orders received in the mail. For each mail order, officers have to enter customer’s details such as customer ID, name, address and contact number into the computer system. A recent audit of the order entry process determined that the officers were making many errors in entering data. For example, the address entered for a specific sales order does not match the address record in the customer data file.

Control Problem : The customer sales officers have to enter all the customer’s details into the system. In the process, the customer sales officers can make data entry errors as it is a manual data entry process. The entered data do not match the record in the data files.

Control Plan : Populate inputs with master data

Explanation : The risk relates to data entry errors. The customer sales officers should not have to enter all customers’ details manually as it increases the risks of data entry errors. Since there is a customer ID, the customer sales officers should just enter the customer ID and the system should extract the rest of the customers’ details from the customer data file.

In order to get the full 2 marks for the explanation section, participants must mention specifically about the idea of using the unique “customer ID” field to extract related information from the system. Otherwise, it is considered a vague explanation and shall only be awarded 1 mark.
Scenario 3

Question 3

At Tiger Company, the warehouse delivers goods to the shipping department, accompanied by the picking ticket. If the items tally with the picking ticket, the shipping clerk prepares a three-part shipping notice, one copy of which serves as the packing slip. A recent audit discovered that a dishonest warehouse employee had been forging picking ticket documents, allowing him to have goods shipped to an accomplice

Control Problem : There is fraud/forgery. There is a control problem with the security of assets/resources/goods/inventory. Dishonest warehouse employee can steal goods by forging picking ticket as the shipping clerk did not check whether the picked items are authorized to ship. It has nothing to do with segregation of duties. It has nothing to do with signing the picking ticket.

Control Plan : Independent shipping authorization/notification

Explanation : The risk relates to unauthorized shipment. The shipping clerk should retrieve a copy of the sales order/invoice to match against the picket ticket in order to verify that it relates to a valid sales order. The sales order/invoice serves as an independent proof.

In order to get the full 2 marks for the explanation section, participants must mention specifically about the idea of using a separate independent document such as the sales order/invoice to verify that the picking ticket is valid or do the matching. Otherwise, it is considered a vague explanation and shall only be awarded 1 mark.