

UNIVERSITY OF SOUTHERN QUEENSLAND

**A CONCEPTUAL MODEL FOR PROACTIVE DETECTION
OF POTENTIAL FRAUD IN ENTERPRISE SYSTEMS:
EXPLOITING SAP AUDIT TRAILS TO DETECT
ASSET MISAPPROPRIATION**

A dissertation submitted by
KISHORE HARICHUNDER SINGH

For the award of
Doctor of Philosophy

2012

ABSTRACT

Fraud costs the Australian economy approximately \$3 billion annually, and its frequency and financial impact continues to grow. Many organisations are poorly prepared to prevent and detect fraud. Fraud prevention is not perfect therefore fraud detection is crucial. Fraud detection strategies are intended to quickly and efficiently identify frauds that circumvent preventative measures so that an organisation can take appropriate corrective action.

Enhancing the ability of organisations to detect potential fraud may have a positive impact on the economy. An effective model that facilitates proactive detection of potential fraud may potentially save costs and reduce the propensity of future fraud by early detection of suspicious user activities. Enterprise systems generate millions of transactions annually. While most of these are legal and routine transactions, a small number may be fraudulent. The enormous number of transactions makes it difficult to find these few instances among legitimate transactions. Without the availability of proactive fraud detection tools, investigating suspicious activities becomes overwhelming.

This study explores and develops innovative methods for proactive detection of potential fraud in enterprise systems. The intention is to build a model for detection of potential fraud based on analysis of patterns or signatures building on theories and concepts of continuous fraud detection. This objective is addressed by answering the main question; *can a generalised model for proactive detection of potential fraud in enterprise systems be developed?* The study proposes a methodology for proactive detection of potential fraud that exploits audit trails in enterprise systems. The concept of proactive detection of potential fraud is demonstrated by developing a prototype. The prototype is a near real-time web based application that uses SAS for its analytics processes. The aim of the prototype is to confirm the feasibility of implementing proactive detection of potential fraud in practice. Verification of the prototype is achieved by performing a series of tests involving simulated activity, followed by a full scale case study with a large international manufacturing company. Validation is achieved by obtaining independent reviews from the case study senior staff, auditing practitioners and a panel of experts. Timing experiments confirm that the prototype is able to handle real data volumes from a real organisation without difficulty thereby providing evidence in support of enhancement of auditor productivity. This study makes a number of contributions to both the literature and auditing practice.

CERTIFICATION OF DISSERTATION

I certify that the ideas, experimental work, results, analyses, software and conclusions reported in this dissertation are entirely my own effort, except where otherwise acknowledged. I also certify that the work is original and has not been previously submitted for any other award, except where otherwise acknowledged.

Signature of Candidate

Date

ENDORSEMENT

Signature of Supervisor

Date

Signature of Supervisor

Date

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the guidance, help, support and encouragement from my supervisors, independent reviewers, expert panel members, family and friends. I would like to express my sincere gratitude to my supervisors, Professor Peter Best and Associate Professor Joseph Mula for their professional guidance, assistance and encouragement during this journey. Professor Peter Best provided exceptional technical insight required for this research. Associate Professor Joseph Mula provided outstanding guidance in developing the research and he spent several hours reading and providing exceptional feedback that helped improve the writing and the structure of this dissertation.

I would like to express my thanks to Mr Nalinde Jayasekara and Mr Kamal Manatunga for agreeing to trial the prototype software and for their independent reviews of the prototype. I would also like to thank Mr John J Halliday, Executive Director Advisory, BDO Australia for providing an independent review of the prototype software and for hosting of an expert panel session.

This research would not have been complete without feedback from members of the expert panel. I would like to thank members of CPA Australia (Queensland Division - IT Discussion Group) and ISACA (Queensland Chapter) that participated in the panel, and for their valuable comments and feedback.

My thanks and love is also dedicated to my wife Bharati and my son Akhil. Their encouragement and support gave me strength and persistence to complete this long PhD journey. I would also like to thank all my friends for their support and encouragement.

Finally, I would like to express my humble gratitude to my spiritual master, Sri Sathya Sai Baba, without whose inspiration and guidance, this journey would not have been possible.

TABLE OF CONTENTS

ABSTRACT	i
CERTIFICATION OF DISSERTATION.....	ii
ACKNOWLEDGEMENTS	iii
LIST OF FIGURES	viii
LIST OF TABLES.....	xiii
CHAPTER 1 Introduction.....	16
1.0. Background.....	16
1.1. Research problem.....	19
1.2. Study design	22
1.3. Key definitions.....	23
1.4. Delimitations of scope.....	30
1.5. Research significance	33
1.6. Structure of dissertation.....	35
1.7. Conclusion.....	36
CHAPTER 2 Literature Review	38
2.0. Introduction	38
2.1. Definition of fraud	40
2.1.1. Asset misappropriation.....	42
2.1.2. Corruption.....	46
2.1.3. Fraudulent financial statements	47
2.2. Occurrence and cost of fraud.....	48
2.3. Motivation to commit fraud.....	53
2.4. Framework for perpetrating fraud.....	59
2.5. Fraud scenarios	65
2.6. Proactive fraud detection.....	69
2.7. Continuous monitoring strategies	74
2.7.1. Embedded Audit Modules (EAMs)	77
2.7.2. Monitoring and Control Layer (MCL)	81

2.8.	Enterprise Systems	84
2.9.	SAP Enterprise System	87
2.10.	Audit trails	90
2.11.	Enterprise system audit trails support for fraud detection.....	93
2.12.	Gaps in the literature	97
2.13.	Conclusion	99
CHAPTER 3 Research Design and Methodology.....		102
3.0.	Introduction	102
3.1.	Study design	103
3.2.	Research design	107
3.2.1.	Research questions	107
3.2.2.	Conceptual model.....	109
3.2.3.	Research propositions.....	112
3.3.	Research methodology	118
3.3.1.	Scope of fraud categories	120
3.3.2.	Measures to detect fraud.....	121
3.3.3.	Data requirements to detect potential fraud.....	124
3.3.4.	Prototype.....	127
3.3.5.	Data collection	132
3.3.6.	Proof of conceptual model.....	133
3.3.7.	Expert panel validation of model.....	134
3.4.	Conclusion.....	137
CHAPTER 4 Prototype Design.....		139
4.0.	Introduction	139
4.1.	Prototype design.....	140
4.2.	Data requirements for fraud detection.....	141
4.3.	SAP support for fraud detection	143
4.3.1.	SAP audit trails	144
4.4.	Catalogue of fraud symptoms.....	150
4.4.1.	Critical combinations	151
4.4.2.	Known fraud symptoms	153
4.5.	Design specification for fraud detection strategies.....	154
4.6.	Storage.....	176

4.7.	Output.....	177
4.8.	User interface.....	181
4.9.	Errors.....	183
4.10.	Verification and validation of prototype	184
4.11.	Prototype design and propositions addressed	188
4.12.	Conclusion	190
CHAPTER 5 Prototype Implementation and Testing		192
5.0.	Introduction	192
5.1.	Prototype implementation	193
5.1.1.	Workstation environment	193
5.1.2.	Development environment.....	193
5.1.3.	Data extraction and pre-processing	194
5.1.4.	Reporting system.....	197
5.2.	Verification and testing of prototype	204
5.2.1.	Test data.....	205
5.2.2.	Case study 1a: Data from large international manufacturing company ...	212
5.2.3.	Case study 1b: Subset of case study 1a data.....	218
5.2.4.	Case study 1a: Summary of findings and recommendations.....	220
5.3.	Processing times.....	223
5.4.	Validation and independent review of prototype.....	229
5.5.	Prototype implementation and testing and propositions	236
5.6.	Conclusion.....	238
CHAPTER 6 Conclusion and Further Research		241
6.0.	Introduction	241
6.1.	Summary of results from this study	241
6.2.	Contributions	250
6.2.1.	Theoretical contributions.....	251
6.2.2.	Contributions to the practice of fraud detection	257
6.3.	Limitations.....	259
6.4.	Recommendations.....	261
6.4.1.	Recommendations for further research	261
6.4.2.	Recommendations for extensions to prototype.....	264
6.5.	Conclusion.....	272

LIST OF REFERENCES	274
APPENDICES	287
Appendix 1: Fraud cases	287
Appendix 2: Expert panel protocol	291
Appendix 3: Prototype evaluation questionnaire	293
Appendix 4: Prototype menu navigation	296
Appendix 5: Results from test data	308
Appendix 6: Results from case study 1a	333
Appendix 7: Results from case study 1b	350
Appendix 8: Data extraction	353
Appendix 9: Feedback on prototype	357

LIST OF FIGURES

Figure 2.1: Categories of occupational fraud	43
Figure 2.2: Position of fraud perpetrator	51
Figure 2.3: Fraud cases based on perpetrator's department	51
Figure 2.4: Median loss by perpetrator's department	52
Figure 2.5: Fraud triangle	56
Figure 2.6: Theoretical foundation for research.....	58
Figure 2.7: Fraud perception model (FPM)	61
Figure 2.8: High-level fraud scenarios model (HFSSM).....	63
Figure 2.9: Fraud detection process.....	71
Figure 2.10: Detection of occupational fraud	73
Figure 3.1: Conceptual model	110
Figure 3.2: Research propositions	114
Figure 3.3: Methodology	119
Figure 3.4: Critical AP activities model	122
Figure 3.5: Flipping vendor bank account details	127
Figure 3.6: The prototype model.....	129
Figure 3.7: Prototype input requirements	130
Figure 3.8: Source of data.....	133
Figure 3.9: Expert panel interaction and feedback.....	137
Figure 4.1: Prototype conceptual design.....	141
Figure 4.2: Input specifications	142
Figure 4.3: SAP audit trails	146
Figure 4.4: Process module	151
Figure 4.5: Detection strategy- users violating SoDs principle 1.....	156
Figure 4.6: Detection strategy- users violating SoDs principle 2.....	157
Figure 4.7: Detection – flipping vendor bank account	159
Figure 4.8: Detection – duplicate transactions	160
Figure 4.9: Detection – invoices with round dollar amounts.....	161
Figure 4.10: Detection – invoices below approval limit.....	163
Figure 4.11: Detection – vendor payments exceeding last largest.....	164
Figure 4.12: Detection – use of one time vendors.....	165

Figure 4.13: Detection – vendors with similar names	166
Figure 4.14: Detection – vendors becoming active after long period	167
Figure 4.15: Detection – multiple vendors with different payment details	169
Figure 4.16: Detection – multiple vendors sharing payment details	170
Figure 4.17: Detection – Benford's Law analysis of invoices.....	172
Figure 4.18: Storage module	177
Figure 4.19: Output module	177
Figure 4.20: Visualisation - activity summary	180
Figure 4.21: Visualisation - user profile	180
Figure 4.22: Visualisation – interaction between users and individual vendor	181
Figure 4.23: User-interface	182
Figure 4.24: Verification and validation.....	184
Figure 4.25: Prototype logical design.....	191
Figure 5. 1: User interface.....	195
Figure 5.2: Process map – complete.....	198
Figure 5.3: Analysis process	199
Figure 5.4: Dashboard.....	200
Figure 5.5: User activity reports.....	202
Figure 5.6: Individual vendor reports.....	203
Figure 5.7: Number of records processed	226
Figure 6.1: Model of extended prototype	269
Figure A4.1: Start-up screen	296
Figure A4. 2: Accounts payable summary menu	297
Figure A4. 3: User profiles menu	297
Figure A4. 4: Critical combinations menu.....	298
Figure A4. 5: User activity analysis menu	298
Figure A4. 6: Detailed user activity analysis menu.....	299
Figure A4. 7: User activity reports menu.....	300
Figure A4. 8: Vendor analysis menu	301
Figure A4. 9: Analyse vendor transactions menu	302
Figure A4. 10: Analysis of vendor transactions (reports) menu	303
Figure A4. 11: Search vendor menu.....	304
Figure A4. 12: Configure system menu.....	305

Figure A4. 13: Set date range for analysis menu	305
Figure A4. 14: Set approval limit for invoices & payments menu.....	306
Figure A4. 15: File processing menu.....	306
Figure A4. 16: Data conversion & import menu.....	307
Figure A4. 17: Update/create data warehouse selection screen.....	307
Figure A5.1: Dashboard.....	309
Figure A5. 2: User activities summary	310
Figure A5. 3: User profile – vendor maintenance	310
Figure A5. 4: User profile – invoice transactions	311
Figure A5. 5: User profile – payment transactions.....	311
Figure A5. 6: User profile – invoices or payment transactions.....	312
Figure A5. 7: User profile – all combinations.....	312
Figure A5. 8: Visualisation – all combinations.....	313
Figure A5. 9: Violation of SoDs – users entering invoices and payments	314
Figure A5. 10: Visualisation - users entering invoices and payments.....	314
Figure A5. 11: Violation of SoDs – users performing vendor maintenance.....	314
Figure A5. 12: Visualisation - users performing vendor maintenance.....	315
Figure A5. 13: Violation of SoDs – users performing vendor maintenance.....	315
Figure A5. 14: Visualisation - users performing vendor maintenance.....	316
Figure A5. 15: Violation of SoDs – users performing vendor maintenance,.....	316
Figure A5. 16: Visualisation - users performing vendor maintenance,.....	317
Figure A5. 17: Bank account changes by user - 1USRARSCP	317
Figure A5. 18: Invoice transactions by user - 1USRARSCP.....	318
Figure A5. 19: Payment transactions by user - 1USRARSCP.....	318
Figure A5. 20: Round dollar payments by user - 1USRARSCP.....	319
Figure A5. 21: Vendors touched by user - 1USRARSCP	319
Figure A5. 22: Visualisation – vendors touched by user - 1USRARSCP	320
Figure A5. 23: User 1USRARSCP interacting with vendor 0002000041.....	321
Figure A5. 24: Vendors sharing bank accounts	322
Figure A5. 25: Visualisation - vendors sharing bank accounts.....	323
Figure A5. 26: Vendors with multiple bank accounts	324
Figure A5. 27: Visualisation - vendors having multiple bank accounts.....	325
Figure A5. 28: Vendors with multiple changes.....	326

Figure A5. 29: Vendors with multiple master records	327
Figure A5. 30: Top 5 vendors by sum of invoices	328
Figure A5. 31: Top 5 vendors by sum of payments	328
Figure A5. 32: Benford's Law – analysis of vendor invoices	329
Figure A5. 33: Benford's Law – investigation of spike at digit 49	329
Figure A5. 34: Benford's Law – analysis of vendor payments	330
Figure A5. 35: Benford's Law – investigation of spike at digit 22	330
Figure A5. 36: Transaction history for vendor – showing flipping.....	331
Figure A5. 37: Visualisation - users interacting with vendor	331
Figure A5. 38: Visualisation – vendor transaction history	332
Figure A6.1: Dashboard.....	334
Figure A6. 2: User activities summary	335
Figure A6. 3: User profile – vendor maintenance	335
Figure A6. 4: User profile – invoice transactions	336
Figure A6. 5: User profile – payment transactions.....	336
Figure A6. 6: User profile – invoices or payment transactions.....	337
Figure A6. 7: User profile – all combinations.....	337
Figure A6. 8: Visualisation – all combinations.....	338
Figure A6. 9: Violation of SoDs – users entering invoices and payments	339
Figure A6. 10: Violation of SoDs – users performing vendor maintenance.....	339
Figure A6. 11: Visualisation - users entering invoices and payments.....	340
Figure A6. 12: Visualisation - users performing vendor maintenance.....	340
Figure A6. 13: Violation of SoDs – users performing vendor maintenance.....	341
Figure A6. 14: Violation of SoDs – users performing vendor maintenance,.....	341
Figure A6. 15: Visualisation - users performing vendor maintenance.....	342
Figure A6. 16: Visualisation - users performing vendor maintenance,.....	342
Figure A6. 17: Vendors sharing bank accounts	343
Figure A6. 18: Vendors with multiple bank accounts	343
Figure A6. 19: Visualisation - vendors sharing bank accounts.....	344
Figure A6. 20: Visualisation - vendors having multiple bank accounts.....	345
Figure A6. 21: Vendors with multiple changes.....	346
Figure A6. 22: Vendors with multiple master records	346
Figure A6. 23: Top 5 vendors by sum of invoices	347

Figure A6. 24: Top 5 vendors by sum of payments 347

Figure A6. 25: Benford's Law – analysis of vendor invoices 348

Figure A6. 26: Benford's Law – investigation of spike at digit 36 348

Figure A6. 27: Benford's Law – analysis of vendor payments 349

Figure A6. 28: Benford's Law – investigation of spike at digit 22 349

Figure A7.1: Dashboard..... 350

Figure A7. 2: User activities summary 351

Figure A7. 3: Risky user list 351

Figure A7. 4: Benford's Law – analysis of vendor invoices 352

Figure A7. 5: Benford's Law – analysis of vendor payments 352

LIST OF TABLES

Table 2.1: Categories of occupational fraud and abuse	48
Table 2.2: Sub-categories of asset misappropriation (US Data)	49
Table 2.3: Sub-categories of asset misappropriation (Oceania Data)	50
Table 2.4: Control weakness that contributed to fraud.....	50
Table 2.5: Fraud matrix (FM)	66
Table 3.1: Research paradigms	104
Table 3.1: Mapping of research questions, propositions and process	116
Table 3.2: Methods to detect known fraud symptoms.....	125
Table 4.1: Source of data to detect known fraud symptoms.....	145
Table 4.2: SAP transaction codes.....	152
Table 4.3: Violation of SoDs principle 1	153
Table 4.4: Violation of SoDs principle 2.....	153
Table 4.5: Known AP fraud symptoms	155
Table 4.6: Risk Index variables.....	175
Table 4.7: Activity summary.....	180
Table 5.1: Source of data to detect known fraud symptoms.....	196
Table 5.2: Control values - activities performed by users	206
Table 5.3: Control values - violation of segregation of duties.....	206
Table 5.4: Control values - activities performed by user 1USRARSCP	206
Table 5.5: Control values - summary of vendor transactions	207
Table 5.6: Control values – Benford's Law	207
Table 5.7: Activities performed by users.....	208
Table 5.8: Violation of segregation of duties.....	209
Table 5.9: Activities performed by user 1USRARSCP.....	209
Table 5.10: Summary of vendor transactions	210
Table 5.11: Correspondence between control values and experimental values.....	212
Table 5.12: Activities performed by users.....	213
Table 5.13: Violation of segregation of duties.....	213
Table 5.14: Summary of activities by 1USRA.....	214
Table 5.15: Summary of activities by 1USRMI.....	215

Table 5.16: Summary of activities by 1USREEWAH.....	216
Table 5.17: Summary of activities by 1USRN.....	216
Table 5.18: Summary of vendor transactions	217
Table 5.19: Activities performed by users	219
Table 5.20: Violation of segregation of duties.....	219
Table 5.21: Summary of vendor transactions	220
Table 5.22: Processing time - stage 1 test.....	223
Table 5.23: Number of records processed	224
Table 5.24: Processing time – stage 2 test	224
Table 5.25: Number of records processed	225
Table 5.26: Processing time – stage 3 test	225
Table 5.27: Number of records processed	226
Table 5.28: Summary of records processed for all tests.....	226
Table 5.29: Average processing time for all tests	227
Table 5.30: Operation	231
Table 5.31: Reports.....	232
Table 5.32: Visualisations.....	232
Table 5.33: Accuracy, efficiency and performance.....	233
Table 5.34: Auditor productivity.....	233
Table 5.35: Time to process data manually	234
Table 5.36: Time to process data with other software.....	234
Table 5.37: Time to process data with prototype	235
Table 5.38: Overall evaluation	235
Table A8.1: SAP tables and field requirements	353
Table A8.2: Summary data extraction procedure.....	354
Table A8.3: SAP table extraction documentation	355

