CONCEPTUAL DESIGN MODEL OF COMPUTERIZED PERSONAL-DECISION AID (ComPDA)

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Siti Mahfuzah Sarif

2011

ABSTRAK

Sehingga kini, perhatian yang diberikan kepada penambahbaikan sistem sokongan pemutusan untuk organisasi adalah sangat meluas. Namun begitu, kajian akademik mengenai penambahbaikan sistem sokongan pemutusan berkomputer (SSPB) untuk keputusan peribadi adalah berkurangan dan sebahagiannya sudah lapuk. Kebelakangan ini, kewujudan SSPB untuk keputusan peribadi bercambah seperti cendawan dan semakin mendapat perhatian dari pengguna-pengguna sistem. Namun, persepsi pengguna mengenai strategi dan teknik pemutusan yang sesuai masih tidak berlandaskan kajian yang sistematik. Sorotan karya turut menjelaskan kecenderungan pengguna sistem untuk tidak memilih kaedah matematik yang kompleks dalam membantu membuat keputusan peribadi walaupun kaedah ini telah dibuktikan mampu menangani isu risiko dan ketidakpastian dalam keputusan. Tambahan pula, proses pembangunan kebanyakan SSPB didapati tidak berlandaskan model konseptual dan teori. Sehubungan itu, kajian ini mencadangkan satu model rekabentuk konseptual untuk sistem sokongan pemutusan-peribadi berkomputer (SSPPB). Objektif berikut turut dibentuk bagi menyokong matlamat utama kajian: (i) mengenalpasti strategi dan teknik membuat keputusan yang sesuai untuk SSPPB; (ii) menggabungkan strategi dan teknik yang telah dikenalpasti dalam pembangunan model reka bentuk konseptual SSPPB; (iii) mengimplementasi model reka bentuk konseptual dalam pelbagai situasi melalui kaedah prototaip; dan (iv) mengukur persepsi kebolehbantuan prototaip SSPPB yang dibangunkan. Kaedah reka bentuk penyertaan dijalankan untuk mencapai objektif i dan ii. Dapatan daripada kaedah tersebut digunakan dalam pembangunan model reka bentuk konseptual SSPPB. Bagi mencapai objektif iii, model rekabentuk konseptual telah diimplementasi dalam dua kajian kes yang bertujuan memilih: A- metodologi pembangunan dalam kursus perkomputeran mudah-alih (m^d-Matrix), dan B- telefon bimbit dalam persekitaran pembelian (e^p-Matrix). Manakala objektif iv tercapai melalui pembangunan instrumen yang dinamakan Q-HELP bagi mengukur persepsi kebolehbantuan prototaip SSPPB. Kajian ini telah mengenalpasti empat konstruk untuk mengukur kebolehbantuan: kebolehpercayaan, usaha membuat keputusan, keyakinan dan kesedaran membuat keputusan. Secara keseluruhan, 122 responden telah mengambil bahagian di mana 63 daripada kes A dan 59 daripada kes B. Lapan hipotesis telah dibentuk merangkumi ujian korelasi di antara kempat-empat konstruk dalam Q-HELP dengan kebolehbantuan, ujian untuk menentukan samada penggunaan prototaip SSPPB mampu mengurangkan masa membuat pilihan secara signifikan dan ujian untuk mengesahkan purata kebolehbantuan prototaip SSPPB adalah tinggi. Ujian-t Sampel Berpasangan, analisis Korelasi Pearson dan analisis deskriptif telah digunakan untuk menguji hipotesis di atas. Keputusan ujian hipotesis menunjukkan: keempat-empat konstruk mempunyai korelasi yang signifikan dengan kebolehbantuan, penggunaan m^d-Matrix dan e^p-Matrix mampu mengurangkan masa membuat keputusan secara signifikan, purata kebolehbantuan m^d-Matrix tidak menunjukkan keputusan yang tinggi, dan purata kebolehbantuan e^p-Matrix menunjukkan keputusan yang tinggi. Walau bagaimanapun, kajian ini merumuskan kedua-dua prototaip SSPPB sebagai membantu pengguna dari aspek kebolehpercayaan, meringankan usaha membuat keputusan serta meningkatkan keyakinan dan kesedaran dalam membuat keputusan. Kesimpulannya, hasil kajian ini menghasilkan: (i) satu model rekabentuk konseptual SSPPB, (ii) dua prototaip SSPPB (dan algoritmanya) yang mengesahkan implementasi model rekabentuk konseptual dalam dua situasi yang berbeza, (iii) satu instrumen kajian yang mengukur kebolehbantuan SSPPB dari segi proses dan hasil, dan (iv) analisis perbandingan di antara model, strategi dan teknik pemutusan yang boleh membantu dalam kajian akan datang.

ABSTRACT

To date, the attentions given to the improvement of decision support at organizational level has been enormous. On the contrary, academic research in improving the performance of computerized decision aid (CDA) for personal decision is lacking, in which some are dated. Nowadays, the existence of CDA which handles personal decision is mushrooming and progressively getting attention from users. Despite that, users' perceptions of the suitable decision strategy and technique for CDA have not been subjected to systematic investigation. Literature reviews also indicate that most users do not go for complex mathematical techniques despite the fact that these techniques are better at handling the risks and uncertainties in decisions. In fact, more often than not, the development process of CDAs does not seem to adhere to any conceptual and theoretical model. In view of that, this study aims to propose a conceptual design model for computerized personal-decision aid (ComPDA). The following objectives are outlined to support the general aim: (i) to identify appropriate decision strategy and technique for ComPDA, (ii) to incorporate identified strategy and technique in the construction of conceptual design model for ComPDA (iii) to validate the conceptual design model in different situations via prototyping method and (iv) to measure the users' perceived helpfulness of the ComPDA prototypes. Participatory design method was implemented in order to achieve objective i and ii. The findings were incorporated into the construction of the conceptual design model of ComPDA. In achieving objective iii, the conceptual design model was validated in two different case studies via prototyping: A- choosing development methodology in mobile computing course (m^d-Matrix); and B- purchasing a mobile phone (e^p-Matrix). In achieving objective iv, an instrument (named as Q-HELP) was developed to measure the helpfulness (HLP) of the prototypes. This study identified four relevant constructs pertinent to helpfulness; reliability (REL), decision making effort (EFF), confidence (CON), and decision awareness (AWR). Altogether, 122 respondents participated where 63 were from case study A and 59 from case study B. Eight hypotheses were formulated comprising testing for correlation between all the constructs in Q-HELP with helpfulness, testing the average time spent to make a selection with and without the proposed ComPDA and testing if the mean score of helpfulness of the proposed ComPDA is high. Paired Samples *t* Test, Pearson Correlation analyses and descriptive analyses were utilized to validate the hypotheses. The results show that: REL and HLP are significantly correlated, EFF and HLP are significantly correlated, CON and HLP are significantly correlated, AWR and HLP are significantly correlated, the use of m^d-Matrix and e^p-Matrix significantly reduces the time spent to make selection, mean score of helpfulness of m^d-Matrix is fairly high and mean score of helpfulness of e^p-Matrix is high. However, it is concluded that the overall results exhibit sufficient indication that m^d-Matrix and e^p-Matrix were found helpful to users in terms of reliability, lessening the decision making effort, increasing confidence and also awareness in decision making. This study has produced the following outcomes, along with achieving all of its objectives: (i) a conceptual design model for ComPDA which incorporates suitable decision strategies and techniques identified via systematic investigations; (ii) two functional ComPDA prototypes to validate the conceptual design model and to demonstrate its applicability in different situations, (iii) an instrument for measuring helpfulness which includes dimensions from outcome and process aspects; and (iv) comparative analyses of decision models, strategies and techniques which provide basis for future studies.

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DEDICATION

To:

***Mak** (Hjh. Zaiton Puteh) and*

***Abah** (Hj. Sarif Joned)*

With love;

***Kakak** (Siti Mahfuzah Sarif)*

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LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
CBA	Cost-Benefit Analysis
CDA	Computerized Decision Aid
CDSS	Customer Decision Support System
ComPDA	Computerized Personal-Decision Aid
CS	Computer Science
DSS	Decision Support System
EBA	Elimination by Aspects
EDP	Electronic Data Processing
EIP	Elementary Information Processes
ES	Expert System
GIS	Geographic Information System
HCI	Human Computer Interaction
HLI	Higher Learning Institution
IPO	Intuitive Preference Order
IS	Information System
ITM	Iterative Triangulation Methodology
JME	Java Micro Edition
KMO	Kaiser-Meyer-Olkin test
MAUT	Multi-Attribute Utility Theory
MCDM	Multi-Criteria Decision Making
MIS	Management Information System
PC	Personal Computer
PD	Participatory Design
PhD	Doctor of Philosophy

PPO Prescribed Preference Order

Q-HELP Questionnaire of Helpfulness

RS Recommender System

SDLC System Development Life Cycle

SDM Software Development Methodology

SE Software Engineering

TTB Take-the-Best

WAM Weighted Additive Matrix

LIST OF PUBLICATIONS

JOURNALS

- **Sarif, S.** & Shiratuddin, N. (2010). Measuring Helpfulness of Personal Decision Aid Design Model. *Global Journal of Computer Science and Technology, 10*(5), 64-80.
- Norshuhada, S. & **Siti Mahfuzah, S.** (2009). The m^d-Matrix: a learning tool in the mobile application development course. *International Journal of Mobile Communications, 7*(4), 494-514.

CHAPTER IN BOOK

- Norshuhada, S. & **Siti Mahfuzah, S.** (2009). Construction of Matrix and e-Matrix for Mobile Development Methodologies. In Unhelkar, B. (Ed.), *Handbook of Research in Mobile Business: Technical, Methodological and Social Perspectives* (pp. 113-126). IGI Global: USA.

PROCEEDINGS

- Norshuhada, S. & **Siti Mahfuzah, S.** (2009). e^p-Matrix: A Computerized Decision Aid Incorporating Pugh Matrix Analysis for Purchasing Decision. In *Proceedings of International Conference on Software Engineering & Computer Systems (ICSECS'09): ICT and Industry - The way forward* (pp. 208 - 212).
- Norshuhada, S. & **Siti Mahfuzah, S.** (2008). md-Matrix: Mobile Application Development Methodologies Matrix. In *Proceedings of the International MultiConference of Engineers and Computer Scientists,* 19-21 March, 2008, Hong Kong.

POSTER

- Norshuhada, S. & **Siti Mahfuzah, S.** (2009, December). *m^d-Matrix: An assistive learning tool in blended project based learning for mobile development course.* Poster session presented at Same Places, Different Spaces: Ascilite, Auckland.

AWARDS AND RECOGNITIONS

Here are projects related to this study that have been awarded at both national and international levels:

- **Best Award**

  Event **:** Malaysia Technology Expo 2008, Kuala Lumpur.

  Project Title : Agent Assisted m^d-Matrix (Mobile Development Methodologies Matrix).

  Researcher : Norshuhada Shiratuddin & **Siti Mahfuzah Sarif**.

- **Gold Medals**

  1. Event : International Innovation Expo 2008, Kuala Lumpur.

     Project Title : AADMA - Avatar Assisted Decision Making Advisor in Retail Environment.

     Researcher : Norshuhada Shiratuddin & **Siti Mahfuzah Sarif**.

  2. Event : Malaysia Technology Expo 2008, Kuala Lumpur.

     Project Title : Agent Assisted m^d-Matrix (Mobile Development Methodologies Matrix).

     Researcher : Norshuhada Shiratuddin & **Siti Mahfuzah Sarif**.

- **Silver Medals**

  1. Event : Seoul International Invention Fair 2008, Korea

     Project Title : e^p-Matrix - Decision making eTool

     Researcher : Norshuhada Shiratuddin & **Siti Mahfuzah Sarif**

  2. Event : The International Exhibition of Invention 2008, Geneva

     Project Title : Agent-Assisted eDecision Matrix: m^d-Matrix & e^p-Matrix.

     Researcher : Norshuhada Shiratuddin & **Siti Mahfuzah Sarif**

CHAPTER 1

BACKGROUND OF STUDY

1.1 OVERVIEW

As an introduction to in-depth discussion on the research topic, Chapter 1 provides deliberations on issues that underlie the foundation of the study; the statement of the research problem; research objectives and scope of research; and also, the definition of the terms that are used in this study.

1.2 BACKGROUND

Decisions are an inevitable part of human activities. Although most of the decisions made are minor in terms of its consequences, but still, making an actual decision out of any situation is indeed necessary. Living in the 21st century, it is inevitable to not associate anything with the use of technology and this includes decision making. As technologies are more user-oriented than before, more decision aid technology can be found on the basis of assisting mankind to make decisions.

Human regularly makes decisions of varying importance on daily basis, thus, making the idea of seeing personal decision making as a researchable matter seems odd. However, decades of studies have proven that most human are much poorer at decision making than they think (Anderson, 1985; Newell & Simon, 1972). Thus, explains the existence of decision aids in wide range of domains, which include management, engineering and medicine.

The contents of the thesis is for internal user only

REFERENCES

Abrahamsson, P., Hanhineva, A., Hulkko, H., Ihme, T., Jäälinoja, J., Korkala, … Salo, O. (2004). Mobile-D: An Agile Approach for Mobile Application Development. In *Proceedings of Companion to the 19th annual ACM SIGPLAN Conference on Object-oriented Programming Systems, Languages and Applications* (pp. 174-175). New York, NY: ACM Press.

Afonso, A. P., Regateiro, F. S., & Silva, M. J. (1998). *Dynamic Channels: A New Development Methodology for Mobile Computing Applications* (Technical reports di-fcul-tr-98-4). Lisbon, Portugal: University of Lisbon, Department of Informatics.

Alidrisi, M. M. (1987). Use of multi-attribute utility theory for personal decision making. *International Journal of Systems Science, 18*(12), 2229-2237. doi:10.1080/00207728708967183

Al-Shemmeri, T., Al-Kloub, B., & Pearman, A. (1997). Model Choice in Multi-criteria Decision Aid. *European Journal of Operational Research, 97,* 550-560. doi:10.1016/S0377-2217(96)00277-9

Alter, S. (1977). A Taxonomy of Decision Support Systems. *Sloan Management Review, 19*(1), 39-56.

Alter, S. (1980). *Decision Support Systems: Current Practice and Continuing Challenges*. Reading: Addison-Wesley.

Anderson, B. F. (2002). *The Three Screts of Wise Decision Making*. Portland: Single Reef Press.

Anderson, J. R. (1985). *Cognitive psychology and its implications* (2nd ed). San Francisco: W. H. Freeman.

Ariffin, M. (2009). *Conceptual Design Model of RLM: Towards Entertaining and Fun* (Doctoral dissertation). Universiti Utara Malaysia, Sintok.

Arnott, D., Pervan, G., & Dodson, G. (2005). A Descriptive Analysis of Decision Support Systems Research between 1990 and 2003. *Australasian Journal of Information Systems*, *12*(2), 178-191.

Arsham, H. (2004). *Decision Making: Overcoming Serious Indecisiveness*. Retrieved March 10, 2009 from http://home.ubalt.edu/ntsbarsh/opre640/partXIII.htm

Atkinson, C., & Olla, P. (2004). Developing a wireless reference model for interpreting complexity in wireless projects. *Industrial Management & Data Systems*, *104*(3), 262-272. doi:10.1108/02635570410525807

Avison, D. E., & Fitzgerald, G. (1990). *Information Systems Development: Methodologies*, *Techniques and Tools*. London: Blackwell.

Bahl, H. C., & Hunt, R. G. (1984, Summer). Decision-Making Theory and DSS Design. *ACM SIGMIS Database Newsletter, 15*(4), 10-14. doi: 10.1145/1017726.1017728

Bailey, R., & Doepker, P. (2001). *Learning from students about decision tools in design*. Paper presented at the 2001 ASME International Design Engineering Technical Conferences, Pittsburgh, PA.

Baker, D., Bridges, D., Hunter, R., Johnson, G., Krupa, J., Murphy, J., & Sorenson, K. (2002). *Guidebook to Decision-Making Methods* (Report No. WSRC-IM-2002-00002). Retrieved from Department of Energy, USA website: http://emi-web.inel.gov/Nissmg/Guidebook_2002.pdf

Barclay, S., Esoda, R. M., Cox, C. L., Peterson, C. R., & Weiss, J. J. (1981). *A Friendly Personal Decision Aid* (Technical report TR 81-12-312.43). McLean, VA: Defense Advanced Research Projects Agency, Defense Sciences Office, System Sciences Division.

Batsell, R. R., Polking, J. C., Cramer, R. D., & Miller, C. M. (2003). Useful mathematical relationships embedded in Tversky's elimination by aspects model. *Journal of Mathematical Psychology*, *47*(5-6), 538-544. doi:10.1016/j.jmp.2003.08.004

Bauer, V., & Wegener, M. (1977). Applications of multi-attribute utility theory: Comments. In Jungermann, H., & de Zeeuw, G. (Eds.), *Decision Making and Change in Human Affairs* (pp. 209-214). Dordrecht, Holland: Reidel.

Bauersfeld, P., Bennett, J., & Lynch, G. (1992). Striking a Balance. In *Proceedings of the Conference on Human Computer Interaction* (pp. 293-294). Monterey, CA, USA: ACM Press.

Beach, L. R., & Mitchell, T. R. (1978). A Contingency Model for the Selection of Decision Strategies. *The Academy of Management Review*, *3*(3), 439-449. Retrieved from http://www.jstor.org/stable/257535

Bell, D. E., Raiffa, H., & Tversky, A. (1988). *Decision Making: Descriptive, Normative and Prescriptive Interactions*. New York: Cambridge University Press.

Belton, V., & Gear, T. (1983). On a Short-coming of Saaty's Method of Analytic Hierarchies. *Omega, 11*(3), 228-230. doi:10.1016/0305-0483(83)90047-6

Benbasat, I., & Todd, P. (1996). The effects of decision support and task contingencies on model formulation: A cognitive perspective. *Decision Support Systems: DSS on Model Formulation, 17*(4), 241-252. doi:10.1016/0167-9236(96)00003-6

Benbasat, I., & Zmud, R. W. (1999). Empirical Research in Information Systems: The Practice of Relevance. *MIS Quarterly*, *23*(1), 3-16. doi:10.2307/249403

Bennett, J. L. (1986). *Building Decision Support Systems*. Reading: Addison Wesley.

Bergett, F. B., & Nosofsky, R. M. (2007). A response time approach to comparing generalized rational and take the best models of decision making. *Journal of Experimental Psychology: Learning, Memory and Cognition, 33,* 107-129. doi:10.1.1.169.3273

Bertini, E., Gabrielli, S., & Kimani, S. (2006). Appropriating and Assessing Heuristics for Mobile Computing. In *Proceedings of the Working Conference on Advanced Visual Interfaces* (pp. 119-126). New York: ACM Press.

Bettman, J. R., Johnson, E. J., & Payne, J. W. (1990). A componential analysis of cognitive effort in choice. *Organizational Behavior and Human Decision Processes, 45*(1), 111-139.

Bettman, J. R., & Kakkar, P. (1977). Effects of information presentation format on consumer information acquisition strategies. *Journal of Consumer Research, 3*(4), 233-240. Retrieved from http://www.jstor.org/stable/2489609

Bettman, J. R., & Park, C. W. (1980). Effects of Prior Knowledge and Experience and Phase of the Choice Process on Consumer Decision Processes: A Protocol Analysis. *The Journal of Consumer Research, 7*(3), 234-248. Retrieved from http://www.jstor.org/stable/2489009

Bhattacherjee, A. (2001). An Empirical Analysis of the Antecedents of Electronic Commerce Service Continuance. *Decision Support Systems, 32*(2), 201-214. doi:10.1016/S0167-9236(01)00111-7

Bingi, R. P. (1995). *The Effect of Decision Aids on Decision Confidence and Decision Success: An Empirical Investigation* (Doctoral dissertation). Available from Texas Tech University Electronic Theses and Dissertations database. (UMI No. 31295009151258).

Bjerknes, G., Ehn, P., & Kyng, M. (1987). *Computers and Democracy: A Scandinavian Challenge*. Gower: Brookfield, Vt.

Black, J. B., Bechtold, J. S., Mitrain, M., & Carrol, J. M. (1989). On-line tutorials: what kind of interface leads to the most effective learning? In *Wings for the Mind: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 81 – 83). New York: ACM Press.

Beach, L. R., & Mitchell, T. R. (1978). A Contingency Model for the Selection of Decision Strategies. *The Academy of Management Review, 3*(3), 439-449. Retrieved from http://www.jstor.org/stable/257535

Blue Dot Solutions (2006). *Mobile RAD Methodology*. Retrieved December 28, 2007, from http://www.sneller.com/rad.htm

Boal, A. (1992). *Games for Actors and Non-Actors.* London: Routledge.

Bradley, C., Haynes, R., Cook, J., Boyle, T., & Smith, C. (2008). Design and Development of Multimedia Learning Objects for Mobile Phones. In Mohamed Ally (Ed.), *Mobile Learning in Education and Training*. Athabasca, AB, Canada: Athabasca University Press.

Briggs, J. W. (2003). *An Examination of Decision Aid Reliance in a Dynamic Environment* (Doctoral dissertation). Available from ProQuest® Dissertations & Theses database. (UMI No. 3232273).

Bröder, A. (2000). Assessing the empirical validity of the "Take-The-Best" heuristic as a model of human probabilistic inference. *Journal of Experimental Psychology: Learning,Memory, and Cognition, 26*(5), 1332–1346.

Bröder, A. (2003). Decision making with the "adaptive toolbox": Influence of environmental structure, intelligence, and working memory load. *Journal of Experimental Psychology: Learning Memory, and Cognition, 29*(4), 611–625.

Brodie, M. L., Ridjanovic, D., & Silva, E. O. (1983). On a Framework for Information Systems Design Methodologies. In Olle, T. W., Sol, H. G., & Tully, C. J. (Eds.), *Information Systems Design Methodologies: A Feature Analysis* (pp. 231-241). North-Holland: Elsevier Science.

Brody, R. G., Kowalczyk, T. K., & Coulter, J. M. (2003). The Effect of a Computerized Decision Aid on the Development of Knowledge. *Journal of Business and Psychology, 18*(2), 157-174. Retrieved from http://www.jstor.org/pss/25092854

Bronner, F., & de Hoog, R. (1982). Non-Expert Use of a Computerized Decision Aid. In Humphreys, P., Svenson, O., & Anna Vári, A. (Eds.), *Analysing and Aiding Decision Processes* (pp. 281-299). Amsterdam: North-Holland.

Brown, R. (2008). Decision Aiding Research Needs. In. Adam, F., & Humphreys, P. (Eds.), *Encyclopedia of Decision Making and Decision Support Technologies* (pp. 141-147). USA: IGI Global.

Brown, D. L., & Jones, D. R. (1998). Factors that influence reliance on decision aids: A model and an experiment. *Journal of Information Systems, 12*(2), 75-94. Retrieved from http://ssrn.com/abstract=99288

Busemeyer, J. R., Mehta, S., & Barkan, R. (2003). *Comparing Models of Preferential Choice* (Technical Report No. 253). Indiana, USA: Indiana University, Cognitive Science Program.

Carrol, J. M., & McKendree, J. (1987). Interface design issues for advice giving expert systems. *Communication of the ACM, 30*(1), 14-31. doi:10.1145/7885.7886

Carroll, J., & Johnson, E. (1990). *Decision Research: A Field Guide*. Sage: London.

Center for Technology in Government (1998). *A Survey of System Development Process Models* (Publication No. CTG.MFA-003). Retrieved from Center for Technology in Government Report Online website: http://www.ctg.albany.edu/publications/reports/survey_of_sysdev/survey_of_sysdev.pdf

Cervone, H. F. (2009). Applied digital library project management: Using Pugh matrix analysis in complex decision making situations. *OCLC Systems & Services: International digital library perspectives, 25*(4), 228-232. doi:10.1108/10650750911001815

Chen, M. (2004). A Methodology for Building Mobile Computing Applications. *International Journal of Electronic Business, 2*(3), 229-243. doi: 10.1504/IJEB.2004.005139

Christ, P. (2009). *KnowThis: Marketing Basics.* USA: KnowThis Media.

Christensen-Szalanski, J. J. J. (1980). A further examination of the selection of problem-solving strategies: The effects of deadlines and analytic aptitudes. *Organizational Behavior and Human Performance, 25*(1), 107-122. doi:10.1016/0030-5073(80)90028-8

Chu, P. C., & Spires, E. E. (2003). Perceptions of Accuracy and Effort of Decision Strategies. *Organizational Behavior and Human Decision Processes, 91*(2), 201-214. doi:10.1016/S0749-5978(03)00056-6

Chung, R., Sundaram, D., & Srinivasan, A. (2007). Integrated personal recommender systems. In *Proceedings of the 9th International Conference on Electronic Commerce* (pp. 65-74). New York, NY: ACM Press.

Cicchetti, D. V., Showalter, D., & Tyrer, P. J. (1985). The effect of number of rating scale categories on levels of interater reliability: A Monte Carlo investigation. *Applied Psychological Measurement, 9*(1), 31-36. doi: 10.1177/014662168500900103

Clemen, R. T. (1996). *Making hard decisions: an introduction to decision analysis*. Pacific Grove: Duxbury Press.

Cole, R., Purao, S., Rossi, M., & Sein, M. K. (2005). Being Proactive: Where Action Research Meets Design Research. In *Proceedings of the 26th International Conference on Information Systems* (pp. 325-336). Las Vegas, USA: AIS.

Connell, N. A. D., & Powell, P. L. (1990). A Comparison of Potential Applications of Expert Systems and Decision Support Systems. *The Journal of the Operational Research Society, 41*(5), 431-439. Retrieved from http://www.jstor.org/stable/2583375

Coombs, C. H., & Kao, R. C. (1955). Non-metric factor analysis. In *Engineering Research Institute Bulletin #38*. Ann Arbor, MI: University of Michigan Press.

Cooper, A., Reimann, R., & Cronin, D. (2007). *About Face 3: The Essentials of Interaction Design.* Indianapolis, IN: Wiley Publishing.

Cosier, R. A., & Dalton, D. R. (1986). The Appropriate Choice and Implementation of Decision Strategies. *Journal of Industrial Management & Data Systems, 86*(3/4), 18-21. doi:10.1108/eb057436

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (2nd ed). USA: SAGE Publications.

Crinnion, J. (1992). *Evolutionary Systems Development: A Practical Guide to the Use of Prototyping within a Structured Systems Methodology*. Cambridge, MA: Perseus.

Cross, N. (2007). Forty Years of Design Research. *Design Research Quarterly*, *2*(1), 3-5.

Cummins, R. A., & Gullone, E. (2000). Why we should not use 5-point Likert scales: The case for subjective quality of life measurement. In *Proceedings of the 2nd International Conference on Quality of Life in Cities* (pp. 74-93). Singapore: National University of Singapore Press.

Davis, E. B. (1998). Decision aids in going concern evaluation: expectations of partial reliance. *Advances in Accounting Behavioral Research, 1*, 33-59.

Dawes, R. M. (1964). Social selection based on multidimensional criteria. *Journal of Abnormal and Social Psychology, 68*, 104-109.

Dholkawala, M. (2005). *Cryptic Capers: Best Practices for Mobile Game Development*. Retrieved March 8, 2010, from http://www.adobe.com/devnet/devices/articles/cryptic_capers.html

Dieckmann, A., Dippold, K., & Dietrich, H. (2009). Compensatory versus noncompensatory models for predicting consumer preferences. *Judgment and Decision Making, 4*(3), 200-213.

Dijkstra, J. J. (1998). *On the Use of Computerized Decision Aids: An Investigation into the Expert System as Persuasive Communicator* (Doctoral dissertation). Available from Dissertaties – Rijksuniversiteit Groningem database. (UMI No. 297332538)

Dix, A., Finlay, J., Abowd, G. D., & Beale, R. (2004). *Human-computer Interaction* (3rd ed). England: Pearson Education Limited.

Doyle, J. (1999). Rational decision making. In Wilson, R. A. & Kiel, F. C. (Eds.), *MIT Encyclopedia of the Cognitive Sciences* (pp. 701-703). Cambridge, MA: MIT Press.

Driedger, S. M., Kothari, A., Morrison, J., Sawada, M., Crighton, E. J., & Graham, I. D. (2007). Correction: Using participatory design to develop (public) health decision support systems through GIS. *International Journal of Health Geographics, 6*(1), 53. doi:10.1186/1476-072X-6-53

Dumke, R. R., & Foltin, E. (1998). Metrics-based evaluation of object-oriented software development methods. In *Proceedings of the 2nd Euromicro Conference on Software Maintenance and Reengineering* (pp. 193 -196). Washington, DC: IEEE Computer Society.

Durand, M. A., Stiel, M., Boivin, J., & Elwyn, G. (2008). Where is the theory? Evaluating the theoretical frameworks described in decision support technologies. *Patient Educ. Couns.*, *71*(1), 125-135.

Dyer, J. S., Fishburn, P. C., Steuer, R. E., Wallenius, J., & Zionts, S. (1992). Multiple Criteria Decision Making, Multiattribute Utility Theory: The Next Ten Years. *Management Science*, *38*(5), 645-654. doi: 10.1287/mnsc.38.5.645

Dykstra, E. A., & Carasik, R. (1991). Structure and support in cooperative environments: The Amsterdam conversation environment. *International Journal of Man-Machine Studies, 34*(3)*,* 419-434. doi:10.1016/0020-7373(91)90028-6

Dynamic Ventures Inc. (2007). *Proven Agile Software Development Process*. Retrieved March 8, 2008, from http://www.dyve.com/dv/methodology.htm

Edwards, R., & Coulton, P. (2006). Providing the Skills Required for Innovative Mobile Game Development Using Industry/Academic Partnerships. *ITALICS: The Journal of the Higher Education Academy Subject Centre for Information and Computer Sciences, 5*(3), 1-8. Retrieved from http://eprints.lancs.ac.uk/21175/

Eekels, J., & Roozenburg, N. F. M. (1991). A methodological comparison of the structures of scientific research and engineering design: their similarities and differences. *Design Studies, 12*(4), 197-203. doi:10.1016/0142-694X(91)90031-Q

Einhorn, H. J., & Hogarth, R. M. (1978). Confidence in judgment: Persistence of the illusion of validity. *Psychological Review, 85*(5), 395-416. doi:10.1037/0033-295X.85.5.395

Einhorn, H. J., & Hogarth, R. M. (1981). Behavioral Decision Theory: Process of Judgment and Choice. *Annual Review Psychology, 32*, 53-88. doi:10.1146/annurev.ps.32.020181.000413

Ellis, R. D., & Kurniawan, S. H. (2000). Increasing the usability of online information for older users: A case study in participatory design. *International Journal of Human Computer Interaction*, *12*(2), 263 – 276. doi**:** 10.1207/S15327590IJHC1202_6

Elrod, T., Johnson, R. D., & White, J. (2004). A new integrated model on noncompensatory and compensatory decision strategies. *Organizational Behavior and Human Decision Processes, 95*(1), 1 – 19.

Engel, J. F., Blackwell, R. D., & Miniard, P. W. (1995). *Consumer behavior* (8th ed). Chicago: The Dryden Press.

Eshlaghy, A. T., & Radfar, R. (2006). A new approach for classification of weighting methods. In Chai, K. H., Hang, C. C., & Xie, M. (Eds.), *Proceedings of the 2006 IEEE International Conference on Management of Innovation and Technology held on 21-23 June 2006 at the National University of Singapore, Singapore* (pp. 1090-1093). Singapore: IEEE.

Etti, B., Brockett, P. L., & Kahane, Y. (n.d). *Risk Management for Enterprises and Individuals*. Retrieved September 18, 2010, from http://www.flatworldknowledge.com/pub/1.0/risk-management-enterprises-an/29723#web-29719

Figueira, J., Greco, S., & Ehrgott, M. (2004). *Multiple Criteria Decision Analysis: State of the Art Surveys*. New York, NY: Springer.

Fischer, G. (2003). Meta-Design: Beyond User-centered and Participatory Design. In Jacko, J., & Stephanidis, C. (Eds.), *Proceedings of the 2003 International Conference of Human Computer Interaction held on 22-27 June2003 in Crete, Greece* (pp. 88-92). Mahwah: Lawrence Erlbaum.

Fishburn, P. C. (1970). *Decision Making: Utility Theory.* New York, NY: John Wiley & Sons.

Fletcher, J. D., & Johnston, R. (2002). Effectiveness and Cost Benefits of Computer-based Decision Aids for Equipment Maintenance. *Computers in Human Behavior, 18*(6), 717-728. doi:10.1016/S0747-5632(02)00026-2

Folch-Lyon, E., & Trost, J. F. (1981). Conducting Focus Group Sessions. *Studies in Family Planning, 12*(12), 443 – 449. Retrieved from http://www.jstor.org/stable/1965656

Fülöp, J. (2005). *Introduction to Decision Making Methods* [Workshop handouts]. Olympia, WA: The Evergreen State College.

Fuerst, W. L., & Martin, M. P. (1984). Effective Design and Use of Computer Decision Models. *MIS Quarterly, 8*(1), 17-26. Retrieved from http://www.jstor.org/stable/249241

Gaines, B. (1981). The technology of interaction-dialogue programming rules. *International Journal of Man-Machine Studies, 14*(1), 133-150. doi:10.1016/S0020-7373(81)80037-5

Galitz, W. O. (1985). *Handbook of Screen Format Design (2nd edition)*. Wellesley, MA: QED Information Sciences, Inc.

Gati, I., Gadassi, R., & Shemesh, N. (2006). The Predictive Validity of a Computer-Assisted Career Decision Making System: A Six Year Follow Up. *Journal of Vocational Behavior, 68*(2), 205-219. doi:10.1016/j.jvb.2005.08.002

Gerlach, J. H., & Feng-Yang, K. (1991). Understanding human–computer interaction for information systems design. *MIS Quarterly, 15*(4), 527–548. Retrieved from http://aisel.aisnet.org/misq/vol15/iss4/6/

Germeijs, V., & De Boeck, P. (2003). Career indecision: Three factors from decision theory. *Journal of Vocational Behavior, 62*(1), 11-25.

GICSoft Application Development Group (2006). *GICSoft Application Development Process*. Retrieved March 9, 2010, from http://www.gicsoft.com/development/about_process.asp

Gigerenzer, G. (2000). *Adaptive thinking: rationality in the real world*. New York: Oxford University Press.

Gigerenzer, G., & Goldstein, D. (1996). Reasoning the fast and frugal way: models of bounded rationality. *Psychological Review, 103*(4), 650–669.

Gilbride, T. J., & Allenby, G. M. (2004). A Choice Model with Conjunctive, Disjunctive and Compensatory Screening Rules. *Marketing Science, 23*(3), 391-406. doi:10.1287/mksc.1030.0032

Girod, M., Elliot, A. C., Wright, I. C., & Burns, N. D. (2000a). Activities in collaborative concept selection processes for engineering design. *Proceedings of the ASME-*DETC2000 *Conference on Design Theory and Methodology, Baltimore, MD,* DETC2000 /DTM-14548.

Girod, M., Elliot, A. C., Wright, I. C., & Burns, N. D. (2000b). A Descriptive Model of Collaborative Concept Selection Process in Engineering Design. *Proceedings of the International Conference on Concurrent Engineering: Advances in Concurrent Engineering, Lyon, France*, 494-503.

Goodman, B., Fischhoff, B., Lichtenstein, S., & Slovic, P. (1978). *The training of decision makers* (ARI Technical Report TR-78-B3). Retrieved from DTIC Online Information for the Defense Community website: http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA077990

Greenbaum, J., & Kyng, M. (1991). *Design at work: Cooperative design of computer systems*. Hillsdale, NJ: Erlbaum.

Gregory, G. (1988). *Decision Making*. New York, NY: Plenum Press.

Hair, Jr., J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis* (6th ed). USA: Pearson-Prentice Hall.

Halpin, H., Moore, J. D., & Robertson, J. (2004). Towards Automated Story Analysis Using Participatory Design. In *Proceedings of the 1st ACM Workshop on Story Representation, Mechanism and Context* (pp. 75-83). New York, NY: ACM Press.

Hammond, J. S., Keeney, R. L., & Raiffa, H. (1999). *Smart choices: A practical guide to making better decisions*. Cambridge, MA: Harvard Business Press.

Hansson, S. O. (1994). *Decision Theory: A Brief Introduction* [Course handout]. Retrieved from Royal Institute of Technology website: http://home.abe.kth.se/~soh/decisiontheory.pdf

Harris, R. (1998a). *Decision Making Techniques*. Retrieved August 2, 2010, from http://www.virtualsalt.com/crebook6.htm

Harris, R. (1998b). *Introduction to Decision Making*. Retrieved April 4, 2009, from http://www.virtualsalt.com/crebook5.htm

Häubl, G., & Trifts, V. (2000). Consumer Decision Making in Online Shopping Environments: The Effects of Interactive Decision Aids. *Marketing Science, 19*(1), 4-21. doi:10.1287/mksc.19.1.4.15178

Hayes, C. C., & Akhavi, F. (2008). Creating Effective Decision Aids for Complex Tasks. *Journal of Usability Studies, 3*(4), 152-172.

Heikkinen, M. T., & Still, J. (2005). Business Networks and New Mobile Service Development. In *Proceedings of the 4th International Conference on Mobile Business* (pp. 144-151). Washington, DC: IEEE Computer Society.

Henderson, J., & Ingraham, R. (1982). Prototyping for DSS: A Critical Appraisal. In Ginzberg, et al. (Eds.), *Decision Support Systems* (pp. 79-96). New York, NY: North-Holland.

Hess, M. (n.d.). Quick, Quality Decision-Making Using Six Sigma Tools. Retrieved July 14, 2010, from http://www.isixsigma.com/index.php?option=com_k2&view=item&id=547&Itemid=1&Itemid=1

Hevner, A. R., March, S. T., & Park, J. (2004). Design Research in Information Systems Research. *MIS Quarterly*, *28*(1), 75-105. Retrieved from http://aisel.aisnet.org/misq/vol28/iss1/6/

Heyes, I. S. (2002). *Just Enough Wireless Computing*. Upper Saddle River, NI: Prentice Hall.

Hoffman, P. J. (1960). The paramorphic representation of clinical judgment. *Psychological Bulletin, 57*, 116-131.

Hogarth, R. M. (1987). *Judgment and Choice*. New York, NY: Wiley.

Holtzblatt, K., & Jones, S. (1993). Contextual Inquiry: A Participatory Technique for System Design. In Schuler, D., & Namioka, A. (Eds.), *Participatory design: principles and practices* (pp. 177-210). Hillsdale, NJ: Lawrence Earlbaum.

Houghton, R. C. (1983). Online help systems: a conspectus. *Communications of the ACM, 27*(2), 126-133. doi:10.1145/69610.357985

Humphreys, P. C. (1977). Applications of multi-attribute utility theory. In Jungermann, H., & de Zeeuw, G. (Eds.), *Decision Making and Change in Human Affairs* (pp. 165-208). Amsterdam, Holland: Dordrecht-Reidel.

Hung, J. S. (2003). *The Effect of Expertise on Consumers' Satisfaction with the Use of a Decision Aid* (Doctoral dissertation). Available from Purdue University dissertations database. (UMI No. AAI3124229)

Işıklar, G., & Büyüközkan, G. (2007). Using a multi-criteria decision making approach to evaluate mobile phone alternatives. *Journal Computer Standards & Interfaces, 29*(2), 265-274. doi:10.1016/j.csi.2006.05.002

Iyengar, S. S., & Lepper, M. R. (2000). When Choice is Demotivating: Can One Desire Too Much of a Good Thing? *Journal of Personality and Social Psychology, 79*(6), 995-1006.

Janis, I. L., & Mann, L. (1977). *Decision Making*. New York, NY: The Free Press.

Janousek, S. (2007). *The Art and Zen of Mobile Game Creation with Flash*. Retrieved March 8, 2010, from http://www.slideshare.net/scottjanousek/fitc-2007-the-art-and-zen-of-mobile-game-creation-with-flash/

Jean-Pierre, B., & Mareschal, B. (1992). *How to Decide with PROMETHEE*. Retrieved April 17, 2010, from http://homepages.ulb.ac.be/~bmaresc/PromWeb.htm

Jiang, J. J., & Klein, G. (2000). Side effects of decision guidance in decision support systems. *Interacting with Computer, 12*(5), 469-481. doi:10.1016/S0953-5438(99)00018-1

Johnson, E., & Payne, J. (1985). Effort and Accuracy in Choice. *Management Science, 31*(4), 395-415. Retrieved from http://www.jstor.org/stable/2631455

Johnson, E. J., Payne, J. W., & Bettman, J. R. (1988). Information displays and preference reversals. *Organizational Behavior and Human Decision Processes, 42*, 1-21.

Johnson, J., & Henderson, A. (2002). Conceptual models: Begin by designing what to design. *Interactions, 9*(1), 25-32. doi:10.1145/503355.503366

Jungermann, H. (1980). Speculations about Decision Theoretic Aids for Personal Decision Making. *Acta Psychologica, 45*(1-3), 7-34. doi:10.1016/0001-6918(80)90019-0

Kaliszewski, I. (2006). *Soft Computing for Complex Multiple Criteria Decision Making*. Berlin: Springer-Verlag.

Karam, G. M., & Casselman, R. S. (1993). A Cataloging Framework for Software Development Methods. *Computer, 26*(2), 34-45. doi:10.1109/2.191987

Keen P. G. W. (1980). Adaptive Design for DSS. *Database, 12*(1-2), 15-25. doi:10.1145/1017672.1017659

Keen, P. G. W. (1981). *Decision Support Systems: A Research Perspective/Decision Support Systems: Issues and Challenges*. Oxford: Pergamon Press.

Keeney, R. L., & Raiffa, H. (1976). *Decisions with Multiple Objectives: Performances and Value Trade-Offs*. New York, NY: Wiley.

Kientz, J. A., Pate, S. N., Tyebkhan, A. Z., Gane, B., Wiley, J., & Abowd, G. D. (2006). Where's My Stuff? Design and Evaluation of Mobile System for Locating Lost Items for the Visually Impaired. In *Proceedings of the 8th International ACM SIGACCESS Conference on Computer and Accessibility* (pp. 103-110). New York, NY: ACM Press.

Kitzinger, J. (1995). Qualitative research: Introducing focus groups. *British Medical Journal, 311*(7000), 299-302.

Kleinmuntz, D. N., & Schkade, D. A. (1993). Information displays and decision processes. *Psychological Science, 4*(4), 221-227.

Kmett, C. M., Arkes, H. R., & Jones, S. K. (1999). The Influence of Decision Aids on High School Students' Satisfaction with their College Choice Decision. *Personality and Social Psychology Bulletin, 25*(10), 1293-1301. doi:10.1177/0146167299258010

Kmietowicz, Z. W., & Pearman, A. D. (1981). *Decision theory and incomplete knowledge*. Aldershort, Hampshire: Gower.

Kottemann, J. E. (1994). Computer-Assisted Decision Making: Performance, Beliefs and the Illusion of Control. *Organizational Behavior and Human Decision Processes, 57*(1), 26-37.

Kowalski-Trakofler, K. M., Vaught, C., & Scharf, T. (2003). Judgment and decision making under stress: an overview for emergency managers. *International Journal of Emergency Management 2003, 1*(3), 278-289. doi:10.1504/IJEM.2003.003297

Krause, P. J., Byres, P. J., & Hajnal, S. (1994). Formal specification and decision support. *Decision Support Systems, 12*(3), 189–197. doi:10.1016/0167-9236(94)90003-5

Ku, A. (2003). The decision of indecision and other dilemmas. *Le Bon Journal, 2*(4), 1-2.

Kuniavsky, M. (2003). *Observing the User Experience.* San Francisco, CA: Morgan Kaufmann.

Law, W. S. (1996). *Evaluating imprecision in engineering design* (Doctoral dissertation). Available from CaltechTHESIS database. (UMI No. 3132).

Li, J., & Busemeyer, J. R. (2009). Combine the Objective Features with the Subjective Feelings in Personal Multi-alternative Decision Making Modeling. In Zhong, N., Li, K., Lu, S., & Chen, L. (Eds.), *Proceedings of the 2009 International Conference on Brain Informatics* (pp. 194-202). Heidelberg: Springer-Verlag Berlin.

Linkov, I., Varghese, A., Jamil, S., Seager, T. P., Kiker, G. A., & Bridges, T. S. (2004). Multi-criteria decision analysis: Framework for applications in remedial planning for contaminated sites. In Linkov, I., & Ramadan, A. (Eds.), *Comparative risk assessment and environmental decision making* (pp. 15-54). Amsterdam, Netherlands: Kluwer.

Liu, M. T. (n.d.). *Hi-Tech Mobile Phone Adoption Intentions: An Empirical Study in China* (335-1604-1-DR). Retrieved Jan 13, 2011, from Academics-Paper website: http://academic-papers.org/ocs2/session/Papers/G4/335-1604-1-DR.doc

MacMillan, D. (2010, Oct. 21). Tech Companies See Dearth of Mobile-Software Developers. *Bloomberg Businessweek*. Retrieved December 15, 2010, from http://www.businessweek.com/technology/content/oct2010/tc20101020_639668.htm

Madsen, M., & Gregor, S. (2000). Measuring human-computer trust. In *Proceedings of the 11th Australasian Conference on Information Systems* (p. 53). Brisbane, Australia: ACIS Press.

Maes, P. (1995). Intelligent Software. *Scientific American, 273*(3), 84-86.

Maes, P., Guttman, R. H., & Moukas, A. G. (1999). Agents that Buy and Sell. *Communications of the ACM, 42*(3), 81-91. doi:10.1145/295685.295716

March, J. G. (1978). Bounded rationality, ambiguity, and the engineering of choice. *Bell Journal of Economics, 9*, 587-608.

March, S. T., & Smith, G. F. (1995). Design and natural science research on information technology. *Decision Support Systems*, *15*, 251-266. doi:10.1016/0167-9236(94)00041-2

Mascha, M. F., & Smedley, G. A. (2001). Can Computerized Decision Aids Do "Damage"? The Case for Tailoring Feedback and Task Based on Pre-Existing Knowledge. *International Journal of Accounting Information Systems, 8*, 73-91.

Mascitelli, R. (2004). *The Lean Design Guidebook: Everything Your Product Development Team Needs to Slash Manufacturing Cost*. Woodside, CA: Technology Perspectives.

Mashable.com (2009a). *Hunch: Flckr Founder to Turn Indecision into Profits*. Retrieved April 16, 2010, from http://mashable.com/2009/03/28/hunch/

Mashable.com (2009b). *Hand Off Life's Big Decisions to Science; Let Simon Decide*. Retrieved April 16, 2010, from http://mashable.com/2009/05/06/let-simon-decide/

Massimi, M., & Baecker, R. (2006). *Participatory Design Process with Older Users* (Research report).Toronto, ON: University of Toronto, Department of Computer Science.

Mayhew, D. J. (1992). *Principles and guidelines in software user interface design*. Englewood Cliffs, NJ: Prentice Hall.

McGuire, R. (2002). Decision Making. *The Pharmaceutical Journal, 269*(7222), 647-649.

MindTools.com (2010). *Cost/Benefit Analysis: Evaluating Quantitatively Whether to Follow a Course of Action*. Retrieved June 16, 2010, from http://www.mindtools.com/pages/article/newTED_08.htm

Mintz, A., Redd, S. B., & Vedlitz, A. (2006). Can We Generalize from Student Experiments to the Real World in Political Science, Military Affairs, and International Relations? The Journal of Conflict Resolution, 50(5), 757-776. Retrieved from http://www.jstor.org/pss/27638520

Moldafsky, N. I., & Kwon, I. (1994). Attributes affecting computer-aided decision making – a literature survey. *Computers in Human Behavior, 10*(3), 299-323.

Molenaar, S., Sprangers, M., Postma-Schuit, F., Rutgers, E., Noorlander, J., Hendriks, J., & de Haes, H. (2000). Feasibility and effects of decision aids: A Review of the Literature. *Medical Decision Making, 20*(1), 112-127. doi:10.1177/0272989X0002000114

Montazemi, A. R., Wang, F., Khalid Nainar, S. M., & Bart, C. K. (1996). On the effectiveness of decisional guidance. *Decision Support Systems, 18*(2), 181-198. doi:10.1016/0167-9236(96)00038-3

Montgomery, H. (1989). From cognition to action: The search for dominance in decision making. In Montgomery, H., & Svenson, O. (Eds.), *Process and structure in human decision making* (pp. 23-49). Chichester, UK: John Wiley & Sons.

Moraveji, N., Li, J., Ding, J., O'Kelley, P., & Woolf, S. (2007). Comicboarding: using comics as proxies for participatory design with children. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1371-1374). New York, NY: ACM Press.

Morgan, D. L. (1996). Focus Groups. *Annual Review of Sociology, 22,* 129-152.

Muller, M. J. (1991a). PICTIVE – An Exploration in Participatory Design. In *Reaching Through Technology: Proceedings of SIGCHI Conference on Human Factors in Computing Systems* (pp. 225-231). New York, NY: ACM Press.

Muller, M. J. (1991b, May). *Participatory design: Practical stories and stories of practice*. Workshop presented at Proceedings of SIGCHI Conference on Human Factors in Computing Systems, New Orleans, LA.

Muller, M. J., & Kuhn, S. (1993). Participatory Design. *Communications of the ACM: Special Issues on Graphical User Interfaces*, *36*(6), 24-28. doi:10.1145/153571.255960

Muller, M. J., Kuhn, S., & Meskill, J. A. (1992). PDC'92: Conference on Participatory Design. In *Proceedings of the Participatory Design Conference*. Palo Alto, CA: Computer Professionals for Social Responsibility.

Muller, M. J., Wildman, D. M., & White, E. A. (1992, April). *Taxonomy of participatory design practices.* Poster session presented at CHI'92 Conference Companion on Human Factors in Computing Systems, Monterey, CA.

Muller, M. J., Wildman, D. M., & White, E. A. (1993). Taxonomy of PD Practices: A Brief Practitioner's Guide. *Communications of the ACM, 36*(6), 26-27.

Muller, M. J., Wildman, D. M., & White, E. A. (1994). Participatory design through games and other group exercises. In *Proceedings of CHI'94 Conference Companion on Human Factors in Computing Systems* (pp. 411-412). New York, NY: ACM Press.

Mullur. A. A., Mattson, C. A., & Messac, A. (2003). New Decision Matrix Based Approach for Concept Selection Using Linear Physical Programming. In *44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics, and Materials Conference* (pp. AIAA 2003-1446). Norfolk, Virginia: AIAA Publisher.

Munda, G. (1996). Cost-Benefit Analysis in Integrated Environmental Assessment: Some Methodological Issues. *Ecological Economics, 19*(2), 157-168. doi:10.1016/0921-8009(96)00048-1

Namioka, A., & Schuler, D. (1990). PDC '90: Conference on participatory design. In *Proceedings of the Participatory Design Conference*. Seattle, WA: Computer Professionals for Social Responsibility.

Naude, P., Lockett, G., & Holmes, K. (1997). A Case Study of Strategic Engineering Decision Making Using Judgmental Modeling and Psychological Profiling. *IEEE Transactions on Engineering Management, 44*(3), 237-247. doi:10.1109/17.618075

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

Newell, B. R., Lagnado, D. A., & Shanks, D. R. (2007). *Straight Choices: The psychology of decision making*. New York, NY: Psychology Press.

Newell, B. R., & Shanks, D. R. (2003). Take the best or look at the rest? Factors influencing "one-reason" decision making. *Journal of Experimental Psychology: Learning, Memory,and Cognition, 29*(1), 53–65.

Newell, B. R., Weston, N. J., & Shanks, D. R. (2003). Empirical tests of a fast-and-frugal heuristic: Not everyone "takes-the-best". *Organizational Behavior and Human Decision Processes, 91*(1), 82–96. doi:10.1016/S0749-5978(02)00525-3

Nielsen, J. (n.d.). *Ten Usability Heuristics*. Retrieved September 12, 2007, from http://www.useit.com/papers/heuristic/heuristic_list.html

Nielsen, J. (1997). The Use and Misuse of Focus Groups. *IEEE Software, 14*(1), 94-95. doi:10.1109/52.566434

Norman, D. (2004). *Ad-Hoc Personas & Empathetic Focus.* Retrieved July 16, 2011, from http://www.jnd.org/dn.mss/ad-hoc_personas_empathetic_focus.html

Noro, K., & Imada, A. S. (1991). *Participatory Ergonomics.* London: Taylor and Francis.

Norshuhada, S., & Shahizan, H. (2010). *Design Research in Software Development: Constructing and Linking Research Questions, Objectives, Methods and Outcomes*. Sintok: Penerbit Universiti Utara Malaysia.

O'Connor, A. M., & Jacobsen, M. J. (2003). *Decisional Conflict: Assessing and Supporting Patients Experiencing Uncertainty About Choices Affecting their Health* [Course handout]. Ottawa, ON: University of Ottawa, School of Nursing.

O'Keefe, R. M. & McEachern, T. (1998). Web-based Customer Decision Support Systems. *Communications of the ACM, 41*(3), 71-78. doi:10.1145/272287.272300

Offermann, P., Levina, O., Schönherr, M., & Bub, U. (2009). Outline of a Design Science Research Process. In *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology* (Article no. 7). New York, NY: ACM Press.

Oppenheim, A. N. (1983). *Questionnaires design and attitude measurement*. London: Biddles Ltd.

Otterbacher, J. (2009). "Helpfulness" in Online Communities: A Measure of Message Quality. In *Proceedings of the 27th International Conference on Human Factors in Computing Systems* (pp. 955-964). New York, NY: ACM Press.

Oz, E. (2002). *Management Information System* (3rd ed). New York, NY: Course Technology.

Pastor Urban, J. L., & Whiddett, R. J. (1996). The relationship between systems development methodologies and organizational demographics: A survey of New Zealand organizations. In *Proceedings of the 1996 Information Systems Conference of New Zealand* (p. 179). Washington, DC: IEEE Computer Society.

Payne, J. W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. *Organizational Behavior and Human Performance, 16*(2), 366-387. doi:10.1016/0030-5073(76)90022-2

Payne, J. W. (1982). Contingent decision behavior. *Psychological Bulletin, 92*(2), 382 – 402. doi:10.1037/0033-2909.92.2.382

Payne, J. W., & Bettman, J. R. (2002). Choice Selection. In Nadel, L. (Ed.), *The Encyclopedia of Cognitive Science* (p. 500). Michigan: Nature Publishing Group.

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1988). Adaptive strategy selection in decision making. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *14*(3), 534-552. doi:10.1037/0278-7393.14.3.534

Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). *The adaptive decision maker*. Cambridge: Cambridge University Press.

Payne, J. W., Bettman, J. R., Johnson, E. J., & Coupey, E. (1990). Understanding contingent choice: a computer simulation approach. *IEEE Transactions on Systems, Man and Cybernetics, 20*(2), 296-309. doi:10.1109/21.52541

Payne, J. W., Bettman, J. R., & Luce, M. F. (1996). When time is money: decision behavior under opportunity-cost time pressure. *Organizational Behavior and Human Decision Processes*, *66*(2), 131–152. doi:10.1006/obhd.1996.0044

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2008). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, *24*(3), 45-77.

Peters, C. O., Bradbard, D. A., & Martin, M. C. (2005). Customer Decision Support Systems: Resources for Student Decision Making. *The Journal of Educators Online, 2*(2).

Power, D. J. (1998). *Designing and Developing a Computerized Decision Aid - A Case Study*. Retrieved June 16, 2009, from http://dssresources.com/papers/decisionaids.html

Power, D. J. (2002). *What is an example of a decision process?* Retrieved June 16, 2009, from http://dssresources.com/faq/index.php?action=artikel&id=20

Power, D. J. (2005). *What is an example of a decision process?* Retrieved June 16, 2009, from http://dssresources.com/faq/index.php?action=artikel&id=20

Power, D. J. (2006). *Are computerized decision aids decision support systems?* Retrieved June 16, 2009, from http://dssresources.com/faq/index.php?action=artikel&id=154

Power, D. J., & Sharda, R. (2007). Model-driven decision support systems: Concepts and research directions. *Decision Support Systems, 43*(3), 1044-1061. doi:10.1016/j.dss.2005.05.030

Preece, J., Rogers, Y., & Sharp, H. (2007). *Interaction Design: Beyond human-computer interaction* (2nd ed). England: John Wiley & Sons.

Pugh, S. (1990). *Total Design*. Reading, MA: Addison-Wesley.

Quek, A., & Shah, H. (2004). A Comparative Survey of Activity-based Methods for Information Systems Development. *Proceedings of the 6th International Conference on Enterprise Information Systems, Portugal, 5,* 221-232.

Rahul (2010, October 24). Demand for mobile software developers and designers to increase. [Web log post]. Retrieved from http://onlysoftwareblog.com/2010/10/demand-for-mobile-software-developers-and-designers-to-increase/

Ramsey, H., & Atwood, N. E. (1979). *Human Factors in Computer Systems: A Review of the Literature* (Technical report SAI-79-111-DEN). Englewood, CO: Science Applications.

Ratner, R. K., & Herbst, K. C. (2005). When good decisions have bad outcomes: The impact of affect on switching behavior. *Organizational Behavior and Human Decision Processes, 96*(1), 23-37. doi:10.1016/j.obhdp.2004.09.003

Reason, J. T. (1990). *Human Error*. Cambridge: Cambridge University Press.

Rhee, C., & Rao, H. R. (2008). Chapter 51: Evaluation of Decision Support Systems. In Burstein, F., & Holsapple, C. W. (Eds.), *Handbook on Decision Support Systems 2: Variations* (pp. 313-327). New York, NY: Springer.

Ricci, F., & Wietsma, R. T. A. (2006). Product Reviews in Travel Decision Making, Information and Communication Technologies in Tourism 2006. In *Proceedings of the International Conference Lausanne, Switzerland* (pp. 296-307). Wien, Austria: Springer-Verlag.

Rich, P. (1999). *A Process for Effective Decision Making*. Retrieved April 5, 2009, from http://www.selfhelpmagazine.com/article/decision-making

Rieskamp, J., & Hoffrage, U. (1999). When do people use simple heuristics, and how can we tell? In Gigerenzer, G., Todd, P. M., & ABC Research Group, *Simple heuristics that make us smart* (pp. 141–167). New York, NY: Oxford University Press.

Rieskamp, J., Busemeyer, J. R., & Mellers, B. A. (2006). Extending the Bounds of Rationality: Evidence and Theories of Preferential Choice. *Journal of Economic Literature, 44*(3), 631-661.

Robertson, S. P., Olson, G. M., & Olson, J. S. (1991). CHI'91: Reaching Through Technology. In *Proceedings of Conference on Human Factors in Computing* Systems. New York, NY: ACM Press.

Roe, R. M., Busemeyer, J. R., & Townsend, J. T. (1999). *Multi-alternative Decision Field Theory: A Dynamic Artificial Neural Network Model of Decision Making* (Technical report #232). Bloomington, IN: Indiana University, Department of Psychology.

Roscoe, J. T. (1975). *Fundamental research statistics for the behavioral sciences*. New York, NY: Holt, Rinehart and Winston.

Rose, J. M., Rose, A. M., & McKay, B. (2007). Measurement of Knowledge Structures Acquired Through Instruction, Experience and Decision Aid Use. *International Journal of Accounting Information Systems, 8*(2), 117-137. doi:10.1016/j.accinf.2007.04.002

Ruland, C. M., Starren, J., & Vatne, T. M. (2008). Participatory design with children in the development of a support system for patient-centered care in pediatric oncology. *Journal of Biomedical Informatics, 41*(4), 624-635. doi:10.1016/j.jbi.2007.10.004

Russo, J. E., & Dosher, B. A. (1983). Strategies for multiattribute binary choice. *Journal of Experimental Psychology: Learning, Memory and Cognition, 9*(4), 676-696. doi:10.1037/0278-7393.9.4.676

Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Scandinavian Journal of Forest Research, 15*(3), 234-281. doi:10.1016/0022-2496(77)90033-5

Sanoff, H. (2006). Multiple Views of Participatory Design. *METU Journal of the Faculty of Architecture, 23*(2), 131-143.

Santos, J. V. R., Castaneda, C. C., & Bullon, P. (2008). Development of a Computer Application to help in the Decision Making Process in Teaching Dentistry. *Medicina Oral, Patologia Oral y Cirugia Bucal*, *13*(1), 65-70.

Savage, L. J. (1954). *The Foundations of Statistics*. New York, NY: John Wiley.

Schuler, D., & Namioka, A. (1993). *Participatory design: Principles and Practices*. Hillsdale, NJ: Erlbaum.

Schwaiger, W., Haid, E., & Bortenschlager, M. (2008). *A Rapid Prototyping Software Framework for Early Acceptance Testing of Mobile Applications*. Retrieved March 10, 2010, from http://www.salzburgresearch.at/research/gfx/E4TSoftwareFrameworkWSchwaiger.pdf

Sekaran, U. (1992). *Research methods for business: a skill-building approach* (2nd ed). USA: John Wiley & Sons.

Sekaran, U., & Bougie, R. (2010). *Research Methods for Business: A Skill Building* Approach (5th ed). USA: John Wiley & Sons.

Sharda, R., Barr, S. H., & McDonnell, J. (1988). Decision Support System Effectiveness: A Review and Empirical Test. *Management Science, 34*(2), 139-159. doi:10.1287/mnsc.34.2.139

Shiloh, S., Koren, S., & Zakay, D. (2001). Individual differences in compensatory decision making style and need for closure as correlates of subjective decision complexity and difficulty. *Personality and Individual Differences, 30*(4), 699-710. doi:10.1016/S0191-8869(00)00073-8

Schneiderman, B. (1992). *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Reading, MA: Addison-Wesley Longman.

Shugan, S. (1979). The Cost of Thinking. *Journal of Consumer Research, 7*, 99-111.

Silver, M. S. (1991). Decisional Guidance for Computer-Based Decision Support. *MIS Quarterly, 15*(1), 105-122. doi:10.2307/249441

Simon, H. (1965). *Administrative behavior* (2nd ed). New York, NY: Free Press.

Simon, H. A., Dantzig, G. B., Hogarth, R., Piott, C. R., Raiffa, H., Schelling, … Winter, S. (1986). *Report of the Research Briefing Panel on Decision Making and Problem Solving*. Washington, DC: National Academy Press.

Sprague, Jr. R. H. (1980). A Framework for the Development of Decision Support Systems. *Management Information Systems Quarterly, 4*(4), 1-26. Retrieved from http://www.jstor.org/pss/248957

Sprague, Jr. R. H., & Carlson, E. D. (1982). *Building Effective Decision Support Systems*. Englewood Cliffs, NJ: Prentice-Hall.

Stokes, J. R., & Harper, J. K. (2008). An Excel-Based Decision Aid for Evaluating Financing Alternatives and the Marginal Cost of Capital. *Agricultural Finance Review, 68*(2), 339-348. doi:10.1108/00214660880001234

STRATpoint Technologies (n.d). *Software Development Life Cycle (Development & Product Testing)*. Retrieved Jan 11, 2008, from http://ww.stratpoint.com/content/software-development-lifecycle

Suchman, L. (1988). Designing with the user: book review of “Computers and Democracy: a Scandinavian challenge". *ACM Transactions on Information Systems, 6*(2), 173-183. doi:10.1145/45941.383895

Syamsuddin, I., & Hwang, J. (2009). The Application of AHP to Evaluate Information Security Policy Decision Making. Int*ernational Journal of Simulation, Systems, Science and Technology, 10*(5), 33-37. Retrieved from http://ijssst.info/Vol-10/No-5/paper5.pdf

Takai, S., & Ishii, K. (2004). Modifying Pugh’s Design Concept Evaluation Methods. In *Proceedings of 2004 ASME Design Engineering Technical Conferences* (DETC2004-57512). Salt Lake City, Utah: American Society of Mechanical Engineers.

Talin (1998). *A Summary of Principles for User-Interface Design*. Retrieved September 11, 2007, from http://www.sylvantech.com/~talin/projects/ui_design.html

Tarng, M. Y., & Chen, H. M. (1989). Decision processes and information. *Journal of Information Science*, *15*(6), 355-359.

Timmermans, D. (1993). The Impact of task complexity on information use in multi-attribute decision making. *Journal of Behavioral Decision Making*, *6*(2), 95-111. doi:10.1002/bdm.3960060203

Todd, P., & Benbasat, I. (1991). An Experimental Investigation of the Impact of Computer Based Decision Aids on Decision Making Strategies. *Information Systems Research, 2*(2), 87-115. doi: 10.1287/isre.2.2.87

Todd, P., & Benbasat, I. (1992). The use of information in decision making: An Experimental Investigation of the Impact of Computer-based Decision Aids. *MIS Quarterly*, *16*(3), 373-393. Retrieved from http://aisel.aisnet.org/misq/vol16/iss3/6/

Todd, P., & Benbasat, I. (1994). The influence of decision aids on choice strategies: An experimental analysis of the role of cognitive effort. *Organizational Behavior and Human Decision Processes, 60*(1), 36-74. doi:10.1006/obhd.1994.1074

Touil, G., & Ahmed-Nacer, M. (2006). An approach for selecting Software Development Methodology. In Cheng, A. M. K. (Ed.), *Proceedings of the Conference of Software Engineering and Applications* (Track 514-126). Dallas, TX: ACTA Press.

Triantaphyllou, E. (2000). *Multi-criteria Decision Making Methodologies: A Comparative Study* (Applied Optimization, Volume 44). Dordrecht: Kluwer Academic.

Triantaphyllou, E., & Mann, S. H. (1995). Using the Analytic Hierarchy process for decision making in engineering applications: some challenges. *International Journal of Industrial Engineering: Applications and Practice, 2*(1), 35-44.

Trochim, W. (2006). *Probability Sampling: Simple Random Sampling*. Retrieved October 28, 2010, from http://www.socialresearchmethods.net/kb/sampprob.php

Trochim, W., & Donnelly, J. P. (2007). *The Research Methods Knowledge Base*. Ohio, OH: Atomic Dog.

Tsoukiàs, A. (2008). From decision theory to decision aiding methodology. *European Journal of Operational Research*, *187*(1), 138-161.

Turban, E. (1995). *Decision support and expert systems: Management support systems* (4th ed). Upper Saddle River, NJ: Prentice-Hall.

Turnbull, P. W., Leek, S., & Ying, G. (2000). Customer Confusion: The Mobile Phone Market. *Journal of Marketing Management*, *16*, 143-163. doi:10.1362/026725700785100523

Turner, J., & Kraut, R. (1992). Sharing perspectives. In *Proceedings of the Conference on Computer-supported Cooperative Work: Sharing Perspectives* (pp. 67-74). New York, NY: ACM Press.

Tversky, A. (1972). Elimination by aspects: A theory of choice. *Psychological Review*, *79*(4), 281–299.

Tversky, A. (2004). Elimination by Aspects: A Theory of Choice. In Shafir, E. (Ed.), *Preference, belief and similarity: selected writings* (pp. 463-490). USA: MIT Press.

Ullman, D. G. (2006). *Decision Making for TRIZ*. Retrieved September 16, 2009, from www.triz-journal.com/archives/2006/02/08.pdf

Ullman, D. G. (2002). *The Ideal Engineering Decision Support System*. Retrieved March 10, 2009, from http://www.robustdecisions.com/theidealenginsyste1.pdf

US EPA (2010). *Guidelines for Preparing Economic Analyses.* United States Environmental Protection Agency (EPA). Retrieved December 12, 2010, http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/Guidelines.html

Vaishnavi, V., & Kuechler, W. (2004). *Design Research in Information Systems*. Retrieved August 16, 2009, from Association for Information Systems website: http://desrist.org/design-research-in-information-systems

Vincke, P. (1992). *Multi-criteria Decision Aid*. Chichester: John Wiley.

Walls, J., Widmeyer, G., & El Sawy, O. (1992). Building an Information System Design Theory for Vigilant EIS. *Information Systems Research, 3*(1), 36-59. doi:10.1287/isre.3.1.36

Walmsley, M. (2005). *Pugh Matrix: Decisions, Decisions, Decisions*. *Sixsigmafirst Group*. Retrieved August 16, 2009, from http://www.sixsigmafirst.com/PughMatrix.htm

Wang, W., & Benbasat, I. (2009). Interactive Decision Aids for Consumer Decision Making in E-Commerce: The Influence of Perceived Strategy Restrictiveness. *MIS Quarterly, 33*(2), 292-320. Retrieved from http://aisel.aisnet.org/misq/vol33/iss2/6/

Wasserman, A. I. (1983). Characteristics of Software Development Methodologies. In *Proceedings of the Conference of Information Systems Design Methodologies* (pp. 37-62). North Holland: Elsevier Science.

Weber, E. U., & Coskunoglu, O. (1990). Descriptive and prescriptive models of decision-making: implications for the development of decision aids. *IEEE Transactions on Systems, Man and Cybernetics, 20*(2), 310-317. doi:10.1109/21.52542

Whitecotton, S. M., & Butler, S. A. (1998). Influencing Decision Aid Reliance Through Involvement in Information Choice. *Behavioral Research in Accounting*, *10*, 182-206.

Widing II, R. E., & Talarzyk, W. W. (1993). Electronic Information Systems for Consumers: An Evaluation of Computer-Assisted Formats in Multiple Decision Environments. *Journal of Marketing Research*, *30*(2), 125-141. Retrieved from http://www.jstor.org/pss/3172823

Wiegers, K. E. (2002). *Seven Truths about Peer Reviews*. Retrieved November 12, 2010, from http://www.processimpact.com/articles/seven_truths.html

Wildman, D. M., White, E. A., & Muller, M. J. (1993). *Participatory design through games and other techniques*. Tutorial presented at Conference on Human Factors in Computing Systems, Amsterdam, Netherlands. Retrieved from http://portal.acm.org/ft_gateway.cfm?id=255960&type=pdf

Willemain, T. R., Wallace, W. A., Fleischmann, K. R., Waisel, L. B., & Ganaway, S. N. (2003). Bad Numbers: Coping with Flawed Decision Support. *The Journal of the Operational Research Society, 54*(9), 949-957. Retrieved from http://www.jstor.org/stable/4101635

Wooler, S. (1982). A Decision Aid for Structuring and Evaluating Career Choice Options. *Journal of Operational Research Society*, *33*(4), 343-351. Retrieved from http://www.jstor.org/stable/2581644

Wright, E., & Monk, A. (1991). A cost-effective evaluation method for use by designers. *International Journal of Man-Machine Studies, 35(*6), 891-912. doi:10.1016/S0020-7373(05)80167-1

Wright, P. (1975). Consumer choice strategies: Simplifying vs. Optimizing. *Journal of Marketing Research*, *12*(1), 60-67. Retrieved from http://www.jstor.org/pss/3150659

Yaniv, H. (2008). ThinkTeam: GDSS Methodology and Technology as a Collaborative Learning Task. In Adam, F., & Humphreys, P. (Eds.), *Encyclopedia of Decision Making and Decision Support Technologies* (pp. 872-881). USA: IGI Global.

Yakowitz, D. S., Lane, L. J., & Szidarovszky, F. (1993). Multi-Attribute Decision Making: Dominance with Respect to an Importance Order of the Attributes. *Journal Applied Mathematics and Computation*, *54*(2-3), 167-181. doi:10.1016/0096-3003(93)90057-L

Yato, A., Rodriguez, J. R., Cangur, G., Boonbutra, R., Kumte, R., & Lahagu, R. (2001). Car Purchase Decisions. In *Proceedings of the Portland International Conference on Management of Engineering and Technology, Vol. 1* (p. 126). Portland, OR: IEEE Explore.

Yin, R. K. (1994). *Case Study Research: Design and Methods* (2nd ed). Thousand Oaks: Sage.

Yin, J., & Rothrock, L. (2006). Experimentation Framework for Investigating Compensatory and Noncompensatory Decision Making. In *Proceedings of 2006 IEEE International Conference on Systems, Man and Cybernetics* (pp. 3567-3572). Taipei: IEEE Explore.

Zachary, W. (1986). A Cognitively Based Functional Taxonomy of Decision Support Techniques. *Human-Computer Interaction, 2*(1), 25-63.

Zanakis, S. H., Solomon, A., Wishart, N., & Dublish, S. (1998). Multi-attribute decision making: A simulation comparison of select methods. *European Journal of Operational Research, 107*(3), 507-529.

Zannier, C, Chiasson, M., & Maurer, F. (2007). A model of design decision making based on empirical results on interviews with software designers. *Information and Software Technology*, *49*(6), 637-653. doi:10.1016/j.infsof.2007.02.010

Zapatero, E. G., Smith, C. H., & Weistroffer, H. R. (1997). Evaluating Multi-Attribute Decision Support Systems. *Journal of Multi-Criteria Decision Analysis*, *6*(4), 201-214. doi:10.1002/(SICI)1099-1360(199707)6:4<201::AID-MCDA138>3.0.CO;2-Z

Zeleny, M. (1982). *Multiple Criteria Decision Making*. New York, NY: McGraw-Hill.

Zhou, Q., & Yuan, L. (2003). Computer-aided Course Major Decision Making Tool for Remote Students. In *Proceedings of the 2nd International Conference on Cyberworlds* (p. 404). Washington, DC: IEEE Computer Society.

Zulkarnain, Z. (2001). *Statistik pengurusan*. Sintok: Penerbit Universiti Utara Malaysia.