Preface

Knowledge of research methodologies is critical for advancing our scientific knowledge (Popper, 2002; Bhaskar, 2008). In particular, given the increasing complexity and interaction of Systems Engineering, Software Engineering (Boehm, 2000, 2006) and Information Systems disciplines (Mora et al. 2008), and the myriad of classic research methodologies and innovative hybrid or multi-methodological approaches (Glass et al. 2004; Mingers, 2000; 2001; Valerdi & Davidz, 2009), we consider that research faculty involved in such disciplines are faced with the challenge to incorporate in their research methodological repertory, a set of updated approaches (e.g., the design vs. natural research approach (March & Smith, 1995; Hevner et al. 2004), among others).

While there are excellent and multiple research books available at present, a majority of them are focused either on a single discipline, a single approach, or on statistical or qualitative procedures and techniques. Furthermore, while some integrative studies on research approaches appear in refereed journals and conference proceedings, these are scarce.

We believe that the integrative and systemic approach -used in this book with its interdisciplinary and multi-methodological research chapters- will provide an integrated source of high-quality material with rigor and relevance on research approaches for researchers in the highly interrelated disciplines of Software Systems Engineering and Information Systems. Adopting such a systemic approach from an editorial perspective, we propose that a research approach (extended from Ackoff et al. 1962; Checkland, 1983, 2000; Jackson, 1991; Gelman & Garcia, 1989)) may be used as an answering and problem-solving system comprising: (i) philosophical paradigms (P's: an ontological, epistemological and axiological stance on the world): (ii) theoretical frameworks (F's: ideas-constructs, theories, and models); (iii) methodologies (M's: methods, techniques, and instruments), and (iv) situational domains (D's: natural, artificial or social objects, artifacts and subjects under study).

Thus, this book invited authors through an open call for chapters and through special contributions, for submitting high-quality chapters which enhance our scientific knowledge on Software Systems Engineering and Information Systems. We had a very positive academic response of the scientific community interested in the theme of research paradigms and methodologies. Finally, after a rigorous peer-review process, 21 high-quality chapters were approved for their publication. These 21 chapters are grouped in three sections. The section 1 titled "Foundations de Research Methods and Paradigms" includes 8 chapters. The section 2 titled "Contemporaneous Research Methods and Techniques" includes 7 chapters, and the section 3 titled "Innovative Research Methods and Techniques" includes 6 chapters.

Section 1 -"Foundations of Research Methods and Paradigms"- present 8 chapters that address philosophy of science themes as well as particular methodological research problems (extension of classic science methods used in SwE, development of process theories, and a survey of research methods and paradigms). In chapter 1, Eileen M. Trauth and Lee B. Erickson, both in the Pennsylvania State Univer-

sity, USA, highlight the relevance that researchers in the IT field can identify the philosophical framing which they are, explicitly or implicitly, endorsing through their selected research methodologies. For this aim, the authors propose a 5-dimensional framework (on epistemology, theory, review of literature, stakeholder perspective, and rigor-relevance) for reporting several research methods. Authors concludes with the defense of being methodologically plural given that while "Methodological conservatism might be in order in some areas" ... "research that endeavors to respond to real-world problems needs to employ a variety of methodological tools".

In chapter 2, Damodar Konda, Vice President, Global Business Applications at RGIS, LLC , Michigan, USA, presents a comprehensive IS research process model which highlights rigor as well relevance. The author identifies that a trade-off situation is usually accepted in IT research circles, and that such a debate for a balance between rigor and relevance must be reached. However, author also identifies that few studies from practitioner's view have been conducted. Consequently, author elaborates a research process model -based on extant literature- but strongly focused on a praxis view, given his experience as an IT consultant. This chapter, thus contributes bringing to the IT academic arena, the voice of IT users through IT consultant.

In chapter 3, Jan H. Kroeze in the School of Computing, University of South Africa, South Africa, develops the thesis of placing Interpretivism as a legitimate Potsmodernism philosophical stance for Information Systems, in contrast to other intellectual positions where Interpretivism is considered as parallel to Postmodernism (Klein & Myers, 1999, p. 68). Once he established it, the author reviews the utilization of ontologies in the ICT domain under a Postmodernism perspective. Given that "*Postmodernism accepts a plurality of ethics and lifestyles. It rejects ontological priority and allows alternative understandings*" and *"Postmodernism is skeptic about a solid basis to differentiate between truth and falsehood. It rejects traditional authorities and grand narratives"*, Given the pluralistic and anti-foundational nature of Postmodernism, the deployment of formal ontologies is considered more of a hyper-multiple reality specification rather than a formal and unique one. The author concludes that despite such perils *"the marriage of ontology and information systems also creates interesting opportunities to humanize technology. Interpretivist research approaches will often be the vehicles used to facilitate this process."*

In chapter 4, Phillip Dobson, in Edith Cowan University, Australia, elaborates a brief but substantial review on the tenets of Bhaskar's Transcendental Realism philosophy of science – also called Critical Realism- and reports a set of methodological recommendations for its better utilization in IT research. Author reports that Transcendental Realism has been few used in this domain and that additionally its utilization is not ease. Author identifies Abduction as the main innovative logical mechanism – in contrast to Deduction and Induction as classic modes of scientific inferences, as well as other core tenets of Transcendental Realism as follows: the intransitive (e.g. the ontological layer) vs the transitive layer (e.g. the epistemological layer), the empirical, actual and real layers, and the need to compare diverse competitive models before to arrive to a plausible finding. Furthermore, author proposes to rely on Hedström and Swedberg's and Archer's morphogenetic models as methodological guidelines to apply Transcendental Realism in IT research.

In chapter 5 Luccio Biggiero in the Department of Economic Systems and Institutions in the L'Aquila University, Italy, analyzes the still -in some domains- dichotomy and confrontation of Realist and Constructivist views of what is knowledge: as an object versus as a process. Author reviews the main arguments of each intellectual position and proposes to introduce a Pragmatic philosophical stance for integrating both specifications of what is knowledge. Furthermore, given that position of knowledge as process is supported mainly by social scientists which also endorses the autopoiesis theory, the author

claims that exist several second-order cybernetics conceptual tools – like automata studies, complexity theory, artificial life, social network analysis, and researches in organizational cognition and learning – already available that becomes autopoiesis an unnecessary theory. Author concludes that "the development of IS/IT studies and the design of knowledge management systems would substantially benefit" of an accepted dual-view of knowledge.

In chapter 6, Gonzalo Génova, Juan Llorens and Jorge Morato, all of them in Universidad Carlos III de Madrid, Spain, review the general assumption on the sufficiency of using a classic scientific method (observation, hypotheses, and experimentation for not refutation/refutation of hypotheses). They suggest that such a process, while is totally sufficient for physical-alike sciences could be not so totally suitable for Software Engineering domain. The main reason is that Software Engineering (and other IT related disciplines) have systems as units of study comprising technology and humans, and they are affected by human social environments. Authors support their claims alerting on the risks of using the classic scientific method through a mechanical mode. Thus, authors elaborate the thesis and the supporting arguments to have a plurality of research methods in the Software Engineering domain.

In chapter 7, Martha García-Murillo and Ezgi Nur Gozen, in Syracuse University, USA, identify the relevance and lack of utilization of process theories in the domain of IT research. Authors consider that due to IT field "IS field is grounded in its applications to organizations, the challenge is to develop a coherent theoretical body of scholarly research, while also remaining relevant to the needs of the practitioner community". Under such a situation, authors consider that variance-based theories, while are useful, do not account for all research situations. Consequently, they must be complemented with process theories. Authors, thus, review the process theories tenets and provide a taxonomy for guiding new IT researchers interested in using this research view.

Section 1 ends with the chapter 8 from book guest editors (Manuel Mora from Autonomous University of Aguascalientes, Mexico; Annette Steenkamp from Lawrence Technical University, Michigan, USA; Ovsei Gelman from Universidad Nacional Autónoma de México, México; and Mahesh S. Raininghani from Texas Woman's University, USA). In this chapter, we review the landscape of research methodologies and paradigms available for Information Technology (IT) and Software Engineering (SwE). Our objectives are two-fold: (i) create awareness in current research communities in IT and SwE on the variety of research paradigms and methodologies, and (ii) provide an useful map for guiding new researchers on the selection of an IT or SwE research paradigm and methodology. To achieve this, we review the core IT and SwE research methodological literature, and based on the findings, we illustrate an updated IT and SwE research framework that comprehensively integrates findings and best practices and provides a coherent systemic (holistic) view of this research landscape.

Section 2 -"Contemporaneous Research Methods and Techniques"- present 6 chapters that are focused on current modern research methods and techniques. Statistical-based modern techniques like covariance-based SEM, variance-based structural equation modeling, action research, grounded theory, and case studies are reported. Additionally practical recommendations for organizing theories and for combining conceptual and empirical research are addressed. In chapter 9, Theresa M. Edgington in Baylor University, USA and Peter M. Bentler, in the University of California – Los Angeles -, USA, review the covariance-based structural equation modeling execution and analysis procedures. They explain that despite of the almost 15 years of being used in the IT discipline, still there are critical omissions in the statistical information reported in IT research papers. Authors report methodological guidelines illustrating them through EQS – a software platform which implements covariance-based algorithms posed by one of the authors (Bentler and Weeks, 1980). Their target users are covariance-based structural equation modeling users rather than developers of such software tools, with the final aim to reduce inconsistency in acceptance criteria for well-executed research using covariance-based SEM.

In chapter 10, José L. Roldán and Manuel J. Sánchez-Franco, both in the University of Sevilla, Spain, complement chapter 9 with a thoughtful review of the main SEM method: Partial Least Squares (PLS). PLS is variance-based SEM in contrast to most known and used covariance-based SEM implemented in LISREL, AMOS or EQS software tools. Authors recognize that studies reporting PLS limitations exist in the literature. However, as it is reported in the chapter, PLS is a correct data analysis technique for SEM when their research assumptions are respected. In particular, authors report that such conditions are less restrictive that covariance-based SEM techniques, but their purpose must be also limited to predictive.

In chapters 11 and 12, M. R. (Ruth) De Villiers, in the University of South Africa, South Africa, presents the a review of interpretative research methods. Action research and Grounded Theory research methods are presented in first part. Development research, design-science research, and design-based research (a term coined for educational technology research) are presented in second part. Author provides a well-structured descriptive review of such five research methods. Such descriptions help to new researchers to for being introduced in such methods and capturing a well-developed global perspective from an efficient release mode.

In chapter 13, Rory O'Connor in Dublin City University, Ireland, elaborates a methodological research integration of two well-known qualitative research methodologies: Case Study and Grounded Theory. The author indicates that while the former is widely used in Information Systems, the latter is less known despite its similar initial reports of use in the early 1990s. Succinctly the author distinguishes the concept of methodology (as a full set of procedures and philosophical assumptions) and from methods (as individual techniques) for elaborating a full integrated methodology. Additionally it is enhanced with a Focus Group data collection technique. The author illustrates it with a real case in the Irish software industry of VSB.

In chapter 14, T. Schwartzel and M. Eloff, in the University of South Africa, identifies an international problem of a high rate of non-completion graduate studies in developed countries. The authors suggest that a wrong research methodological preparation of such graduate students is a main cause of it. Based on the Johnstone El-Bana's Model, the authors suggest that such graduate students could select a high-difficulty problem with many included sub-problems. The authors review several research frameworks to identify shared phases and aims, and elaborate an thoughtful integration consisting of four phases: Planning, Approach, Analysis and Evaluation, and Validation. The authors provide sufficient methodological guidelines on it.

In chapter 15 Annette L. Steenkamp in Lawrence Technological University, USA, and Theresa Kraft in University of Michigan-Flint, USA, provides an integrated methodological research approach which includes conceptual and empirical methods. Authors illustrate their 4-theme based methodology with a real case in the domain of success factors for managing IT Projects. The themes are: Research Planning (Problem Analysis & Literature Review); Proposal Development; Conceptualization; and Experimentation and Research Validation.

Section 3 - "Innovative Research Methods and Techniques"- completes this book with 6 chapters that report modern and still few used research methods and techniques. These are: analysis of content (latent dimensions) through visualization of the network and vector spaces, system dynamics, soft systems and work systems, systems engineering, and engineering design. In chapter 16 Esther Vlieger and Loet Leydesdorff, in the University of Amsterdam, The Netherlands, report an innovative quantitative technique to visualize latent dimensions (called frames) enclosed in a collection of textual messages. Authors indicate that social scientists are advancing their usual analysis of latent dimensions in messages from classic factor analysis and multidimensional scale analysis to a more rich vizualization mode. Authors describes one of such innovative modes based in computer-based content analysis in the network and

vector spaces of the usual word-document matrix. Final long-term aim of this research is advancing the modeling of the dynamics of knowledge in scientific discourse, under the premise of that is happens in the vector space rather in the network space.

In chapter 17, Miroljub Kljajić, Mirjana Kljajić Borštnar, Andrej Škraba and Davorin Kofjač, in the University of Maribor, in Slovenia, elaborates the case for System Dynamics as a legitimated research methodology for doing research in Information Systems. Authors report that despite of the old origin of System Dynamics (early 1960s), their utilization in Information System research is reduced. Authors describe the methodological steps used in System Dynamcs and illustrate with three already reported cases of use in the literature. Authors indicate as main advantage of System Dynamics -as a part of the Systems Approach methodologies- ist ability to define in natural language a problem model, which finally can be translated in the simulation model for convenient qualitative and quantitative analysis in a computer program.

In chapter 18, Doncho Petkov in Eastern Connecticut State University, USA, and Steven Alter, in the University of San Francisco, USA, lead a chapter – written jointly with John Wing, Alan Singh, and Theo Andrew, in Durban University of Technology, South Africa, and Olga Petkova in Central Connecticut State University, USA and Koshesh Sewchurran, inUniversity of Cape Town, South Africa- on the modes of Soft Systems Methodology, Work Systems Method, and Agile System Development can be used jointly for particular system development project contexts. Authors quote a Professor Boehm's call for using a more holistic approach for developing current complex software systems. On such recommendation the authors identify and compare alternative contexts for software and system development and pose guidelines for using combinations of the aforementioned methodologies in particular project contexts. This research, then, advances on the integration of two system development methods (Work System Method and Agile Development) with a research-oriented methodology (soft systems methodology) for Software Engineering.

In chapter 19, Moti Frank in Holon Institute of Technolog, in Israel, reports an innovative combination of interpreting findings from experimentation with single case of studies (different of the usual experimentation on at least two groups with at least 20 subjects by group) as a wider descriptive research study. The author uses two date from two case studies (using experiments on single case studies) in the domain of Systems Engineering for large-scale system projects. One case is about the contrast of the system development strategy for Defense Projects, and the other one about the contrast of the system integration strategy for electronics-software embedded systems. Author contributes with an innovative research descriptive proposal for coping with real Systems Engineering problems related with the selection of development and integration strategies, which cannot be studied by normal experimentation by the cost and other organizational difficulties related with these kind of projects (time pressures, confidentiality of information, scope and size of projects, among others).

In chapter 20, Timothy L.J. Ferris, in University of South Australia, Australia, elaborates the case for Engineering Design as a legitimate research methodology. Author traces Engineering journals to identify a shared research purpose of Engineering Design. A contrast with Science oriented research is reported where a generalizable knowledge on the extant things is expected, while that in Engineering design research is about to propose satisfying solutions to current needs. Author argues that Research Design is valued by its contribution to the know-how and the knowing types of knowledge while that Science is focused in advancing the "know that" type of knowledge. Finally, author advances on usual Engineering general hypothesis from feasibility of building an artifact to feasibility of building an artifact which satisfies a particular need.

In chapter 21, Rafael A. Gonzalez in Javeriana University, in Colombia, and Henk G. Sol, in University of Groningen, in The Netherlands, elaborate a theory validation scheme for Design Research for Information Systems. The authors initially describe the theory validation problematic in Design Research, for which a variety of guidelines but not still uniquely accepted are available. Authors elaborate such a validation scheme through a thoughtful review of epistemological types, reasoning types, and theory types, which should be considered for a logical consistency and coherence in the selection and utilization of the suitable evaluation technique. Authors contribute to Design Research with a comprehensive review of the main different and conflicting tenets reported in the literature. Given the complexity of this topic, authors suggest several open questions, where the notion of insufficiency of evaluation or validation of the artifact can happen "*... because its acceptance or usefulness may not necessarily be an inherent property of the artifact and its theoretical premises, but rather the result of its configuration in a particular context (and as such, contextual factors should enter into the evaluation / validation effort). Conversely, if the artifact does not work or does not work as expected, this may suggest contextual limitations, rather than disconfirmation*"

This book was projected to pursue the following aims: (i) to advance our scientific knowledge on the diverse research approaches used in Engineering of Software Systems and Information Systems, (ii) to update and integrate disperse and valuable knowledge on research approaches isolated in each discipline, (iii) to make available to Software Systems Engineering and Information Systems faculty a repertory of such research approaches in a single source, and (iv) to serve to the following academic and research international audiences: research-oriented faculty in Engineering of Software Systems and Information Systems disciplines, PhD Students on in Engineering of Software Systems and Information Systems disciplines, and Instructors of graduate Research Methods courses on Engineering of Software Systems and Information Systems disciplines.

Hence, we believe that the 21 high-quality chapters included in this book, makes real the aforementioned objectives. We finally, thank all chapter authors, external reviewers, and the IGI Editorial staff as their collaborative work has made this book possible..

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REFERENCES

Ackoff, R. with Gupta, S., & Minas, J. (1962). *Scientific method: Optimizing applied research decisions*. New York, NY: Wiley.

Bhaskar, R. (2008). *A realist theory of science*. London, UK: Leeds Books.

Boehm, B. (2000). Unifying software engineering and systems engineering. *Computer*, (March): 114–116. doi:10.1109/2.825714

Boehm, B. (2006). Some future trends and implications for systems and software engineering processes. *Systems Engineering*, *9*(1), 1–19. doi:10.1002/sys.20044

Checkland, P. (1983). O.R. and the systems movement: mappings and conflicts. *Journal of Optical Research Society*, *34*(8), 661–675.

Checkland, P. (2000). Soft systems: A 30-year retrospective . In Checkland, P. (Ed.), *Systems thinking, systems practice* (pp. A1–A65). Chichester, UK: Wiley.

Gelman, O., & Garcia, J. (1989). Formulation and axiomatization of the concept of general system. Mexican Institute of Planning and Systems Operation. *Outlet IMPOS*, *19*(92), 1–81.

Glass, R., Ramesh, V., & Vessey, I. (2004). An analysis of research in computing disciplines. *Communications of the ACM*, *47*(6), 89–94. doi:10.1145/990680.990686

Hevner, A., March, S., Park, J., & Ram, S. (2004). Design science in Information Systems research. *Management Information Systems Quarterly*, *21*(8), 75–105.

Jackson, M. (1991). *Systems methodology for the management sciences*. New York, NY: Plenum.

March, S., & Smith, G. (1995). Design and natural science Research on Information Technology . *Decision Support Systems*, *15*(4), 251–266. doi:10.1016/0167-9236(94)00041-2

Mingers, J. (2000). Variety is the spice of life: Combining soft and hard OR/MS methods. *International Transactions in Operational Research*, *7*, 673–691. doi:10.1111/j.1475-3995.2000.tb00224.x

Mingers, J. (2001). Combining IS research methods: Towards a pluralist methodology. *Information Systems Research*, *12*(3), 240–253. doi:10.1287/isre.12.3.240.9709

Mora, M., Gelman, O., Frank, M., Paradice, D., Cervantes, F., & Forgionne, G. (2008). Toward an interdisciplinary engineering and management of complex IT-intensive organizational systems: A systems view. *International Journal of Information Technologies and Systems Approach*, *1*(1), 1–24. doi:10.4018/jitsa.2008010101

Popper, K. (2002). *The logic of scientific discovery*. London, UK: Routledge.

Valerdi, R., & Davidz, H. (2009). Empirical research in systems engineering: Challenges and opportunities of a new frontier. *Systems Engineering Journal*, *12*(2), 169–181. doi:10.1002/sys.20117