Design science research approach in studying e-negotiations: models, systems, experiments*

by

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Abstract: Inspired and led by Dr. Gregory E. Kersten, a number of research projects have been conducted at the InterNeg Research Centre. This paper intends to acknowledge Dr. Kersten's unique role as a pioneer in e-negotiation research, particularly in exploring and integrating various elements in e-negotiations. From the design science research perspective, this paper reviews a series of relevant research works in e-negotiation modeling, system design and development, and experimental studies. This provides an integrative view of interconnected elements in this field, and also helps framing the various studies into different aspects and stages of e-negotiation research. The paper then suggests several guidelines and directions for future design science research in e-negotiations.

Keywords: e-negotiations, design science research, negotiation models, negotiation systems, negotiation experiments, multi-attribute auction, decision support, mechanism design, system design

1. Introduction

In the year 1985 Dr. Gregory E. Kersten (Kersten, 1985) initiated a stream of research in negotiations, particularly in developing various models and systems to support negotiation with information and communication technologies. The research has been further advanced with the development of Internet and e-commerce in late 1990s and then in the 21st century. In 1996, Dr. Kersten created a Web portal (interneg.org) to facilitate and support research projects with scholars worldwide. The pioneer empirical study for online negotiations was first reported in 1997 and then published in 1999 (Kersten and Noronha, 1999b), and this study has been cited more than 550 times by the end of 2020. In

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2002, Dr. Kersten led the "e-negotiation project" and teamed up scholars from more than 15 international institutions. E-negotiation research has since then broadened to study every aspect of negotiations via electronic means (Kersten and Lai, 2007a).

In the past three decades, Dr. Kersten's work has widely ranged, from bilateral negotiations to multi-bilateral negotiations and multi-attribute auctions, from decision support systems and expert systems to negotiation support systems (NSSs) and e-negotiation systems (ENSs), and from labour dispute resolution to procurement contracts and sustainability issues. To date, Dr. Kersten's work has been cited about 6,000 times. The present work intends to share one part of his great effort in initiating, guiding and supporting e-negotiation research at the InterNeg Research Centre (interneg.concordia.ca).

From the design science research perspective, this study reviews the approach from a number of relevant studies on e-negotiation models, systems and experiments. A research framework is developed to help guide future research in this field.

The rest of this paper is organized as follows. Section 2 briefly introduces the design science research approach and a system view of e-negotiations. Section 3 reviews the relevant studies that are formulated as design science research. The paper concludes in Section 4 with discussions and implications for future research.

2. Design science research and e-negotiations

The design science research approach is rooted in natural sciences and has been adapted and applied in social sciences, particularly in market engineering (Roth, 2002) and information systems (Hevner et al., 2004). The former stream has focused on mechanism design that defines the rules to govern and facilitate market transactions, and the latter considers information systems as artifacts that can and need to be designed to address practical issues. The advancement of information technologies has enabled and boosted several interdisciplinary research themes from economics, computer science, management science and information systems fields, including: computational economics, behavioral economics, mechanism design, online auctions, automated negotiations, and e-markets (see, e.g., Bichler, Field and Werthner, 2001; Kersten, 2003; Kersten and Lo, 2003; Roth and Ockenfels, 2002; Schoop, 2002; Smith, 2003).

Design science research studies share the common procedures and usually address "*how to*" questions. In particular, Hevner et al. (2004) proposed a set of guidelines in information systems research. It defines "design as an artifact that can be in the form of a construct, model, method or instantiation". It is also suggested to rigorously evaluate the design and to demonstrate its value (or utility) to practice. It is worth to note that design science research is not limited to design a product or to develop a software. It usually requires not

only a general usability test of the designed system, but also more rigorous tests with controlled experiments and treatments. As a result, design science research should and can contribute to research in terms of theories and/or methodologies.

In e-negotiations, parties (humans and/or agents) interact via electronic means towards dispute resolutions or mutual agreements (Kersten, 2004). E-negotiation as a social interactive process can be structured with the following elements (Bichler, Kersten and Strecker, 2003; Kersten, 2003; Kersten and Lai, 2008):

- the parties and their interests, preferences and objectives;
- the issues or attributes with various options (e.g., price with a dollar range, quality standards with different grades);
- the procedure and/or rules that the parties follow to interact and to terminate;
- the proxy or user interface through which the parties exchange information (e.g., offers, messages); and,
- the outcome of the process (e.g., agreements, contracts).

These elements can be viewed in a system environment, wherein they may be designed and configured in such a way as to fit each other and to lead to better outcomes. E-negotiation systems can be considered as artifacts that may involve various constructs (e.g., problem structure, contract templates, platforms), models and methods (e.g., procedures, protocols), and instantiations (e.g., specific cases and applications). The design science research approach can be adopted to design, develop and evaluate practical issues in e-negotiations (Vahidov, 2006, 2012). The Times model (see Fig. 1) was proposed to integrate the mechanism design and system design perspectives in studying e-negotiations (Kersten and Lai, 2007a).

The Times model takes into account the main factors that may affect the design and use of e-negotiation systems, including: tasks or problems, individual participants, mechanisms, context, and system features. While individual characteristics (e.g., personal traits) may not be fully predictable and predefined, the other factors can be controlled and manipulated in experiments. Thus, a number of e-negotiation studies has been carried out to follow the design science research approach. The present work then refers to this framework to review the relevant studies.

3. Relevant InerNeg studies on e-negotiations

The InterNeg Research Centre was established and led by Dr. Kersten to initiate, facilitate and support projects and collaborations in negotiation research. Among several streams of research at the Centre, one has focused on the approach to the study of e-negotiation systems.

In one of his keynote speeches, Dr. Kersten (2004b) reviewed the systems that were developed during 1985-2004 to support negotiators, namely: Nego,
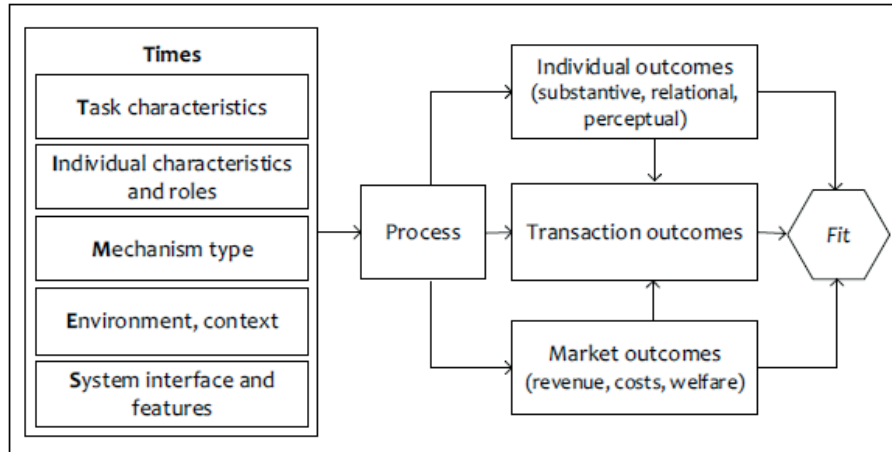
Figure 1. The Times model

NEGOPLAN, SimpleNS, Inspire, Aspire, INSS and Invite. Later on, his team enhanced the Inspire system and developed Inspire2; then, an expansion has taken place towards comparing auctions and negotiations, which led to two new systems (Imbins and Imaras). Table 1 provides a list of the systems and relevant studies initiated and/or carried out at the Centre.

In the early stage (1995-2004), the studies were focused on bilateral negotiations and experimental studies using the Inspire system, and then incorporated software agents with the Aspire and eAgora systems. The negotiation problem is mainly predefined with a structure of two parties bargaining on multiple issues with various options. The process is based on a multi-phase model (Kersten and Noronha, 1999b), including: preparation, negotiation, and post-settlement. The negotiations are formulated to allow both distributive and integrative approaches (Kersten, 2001).

The Inspire system incorporates three types of functions and features to support negotiators: (1) decision support with analytic tools for preference elicitation, conjoint analysis, offer evaluations and post-settlement for optimal solutions; (2) communication support with the exchanges of offers and messages in lab experiments, plus email notifications for online experiments; and, (3) graphical support to dynamically depict the negotiation process with offer values and timeline (i.e., negotiation history chart). Later, two other systems were developed that combine Inspire and software agents (i.e., Aspire and eAgora), which introduced features to automate offer generation and recommendations based on participants' preferences and the counter offers. While Aspire is a standalone system, eAgora can be used as an e-marketplace, where buyers and sellers can be paired into multiple negotiation instances.

A great number of experimental studies have been conducted using the Inspire system in both laboratory and online settings. The focus has been to assess the system features for negotiation support and to examine users' behavior and outcomes. A set of standard questionnaires have been developed, tested, and then widely utilized for data collection, including: demographics, dual-concerns, satisfaction, behavioral intension, self and counterpart strategies, and system assessment. For instance, the analytical features for decision support or aids in e-negotiations have been perceived valuable (e.g., Kersten and Noronha, 1999b; Vetschera, Kersten and Koeszegi, 2006), the communication facilities may have different effects across different cultural groups (e.g., Koeszegi, Vetschera and Kersten, 2004; Lai et al., 2006), and the graphical tools may help in both decision making and communications (e.g., Weber, Kersten and Hine, 2006).

Again, Dr. Kersten has generously shared all the data collected from the system and experiments with people worldwide. To date, researchers in the e-negotiation field are still using the dataset, and instructors and students are also using the system for teaching and learning.

In 2004, the Invite platform (see Fig. 2) was developed in order to construct e-negotiation systems with different models and features (Law et al., 2004). It is built on a database-driven protocol that allows to design, configure and implement different elements in e-negotiation systems (Kim et al., 2006). A number of systems were then developed on the Invite platform, including: SimpleNS (a simplified version of Inspire without restriction of structured offers), Inspire2 (an enhanced version with capabilities to manipulate the phases and interactions, to configure system features, to automate processes, and to represent more graphically), and INSS (an expansion of Inspire that allows for flexible and dynamic negotiation structures, such as the number of parties and the number of issues/options). The rapid design and development of these systems (2004-2007) demonstrated the soundness and applicability of this design approach (Kersten and Lai, 2007b; Kim et al., 2006; Wu, Kersten and Benyoucef, 2006).

The experimental studies using Inspire2 have sparked a wide range of research topics in e-negotiation, including: preference impartation and decision support (Kersten et al., 2010; Kersten, Roszkowska and Wachowicz, 2017, 2018; Wachowicz, Kersten and Roszkowska, 2019), human and agent interactions (Vahidov, Kersten and Yu, 2017), motivations and objectives (Kersten, Wu and Oertel, 2011; Wu, Kersten and Beaudry, 2012), language and culture (Lai, Lin and Kersten, 2010), and profiles and patterns (Kersten and Wu, 2010; Yu and Kersten, 2018). These studies have significantly broadened and deepened our knowledge of e-negotiation. For instance, more in-depth analysis on various decision support and aids have shown that different effects and even biases may exist depending on the negotiation problem formulation, preference structures and elicitation process and users' capabilities (e.g., Kersten et al., 2010; Kersten, Roszkowska and Wachowicz, 2016; Wachowicz, Kersten and Roszkowska, 2019), and different motivations and objectives may exist among negotiators, affecting

Table 1. E-negotiation systems developed at InterNeg Research Centre (1996-2020)

| System / platform	Main functions / features	Relevant studies
Invite	It is a software platform that builds a virtual integrated transaction environment. It is a platform to construct various e-negotiation systems.	Kim et al. (2006); Law, Kersten & Strecker (2004); Law et al. (2004)
SimpleNS	It distinguishes offers and messages and tracks the negotiation process; the system is as easy to use as simple email is.	Law et al. (2004)
Inspire	It supports bilateral negotiations with negotiation analytic methods, communication facilities and graphical tools.	Gettinger, Koeszegi & Schoop (2012); Kersten & Noronha (1999a, b); Koeszegi, Vetschera & Kersten (2004); Lai et al. (2006); Vetschera, Kersten & Koeszegi (2006); Weber, Kersten & Hine (2006)
Aspire	It combines Inspire with a software agent to support negotiators and automate a part of negotiation process.	Braun et al. (2006); Kersten & Lo (2001, 2003)
eAgora	It is built on Inspire with software agents to facilitate negotiations in an e-marketplace.	Chen, Kersten & Vahidov (2004, 2005)
INSS	It combines Inspire with the flexibility in defining negotiation problem structure and dynamically adding issues and options.	Wu & Kersten (2005); Wu, Kersten & Benyoucef (2006)
Inspire2	It is built on Inspire with enhanced negotiation analytic methods, communication, and dynamic and user-controlled graphical tools.	Kersten et al. (2010); Kersten, Roszkowska & Wachowicz (2016, 2017, 2018); Kersten & Wu (2010); Kersten, Wu & Kersten (2016); Wu & Kersten (2017); Vahidov & Kersten (2012a, b); Vahidov, Kersten & Yu (2017); Wachowicz, Kersten & Roszkowska (2019); Wu, Kersten & Beaudry (2012); Yu & Kersten (2018)
Imbins	It supports multi-bilateral multi-issue negotiations and allows users to employ graphical tools for alternative generation and assessment.	Bellantuono et al. (2014); Kersten et al. (2011, 2013); Kersten, Vahidov & Gimon (2013); Kersten, Wachowicz & Gimon (2013); Wu & Kersten (2016); Yu, Kersten & Wu (2008)
Imaras	It supports multi-attribute auctions using a novel algorithm that does not require disclosure of private information.	Bellantuono et al. (2014); Kersten et al. (2011, 2013); Kersten, Pontrandolfo & Wu (2012); Kersten, Vahidov & Gimon (2013); Kersten, Wachowicz & Kersten (2016); Yu, Kersten & Vahidov (2015); Yu, Kersten & Wu (2008)
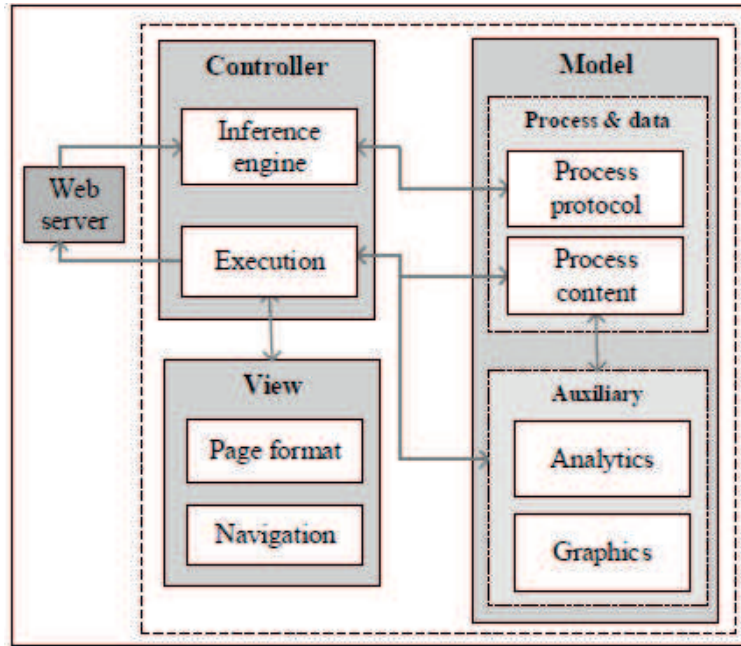
Figure 2. The Invite platform

their behavior and negotiation outcomes (e.g., Kersten and Wu, 2010; Kersten, Wu and Oertel, 2011; Wu, Kersten and Beaudry, 2012; Yu and Kersten, 2018). This has also called for effort in developing more comprehensive instrument in order to measure process performance, substantive outcomes and subjective or social outcomes (e.g., Wu, Kersten and Beaudry, 2012; Wu, Yu and Kersten, 2013).

Recently, the scope of e-negotiation research has also expanded to comparing difference mechanisms for procurement contracts. This may have been initiated by Dr. Kersten's early work in addressing different types of negotiation models and approaches (Kersten, 2001; Kersten, Noronha and Teich, 2000), while it is also due to the fact that advanced information technologies have enabled more complex market exchange mechanisms in e-commerce. Both academics and practitioners have shown the different, but possibly alternate mechanisms for the same commerce–related situations (e.g., Handfield and Straight, 2003; Kaufmann and Carter, 2004). In order to make appropriate decisions in designing, selecting and applying these alternative mechanisms, Dr. Kersten and his team developed the Times model to guide comparative studies on market mechanisms (Kersten et al., 2008). A series of studies have contributed to this initiative.

First of all, a common business scenario is required wherein both auctions and negotiations can be applied and then compared. This was addressed by designing and testing business cases, and a logistics service contract case was then developed (Bellantuono, Kersten and Pontrandolfo, 2008). The later experimental studies have been based on this case.

Secondly, a comparable set of mechanisms needs to be designed and implemented. In particular, two mechanisms were designed for multiple-attribute auctions and multi-bilateral negotiations, respectively (Kersten et al., 2011; Wu, Kersten and Vahidov, 2014). The multi-bilateral negotiation was built on the bilateral negotiation model in Inspire, whereas there was no such comparative auction model to allow for controlling information revelation from one side to another side. Thus, a novel auction method was invented to meet the needs and has been awarded a patent (Kersten and Wu, 2012). This invention made it possible to apply both mechanisms in the same business scenario (multiple parties, multiple issues/attributes, one-to-many interaction with controllable information). Figure 3 illustrates the two comparable mechanisms for e-procurement (Wu, Kersten and Vahidov, 2014).
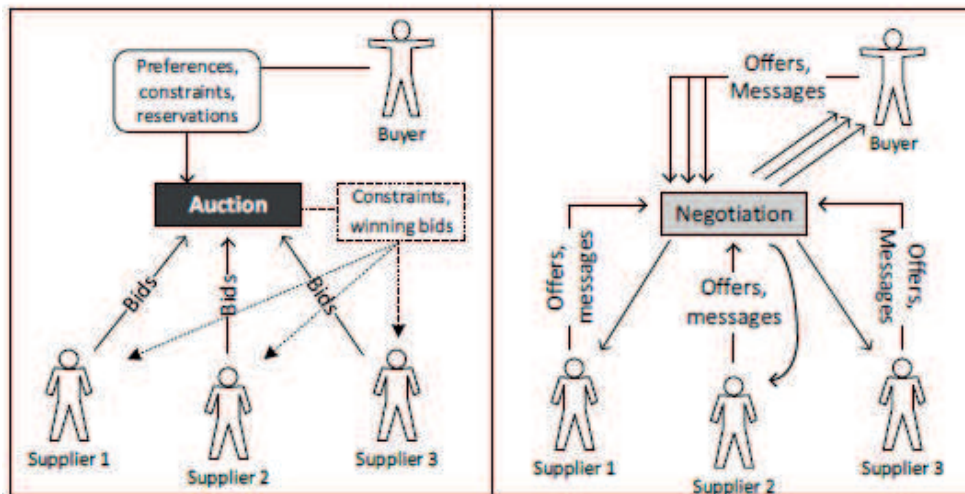
Figure 3. Two comparable mechanisms for e-procurement (auction vs. negotiation)

Next, in order to compare the designed mechanisms, other factors also need to be controlled or manageable (e.g., environment, system user interface). Thus, the two mechanisms were implemented in the Invite platform, and accordingly two systems were developed, respectively, Imaras for multi-attribute auctions and Imbins for multi-bilateral negotiations (Wu, Kersten and Vahidov, 2014). The same environment (Invite) allows the two systems to share common functions, features and user interface (see Figs. 4 and 5).

Figure 4. The Imaras system implemented in the Invite platform

Figure 5. The Imbins system implemented in the Invite platform

Following the design science research approach, the design of these artifacts can be evaluated through various methods (e.g., experiments). Experimental studies have been conducted to assess the systems, to compare the mechanisms, and to examine the participants' behavior and outcomes (e.g., Bellantuono et al., 2014; Kersten, Gimon and ShiKui, 2013; Kersten et al., 2011; Kersten, Vahidov and Gimon, 2013; Kersten, Wachowicz and Kersten, 2016; Wu and Kersten, 2017; Yu, Kersten and Vahidov, 2015). Note that auctions and negotiations can be considered as a class or type of mechanisms, and each type may contain a number of instantiations of these mechanisms (i.e., variants of mechanisms) (Wu, Kersten and Vahidov, 2014). For instance, the auction mechanisms may be classified with specifications and configurations of several design parameters, such as time control (continuous auctions vs. multi-round auctions), information revelation (bidding information, bidder's identity) and bidder differentiation (homogenous vs. heterogenous) (e.g., Kersten, Pontrandolfo and Wu, 2012; Wu and Kersten, 2013). Similarly, the negotiation mechanisms can be designed with variants in terms of information types (e.g., structured offers, free-text messages) and information revelation (e.g., verified offers or outstanding offers) (e.g., Kersten, Wachowicz and Kersten, 2016). Thus, the treatments in the experiments may vary at different design levels or layers (Vahidov, 2012), including:

- *Generic mechanisms and models*: Several studies have compared the effects of different mechanisms (e.g., auctions vs. negotiations) by controlling the system features and user interface. Some common findings show that indeed the mechanisms affect the process and outcomes. For instance, auctions overall lead to higher level of competition among the bidders and thus favor the auction host with substantive outcomes, while negotiations can generate more balanced contracts (e.g., Bellantuono et al. 2014; Kersten, Vahidov and Gimon, 2013; Wu and Kersten, 2017).

- *Variants of mechanisms and models*: Studies also more specifically compared some variants of those generic mechanisms such as information revelation rules (e.g., negotiations with vs. without verifiable offers, auctions with different information revelation). This effort has further advanced our knowledge and understanding of key design parameters or factors within each type or class of mechanisms. It has been observed that the disclosure of certain information affects the process and outcomes, particularly joint gains and social welfare (e.g., Kersten, Vahidov and Gimon, 2013; Kersten, Wachowicz and Kersten, 2016; Wu and Kersten, 2013).

The findings from these experiments helped to verify the design of mechanisms and their variants, which has provided insights for future research and practice in designing, selecting and using these mechanisms.

4.   Discussions and implications

Guided and led by the great effort of Dr. Kersten, the scholars and collaborators at the InerNeg Research Centre have conducted a number of studies that contribute to the e-negotiation field. The present work intends to memorize and appreciate Dr. Kersten as a pioneer in this domain. In particular, the paper reviews the relevant studies from the design science research perspective, with a system view of e-negotiations and a wish to systematically approach the study of e-negotiations.

The Times model has provided a general framework and guideline for e-negotiation research, which can incorporate theories and methods from multiple disciplines (e.g., economics, computer science, management science, information systems). This has broadened our view and enriched the knowledge of this field. It takes into account the main factors in a system environment, and potentially reaches the desired outcomes by controlling and manipulating those factors. Form the design science research perspective, the model can be revised to provide a clearer picture of what we study and a more logical route to guide how we may study e-negotiations. Figure 5 presents a revised research framework for design science research approach in studying e-negotiations.

The framework suggests future studies with this approach, beginning with the design and implementation of mechanisms (e.g., auctions, negotiations, and their variants) and auxiliary models (e.g., analytic, communication and graphical support). Since the Invite platform supports construction and implementation of different mechanisms and auxiliary models, those two elements can be configured and tested together with the similar system features and user interface. It is also possible to control the mechanisms and auxiliary models while configuring and testing various system features and interfaces (e.g., different formats, such as tabular and textual information) (Wu, Kersten and Vahidov, 2014).

Once the system designed and implemented, it becomes an instantiation that can be used as a test-bed for experimental studies. The environment (e.g., laboratory, online), tasks (e.g., business case) and participants may be controlled and the whole setting manipulated with different treatments. We can then observe the participants (i.e., negotiators and bidders as system users) in order to examine how they behave and what they achieve. The impact can be both process efficiency and social and economic outcomes. The assessments can also be multi-dimensional regarding the process, the outcomes, the counterpart, the mechanism, the models, and the system (Wu, Yu and Kersten, 2013). The findings can be referred to reconfigure the experiment settings (i.e., e-negotiation systems and its surrounding factors for selection and use), and if needed, to redesign and reimplement the system with different mechanisms and/or auxiliary models. This iterative mode is the "design as a search process" (Hevner et al., 2004).
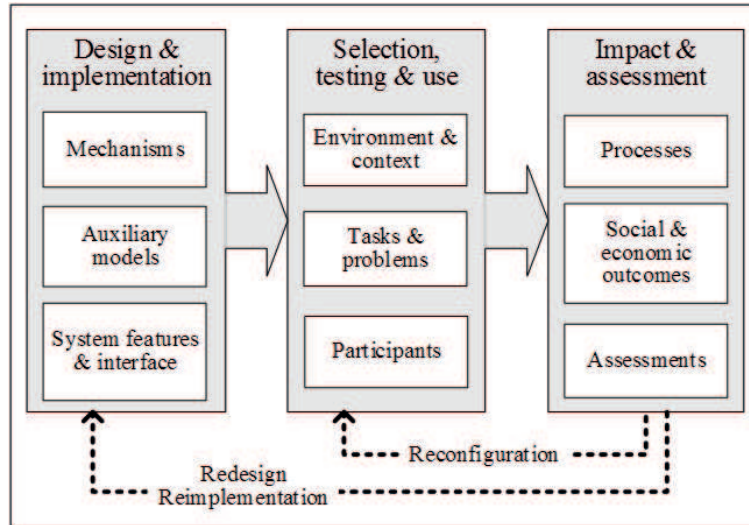
Figure 6.   A revised research framework for design science research in e-negotiations

This framework will help us to not only answer "*how to*" questions, but also address other questions (e.g., *who*, *when* and *why*) in e-negotiations. Thus, it can contribute to e-negotiation research both in improvement of methodology and in theoretical development.

Future research, if possible, may be conducted in a field study with real-world business scenarios (e.g., SmartSettle for dispute resolutions). This will enrich the contextual factors and the evaluation methods.

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