

Combining Case Study, Design Science and Action Research Methods for Effective Collaboration Engineering Research Efforts

Josephine Nabukenya
josephine@cit.mak.ac.ug

School of Computing & Informatics Technology, Makerere University, Uganda

Abstract

Collaboration Engineering (CE) is a new and growing field of research and practice which involves the designing of recurring collaboration processes that are meant to cause predictable and success among organizations' recurring mission-critical collaborative tasks. In pursuing a CE research effort (scientific research into the designing and evaluation of CE processes), collaboration engineers follow a five ways model. Among these ways is the way of working framework that describes structured design methods. In the CE context, the way of working defines the design activities of the CE approach. As such it points to the need to use a research methodology in order to measure the effectiveness of CE research efforts. This article therefore provides a combined research methodology that can be used to determine the effectiveness of a CE research effort. In establishing the combination, we are guided by an overview of selected research methods, with an assessment of their applicability to CE. The primary examples used show that a combined research methodology can indeed support validating CE research efforts' effectiveness.

1. Introduction

Collaboration Engineering (CE) is a new and growing field of research and practice [6, 5]. [6] define *collaboration engineering* as “designing recurring collaboration processes that can be transferred to groups that can be self-sustaining in these processes using collaboration techniques and technology”. The result of engineering in CE is an object of a collaboration process and collaboration support, including rules and capabilities that should support groups in instituting this process [6]. To design collaboration processes in CE research therefore, collaboration engineers need to follow a five ways model (in our case an engineering approach which is given in this model) suggested by [19] in [4]:

way of thinking where the concepts and theoretical foundations are given; *way of working* describes structured design methods; *way of modeling* describes conventions for representing aspects of the domain and the approach; *way of controlling* describes measures and methods for managing the engineering process; and the *way of supporting* describes tools, approaches and techniques to support the designer.

In the CE research context, the *way of working* framework defines the design activities of the CE approach [6]. Basing on [6], the first phase involves identifying best practices (regularly found in the body of reference knowledge) for a given task that a group needs to execute. The second phase involves designing the prototype collaboration process using best practices (identified in phase one), while following the collaboration engineer's reference knowledge on collaboration and facilitation. Executing and refining the prototype collaboration process in a number of pilots is done in the third phase leading to organizational roll-out of the final process in the last phase. Organizational roll-out involves practitioners' training in both the underlying principle and execution of the process as well as documentation of the design for the practitioners.

From the CE way of working framework described above, if analyzed closely, execution of its phases in the real world environment would necessitate following a research methodology. More over for a CE research to be effective to real world organizations, it must be relevant to their needs of practice and also used by its practitioners. To measure the effectiveness of CE research effort (scientific research into designing and evaluation of CE processes) therefore, we would need to use a research methodology. A *research methodology* is a combination of one of more data collection, and analysis methods used to answer a research question. Several research methodologies can be used to conduct research; however they may be appropriate in different situations depending on the research question being addressed. The methodologies that can

be used in conducting CE research may include but are not limited to: case-study, action research, survey research, experimental research, grounded theory research, games and simulations, and design science.

Notwithstanding the great potential of CE research in organizational work-practices, there is a need to determine its effectiveness. This paper therefore focuses on research methods that can be used to validate this potential. As such, we illustrate how the combination of the case study, design science and action research methods can be used to determine the effectiveness of a CE research effort. We combine these methods because they are observed to be suitable for pursuing the activities described in the CE way of working framework discussed above. Additionally, the choice of these methods is guided by an overview of selected research methods and an assessment of their applicability to CE. We use three examples with the primary one being the collaborative organizational policy making process, to

demonstrate how these methods are conducted to measure the effectiveness of the CE research effort.

2. Assessment of research methods: Overview and applicability to CE

In table 1, we provide a summary of the most generally used research methods and how they can be applied to the CE approach to ascertain its effectiveness in fulfilling its intended efforts. In the same table we also illustrate how these research methods can be supplemented by each other towards fulfilling a comprehensive CE research. In this paper therefore, we don't aim at broadly discussing the selected methods but rather how a combined methodology can be used to support conducting a comprehensive CE research. To this end, a broad description of each of the research methods such as their characteristics, strengths and weaknesses, we refer to [10, 17, 23, 3, 7, 20, 9, 18, 16, and 13].

Table 1: Summary Table of Research Methods

Summary Table of Research Methods: Overview and Applicability to CE Research Effort			
Research Method	Relevancy to CE	Example(s) of CE research issue(s)	Supplement Research Method
Case Study Research (CSR)	i).Provides detailed contextual views on phenomenon of interest, i.e. reference knowledge on application domain for collaboration processes to be designed	Improving “ <i>quality</i> ” of a CE collaboration process; e.g. we would need descriptions of the process such as: <i>i).characteristics,</i> <i>ii).deliverables,</i> <i>iii).challenges</i>	i). <i>GT</i> – to build/develop theory from descriptions of phenomena ii). <i>SR</i> – to test, for example, constructs defined; and theories developed using CSR ii). <i>AR</i> – theory application and evaluation concurrently (theory testing) from CSR
Action Research (AR)	i).Addresses the “ <i>how to</i> ” research questions ii).The continuous design and evaluation of the collaboration processes designed may not be easy to study in constructed settings iii).Allows evaluation and improvement of problem-solving techniques or theories during a series of interventions, e.g. how to improve transferability techniques of collaboration processes to practitioners	i).How to test, measure, and evaluate a collaboration process/theory? ii).How might CE aid in supporting to improve the quality of the collaboration process effort (design and support)?	i). <i>GT</i> – to organize data i.e. coding methods can be used to enrich the theoretical underpinnings of an AR case study. ii). <i>CSR</i> – to provide descriptions of phenomena in an AR iii). <i>Survey Research</i> – to produce quantitative descriptions on phenomena in an AR iv). <i>Experimental Research</i> – to test interventions in AR v). <i>DSR</i> – to construct knowledge and artifacts for validation in AR
Grounded Theory Research (GT)	i).Permits development of a theory (e.g. improving satisfaction) that can be used to account for variations in the outcome of interest.	Improving “ <i>satisfaction</i> ” with group processes and product among stakeholders who are developing a CP; e.g. i).Causes of stakeholders to feel satisfied with outcome and the process by which the outcomes	i). <i>CSR</i> – to provide description of phenomena ii). <i>AR</i> – to test and validate theory built in GT

		are attained ii). Factors that influence successful CP execution iii). Causes of stakeholders to agree on the outcome iv). Causes for stakeholders to be productive	
Survey Research (SR)	i). To make measurement of the success of collaboration process outcomes and process designs ... asks participants/practitioners feedback (variable relationship) in an intervention	i). Stakeholders' stake on collaboration process and support ii). What stakeholders need to see in a domain collaboration process that is different from the traditional one	i). <i>CSR</i> – to be used together with SR ... develops a richer, more detailed, and complete understanding of how and why certain results occur in SR ii). <i>Application of Naturalistic observation</i> – to systematically watch and record naturally occurring behavior
Design Science Research (DSR)	i). To construct knowledge and artifacts for collaboration processes designs and support	i). How to develop and design thinklets that are suitable for transferability of a CP design to domain practitioners/stakeholders ii). What design assumptions/requirements of CE might follow from a given domain? iii). How do existing thinklets support the designing of a given domain collaboration process	i). <i>Action Research, Survey Research and Experimental Research</i> – to test, validate and evaluate knowledge and artifacts constructed in DSR <i>AR</i> – can be used to validate and evaluate the performance of the artifact for its qualities in an intervention.

Case study research (CSR) is defined by [23], as an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. It can be characterized as qualitative and observatory, using predefined research questions [23, 22]. As such CSR is very useful when CE researchers want to get a detailed contextual view of the phenomenon of interest; for instance, if he/she wanted to improve qualities of collaboration processes, he/she would need to carry out an in-depth investigation to get better understanding of this domain. However, CSR has some limitations: First, it is difficult to design and scope a CSR project in order to ensure that the research question(s) can be appropriately and adequately answered. Secondly, the availability of suitable case study sites may be restricted, as business and other organizations are not always willing to participate in CSR. The reporting of CSR can also be difficult, that is, the rigor of the process used to arrive at the results and the validity of the findings and conclusions reached need to be established, therefore CSR has often been considered to be lacking rigor.

Hence, because of its limitations, it would be advantageous for the CE researcher to supplement CSR with other research methods in order to be more effective. These may include but are not limited to:

GT can be used to build/develop theory; the CSR can be combined with other research methods in studies where there is more than one research aim. For example, the use of CSR to first define constructs and develop theory which can subsequently be tested using survey research methods; and AR can be used for theory application and evaluation concurrently since CSR does not provide for theory testing.

Action Research (AR) is an inquiry into how people design and implement action in relation to each other [2]. [7] state that action research refers to research which, broadly, results from an involvement by the investigator with members of an organization over a matter which is of genuine concern to them and in which there is intent by the organization's members to take action based on the intervention. According to [11] definition, four major characteristics of AR are distinguishable. AR aims at an increased understanding of an immediate social situation, with emphasis on the complex and multivariate nature of this social setting in the IS domain; It assists in practical problem solving and expands scientific knowledge; It is performed collaboratively and enhances the competencies of the respective actors a process of participatory observation is implied by this goal; and AR is primarily applicable for the understanding of change processes in social systems [21, 2, 7].

The main critique about AR is that it is seen as a consultancy. Consultants consider AR to be a technique for organizational development [3]. More so, with AR, the lack of impartiality of the action researcher may lead to researcher bias. The usual personal over-involvement of researchers with client organizations in AR projects may hinder good research by introducing personal biases in the conclusions. This is particularly true in situations involving a conflict of interests [12].

As such a CE researcher may supplement AR with GT in order to organize data i.e. coding methods can be used to enrich the theoretical underpinnings of an AR case study; CSR to do an in-depth investigation i.e. provide descriptions of phenomena; and SR to produce quantitative descriptions on phenomena; while the Experiment Research can be used to test interventions in action research.

Grounded Theory (GT) is an inductive, theory discovery methodology that allows the researcher to develop a theoretical account of the general features of a topic while simultaneously grounding the account in empirical observations or data [9]. GT aims to develop a theory from data rather than to gather data in order to test a theory or hypothesis, i.e. qualitative methods are used to obtain data about a phenomenon and that a theory emerges from the data. The theory is grounded in the reality as represented in the data. There should be a continuous interplay between data collection and analysis [9, 20]. [20], state that well performed GT meets all the requirements of good science i.e. significance, theory-observation, compatibility, generalizability, reproducibility, precision, rigor, and verification.

However, GT is constrained by the danger of placing too much emphasis on identifying codes as the exclusive feature of the process without theoretically coding, i.e. explaining how codes relate to each other. More so GT involves the search for negative cases which may be time-consuming and may involve rethinking tentative conclusions; and because of the nature of the method, it often takes the research in a number of different directions before a plausible theory starts to emerge [20]. To this end, a CE researcher would need to employ CSR and AR methods for an effective CE research outcome.

Survey research (SR) refers to surveys that are conducted to advance scientific knowledge. SR is especially well-suited for answering questions about what, how much and how many, and to a greater extent than is commonly understood, questions about how and why; control of the independent and dependent variables is not possible or not desirable; the phenomena of interest must be studied in its

natural setting; the phenomena of interest occur in current time or the recent past [18]. In summary, the basic idea behind survey methodology is to measure variables by asking people questions and then to examine relationships among variables.

SR also suffers from limitations such as reactivity, where respondents tend to give socially desirable responses that make them look good or seem to be what the researcher is looking for; sampling frame – it is difficult to access the proper number and type of people who are needed for a representative sample of the target population; measurement error, i.e. surveys are often full of systematic biases, and/or loaded questions; and you can make inferences, but not at the level of cause-and-effect i.e. SR is not sufficient to determine the direction of causality [18].

Hitherto, a CE researcher to achieve effective results from SR, it would be advantageous to supplement it with other research methods such as the CSR should be used together with SR in order to develop a richer, more detailed, and complete understanding of how and why certain results occur, among others. As such SR can be used by CE researchers to make measurement of the success of collaboration process outcomes and process designs more precise by seeking uniformity from the participants in an intervention. CE researchers may ask many questions about a given collaboration process context to be able to achieve considerable flexibility to the analysis of the intervention results.

Design Science Research is a problem-solving paradigm that seeks to create innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of information systems can be effectively and efficiently accomplished [10]. It also involves the analysis of the use and performance of designed artifacts to understand, explain and to improve on the behavior of aspects of information systems. Such artifacts include but are not limited to: algorithms, human/computer interfaces and system design methodologies or languages [16]. The function of DS is solving problems by introducing into the environment new artifacts [8]. DS has two fundamental processes: construction and evaluation: *construction* is a creative, problem solving process whereby artifacts are produced for intended purposes; and *evaluation* is an assessment process whereby the efficacy of produced artifacts is determined [13].

This means a CE researcher would benefit from the DSR by supplementing it with the following evaluation methods: CSR can be used to study artifact in depth; Experiment research can be used to study the artifact in a controlled environment for its

qualities; while AR can be used to validate and evaluate the performance of the artifact for its qualities in an intervention. DSR can be used by CE researchers to construct knowledge and artifacts for the collaboration processes designs. For example in a CE research, if the collaboration engineers would wish to design collaboration processes that are transferable to practitioners, then this would require development and design in addition to existing thinklets that are supportive in transferring a collaboration process to practitioners of which they can execute by themselves.

3. Why combine CSR, DSR and AR for CE research?

In the introduction section, we discussed that the CE way of working framework defines the design activities of the CE approach. If analyzed closely, the execution of these activities points to the need to use a research methodology. From this analysis, we observe that the combination of CSR, DSR, and AR research methods is most suitable to support the execution. Besides, from the preceding table and using the analysis of each research method, we argue that combining CSR, DSR and AR methods is most appropriate in fulfilling a comprehensive CE research effort based on the following strengths:

1. CSR and AR permit involvement of the CE researchers with members of case organizations in the problem setting [17, 23, and 7]. That means CSR and AR would assist collaboration engineers with reference knowledge (basic understanding) of the application domains for the intended collaboration processes. Such reference knowledge would include but not limited to: descriptions of characteristics, deliverables and challenges of any given application domain.
2. AR method permits CE researchers to continuously design, evaluate and improve their theories in natural settings [11]. That is, the collaboration process prototype and collaboration support are designed and implemented in a series of interventions in which evaluations are performed to make improvements.
3. The CSR and AR methods focus on the process, that is, “how” and “why” CE research questions [17, 23, and 3]. In other words CSR and AR focus on how to test, measure, and evaluate a CE phenomenon of interest e.g. satisfaction, transferability and productivity of a CE theory.

4. The DSR method is used since the CE approach requires the development of design support and design object. DSR seeks to understand and improve both the artifacts (design object) themselves and the processes (design support) by which they are created [13].
5. Additionally, in the preceding section we observed that each of these three research methods had its limitations. To address them, we use CSR to first define process requirements for the CE theory. Then use DSR to design decisions and design objects that are used to further develop the CE theory. This theory is subsequently tested using AR. Moreover we supplement AR with DSR because we use the CE theory-driven design approach to make causal connections and explanations of the theory. Also various iterations of collaborative workshops to generalize results are used.
6. Lastly, since the CE design process requires clear iteration between construction and evaluation of the collaboration process, it means that the quality and efficacy of the design artifact must be demonstrated by well-executed evaluation methods. Therefore among the many evaluation methods proposed by [10], we choose the AR evaluation method. The AR is used to monitor the use of the artifact (CE collaboration process prescription, and the pattern language) in the real-world environment (organizational work-practices). In addition, it is used to validate and evaluate the performance of the artifact for its qualities in an intervention.

4. Application of CSR, DSR and AR to CE research effort

4.1. CSR, DSR and AR combined

To conduct individual steps in a CE research effort, the case study, design science and action research methods are sequentially employed. This is because the CE way of working framework phases described in the introduction section indicates this sequence as illustrated in Figure 1. To appreciate the CSR, DSR and AR methods’ usefulness and applicability to CE research efforts, best practices in which the same have been employed are highlighted. Among these include but are not limited to:

First example is on a research that involves enhancing decision making for business process agility (BPA) [1]. To achieve its goal, the research begins with an inquiry to explore a case’s business

environment in order to gain an in-depth understanding of BPA and to establish the decision enhancement requirements for BPA improvement including identification of the tools and techniques to support the requirements. These requirements and suitable tools and techniques are used as an input to the design of the decision enhancement studio to support workflow analysis, risk assessment and collaboration during the decision process involved in business process improvement alternative exploration. The studio consists of a collaboration process designed to support the decision process. Using collaboration sessions, the studio was evaluated for its usefulness and usability in enhancing the decision process inherent in BPA.

Second example involves a research on supporting enterprises to design and or evaluate their architectures [15]. The aim is to collaboratively evaluate their enterprise architectures' design alternatives. To achieve this, case studies are made with respective case organizations to establish if they have architectures. For those that do have an analysis of their strengths and weaknesses is done from which an improvement is recommended for better design alternatives. For those that do not have, business information is gathered from which design alternatives are generated that are used to design an enterprise architecture. To support the evaluation of an existing and or to design new enterprise architectures, a collaboration process is used. The collaboration process was tested for its satisfaction with process and outcomes, and effectiveness.

Using the specific example on improving collaborative organizational policy making processes [14], the CSR focuses on describing the processes in the organizational policy making environment; this relates to the first phase of the CE way of working where the collaboration engineer is tasked to gain a basic understanding of the application domain from the body of reference knowledge. The DSR involves creating the knowledge and artifacts for designing quality collaborative policy making processes designs and collaboration support; this relates to the second phase which involves designing the prototype collaboration process using best practices (identified in phase one), while following the collaboration engineer's reference knowledge on collaboration and facilitation. Finally, the AR involves the intervention

and use of the theory for improving organizational policy making processes; this relates to the execution and refinement of the prototype collaboration process in a number of pilots done in the third phase leading to organizational roll-out of the final process in the last phase. Figure 1 visualizes the sequential application of CSR, DSR, and AR as indicated in the CE way of working framework phases when conducting a CE research effort.

In figure 1, the CSR is applied through visiting case organizations. It is used to carry out an in-depth investigation to get a better understanding of the organizational policy making domain. Among the in-depth investigation results collected are stakeholders' perspectives on what they consider as key characteristics/concerns in their organizational policy making processes. The results from these sources of data in form of process requirements form the initial theory needed to solve the research problem. The problem being dealt with is improving collaborative organizational policy making processes.

From the exploratory study conducted, the DSR method is employed in order to further develop the theory (create design decisions and design objects – collaborative policy making process prescription, and the pattern language) that is to be used to improve organizational policy making processes. The design decisions are required for designing and determining the situation in which the collaborative policy making process design needs to be executed and evaluated.

Lastly, after developing the theory, there is need to measure the improvement made. To measure this improvement therefore, the AR method is used to implement and evaluate the theory developed above in the policy making real-world environment. Specifically the [24]'s action research method is followed in which four activities/phases that can be carried out over several iterations are involved. The first activity *Planning* is concerned with the exploration of the research site and the preparation of the intervention. The second phase *Act* involves the actual intervention made by the researcher. In the third phase *Observe*, collection of data during and after the actual intervention to enable evaluation is done. Finally, the fourth activity *Reflect* involves the analysis of collected data and infers conclusions regarding the intervention that may feed into the plan activity of a new iteration.

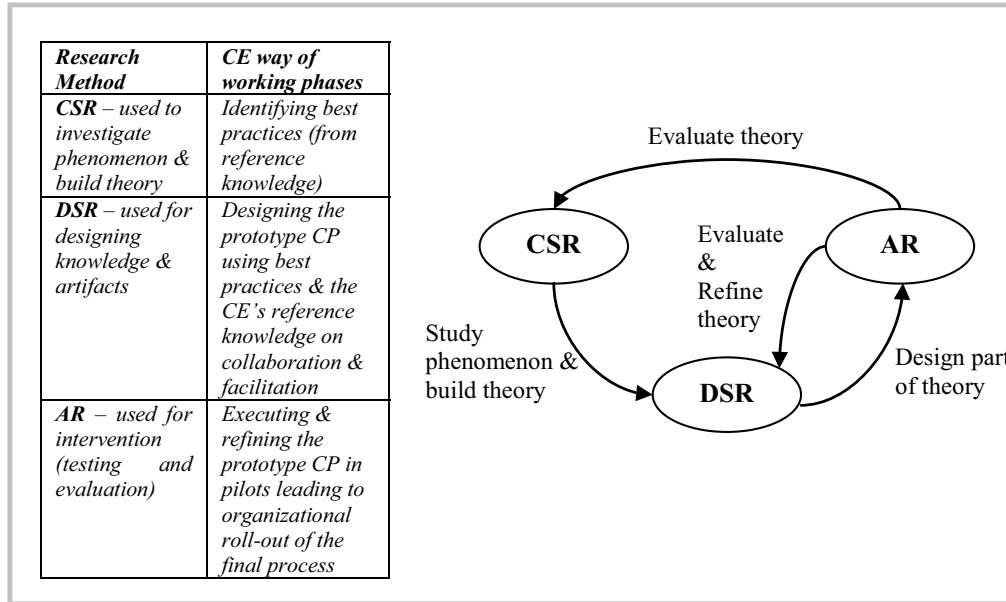


Figure 1: Application of CSR, DSR & AR Research Methods to CE Research Context

4.2. Actual scenario: Improving organizational policy making processes

A. CSR: Studying the phenomenon of interest (POI)

In using the CSR, an exploratory study was conducted from which the initial theory that entailed inductively identified requirements (see table 2) needed to improve collaborative organizational policy making processes (POI) was derived. The case studies conducted provided an understanding of the organizational policy making domain. Specifically this entailed stakeholders' perspectives on what they understood by an organizational policy and policy making, business levels at which organizational policy making is done, key characteristics, requirements, and challenges/concerns of organizational policy making processes, including recommendations, understanding of a quality organizational policy outcome, and key characteristics of a quality organizational policy making process, and finally the type of policy making process model followed/used (if any) when creating organizational policies.

The results from the investigation were used as reference knowledge to identify PMP collaborative concerns, from which collaborative needs were derived (see table 2). The outcome of these collaborative needs in addition to the analyzed

abstraction on qualities of PMPs was used to obtain an insightful set of quality dimensions considered as design decisions needed to design quality CPMP prescriptions (see table 3). Additionally, the reference knowledge was used to identify the CPMP task goal and deliverables for policy creation. Lastly, the results on qualities of the process deliverables were used for the CPMP design validation discussion.

B. DSR: Designing the artifact (CPMP)

As mentioned in the preceding paragraph, part of the analysis and insights was used to develop quality dimensions from which theoretical propositions for the CPMP process design and design decisions were derived (see table 2). Since the theory required designing a collaborative policy making process (CPMP), and the pattern language; the theoretical propositions were used to position these requirements (see table 3) to the CPMP process design/prescription and pattern language. These were then used to support designing the CPMP prescription and pattern language following the CE design approach.

C. AR: Evaluation of the designed artifact

Following [24]'s action research method (sub section 4.1), in the *planning* activity, four case organizations (with a total of 34 participants) were visited to request to conduct collaborative workshops

for implementation and evaluation of the theory developed. This was followed by the *act* activity in which the actual implementation of the theory in the field was done. In the actual intervention, various people were involved (researcher(s), problem owner, and participants) and each played different roles. The participants evaluated the meeting and design process (using “satisfaction” variable as an example of one of the validation criteria: see table 4). Additional researchers were used to avoid main researcher bias and they also gave additional evaluations on the

collaboration sessions. To evaluate the theory empirically, qualitative and quantitative data was collected and analyzed during the *observe* activity. Data collected was used to make improvements to the theory during the *reflect* activity. That is, in evaluating and validating the CPMP process design and pattern language, we aimed at addressing the research propositions summarized in tables 2 and 3. From the evaluation and validation goal, the CPMP process design underwent four iterations prior to deriving the resulting generic CPMP process design.

Table 2. Summarized CE Benefits to Collaborative Concerns and Needs

Collaborative Concern	Derived Collaborative Need(s)	CE Theorized Benefit
Conflicting objectives and criteria	Policy requirements stakeholder accommodation	ThinkLets built-in rules enable group/team execution of a collaboration process. In other words, thinkLets permit representation of all participants in all collaborative activities
Reaching consensus is intricate	Policy process outcome completeness	The patterns of collaboration 'clarify', 'evaluate' and 'consensus building' offer thinkLets support that enable availability of a shared base for information and knowledge usage
	Stakeholders' ease of identification of policy elements (with their definitions)	The patterns of collaboration 'clarify' and 'consensus building' offer thinkLets support to enable joint development, shared understanding, shared meaning and context, and consensus
Lack of understanding of the policy process	Understanding of the policy process	ThinkLets provide a group/team with explicit detail of how to conduct a collaboration process
No clear approach to reach an acceptable policy result	Structured policy problem solving approach	CE is an approach to designing recurring collaboration processes using given patterns of collaboration and thinkLets
Time pressure from organization of stakeholder involvement	Policy process efficiency	Group collaboration facilitates optimal usage

Table 3: Summary of Requirements to CPMP Process Design

Requirement (s)	Effect (s)	Component (s)
Offering specific guidelines and rules to guide participation and adequate contribution	Stimulate participation, stakes accommodation and giving of required resources such as effort, sharing of knowledge and information for attainment of the policy goal	ThinkLets, Scripts (process & thinkLet)
Offering relevant information on the CPMP task such as desired goal and deliverables; Providing an overview of the CPMP process and detailed procedure including the underlying principle behind it; Presenting the rationale of the procedure in a problem-solution arrangement	Cognitive load reduction to stimulate ease of understanding and meaning of policy elements and all other policy aspects for goal achievement	Assumptions document, Sequence of thinkLets, Scripts (activity & thinkLet)
Offering specific levels of details on specific activities	Inspire uniformity and shared meaning in content for proceeding activities	Combined thinkLets, Scripts (activity & thinkLet)

Table 4: Averages of Satisfaction with process and outcome

	1	2	3	4
Satisfaction with process				
Average	4.800	3.838	4.500	4.800
Standard deviation	1.376	0.995	1.366	1.053
Satisfaction with outcome				
Average	5.160	4.363	5.367	5.486
Standard deviation	1.310	1.094	0.908	0.598

5. Conclusion

The assessment of the research methods offered in this paper has been derived from the existing literature on general research methods. From the assessment, we observe that people conduct research in order to increase theoretical knowledge. That is, they want to understand why things happen in a particular area of interest; and also to improve practices in such a way that they expect that research will ultimately result in some useful social outcome. We also observe that researchers use these methodologies to guide them in defining, collecting, organizing, and interpreting their data. For instance, in the context of CE research, a CE researcher may use a survey research to make measurements of the success of the collaboration process outcomes and process designs (variable relationship) in an intervention; while the same researcher may also use a case study for some detailed investigation of a particular phenomenon of interest (POI).

It is from the above assessment that we offer the research methods' relevancy to the CE research community, and particularly how the case study research, design science research and action research methods can be combined to support conducting an effective CE research effort (designing and evaluating CE processes). This potential is evidenced in the three CE research examples. Therefore, and based on the CE way of working framework, the combined research methodology has indeed the fundamentals to support fulfillment of CE research efforts.

While sufficient benefits of a selected number of research methods to CE research have been offered, additional research on how other methods not represented in this work can benefit (relevancy) the CE research community should be done. Research methods such as experimental research, simulation and games research, to mention but a few should be assessed to derive their benefit to the CE research community.

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