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Action research and design science research - Seemingly similar but decisively dissimilar

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ACTION RESEARCH AND DESIGN SCIENCE RESEARCH – SEEMINGLY SIMILAR BUT DECISIVELY DISSIMILAR

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Abstract

Prior research has identified the similarity of Action Research (AR) and Design Science Research (DSR). This paper analyses AR and DSR from several perspectives, including paradigmatic assumptions of ontology, epistemology, methodology, and ethics, their research interests, and activities. We identify that often AR does not share the paradigmatic assumptions and the research interests of DSR, that some activities in DSR are always mutually exclusive from AR, and that there may be no, little, or significant (but not total) overlaps between AR and DSR. Thus we judge that AR and DSR are decisively dissimilar. We further identify several key problems with combining AR and DSR based on the ethical requirement of researchers to identify and manage risks to research stakeholders. Management of such risks is done by careful disclosure, identifying research limitations or by choosing alternative methods than AR for accomplishing DSR.

Keywords: Action Research, Design Science Research, Research Paradigm, Ontology, Epistemology, Research Methodology, Ethics.

1 INTRODUCTION

The recent attention to Design Science Research has led many commentators to consider the relationship between Action Research (AR) and Design Science Research (DSR) (e.g. Burstein and Gregor, 1999; Cole et al., 2005; Järvinen, 2007). Järvinen especially makes a strong case for DSR being similar to AR. He analyzed and aligned the matching activities and characteristics of both AR and DSR. He found that AR and DSR have five main activities in a research cycle, which match. He also identified seven characteristics of AR and six characteristics of DSR and shows how they match. Overall, he found AR and DSR to be very similar, and as a consequence suggests that AR as a qualitative research method has a wrong "home" and should be more closely associated with DSR.

We agree that AR and DSR share many features, but at the same time we view Järvinen's conclusions as overly hasty. First, if we accept that, as DSR has been implicitly practiced in engineering for centuries and in Computer Science and Software Engineering for decades, it is hard to interpret that all this DSR has actually been AR. In our opinion, doing so would extend the concept of AR much too far (we will discuss the concepts of AR and DSR in the next section).

Second, in our opinion, Järvinen's analyses of both AR and DSR are based on somewhat biased conceptions of AR and DSR. In the case of AR, he sees action researchers' intent as to plan and take action in order to change a part of reality. His focus is on the practical problem solving interest side of AR, deemphasizing its research interest side (McKay and Marshall 2001). This focus may bias his interpretation of AR toward one that aligns better with DSR. In the case of his interpretation of DSR, Järvinen relies heavily on van Aken (2004). Although van Aken (2004) distinguishes improvement problems and construction problems, his major interest lies in improvement problems rather in construction of complex artifacts. Solution concepts (van Aken 2004) – whether general or specific – to improvement problems often are not complex artifacts, although they may be implemented in a complex and messy organizational environment. As a consequence, building artifacts does not have as central a role in addressing improvement problems as it does in addressing construction problems. Järvinen's focus on van Aken's (2004) emphasis on improvement problems in DSR biases his interpretation of DSR toward one that aligns better with AR than DSR would align more generally.

The purpose of the present paper is to continue the discussion about the relationship between AR and DSR. We will argue that although AR and DSR are seemingly similar, they are quite different phenomena. This conclusion is based on two analyses. First in Section 3, we analyze the paradigmatic – ontological, epistemological, methodological and ethical – roots and assumptions of AR and DSR, finding that they are somewhat different, but not incompatible. For our second analysis, Section 4 will analyze the research interests and activities of AR and DSR, showing how, while they are again compatible and may significantly overlap, they are decisively different. Based on these analyses and some further literature, Section 5 will discuss some ethical problems and more pragmatic reasons to keep AR and DSR as separate, especially when the focus of DSR is building and testing innovative artifacts. These all revolve around the fact that when building innovative, cutting-edge artifacts, possible failure is always present. That may make it difficult and also risky to combine AR and DSR.

2 WHAT IS ACTION RESEARCH AND WHAT IS DESIGN SCIENCE RESEARCH?

In this section we delineate the conceptions of AR and DSR adopted in the present paper.

2.1 Action Research

Action Research has been widely discussed in the IS literature (e.g. Davison et al. 2004; Kock 2004; Lau 1999; McKay and Marshall 2001). The purpose here is not to repeat that discussion, but to summarize the interpretation of AR adopted in the present paper.

A widely adopted definition of AR by Rapoport (1970) characterizes it as follows: "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework". According to this definition AR has a dual goal of contributing to practice and research at the same time. The definition also assumes that there is a concrete client involved. As a consequence, AR is highly context dependent while attempting to address the specific client's concerns.

Action Research is not a homogenous whole, but includes a number of versions (Baskerville and Wood-Harper 1998; Chandler and Torbert 2003). This paper focuses on Canonical Action Research (CAR) (Davison 2004), which is based on five principles:

1. The principle of the researcher-client agreement
2. The principle of the cyclical process model
3. The principle of theory
4. The principle of change through action, and
5. The principle of learning through reflection

The definition of AR by Rapoport (1970) emphasizes the first principle. The cyclical model of Susman and Evered (1978) – diagnosing, action planning, action taking, evaluating, and specifying learning – is the most well-known example of the second principle. McKay and Marshall (2001) summarize other cyclical AR models and propose a dual cycle model in which the cycle of research interest and the cycle of problem solving interest proceed in parallel while closely interacting with each other. For the third principle Davison et al. (2004) note that a CAR project may begin with theory-free action learning, but suggest that action researchers need theory to guide and focus their activities. We agree that qualitative research project may start relatively theory-free, but not totally. However, "theory" is an ambiguous concept (Sutton and Staw 1995) with multiple meanings (Gregor 2006). Most often it refers to theories for predicting and explaining, which are rare in IS research. Therefore, in line with McKay and Marshall (2001), we would speak about theoretical frameworks rather than about theories. The fourth principle, the principle of change through action, attempts to ensure that diagnosing the problem, action planning, action taking and evaluating are appropriately done so that one can expect an improvement in the client's problematic situation (Davison et al. 2004). The final principle, the principle of learning through reflection, attempts to ensure that both researchers and the client examine what they have learned in an explicit, systematic and critical manner (Davison et al. 2004).

2.2 Design Science Research

To our knowledge, there is no widely accepted definition of Design Science Research. Vaishnavi and Kuechler (undated) characterize "Design Research" as "yet another "lens" or set of analytical techniques and perspectives (complementing the Positivist and Interpretive perspectives) for performing research in IS. Design research involves the analysis of the use and performance of designed artifacts to understand, explain and very frequently to improve on the behavior of aspects of Information Systems." Hevner et al. (2004) note that the design science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts, including constructs, models, methods, and instantiations (also as in March and Smith, 1995). Venable (2006) identified "solution technology invention" as the core of DSR. We are ready to define DSR as a research activity that invents or builds new, innovative artifacts for solving problems or achieving improvements, i.e. DSR creates new means for achieving some general (unsituated) goal, as its major research contributions. Such new and innovative artifacts create new reality, rather than explaining existing reality or helping to make sense of it.

When compared with AR, an essential difference is that DSR assumes neither any specific client nor joint collaboration between researchers and the client. One should note, however, that typically the developed artifact aims at addressing a class of problems (Walls et al. 1992) in a way that it is useful in addressing specific problems of a specific client. As a consequence, one could argue that DSR has would-be-clients who comprise "The set of all members of the generalised class of all people or

organizations who could potentially be motivated to solve instances of the generalised class of problem(s)" (Venable 2009) addressed by the DSR outcome (artifact).

Some researchers have advocated a 'soft' version of DSR. Venable and Travis (1999) and Venable (2006) argued that more qualitative methods, including AR, could be used for evaluation of DSR outcomes. Venable (2006) further noted that AR could be used across the entire DSR lifecycle (on the naturalistic evaluation side). Baskerville et al (2007) proposed the development of a Soft DSR approach to better accommodate risks in DSR, including poor problem understanding and the potential for evaluation to give rise to type I or type II errors. However, these 'soft' approaches to DSR still assume a general, unsituated goal or problem to be solved rather than the situated one inherent in AR.

More fundamentally, equating AR to DSR suffers from the category problem: AR is a research method while DSR is more a research orientation, within which one can use different research methods (including AR). See the various research methods identified for evaluating innovative solutions as part of DSR in Hevner et al (2004) or Venable (2006), the latter of which includes AR.

3 PARADIGMATIC ASSUMPTIONS OF AR AND DSR

One possibility to scrutinize similarities and differences between AR and DSR is to analyze their paradigmatic assumptions. The section introduces first the paradigmatic framework to be applied. After it AR and DSR are analyzed in turn using the framework and finally the results are summarized.

3.1 The paradigmatic framework

Adopting Burrell and Morgan (1978), Iivari (1991) analyzed paradigmatic assumptions of a number of IS development approaches. The analytical framework included ontology, epistemology, methodology and ethics of research. In the following we will apply this framework.

Burrell and Morgan (1978) distinguish two extremes in the case of ontology: realism vs. nominalism. Realism "postulates that the social world external to individual cognition is a real world made up of hard, tangible and relatively immutable structures. [...] For the realist, the social world exists independently of an individual's appreciation of it [...] the social world has an existence which is as hard and concrete as the natural world" (p. 4). Nominalism, on the other hand, "revolves around the assumption that the social world external to individual cognition is made of nothing more than names, concepts and labels which are used to structure reality […]" (p. 4).

Similarly, Burrell and Morgan (1978) identity two epistemological positions: positivism vs. anti-positivism. Positivism seeks "to explain and predict what happens in the social world by searching for regularities, causal relationships between its constituent elements", whereas anti-positivism maintains that the social world "can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied. Anti-positivists reject the standpoint of the 'observer', which characterizes positivist epistemology, as a valid vantage point for understanding human activities. They maintain that one can only 'understand' by occupying the frame of reference of the participant in action. One has to understand from the inside rather than the outside." (p. 5).

In the case of methodology, Iivari (1991) distinguishes three categories: nomothetic methods, idiographic methods and constructive methods. The last category complements Burrell and Morgan's distinction between nomothetic methods and idiographic methods. Focusing specifically on IS development, Iivari (1991) distinguished conceptual development and technical development in the context of constructive methods explaining that "Conceptual development as a category of constructive research methods refers to the development of various models and frameworks which do not describe any existing reality but rather help to create a new one, and which do not necessarily have any "physical" realization (e.g. IS development "methodologies"). Technical development produces as its outputs "physical" artifacts, the adjective "physical" being interpreted here broadly to include

executable software (e.g. CASE environments)" (Iivari 1991, p. 257). These characterizations attempted to capture specific research methods used in the development of the above artifacts.

In the case of ethics, Iivari (1991) distinguishes three ethical positions: means-end, interpretive, and critical. In the first case, research aims at providing means knowledge for achieving given ends (goals), without questioning the legitimacy of the ends. The interpretive stance questions the realism of the idea of human and organizational action as goal-directed action. Goal statements follow rather than precede action (cf. March and Olsen, 1976). They are reconstructed retrospectively to give meaning to action. According to Chua (1986), the aim of an "interpretivist scientist is to enrich people's understanding of their action" and "how social order is produced and reproduced" (p. 615), and a critical scientist sees that research has "a critical imperative: the identification and removal of domination and ideological practice" (p. 622). As a consequence, critical research subjects goals (ends) to a critical analysis.

In the following we apply the above paradigmatic framework to analyze similarities and differences between AR and DSR.

3.2 Paradigmatic assumptions of Action Research

To our knowledge, the early article of Oquist (1978) and the recent article of Cassell and Johnson (2006) are the most serious attempts to analyze the philosophical assumptions of AR. Oquist (1978) analyzed the kind of knowledge AR produces and its relation to different schools of philosophy of science (Empiricism, Logical Positivism, Structuralism, Pragmatism and Dialectical Materialism). Although his main focus lies in the epistemology, his analyses also cover ontological and ethical assumptions. He concludes that AR is compatible with the assumptions of Pragmatism and Dialectical Materialism, but incompatible with those of Empiricism, Logical Positivism and Structuralism.

Cassell and Johnson (2006) argue that the diversity of AR is due to different philosophical assumptions adopted. More specifically, they discuss philosophical assumptions underlying five different approaches to AR, which they label “experimental”, “inductive”, “participatory action research”, “participatory”, and “deconstructive”. “Experimental” AR covers Lewinian and Tavistockian traditions of AR with realistic ontology and positivistic epistemology. Cassell and Johnson (2006) explain “inductive” AR as an approach in which “theory … is generated from the data (…) of thick descriptions of the patterns of subjective meanings that organizational actors use to make sense of their worlds, rather than entailing the testing of hypotheses deduced from a priori theory that causally explains what has been observed by the action researchers” (p. 793). They refer to grounded theory as an example of the inductive approach and discuss “action science” (Argyris et al. 1985) as an example of the “inductive” approach. “Participatory action research” in Cassell and Johnson (2006) refers to an AR approach in an organizational or corporate setting in which the researcher usually works in a consultancy role serving the corporate elite, while “participatory research”, typically informed by ‘critical theory’, “requires that those individuals and groups whose perspectives are ordinarily silenced in organizations must be given voice through action research” (p. 798). Finally, “deconstructive” AR is an emerging approach that is based on postmodernism. It assumes a plurality of incommensurable voices, implying that “any discursive closure, whether grounded on democratic consensus or otherwise, implies the arbitrary dominance of a particular discourse which serves to silence alternative possible voices” (p. 804). Quite interestingly, none of the five approaches discussed by Cassell and Johnson (2006) directly corresponds to CAR, but in our view the “inductive” approach is closest to it.

Based on Oquist (1978) and Cassell and Johnson (2006) and our own reading of AR, we conclude that the ontology of CAR is anti-realist. It does not see (social) reality as “hard, tangible and relatively immutable structures” (Burrell and Morgan 1978), but as socially constructed that can be changed. At the same time we do not interpret that AR necessarily adopts the extreme ontological position of nominalism. Therefore we characterize the ontological position of CAR as anti-realist.

Similarly, the epistemological position of CAR is mainly anti-positivist. Although an action researcher may search for regularities and causal relationships in the social world or may apply such when interpreting the world, CAR clearly recognizes the limits of such regularities. Each CAR project is unique and the case can only be understood from the point of view of the individuals who are directly involved in the activities which are to be studied. As a consequence, in accordance to Iivari (1991), we interpret that AR as a research method is clearly idiographic.

In the case of ethics, we interpret that CAR is mainly means-ends oriented, but can also be interpretive. The major reason is that CAR is typically oriented in solving or alleviating a specific client's problems, as evidenced by the 5-step AR cycle proposed by Susman and Evered (1978). CAR can also be interpretive if evaluation focuses on rich understanding of meanings attached to the executed action and its intended and unintended consequences. To some extent differing from Oquist (1978), we do not see CAR as representing a critical approach in the sense that it would challenge existing power structures or structures of domination and would suggest radical changes in that meaning. The major reason is that CAR represents joint collaboration between researchers and the specific client, within a mutually acceptable ethical framework. It is extremely unlikely that the most powerful representatives of the client (its management) would be ready for such radical changes.

Assuming that CAR is closest to the "inductive" approach discussed by Cassell and Johnson (2006), our assessment differs from theirs in that they conclude that the "inductive" approach ultimately reflects positivistic epistemology. The positivistic epistemology manifests in the presupposition of neutral observational language, and in the privileged position of the researcher who is assumed to access empirically data from the independent reality. We agree with Cassell and Johnson (2006) in the sense that the positivistic epistemology is so deep-rooted in our conception of research and science that often times when one scratches the surface of seemingly anti-positivistic approach, positivistic ideas can be found beneath the surface. One should note, however, that we do not see positivism and anti-positivism as mutually exclusive, but a research approach may – possibly unconsciously - include ideas from both philosophical positions. In our view CAR implies a clear move towards anti-positivistic epistemology although it may include some positivistic ideas.

3.3 Paradigmatic assumptions of Design Science Research

The DSR literature only rarely discusses its paradigmatic assumptions. Iivari (2007) discusses DSR's ontology based on Popper's 3-world ontology, epistemology in terms of types of knowledge associated with DSR, distinctive constructive research methodology, and ethics, but does not focus on its assumptions specifically. Vaishnavi and Kuechler (undated) briefly discuss DSR's ontology, epistemology, methodology and axiology (≈ ethics), contrasting DSR with positivism and interpretivism. Unlike Vaishnavi and Kuechler (undated), the present paper does not see DSR as a third "paradigm", but as based on more or less "positivistic" or "interpretivist" assumptions. This is in line with Niehaves (2007) who has a detailed analysis of the epistemological assumptions of DSR, claiming that "interpretive" (non-positivistic) epistemology is highly relevant in the context of DSR.

We conclude that DSR may adopt a realistic or anti-realistic ontological position. DSR especially in engineering exemplifies the realistic position, but we do not see realism inherent to DSR. Markus et al. (2002) exemplifies this point – in our view it clearly adopts a non-realistic ontological position.

DSR may also adopt both positivistic and anti-positivistic epistemology. Much of DSR in engineering is based on positivistic epistemology. Although March and Smith (1995) and Hevner et al. (2004) have a positivistic epistemological bias (Niehaves 2007), we agree with Niehaves (2007) that the anti-positivistic epistemology is also relevant in DSR, especially in evaluation of developed artifacts. For example, Baskerville et al (2007) propose "Soft Design Science" and Venable (2006) and Venable and Travis (1999) identify interpretive methods as appropriate for naturalistic, in situ evaluation of DSR outputs. On the other hand, since DSR aims at producing general solution concepts (van Aken 2004) or meta-artifacts (Walls et al. 1991; Iivari 2003), which are more widely applicable than in a specific organizational context, DSR aims at general knowledge typical to the positivistic epistemology.

Methodologically, DSR may apply both nomothetic and idiographic methods, as the variety of design evaluation methods proposed by Hevner et al. (2004) implies. As explained above, Iivari (1991) suggested constructive research as a third category of methods. Since it focuses on building IT artifacts, it can be considered a distinctive category of methods in the case of DSR.

With respect to ethics, much (if not all) of DSR is means-end-oriented. The artifact to be developed is assumed to have some purpose (Hevner et al. 2004; Gregor and Jones 2007). However, Venable (2009) claims that Hevner et al. (2004) consider profit (utility) maximization as the ultimate goal of DSR and that, overall, they privilege managers as a stakeholder group on business organizations. In AR, one can also use interpretive evaluation studies that aim at a rich understanding of the meanings attached to the constructed artifact and its intended and unintended consequences in practice. However, DSR may more easily have a critical orientation. DSR may aim at developing new artifacts that challenge existing power structures of domination. The Scandinavian trade-unionist IS development approach, is an example this orientation (see Iivari et al. 1998).

3.4 Summary of the analyses

Table 1 summarizes the above analysis. It suggests that DSR is more varied in its paradigmatic assumptions than AR. Paradigmatically, AR can be considered a special case of DSR, yet keeping in mind that DSR by definition includes building new innovative artifacts (unlike AR). As a consequence, there is not necessarily any paradigmatic incommensurability problems between AR and DSR, so they can be applied together, especially if DSR adopts paradigmatic assumptions that are compatible with those of AR. We also believe that if DSR activities of building an artifact and its evaluation are separate, one can easily apply AR in the evaluation (Venable, 2006, Johnstone and Venable, 2008), even if the building of the artifact has been based on paradigmatic assumptions that differ from those of AR. For example, one may have engineered an artifact based on a positivistic epistemology reflecting a realistic ontology (e.g. laws of physics). The evaluation of the very same artifact may follow an anti-positivistic epistemology and an anti-realistic ontology. In fact, we believe that idiographic research methods reflecting an anti-positivistic epistemology are often justified when attempting to understand organizational or individual appropriation, usage and consequences of any technology in real life.

Paradigmatic dimension	**Action Research**	**Design Science Research**
Ontology	Anti-realism	Realism or anti-realism
Epistemology	Mainly anti-positivism	Mainly positivism, but also anti-positivism especially in evaluation
Methodology	Idiographic	Constructive (building) Nomothetic (evaluation) Idiographic (evaluation)
Ethics	Means-end Possibly interpretive Unlikely critical	Means-end Possibly interpretive Possibly critical

Table 1. Summary of the paradigmatic assumptions of Action Research and Design Science Research.

4 COMBINING AR AND DSR

As noted in Section 2 considering our conceptions of AR and DSR, by definition the research interest of DSR is to construct new and innovative ways to solve a class or classes of problems, thus creating new reality. AR does not necessarily share any such purpose. Much of AR is conducted to understand existing reality, such as the complex workings of organisational situations and human behaviour. These research interests are decidedly different.

We now turn our analysis to the activities of AR and DSR. To facilitate our analysis, we conceptualize of two broad classes of problems and solutions: purely technical problems and innovations and socio-technical problems and innovations. Furthermore, we assume that any solutions or innovations to purely technical problems do not have direct and complex implications for the socio-technical systems within which they will be embedded (other than monetary costs, which are always taken into consideration in any innovation). Therefore, there is little or no interest in such problems and innovations in the context of AR, although there can be considerable interest in the context of DSR. Rather, AR is exclusively interested in innovations with significant impacts on socio-technical systems and the human context. This distinction between purely technical and socio-technical problems and innovations is reflected in the potential activities or AR and DSR, which we will now analyse.

We base our analysis of AR and DSR activities on the model of DSR activities presented in Venable (2006), which extended the multi-methodological framework of Nunamaker (1990) and Venable and Travis (1999) to differentiate between Naturalistic and Artificial evaluation in DSR, as in Figure 1.

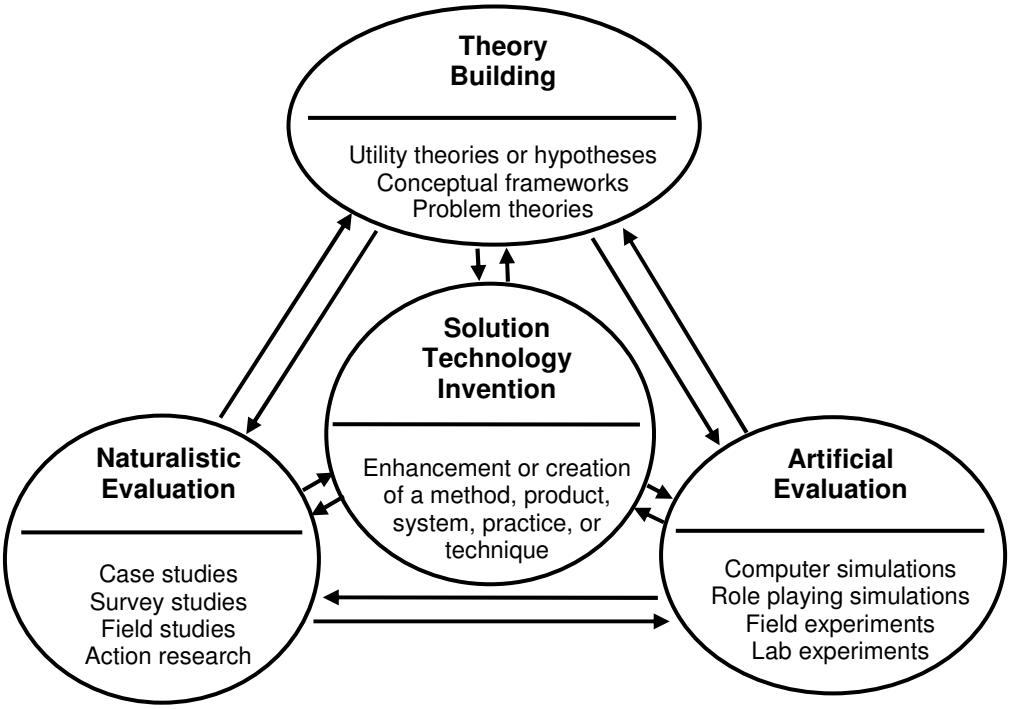

Figure 1. Framework and Context for DSR (Venable, 2006).

In Figure 1, AR is shown as one of several means of conducting naturalistic evaluation of a new and innovative "solution technology" (Venable, 2006). DSR can also (or alternatively) conduct artificial evaluation. Artificial evaluation may be all that is required for purely technical artifacts. Artificial evaluation is not part of or relevant to AR, which is a decisive difference between AR and DSR.

Using this framework to analyze the overlapping activities between AR and DSR, we can identify three different cases: (1) completely non-overlapping (in three different ways), (2) slightly overlapping, and (3) significantly overlapping. Note that we do not call the third case "fully overlapping", because artificial evaluation will never be a part of AR, as described in the previous paragraph. We will consider each of these three cases in turn.

In the first case, AR and DSR activities will be completely non-overlapping. Here AR is not concerned at all with the DSR research interest of building and evaluating innovative artifacts. One such situation is where the problem solving interest of the client will be addressed without any technology or through the application of existing solutions without innovation. In the latter case AR may include design, but it is normal design practice rather than DSR. Here, in so far as the action researcher is concerned with

the efficiency or effectiveness of the solution technology, it is concerned with the client's problem solving interest. This problem solving interest merely provides the context and opportunity to research other aspects of socio-technical systems, such as organisational or human behaviour.

A second situation in which there is no overlap (which we will call case 1b) is where the DSR is concerned with solving a purely technical problem. In this case, evaluation is primarily artificial and there is no need for naturalistic evaluation (applying AR, for instance).

A third situation in which there is no overlap (which we will call case 1c) is where the DSR is concerned with solving a socio-technical problem, but not arising in an AR context and where AR is not used for naturalistic evaluation. Evaluation may be conducted artificially and/or using other research methods for naturalistic evaluation, such as case studies or surveys. Note that such evaluation could complement, precede, or follow separate AR evaluations (see case 2 below).

The second case concerns the use of AR to evaluate DSR. In this case, the action researcher does not develop a new, innovative artifact or solution technology, but has the express purpose of evaluating an existing solution technology that is still of research interest. In this case, the research interest (or a major part of it) is the evaluation and a planned research outcome is statements about the efficiency, effectiveness, or efficacy of artifacts that have been proposed and developed by other researchers or practitioners. In this case, there is only slight overlap, which is limited to the naturalistic evaluation activities in Figure 1.

The third case (significant overlap) is where the action researcher actually is also conducting DSR, in that he/she is inventing a new, innovative artifacts or solution technology to better address the client's problem solving interest (a socio-technical problem). In this case, the research interest includes the development and evaluation of the solution technology. In the framework shown in Figure 1, this would include the theory building, solution technology invention, and naturalistic evaluation activities.

Table 2 summarizes these three cases.

Case	AR Interest	DSR Interest	DSR Activities
1a. No overlap	Understanding reality in an organizational context	None	None
1b. No overlap	None	Solving a purely technical problem by developing and evaluating a new solution technology	Theory building, Solution technology invention, and Artificial evaluation
1c. No overlap	None	Solving a socio-technical problem in a non-AR context by developing a new solution technology, but evaluating it by means other than AR	Theory building, Solution technology invention, and Artificial and/or naturalistic evaluation
2. Slight overlap	Evaluating an existing solution technology in an organizational context	Evaluation of a solution technology developed separately	Naturalistic evaluation only
3. Significant overlap	Solving a socio-technical problem by developing and a new solution technology and evaluating it in an organizational context	Solving a socio-technical problem by developing and a new solution technology and evaluating it in an organizational context	Theory building, Solution technology invention, and Naturalistic evaluation

Table 2. Overlaps in activities between AR and DSR.

5 PRACTICAL PROBLEMS OF COMBINING AR AND DSR

Although AR and DSR are in principle compatible with each other, they may be difficult to combine for more practical reasons. In the following we shall discuss these difficulties in more detail.

As pointed out above, AR assumes collaboration between researchers and the client within a mutually acceptable ethical framework. This ethical framework may not be self-evident in an AR project, but if the AR is part of a larger DSR effort, it may be particularly difficult to achieve such agreement since the major parties, researchers vs. clients, may have widely opposing goals. DSR by definition attempts to construct new and innovative artifacts or solution technologies. As a consequence, it operates at the edge of the existing technology. Such cutting edge technology is not usually robust. Petroski (1982) claims that failure is central to understanding engineering, and that lessons learned from failures can advance engineering knowledge more than all the successful cases. Similarly, DSR may push a new technology to its limit until it collapses. However, in AR the client's interest is usually that the technology employed is proven and robust and does not disturb the performance of their work. Having a technology fail would be unlikely to be appropriate or agreeable to the client in an AR context.

Weedman (1998, 2008) describes such a conflict of interest in the Sequoia 2000 project. It was essentially a combined DSR and AR project, although she does not refer to AR in her two papers. The project comprised computer scientists who acted as researchers and earth scientists as users. She describes the conflict of interest when the technology was repeatedly pushed to the limit by computer scientists until it broke, with consequent costs to the users when the system crashed and the users' work came to a halt.

In conclusion, DSR may apply a conscious "learning from failures" strategy when developing new, innovative artifacts. Although the goal of this "learning from failures" strategy is to develop more robust technology that would be safer for the potential users of the developed technology or artifact, one should note that new technology is always failure prone and risky. In such a case, the research interest of the researcher would conflict severely with the problem solving interest of the client.

AR in the DSR context implies that potentially failure prone technology is applied in the real-life context. Depending on the nature of technology and situation, it is more or less risky to the client. The potential of risk to the clients or the public have led DSR in engineering and medicine to prioritize laboratory testing in the initial evaluation (testing) of the developed artifacts or technology. This initial testing is done clearly separated from potential clients, partially to reduce risks.

In terms of the framework from Venable (2006) in Figure 1 above, where there are significant risks, the evaluation of the developed artifacts (e.g. as in case 2 above) should be done artificially, if possible, before attempting to evaluate naturalistically, using AR, for example. One can identify two opposing aspects in AR as far as risks to the client are concerned. On one hand, the involvement of the researcher in choosing the appropriate solution technology and the provision of on-going guidance for the using client organization during the AR study may mitigate the risk to the client. On the other hand, the AR researcher is often an advocate of the solution technology, and therefore may be prepared to push the technology too far from the client's viewpoint in order to make it work. To mitigate this the client should always to have the right to quit, if it does not want to continue the AR project.

When AR overlaps significantly with DSR (as in case 3 in the previous section), the solution technology invention is "on the fly", which is inherently more risky than careful and thorough development before moving on to a separate evaluation. Thus, in our view, the mixed invention and evaluation of a new solution technology combining AR and DSR should only be used in situations where the risk to the client (and other stakeholders) is acceptably low. Also, the mutually agreeable ethical framework for the research should identify and make clear the risk of developing and trying out something new and take steps to mitigate that risk.

Finally, as identified in Venable (2009) and Pries-Heje et al (2008), there are risks in DSR that new or innovative solutions, once published and made available to be adopted by the public, do place these other stakeholders at risk. It is necessarily the case that AR is conducted in a narrow context, which implies that a new solution technology is untried in other contexts. Steps therefore need to be taken to clarify the extent of the evaluation in the AR context and to decide and state whether risks are yet

acceptable for public consumption of new technologies. Alternatively, other research methods than AR might be more appropriate for conducting the DSR.

6 CONCLUSIONS

There has been a significant and ongoing theoretical discussion in the IS field as to the nature and compatibility of AR and DSR, some of which has claimed that the two are similar, if not identical. In this paper we have analyzed the similarities and differences between AR and DSR based on their respective paradigmatic roots and assumptions, their research interests, the overlaps in their activities, and potential problems in combining the two approaches. Our conclusion is that, while the two approaches are compatible (and their synergistic use warrants further development), their paradigmatic assumptions, research interests, and activities may differ dramatically, depending on the purpose of research. More fundamentally, their levels or categories as research orientation (DSR) or method (AR) are different. Thus, we find that their similarities are actually quite superficial and the two things are decisively different.

Considering the practical implications of this analysis, we further identify that the employment of AR in the conduct of DSR needs to be done with care, especially where there is the potential for significant risk to the client or other stakeholders. Steps need to be taken where new technologies are being evaluated with AR to ensure that the evaluation is done carefully and that the completeness of the evaluation is judged and reported with a view to its limitations and remaining risk. This is especially the case where the new technology is developed "on the fly" as part of an AR project.

Our further recommendation is that clear consideration of risks due to the untried nature of the technology must be part of an ethical framework to be agreed at the beginning of a joint AR and DSR project. This is not just for improving the likelihood of successful conduct of the research project, but is the ethical responsibility of the researcher. Such agreement must be reached with the full, informed, and uncoerced consent of the client. Steps should also be taken, where possible, to reduce the risk to the client by evaluating the technology beforehand using other evaluation methods.

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