# Effectuation and Its Implications for Socio-Technical Design Science Research in Information Systems

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**Abstract.** We study the implications of the effectuation concept for socio-technical artifact design as part of the design science research (DSR) process in information systems (IS). Effectuation logic is the opposite of causal logic. Effectuation does not focus on causes to achieve a particular effect, but on the possibilities that can be achieved with extant means and resources. Viewing socio-technical IS DSR through an effectuation lens highlights the possibility to design the future even without set goals. We suggest that effectuation may be a useful perspective for design in dynamic social contexts leading to a more differentiated view on the instantiation of mid-range artifacts for specific local application contexts. Design science researchers can draw on this paper's conclusions to view their DSR projects through a fresh lens and to reexamine their research design and execution. The paper also offers avenues for future research to develop more concrete application possibilities of effectuation in socio-technical IS DSR and, thus, enrich the discourse.

**Keywords:** effectuation; causation; socio-technical artifact; socio-technical system; emergence; transformation

## 1 Introduction

The current design science research (DSR) in information systems (IS) literature commonly understands DSR as a structured search process for the solution to problems (or a class of problems) of real-world socio-technical systems. The solution takes shape in form of an artifact/design theory, which draws on and should contribute to extant descriptive and prescriptive knowledge [1]. The artifact is to be introduced into one or more real-world application context(s) and evaluated as to how well it can solve the (class of) problem(s) while providing measurable utility [2]. On this basis, the designed artifact can be refined iteratively in cycles to provide a superior solution for the given problem [3]. Current thinking regards factors from within the artifact's application context which threaten an artifact's utility (such as unexpected

developments, contingencies, or surprises) as factors the designers' skills need to mitigate [4].

This straight orientation towards finding an optimum (or at least, satisfactory) solution for a given problem within an exogeneous environment mirrors, to a certain extent, the causal perspective of explanatory-oriented research. This type of research seeks to identify, validate, or falsify causes for a given effect in the likewise exogenous real world [5]. Applied to DSR, the artifact is the cause embodying the intended effect (solve the problem) and the design goal is to strive for the most effective cause. Gregor and Jones even develop their design theory elements on the grounds and terminology of Aristotelian causation [6]. Such a cause-effect perspective has DSR oppose and not embrace contingencies and emergence in dynamic social artifact application contexts.

However, an alternative school of thought coming from entrepreneurship research proposes to consider thinking not in causation, but effectuation logic [7]. Effectuation does not focus on identifying or triggering specific cause-effect relations, but on using the means at hand to achieve desirable effects and, thus, shaping and controlling the future. Effectuation has been loosely connected (and found to be conforming to) organizational DSR [8], but has, to the authors' knowledge, not yet been discussed in the context of designing socio-technical IS. We intend to fill this gap in this research-in-progress paper by first giving a brief overview of effectuation itself and its past application in the context of entrepreneurship research as a science of the artificial. Afterwards we discuss general implications for socio-technical artifact design as well as for corresponding DSR processes and outline further research avenues.

## 2 Effectuation and Its Role in Sciences of the Artificial

In this section, we briefly summarize the effectuation concept and show its application in another science of the artificial: entrepreneurship research.

### 2.1 The effectuation concept in a nutshell

Sarasvathy conceptualized effectuation as the opposite of causation [9]. Unlike causation, effectuation does not focus on finding causes that explain or achieve a given (intended) effect, but considers available actions through given means and their spectrum of possible effects. Effectuation therefore is about generating alternatives with differing effects (and choosing one of them) instead of choosing among given alternatives which all lead to the same effect. Thus, effectuation logic constitutes a logic of control [7], specifically controlling the future by actively shaping one's environment within one's possibilities, while being open to the direction of one's actions.

In effectuation, the choice of action depends on the three given means of 1) the actors (*effectuators*) themselves and their traits ("who I am"), 2) their knowledge ("what I know"), and 3) their social connections ("whom I know") [7]. It also depends on what the effectuators can imagine to be possible effects and what they perceive the corresponding risks or potential losses to be. These risks and losses are matched with

effectuator's set of human aspirations, leading to the eventual choice of action. Neither the means nor the aspirations are treated as invariant, leading to a concept that embraces flexibility and dynamism, allowing the exploitation of emerging contingencies [10].

### 2.2 An effectuation lens on entrepreneurship

Effectuation is the cornerstone Sarasvathy uses to reconceptualize entrepreneurship research as a science of the artificial [8]. In her view, entrepreneurs design firms or even markets – which she therefore considers as human artifacts. This design perspective in effectuation also extends to a more micro level as generating alternatives effectively means designing them.

In positing that firms are tools that entrepreneurs use to shape or even create their future market(s), Sarasvathy, in fact, reverses the common view on firms as the cornerstone or foundation of entrepreneurial action [10]. In her view, firms and markets are not exogeneous entities, but human artifacts that start to exist at some point in time, continuously evolve, grow, shrink, change their purpose or their evolutionary direction, and may eventually fail and cease to exist. The overall process usually starts with a path-creation incident in the form of an initial entrepreneurial decision and continues path-dependent from there [9]. Even the lessons the artifact users (entrepreneurs) learn from failing may contribute to their future successes with new and different artifacts (firms). Sarasvathy further states that entrepreneurs first find possibilities in the world, turn possibilities into opportunities, and go from there to start an ongoing, typically path-dependent, process of designing new and transforming products, services, firms, and, eventually, markets in ways they perceive as suitable to exploit the perceived opportunities and implement the possibilities [10]. Thus, in this entrepreneurship perspective, the entrepreneurs' perceptions of extant possibilities in the world set the whole process of artifact (firm) design in motion.

Moving forward, Sarasvathy et al. [8] identify three crucial factors limiting entrepreneurial design decisions: 1) Knightian uncertainty (with impossibility to calculate probabilities for consequences of future actions), 2) goal ambiguity (no given ordered set of preferences), and 3) environmental isotropy (lack of clarity which information about the environment entrepreneurs should pay attention to for decision-making). Based on a strategy type framework developed by Wiltbank et al. [11], Sarasvathy et al. [8] further distinguish four different strategies entrepreneurs can apply to actually go about designing and transforming products, services, firms, and markets: 1) by planning, 2) by adapting to the environment, 3) by following a clear vision, and 4) by being transformative in the sense of applying effectual logic. In a sample case, Sarasvathy et al. illustrate that the successful Starbucks coffee shop chain has employed all four strategies to varying degrees [8].

Linking their findings to organizational DSR, they conclude that effectuation logic corresponds to van Aken`s postulation of the need to develop theoretically grounded and empirically validated design principles [12], that effectuation logic provides a coherent set of such principles, and that effectuation logic allows their users to cope

with emergence during their design effort better than with traditional planning-oriented approaches that seek to identify causes to reach desired effects.

## 3 Implications for Design Science Research in Information Systems

With this basic understanding of effectuation, we now discuss implications for IS DSR first with a focus on single socio-technical artifact design, second with a focus on artifact populations (applicable to mid-range artifacts which are applied to a number of contexts), and finally for the overall DSR process.

### 3.1 Implications for the design of socio-technical artifacts

We see effectuation's greatest potential for socio-technical artifacts that contain a dominant social component and social context. These two elements add the necessary space for opportunities, contingencies, flexibility, and emergence that is a prerequisite for applying effectuation. Thus, the scope of the subsequent discussions is limited to, for example, traditional business information system artifacts where the technical IT component is a means to an end, to IS artifacts for social domains such as smart cities, or to purely social artifacts such as project management frameworks.

Looking at the three crucial factors for entrepreneurial decisions that Sarasvathy et al. [8] identify, Knightian uncertainty and environmental isotropy apply to IS DSR projects as well. It is impossible to calculate probabilities for an artifact application's consequences for a social context and, given its complexity, unclear which information about a social context is relevant to assess the consequences. The third factor, goal ambiguity, does not apply as directly since utility goals are typically well-defined in IS DSR. This may seem to limit the effectuation concept's applicability to IS DSR at first. However, it may well be the case for an IS DSR project that other goals would be viable as well, which is something that researchers can establish early in the DSR process. Also, this draws attention to the actual problem formulation stage of a DSR process which has not received a lot of research attention yet. Finally, the two formerly named factors are limitations of the traditional causation perspective on DSR as well. Therefore, they serve as (often unspoken) limitations in traditional IS DSR endeavors anyway.

Regarding an artifact's social application context, effectuation highlights that this context is not static and that goals may change. Also, the existence (or implementation) of artifacts may create new goals. Overall, this conveys a more dynamic perspective to the normally static depictions of DSR processes in the literature that often do not match the reality of design projects. Whereas current IS DSR revolves around a stable problem, effectuation in its pure form lacks such a stabilizing element. The closest counterpart to given goals are probably the human aspirations which act as a yardstick to generate and evaluate alternatives. For effectuation-oriented DSR, this would mean not having problems or goals, but human aspirations to drive the DSR process. Such aspirations may lead to quite different resulting designs (effects) which

would then be evaluated in terms of which design is most desirable to satisfy the human aspirations.

Taking this aspiration orientation further, effectuation-oriented DSR is not about maximizing the intended effect of the designed socio-technical artifacts, but treating artifact design as well as artifact application to a specific context as a journey along the path of achieving the underlying aspirations. The lack of a set goal as a yardstick also leads to the question where this leaves artifact utility as a dependent variable[1] [13]? What would be its effectuation counterpart? Artifact utility could be, for example, evaluated ex-ante as artifact potential to reach the aspirations with a given set of means within a particular context. An ex-post evaluation could interpret artifact utility as its power to change a socio-technical system in concordance to the aspirations, regardless whether the actual changes were planned or emerged by themselves. Thus, following Sarasvathy [10], when individuals' perceptions of real-world possibilities form the starting point of effectuation processes, another form of artifact utility could be an artifact's power to let its users perceive and exploit such possibilities in the first place. Even these three abstract examples for artifact utility make it clear that replacing measurable goals with human aspirations adds – almost paradoxically – a strong human (and thus, subjective) element to artifacts and artifact utility. In addition, the dynamic and emergence-oriented nature of effectuation leads to a requirement for socio-technical artifacts to cope with this nature. This requirement reinforces the importance to consider artifact fitness in addition to artifact utility [13].

For actual artifact design, current IS DSR does not only follow a causal pattern in general, as discussed in the Introduction, but design researchers also draw on explanatory and often causal theories to arrive at design decisions. To bridge the two realms of explanatory theories and design artifacts, researchers often rely on an intermediate step which Gregor and Hevner call *prescriptive knowledge* [1]. This type of knowledge often takes the basic form of "if you want to achieve Y in setting Z, then do (something like) X" [14]. The term *prescriptive knowledge* and the previous specification pattern clearly have causal notions. For an effectuation counterpart to capture and specify such action-oriented knowledge, one would have to turn the format around, for example "in setting X with resources Y and Z at hand, one could achieve A, B, or C. Which effect would best match your aspirations and pose an acceptable risk?" The less prescriptive nature of effectuation also points toward the use of softer terminology such as *design proposition* [15] instead of *technological rule* [16], or *suggestive knowledge* instead of *prescriptive knowledge*.

### 3.2 Implications for artifact populations

While in the previous section we limit our perspective to a single socio-technical artifact, in this section we will focus on implications of an effectuation perspective on artifact populations. To make it clear what we mean with artifact populations, we first need to distinguish 1) abstract (or mid-range [1]) socio-technical artifacts (concepts,

[1] Note that even the metaphor *dependent variable* which Gill and Hevner [13] use to highlight the role of artifact utility is derived from causal-oriented language in statistics.

models, methods [17]) and 2) their local instantiations in specific application contexts. The former promise a potential possible future reality for socio-technical systems, while the instantiations are actually part of reality of at least one particular socio-technical system. Effectuation now draws our attention to the process between these two artifact states – an abstract artifact becoming an instantiated one, or, in other words, a potential future reality becomes an effective, actual one. An instantiation of an abstract artifact in several contexts now leads to an artifact population.

This artifact instantiation process has not yet received much research attention in IS DSR. In the management DSR discourse, van Aken proposes to consider not only the object design (the actual abstract artifact), but also a corresponding implementation or realization design prescribing two redesign stages to tailor the abstract artifact to the application context and a final phase of learning to perform [12]. This distinction between these two artifact types opens up a possibility of combining causation and effectuation-oriented DSR: causation-oriented DSR for abstract artifacts and effectuation-oriented DSR for the artifact redesign and instantiation processes. This shields the particulars of each local application context (and thus, the challenge of achieving actual artifact utility) from the abstract mid-range artifact, while still maintaining a connection between the mid-range artifact and its local application contexts.

In addition, in an artifact population perspective, the properties of different contexts for artifact instantiation become a research concern. Here it is conceivable that for the same abstract artifact, the redesign process for different contexts will need to turn out quite differently to maximize artifact effectiveness in terms of changing the context in a desired way. For stable contexts, a traditional causation oriented change process might stay the paradigm of choice, while for dynamic contexts a stronger emphasis on effectuation will allow the exploitation of extant contingencies as opportunities to realize the underlying goals or aspirations even better.

### 3.3 Implications for the design research process and the designers

The points raised in the two previous sections made it clear that an effectuation perspective on IS DSR has profound implications on our understanding of socio-technical artifact design. In this section, we want to highlight corresponding implications for the DSR process as well as the persons executing it – the designers.

Viewed in a DSR context, Wiltbank et al.'s [11] four strategies mentioned in Section 2.2 can serve as general strategies to design socio-technical systems. Of the four strategies, the planning strategy corresponds to traditional IS DSR, while the transformative strategy corresponds to a pure form of effectuation-oriented DSR. Different forms of DSR do not only lead to different design artifact types but also to the need to execute the design research process differently. Following Wiltbank et al.'s advice, a transformative approach promises to be more suited for dynamic contexts than a planning approach. In such a context, a more feasible guiding question for the DSR process is not how to design and execute a process to reach an actual solution, but how to foster the (possibly continuous) effectuation process to look for an improvement of the current situation (a local optimum, so to speak) through socio-technical artifact (re)design.

When differentiating more distinctly between artifact design and instantiation, the distinction between artifact designers and users also needs a cleaner differentiation. In an effectuation lens, during an artifact instantiation a transformation of the actual reality into a different future reality takes place. Here, the abstract artifact just serves as part of the extant means to guide this transformation by highlighting an alternative future. This allows the isolation of a novel role in the DSR process: the *transformers* who control this artifact instantiation process. This role may be filled by the abstract artifact's designers, by the artifact end-users, or by a separate group of people who take the abstract artifact, tailor it to and implement it within a specific application context.

We contend that effectuation further highlights the importance of creativity for the designers [18] (and, consequentially, also for the *transformers*). Here, effectual logic provides a frame to stimulate creativity as Sarasvathy et al. demonstrate in several instances throughout their papers [7–9]. When artifact design and instantiation is a journey into the unknown (see Section 3.1), a key question for the DSR process is when and how the design researchers should evaluate their journey? How can one differentiate an effective journey compared to a journey following the adage of "we are lost, but making good progress" – ideally, *while still being underway*?

## 4 Discussion and Conclusion

Our goal in this paper is to illustrate how the effectuation concept from entrepreneurship research can provide an alternative and novel lens of viewing and understanding socio-technical DSR and artifact instantiation processes. We also suggest that effectuation has the potential to be an alternative positioning that design researchers can employ to conduct IS DSR in the context of complex socio-technical environments. We do not claim that effectuation is a replacement for traditional causation-oriented DSR, but we see potential in coexistence between both paradigms in the future. It is difficult to see where, when introducing an artifact, it would make sense to stop trying to cause intended reactions of a socio-technical system in stable, predictable, and well-known contexts. However, for unknown and dynamic contexts or wicked design problems, an effectuation-oriented design approach may prove to be complementary or even superior to traditional DSR. In any case, taking and considering the alternative effectuation perspective may provide design researchers with fresh insights necessary to deal with design for a challenging environment. A clear limitation of the effectuation perspective exists when clear goals are set which cannot be changed or may not be deviated from during a DSR project. As we have not employed an effectuation lens to an actual DSR effort yet, this paper itself has a clear limitation in remaining purely conceptual.

We therefore see one avenue for further research to re-examine past DSR projects through an effectuation lens and see whether and to which extent the conceptual issues raised in this paper correspond to DSR reality. Throughout Section 3, this paper further raises many questions and provides open-ended opportunities for further research, such as the search for new compatible evaluation methods. The same applies

to connecting the highlighted issues to extant literature, for example to action design research [19] or critical realism [20] and its generative mechanisms. Also, many IS DSR endeavors double as entrepreneurial projects, designing innovative products or services as theory-driven artifacts. Future research could apply the effectuation perspective simultaneously to both the artifact driving the entrepreneurial endeavor as well as the entrepreneurial endeavor itself. Such interplay has the potential to advance our understanding of artifact-driven entrepreneurship and organizational innovation activities [21].

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