Systems, Signs & Actions
An International Journal on
Information Technology, Action,
Communication and Workpractices
Vol. 11 (2018), No. 1, pp. 54–78
http://www.sysiac.org/

Multi-Media and Web-based Evaluation of Design Artifacts - Syntactic, Semantic and Pragmatic Quality of Process Models

Patrick Brandtner [(1)] and Markus Helfert [(2)]
(1) University of Applied Sciences Upper Austria
(2) Dublin City University

Abstract

Evaluation of design artifacts is of crucial importance in design science research (DSR). A plethora of evaluation approaches and methods can be found in literature; nevertheless, little work has been done so far to investigate the relation between the evaluation strategies, methods and techniques in DSR evaluations. Prototype implementations, together with case studies seem to be dominant and the technique of choice to evaluate, often complex artifacts. This paper goes beyond the common approach in DSR, and presents a multi-media and web-based DSR evaluation approach focussing on syntactic, semantic and pragmatic quality. We present the definition of evaluation criteria, the selection of evaluation methods and the findings and experiences gained. The results of this paper can support other design science re-search approaches concerned with the evaluation of concepts or process models.

Keywords: Design science research, artifact evaluation, conceptual modelling, process model

Received: 3 August 2017; Revised: 3 March 2018; 13 August 2018; Accepted: 14 August 2018
Accepting Editor: Jonas Sjöström

1 Introduction and Background

In design science research (DSR) artifact evaluation within a specific environment is of crucial importance (Venable et al. 2016; Goldkuhl 2013; Peffers et al. 2012). Artifacts should be evaluated based on the requirements of the context of their respective application and implementation environment (Peffers et al. 2012). According to Niederman and March (2012), the initial evaluation of a novel artifact may simply be to show that it works and produces adequate solutions. The challenge is to define "adequacy". However, as evaluation criteria are socially constructed, what one researcher may consider adequate, may be considered inadequate by another (Niederman, March 2012). This challenges the selection of a suitable evaluation method.

A plethora of evaluation approaches and methods in DSR can be found in literature, e.g. in Peffers et al. (2012), March and Smith (1995) or Helfert et al. 2012. Nevertheless, little work has been done so far specifically addressing the choice and combination of evaluation strategies, methods and tools in DSR evaluations (Prat et al.

2014; Sonnenberg, Brocke 2012). Numerous design science evaluation approaches centre on prototype implementation and build the analysis around usability. They often apply the well-known method of case study research (Peffers et al. 2007; Markus et al. 2002). However, DSR evaluation can go far beyond evaluating implemented prototypes by conducting case studies and interviews.

The development and use of evaluation methods and new evaluation metrics represents an important category of contributions in DSR (Hevner et al. 2004) and the need to develop novel strategies to evaluation in DSR is high (Venable et al. 2016).

This paper aims at presenting a multi-media, web-based DSR evaluation approach in the form of a survey, enriched with multi-media content. The evaluation approach described in this paper is part of a longer-term project that includes the development of a process model for innovation management. More specifically, the aim of this project is to develop a process model addressing the Front End of Innovation. The process model represents the earlier stages of innovation and includes the activities that come before the formal and well-structured new product development (NPD) process (Brandtner 2018; Brandtner et al. 2015a). The process model is described using event-driven-process-chains (EPC) and has been evaluated from an ex-ante and an ex-post perspective. The study context and the ex-ante aspects of the evaluation using focus group research have been documented in Brandtner et al. (2015b). Expanding our earlier work, this paper focuses on the ex-post evaluation (i.e. evaluating the process model after it has been developed in its final form but without implementing it in practice) and how a multi-media, web-based approach is employed. The evaluation approach presented in the paper allows for assessing practical implications of the process model after its development (ex-post) and before implementing it. In this regard, the evaluation approach could also be taken as an ex-ante approach, i.e. evaluating a process model before implementing it with the intention to further refine or elaborate (parts of) the process model.

The remainder of this paper is structured as follows: In the subsequent sections, a short overview of literature on DSR evaluation (section 2), the ex-post evaluation approach of the research project mentioned above (section 3) and the findings and learnings of the application and conduction of this evaluation approach are discussed and explained (section 4).

2 Evaluation in DSR

Even though the importance of artifact evaluation is acknowledged in many design science contributions, many researchers focus often on a fragmented or incomplete list of evaluation criteria. Most researcher emphasise utility and usability as important criteria. However, the application of appropriate evaluation criteria is essential in scientific research in general and in particular in design science projects where artifacts have to be assessed against criteria of value or utility (March, Smith 1995). In addition, often evaluation methods are described without guidance on how to apply which methods to which criteria (Prat et al. 2014; Ostrowski, Helfert 2012).

One of the few papers addressing the definition of DSR evaluation strategies is contributed by Pries-Heje et al. (2008), who proposed a framework supporting researchers in building such strategies. They distinguish between three core dimensions of an evaluation strategy: when to evaluate, what to evaluate and how to evaluate. “When to evaluate” aims at defining if an ex-ante or ex-post evaluation is needed.

Choosing between these two options or deciding for both depends on the scope of the respective research project. However, Pries-Heje et al. (2008) clearly state that "*evaluation is not limited to a single activity conducted at the conclusion of a design-construct-evaluate cycle. In fact, there are at least two evaluation episodes available: design-evaluate construct-evaluate*".

Regarding the "what to evaluate" perspective, the objective is to define whether to evaluate the artifact design process or the product of the artifact design (Sonnenberg, Brocke 2012).

Finally, "how to evaluate" relates to the form of evaluation and may be naturalistic or artificial. Naturalistic evaluation focusses on exploring respectively evaluating the artifact in its real environment, in our instance in the organisations of survey participants (Venable et al. 2012). This allows for embracing all the complexities of real users, real problems and real systems (Sun, Kantor 2006). Naturalistic evaluations are always empirical and may be positivist, critical and/or interpretive. Typical naturalistic evaluation approaches include field studies, focus groups, surveys or case studies. Artificial evaluation on the other hand includes laboratory settings, field experiments, mathematical proof or simulations. Each of these evaluation forms has its strengths and weaknesses (Venable et al. 2012; Sun, Kantor 2006): The dominance of the naturalistic paradigm brings to naturalistic DSR evaluation the benefits of internal validity. However, naturalistic evaluation results could also be affected by confounding variables or misinterpretation. The dominance of scientific/rational paradigm brings to artificial evaluation the benefits of stronger reliability in the form of better falsifiability and repeatability. However, artificial evaluation may not allow for embracing all the complexities of real user, real systems and real problems.

As the goal of the present evaluation approach is to evaluate the artifact in its actual application domain with real users, real systems and facing real problems, naturalistic evaluation methods best fit for the present ex-post evaluation activities. This allows for addressing the complexities which are predominant in real application settings in general and which dominate organisational practice at the FEI. The following DSR evaluation method selection framework (table 1) provides an overview of ex-ante and ex-post evaluation methods and further categorises these into naturalistic and artificial.

In summary, even though the crucial role of artifact evaluation is acknowledged in IS design-science literature, only fragmented or incomplete lists of criteria are provided. Same applies to evaluation methods, which are only presented in a fragmented manner, without much indication on how to apply which methods to which criteria (Prat et al. 2014; Ostrowski, Helfert 2012). Furthermore, what we did not find in literature is an aggregated approach for evaluating artifacts in the form of process models.

Table 1: DSR Evaluation Method Selection Framework by DSR Evaluation Method Selection Framework by Venable et al. (2012).

	Ex-ante	Ex-post
Naturalistic	• Action Research • Focus Group Table text	• Action Research • Case Study • Focus Group • Participant Observation • Ethnography • Phenomenology • Survey (qualitative or quantitative)
Artificial	• Mathematical or Logical Proof • Criteria-Based Evaluation • Lab Experiment • Computer Simulation	• Mathematical or Logical Proof • Lab Experiment • Role Playing Simulation • Computer Simulation • Field Experiment

In the following section of this paper, we present the evaluation approach for a process model developed in the course of a recent DSR project at Dublin City University and the University of Applied Sciences Upper Austria (Brandtner 2017). The process model developed and evaluated addresses the earliest parts of the innovation process – the so called Front End of Innovation and specifically the strategic parts of it (Brandtner et al. 2015a, 2015b; Brandtner et al. 2014). The actual implementation of such a wide-ranging and long-term oriented process model in organisational practice would not be possible in the short or medium term. Furthermore, the results of its implementation in the form of its concrete effects and its factual results in the form of e.g. new products or increased turnover takes additional time to be visible and quantifiable. It would hardly be possible to identify the direct causal relation between actions and measures taken due to process model implementation and specific quantifiable outcomes in organisational practice. Hence, an appropriate evaluation framework needs to be developed, allowing for ex-post evaluation of process model quality and usefulness prior to its actual implementation.

3 Developing a multi-media DSR Evaluation approach

The following sections describe the development of a multi-media DSR evaluation approach together with a discussion on evaluation criteria, the selection of appropriate evaluation methods and the combination of these into a coherent evaluation approach.

3.1 Definition and measurement of evaluation criteria

Previous research states that artifacts can be evaluated e.g. in terms of consistency, accuracy, reliability, fit with the organisation, usefulness and other relevant quality attributes (Hevner et al. 2004; March, Smith 1995). Utility of artifacts is a complex deliverable and may depend on various attributes of the outcomes of artifact use or the artifact itself (Ostrowski, Helfert 2012). The term utility is used synonymously to the term usefulness in literature (Prat et al. 2014) and utility has often been assessed through perceived usefulness (Adipat et al. 2011; Reeder et al. 2011; Featherman 2001). Therefore, the term usefulness or perceived usefulness is selected rather than the term utility in this paper. Artifact evaluation is specific to each artifact, its purpose and the purpose of evaluation. In this context, literature divides between two types of artifacts: product and process artifacts (Ostrowski, Helfert 2012; McNaughton et al. 2010; Pries-Heje et al. 2008). Product artifacts include e.g. tools, software or diagrams, which can be by applied by users to solve certain problems. A process artifact is a method, procedure or model that guides users during the process of problem solving. The current artifact, i.e. the process model developed in the project underlying this paper, can be classified as process artifact and evaluation criteria should be defined accordingly. Process artifact usefulness should be evaluated in the course of user-artifact interaction (Ostrowski, Helfert 2012).

Content measures for artifact evaluation are often closely linked with quality criteria, as quality can be described in terms of more or less measurable sets of criteria (Pries-Heje et al 2008). Differences in quality measurement results reflect differences in the state or quantity of specific artifact attributes (Venable et al. 2016). Various definitions of quality can be found in literature (Basu 2016). The underlying assumption of process-based quality is that a good process will lead to a good process outcome respectively result or product (Pries-Heje et al. 2008). Many approaches address the issue of conceptual model quality (Helfert et al. 2012; Liu et al. 2012; Rittgen 2010; Maes, Poels 2007; Mendling et al. 2007b; Moody et al. 2003; Moody et al. 2002; Venkatesh, Davis 2000; Krogstie et al. 1995; Lindland et al. 1994; Davis et al. 1989), which can be structured along 3 core levels of quality:

- Syntactic Quality (SNQ),
- Semantic Quality (SMQ) or Perceived Semantic Quality (PSQ) and
- Pragmatic Quality (PMQ) or Perceived Usefulness (PU).

These three levels of quality are supported by a plethora of references and are used as the three main evaluation dimensions for the paper (cf. figure 1).

A good description is provided by Mendling, who states that "*syntactic quality relates to model and modelling language; semantic quality to model, domain, and knowledge; and pragmatic quality relates to model and modelling and its ability to enable learning and action*" (Mendling et al. 2007b). According to literature, syntactical issues are well controlled and can be measured objectively. The main evaluation effort would therefore be directed towards semantic and pragmatic model quality, which are potentially harder to measure and evaluate (Mohagheghi et al. 2009; Krogstie et al. 2006; Poels et al. 2003).

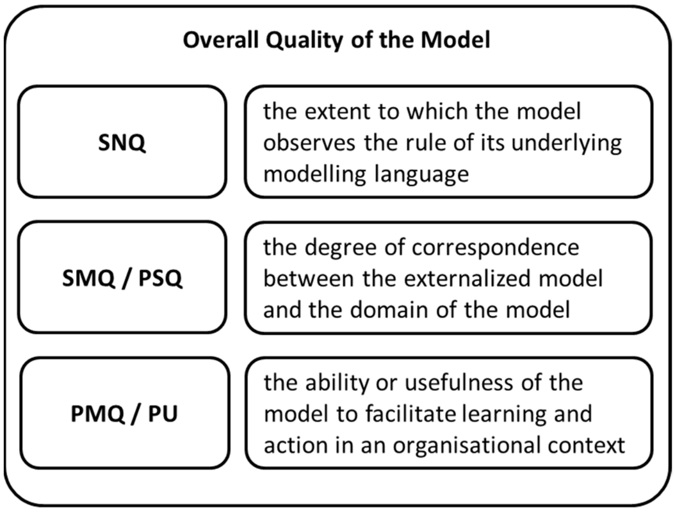

Figure 1: Process Model Quality Dimensions of the Paper.

3.1.1 Syntactic Process Model Quality (SNQ)

The syntactic quality of a model refers to the extent to which it observes the rule of its underlying modelling language (Rittgen 2010), i.e. EPC notation in the present case. In the syntactic quality dimension, only one quality characteristic – namely syntactical correctness is to be evaluated. A model is correct from a syntactical point of view if all statements of the model are according to the syntax and vocabulary of the modelling language and the underlying notation (Krogstie et al. 1995). An EPC process model has to fulfil certain syntactic criteria. A number of approaches that used modelling conventions as a metric for syntactic quality can be found in literature (Rittgen 2010).

Different tools support the verification of EPC soundness and offer automatic consistency checks, syntax checks, animations and filtering features and layout placements (Mendling et al. 2007a; Rosemann et al. 2001). A prominent example of such a tool is the "bflow* toolbox" developed in close collaboration between numerous Universities and Universities of Applied Sciences (Böhme et al. 2010; Gruhn, Laue 2010; Hogrebe et al. 2009; Laue et al. 2009). The bflow* toolbox is constantly revised and maintained and has been applied in various settings and research projects to evaluate syntactical correctness of EPC based process model. This tool allows for modelling EPC based processes and provides the user with immediate feedback regarding the syntactical correctness of the model. It takes into account the requirements defined for evaluating syntactical correctness of process models and is applied to evaluate this quality dimension within this paper.

3.1.2 Syntactic Process Model Quality (SNQ)

Semantic quality of a conceptual model, i.e. the FEI process model in the present case, is defined as the degree of correspondence between the externalised model and the domain of the model (Krogstie et al. 1995). In other words, semantic quality refers to the correspondence between the information that users deem necessary for the conceptual model based on their domain knowledge and the knowledge they think the process model actually contains, i.e. user interpretation (Maes, Poels 2007). Hence, semantic quality measures model quality in terms of correspondance between domain and model

(Liu et al. 2012; Bolloju, Leung 2006). According to Krogstie et al. (1995) the primary goal for semantic quality is reaching the highest degree of correspondence possible.

Evaluating the semantic quality of a conceptual model or schema is more difficult than evaluating its syntactical correctness. The evaluation of semantic quality can only refer to process model users' perception of reality, and evaluation results strongly depend on factors like cognitive abilities, previously acquired knowledge and ontological and epistemological standpoints taken (Maes, Poels 2007; Poels et al. 2005b). Various studies attempt to quantify the level of semantic quality in regard to a specific reference theory or modelling benchmarks serving as substitutes for the real domain (Gemino, Wand 2003). One weakness of such approaches could be the fact that these studies ignore user beliefs of if and how well the model supports and fosters their understanding of the underlying reality (Poels et al. 2005b). According to e.g. Krogstie et al. (1995), Maes, Poels (2007), Rittgen (2010) or Poels et al. (2005b) user perception-based measurements of semantic quality are more suitable to determine whether benefits will result from using a conceptual model than verified but theoretical quality measurements.

As the correspondence between model and domain cannot be checked or established directly, what has to be done at quality control is not to analyse the actual semantic quality, but the perceived semantic quality of the process model based on comparisons of users interpretation of the model and users domain knowledge. The perceived semantic quality in the present case serves an operational surrogate of semantic quality and directly verifies the correspondence between users' domain knowledge and their interpretation of the model.

Relying on the idea of reasoned action (Fishbein, Ajzen 1977) perceived semantic quality was introduced by Shanks et al. (Shanks et al. 2003) and extended respectively revised by other researchers. It has since that undergone substantial empirical validation and has been redefined in experiments based on reliability and validity tests (e.g. in Rittgen 2010). Depending on the respective source, four to seven indicators are used for evaluating perceived semantic quality (Poels et al. 2005a). Maes and Poels proposed and validated a four-indicator measurement system including correctness, completeness, authenticity (realistic) and relevance (Poels et al. 2005b). Shanks et al. (2003) added the attributes conflict and redundancy free, stating that the semantics represented in the single parts of the model should not contradict one another and should not contain redundant semantics (Shanks et al. 2003). These two attributes of semantic quality were subsumed under the indicator of consistency by Lindland et al. (1994). In further studies, Maes as well as Lindland found that consistency is subsumed by both correctness and completeness, and derived and validated the consolidated four-indicator PSQ-system described above (Rittgen 2010; Maes, Poels 2007; Lindland et al. 1994;). The following figure depicts these different indicators applied for evaluating the Perceived Semantic Quality (PSQ) of the process model. It is important to state that these indicators have already undergone substantial empirical validation in the course of experiments based on reliability and validity test (Maes, Poels 2007 or Shanks 2003):

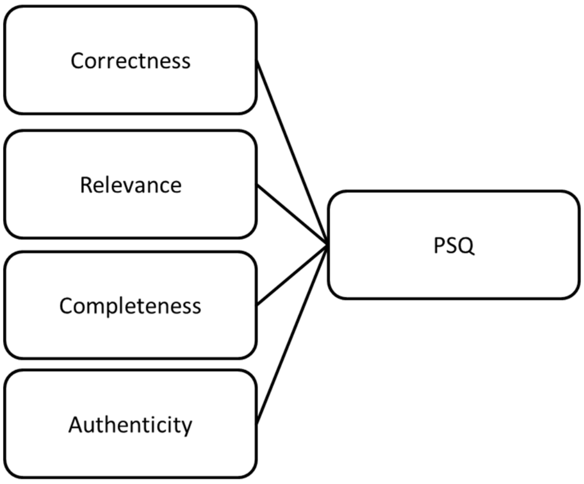

Figure 2: Indicators for PSQ acc. to Rittgen (2010), Maes and Poels (2007) and Poels et al. (2005b).

The items of PSQ and the sources stating their relevance as well as the statements to be measured are presented in table 2. The statements are taken from the validated PSQ measurement system of Rittgen (Rittgen 2010), which are validated and further developed by Rittgen based on Maes and Poels (2007) and based on Maes et al (2005). All items are measured on a 7-point Likert scale, where 1 - strongly disagree, 2 - moderately disagree, 3 - somewhat disagree, 4 - neutral (neither disagree nor agree), 5 - somewhat agree, 6 - moderately agree, and 7 - strongly agree:

Table 2: Items and measurement statements for PSQ.

Item				Statement to be meas-ured
Abbr.	**Title**	**Description**	**Sources for item**	**Statement**
CORR	Correct-ness	All statements in the represen-tation are cor-rect.	Lindland et al. 1994; Krogstie et al. 1995; Poels 2005; Maes, Poels 2007; Rittgen 2010; Moody 2002;	The conceptual model represents the business process correctly.
REL	Relevance	All statements in the represen-tation are rele-vant to the prob-lem.	Rittgen 2010; Krogstie 1995; Moody 2002; Maes, Poels 2007;	All the elements in the conceptual model are relevant for the repre-sentation of the business process.
COMP	Complete-ness	The representa-tion contains all statements about the domain that are correct and relevant.	Rittgen 2010; Poels 2005; Lindland et al. 1994; Krogstie 1995; Maes, Poels 2007; Moody 2002;	The conceptual model gives a complete repre-sentation of the business process.
				Entities, relationships or structural constraints must be added to ade-quately represent the business process.
AUTH	Authentic-ity	The representa-tion gives a true account of the domain.	Rittgen 2010;, Poels 2005; Maes, Poels 2007;	The conceptual model is a realistic representation of the business process.

3.1.3 Perceived Usefulness (Pragmatic Quality of Process Model, PU)

Pragmatic process model quality describes the ability or usefulness of a process model to facilitate learning and action in an organisational context (Burton-Jones, Gallivan 2007; Krogstie et al. 2006; Gemino, Wand 2005). Applied to the present case, pragmatic process model quality describes the usefulness of the model in real organisational FEI processes. Several measures have been proposed for evaluating the pragmatic quality of process models, ranging from analysing comprehension task accuracy to measuring user perceptions of model pragmatics (Burton-Jones, Gallivan 2007; Gemino, Wand 2005; Maes et al. 2005; Bodart et al. 2001; Siau et al. 1997). Users perceptions of pragmatic process model quality have often been measured with instruments for user information satisfaction and ease of use as well as with instruments for usefulness or utility (Burton-Jones, Gallivan 2007; Gemino, Wand 2005; Maes et al. 2005).

Usefulness or utility of artifacts represents probably the most relevant evaluation criterion in DSR, since this research paradigm postulates for its outputs to be above all useful for practitioners (Hevner et al. 2004). In other words, useful means that the artifact built has to benefit to its application environment (the FEI in the present case) and must assist in achieving certain goals of the organisation in this environ-ment (e.g.

achieving a reduction of uncertainty). Usefulness has often been assessed through Percevied Usefulness (PU) (Adipat et al. 2011; Reeder et al. 2011). Useful is hereby defined as proposed by Davis, who stated that a system or model is useful, if it is capable of being used advantageously (Davis 1989). In the context of the evaluation approach, pragmatic process model quality is measured based on the PU of the model as rated by real users.

In the course of the present case, perception-based measurements for pragmatic process model quality respectively for usefulness are chosen for several reasons: Firstly, perceptions of senior executives and middle managers were found to be a good proxy for organisational performance of IT and process models in prior research (Nair et al. 2012; Rittgen 2010; Elbashir et al. 2008). A high convergence between perceptual data collected from senior as well as from lower level management and objective performance measures can be stated (Elbashir et al. 2008; Ray et al. 2005; Venkatraman, Ra-manujam 1987). Secondly, some of the benefits of the process model are intangible or qualitative in nature and are therefore not available as objective measures. Furthermore, most of the data items are strategic and confidential in nature and are not publicly available. Thirdly, the actual implementation of such a comprehensive and wide-ranging process model would require a substantial period of time. The main reason why perception-based evaluation of process model usefulness is chosen is due to the fact that the effects of process model implementation and the benefits to the innovation process would not be reliably relatable to specific outcomes, would hence not be measureable and would mainly be of intangible nature. The use of perception-based measurements is most reasonable in the current context and provides opportunities for insights into these intangible, quality-related future benefits. Evaluation of PU may be done qualitatively or quantitatively (Prat et al. 2014). Quantitative evaluation of PU leads to a perceived numeric value of usefulness. Perception of usefulness can either be estimated directly or through defined items that contribute to overall usefulness (Prat et al. 2014; Rittgen 2010; Davis 1989).

In the area of conceptional modelling, PU has e.g. been applied in prior studies of Prat et al. (2014), Rittgen (2010), Maes et al. (2005) or Moody et al. (2003). Some authors applied an adaption of the Technology Acceptance Model (further referred to as TAM) by Davis (Davis (1987) and Venkatesh, Davis (2000), which has been widely used for different types of artifacts and also for conceptual models (Adipat et al. 2011; Recker, Rosemann 2010). The measurement items of TAM for PU have showed to be robust and have displayed high levels of validity and reliability in a variety of settings and research domains (Recker, Rosemann 2010; Schepers, Wetzels 2007; King, He 2006; Lee et al. 2003).

In accordance with the discussion of PU presented above, an adaption of the TAM in its second version (Venkatesh, Davis 2000) is used to evaluate PU of the artifact. The reasons for this are as follows: Firstly, the development of a new measurement instrument for the present case would bring only limited new insights to the research domain and it would be difficult and not reasonable to validate such a new collection of constructs and items. Secondly, the TAM and adaptions of it have been applied in various settings in the context of conceptual models (Tan, Siau 2006, Riemenschneider et al. 2002) and has showed to produce robust, reliable and valid results (Recker, Rosemann 2010). According to the TAM by Davis (Venkatesh, Davis 2000; Davis 1989; Davis 1987), PU directly influences the actual intention to use a system respectively a process model in this instance (Recker, Rosemann 2010; Rittgen 2010 or Moody 2002).

Perceived Usefulness (PU) is “*the degree to which a person believes that using a particular system would enhance his or her job performance*” (Davis 1989, p. 320). Applied to the present case, PU is the degree to which a person believes that applying the developed process model would enhance his or her performance at the FEI. Validated measures are needed in order to evaluate PU. A literature review revealed several validated multi-item measures for PU, most of them building on the TAM by Davis (Davis 1989; Davis 1987). Based on the original TAM by Davis, Venkatesh and Rittgen proposed specific measures and items for evaluating PU of systems and conceptual models (Rittgen 2010; Venkatesh, Davis 2000):

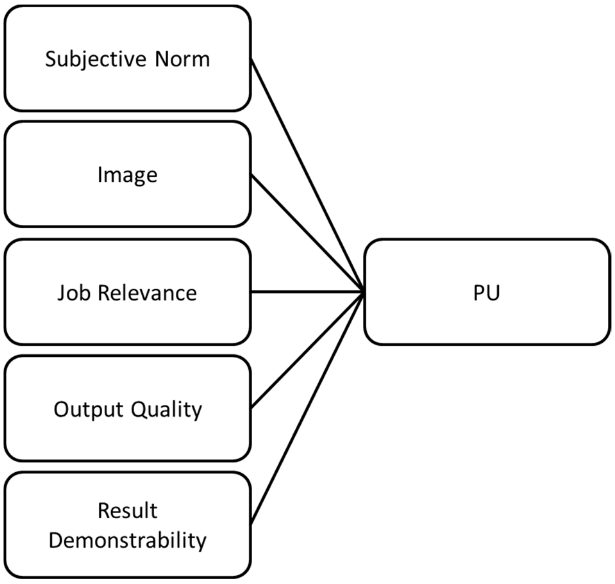

Figure 3: Indicators for PU of conceptual models acc. to Rittgen (2010), Recker (2010) and Venkatesh (2000).

The items of PU and the sources stating their relevance as well as the statements to be measured are presented in Table 2. The concrete statements are adapted to the present case based on the original statements of Venkatesh and Davis (Venkatesh, Davis 2000) by replacing the notion “system” with the notion “process model”. All items are measured on a 7-point Likert scale, where 1 - strongly disagree, 2 - moderately disagree, 3 - somewhat disagree, 4 - neutral (neither disa-gree nor agree), 5 - somewhat agree, 6 - moderately agree, and 7 - strongly agree.

Table 3: Items and measurement statements for PU.

Item			Statement to be measured
Abbr.	**Title**	**Sources for item**	**Statement**
SN	Subjective Norm	Schepers 2007; Venkatesh, Davis 2000; Horst et al. 2007	People who influence my behaviour think that I should use the process model
			People who are important to me think that I should use the process model.
IM	Image	Venkatesh, Davis 2000;	People in my organisation who use the process model would have more prestige than those who do not.
			People in my organisation who use the process model would have a high profile.
			Working with the process model would be a status symbol in my organisation.
JR	Job Relevance	Davis 1989, Venkatesh, Davis 2000; Rittgen 2010;	In my job, usage of the process model is important.
			In my job, usage of the process model is relevant.
OQ	Output Quality	Davis 1989; Moody et al. 2003; Venkatesh, Davis 2000;	The quality of the output I get from the process model is high.
			I have no problem with the quality of the process model's output.
RD	Results Demonstrability	Moody et al. 2003; Venkatesh, Davis 2000;	I have no difficulty telling others about the results of using the process model.
			I believe I could communicate to others the consequences of using the process model.
			The results of using the process model are apparent to me.
			I would have difficulty explaining why using the process model may or may not be beneficial.
PU	Perceived Usefulness	Davis 1989; Venkatesh, Davis 2000; Rittgen 2010; Moody et al. 2003;	Using the process model would improve my performance in my job.
			Using the process model in my job would increase my productivity.
			Using the process model would enhance my effectiveness in my job.
			I find the process model to be useful in my job.

3.1.4 Summary of Process Model Quality Criteria

The process model quality dimensions of our evaluation approach range from syntactic model quality (modelling notation,), to semantic quality (domain knowledge) and to pragmatic model quality (perceived usefulness of the model in its application domain). Syntactical issues are well controlled and can be measured objectively. The main evaluation effort is therefore directed towards semantic and pragmatic model quality. Figure 4 provides an overview of the quality dimensions and their respective items as discussed above:

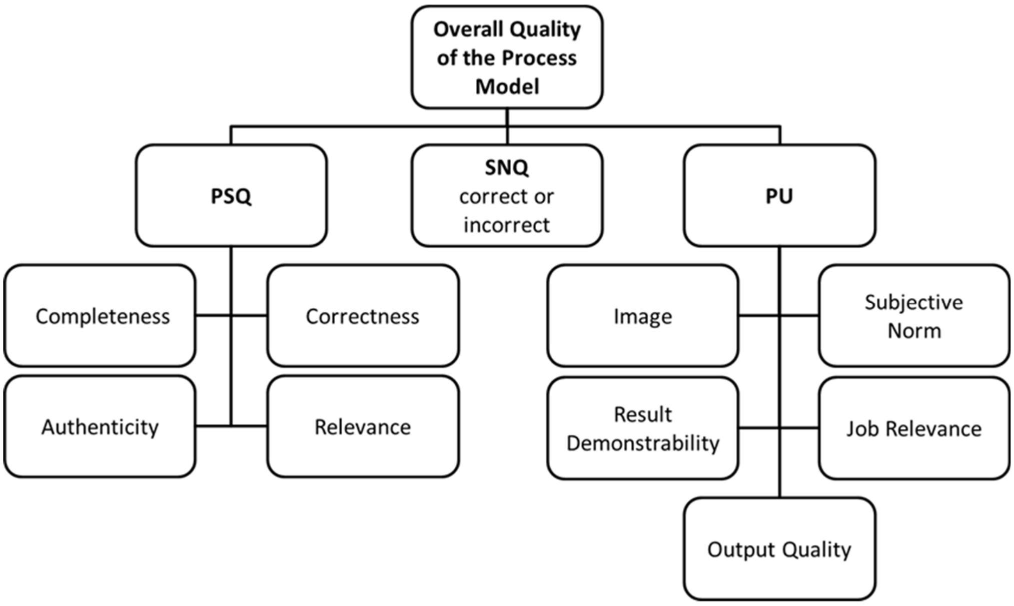

Figure 4: Summary of quality dimensions of our process model and their respective items.

3.2 Design of multi-media evaluation tool

Considering the nature of the evaluation criteria, the research methodology applied and the experiences and recommendations regarding the evaluation of PSQ and PU in research community, a survey method is chosen for ex-post evaluation (Venable et al. 2012; Siau, Rossi 2011; Recker, Rosemann 2010; Rittgen 2010; Cleven et al. 2009; Maes et al. 2005; Poels et al. 2005a). A semi-quantitative, questionnaire based survey with qualitative comment is used for data gathering and collection. The questionnaire contains all the statements presented in table 2 and 3 as well as the additional comment fields for PU and PSQ. All items are measured on a 7-point Likert scale, where 1 - strongly disagree, 2 - moderately disagree, 3 - somewhat disagree, 4 - neutral (neither disagree nor agree), 5 - somewhat agree, 6 - moderately agree, and 7 - strongly agree.

As target groups for the survey, middle and executive management-level domain experts in the area of innovation management and strategic planning, which represent the actual users and beneficiaries of the process model, are approached. Perceptions of senior executives and middle managers from the respective application domain were found to be a good proxy for organisational performance of conceptual process. Before the actual questionnaire, the process model is introduced and presented to survey participants. In order to reduce bias caused by different and varying forms of process model presentation and different accompanying explanations of its modules and activities, this is done in the form of one identical introduction presentation for all participants presented via a web based survey tool, like e.g. in Krogstie, Nossum (2014), Rothe et al. (2010) or Nicholas et al. (2004).

Subsequently, the questionnaire is presented to participants. Web based surveys allow for an efficient and effective way to reach a large population of potential participants (Schonlau et al. 2002). They have been applied in a variety of settings and with different populations (Brown et al. 2016; Moossdorff-Steinhauser et al. 2015). Surveys in general, and web based surveys in particular, represent a good evaluation technique for design methods and conceptual models, especially if the objective is to gather perception information from practitioners (Siau, Rossi 2011). Furthermore, survey and questionnaire design, dissemination and data storage and analysis are efficient and well supported by different survey tools (Greenlaw, Brown-Welty 2009). Participants are invited by e-mail, the selection of potential respondents (experts in the area of innovation management and strategic planning) is done via two innovation management related organisations. More precisely, with the Platform of Innovation Management (PFI) and the Product Development and Management Association (PDMA). As a survey tool for data collection, SoSci Survey is selected. This tool allows for creating online questionnaires and for integration of additional media files (Leiner 2014). Data analysis and evaluation is done using Microsoft Excel. Validity of results is ascertained by applying the validated and acknowledged statements and items presented in section 3.1.

For the evaluation, we selected a semi-quantitative, questionnaire based survey with qualitative comment fields for data gathering and collection (e.g. Venable et al. 2012). In contrast of a typical case study or prototype evaluation, we argue the following study design has some advantages to evaluate process models.

The actual questionnaire is preceded by an introduction to the process model. Therefore, we created one uniformous introduction video presentation for all participants, presented via a web-based survey tool. This allowed us to reduce bias caused by different and varying forms of process model presentation and different accompanying explanations to its modules and activities. We developed the introduction process model presentation using MS PowerPoint. Based on the single slides of this presentation, we elaborated a comment guideline for each part. The comments where then recorded and the audio files generated this way were matched to the respective slides and were included into the final PowerPoint file. Additionally, we used the pointer-feature of PowerPoint to highlight the relevant parts of the single slides according to the timing and content of the audio comment files. The presentation was then saved as a video file, which was uploaded to YouTube in order to be integrated into our SoSci Survey online questionnaire. **Error! Reference source not found.** illustrates the survey layout and provides an overview of the introductionary page of the survey including the video presentation:

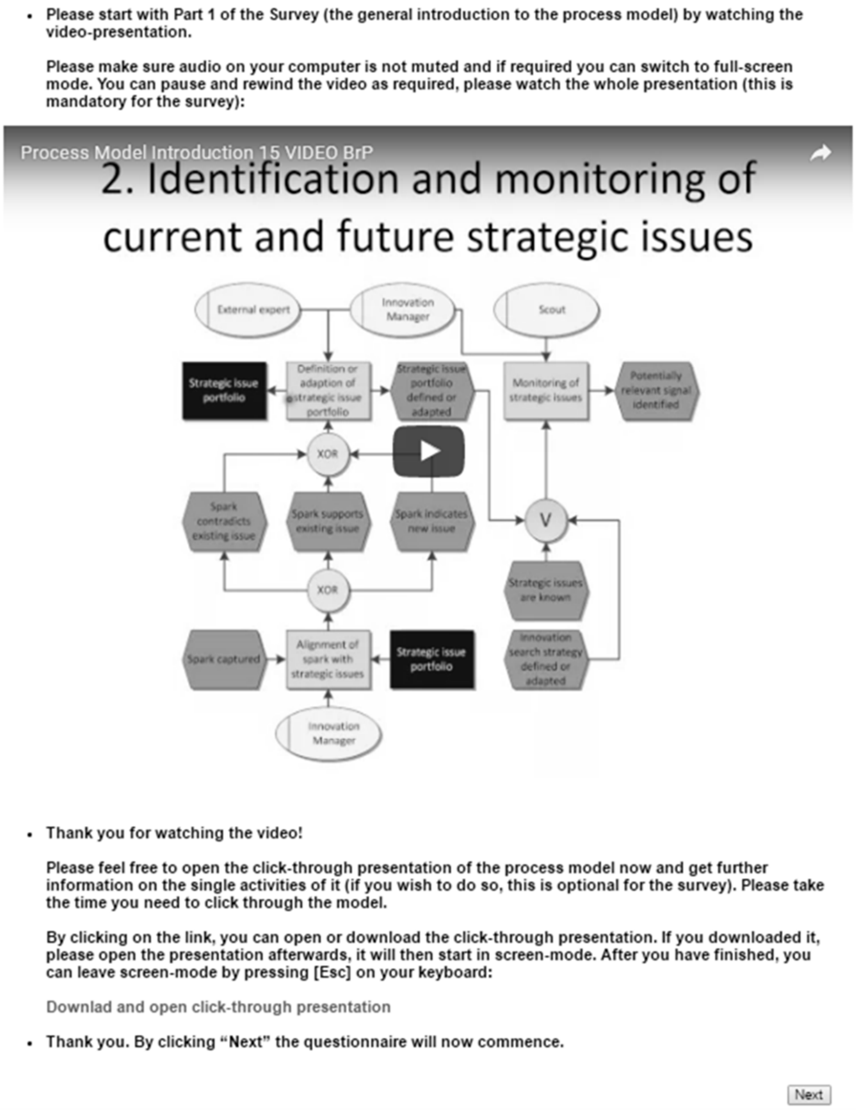

Figure 5: Screenshot of the questionnaire and integration of the video presentation.

Following the introduction video presentation, the process model is explained in the form of a click-through and wiki-like presentation, allowing survey participants to familiarize themselves with detailed information about the process model.

The survey consists of 9 items and 22 statements and additional textual statements (cf. section 3.1). In order to gain additional feedback and qualitative input for process model discussion, textual comments are collected for the selected items of PSQ relevance, PSQ completeness, PU job relevance and PU result demonstrability. Comment fields are shown based on triggering answer options of participants, providing us with the possibility of considering qualitative aspects as well. Furthermore, the collection of textual feedback allows for further interpretations of survey results and ultimately provides us with the possibility to gain further learnings and insights.
The statements investigating the defined items were presented pairwise, the answer options are illustrated in figure 6.

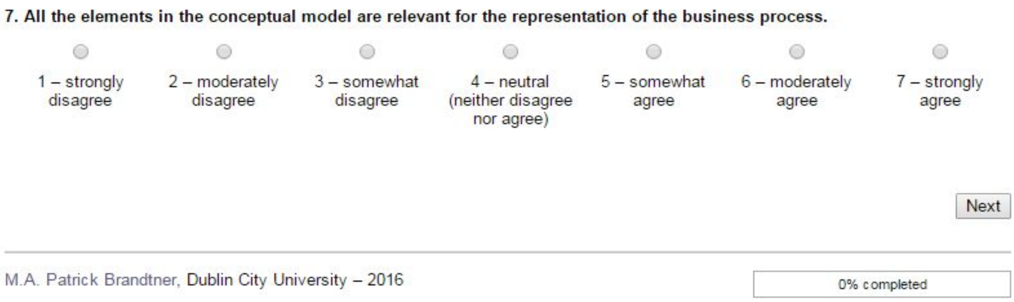

Figure 6: Layout of the questionnaire regarding the statements of PSQ and PU.

As a survey tool for data collection, we selected SoSci Survey, which allows for creating online questionnaires and for integration of additional media files. Microsoft Excel was used for data analysis. Web-based surveys allow for a quick, simple, cheap and effective way to reach a large population of potential participants and have been applied in a variety of settings and with many different populations (Brown et al. 2016). Furthermore, survey and questionnaire design, dissemination and data storage and analysis are efficient and well supported by different survey tools (Greenlaw, Brown-Welty 2009).

In summary, the survey consisted of the following elements: Part 1: Introductionary presentation of the process model (10-minute video, mandatory); Part 2: Additional, information about the process model (optional click-through presentation, duration as required); Part 3: Completion of PSQ and PU questionnaire (10 minutes, mandatory).

4 Experiences of multi-media evaluation

4.1 Test Setting and Pre-Test

As target groups for the survey, middle and executive management-level domain experts respectively actual users and beneficiaries of the process models were approached. Participants were invited by e-mail, the selection of potential respondents - complying with the requirements stated above – was distributed via two innovation management related organisations – namely the Platform of Innovation Management (PFI) and the Product Development and Management Association (PDMA).

A pre-test survey with participants form academia was carried out in order to validate the general structure of the questionnaire, the performance and suitability of the survey tool, the measurement scale proposed and the textual comment functionality of the survey. The collected pre-test comments confirmed the design and structure of the questionnaire and the survey tool. Especially the use of Likert scale and the video-based presentation were regarded to as appropriate and applicable for presenting and evaluating a complex model like in the present case.

4.2 Findings and Discussion

The survey was open for participation from August to October 2016. In total, 52 participants from different industries (ranging from manufacturing, automotive, telecommunication and energy to IT services, construction, software, biotechnology etc.) and 5 five different countries completed our survey. The results of the survey indicated the quality of our process model and are summarised in figure 7:

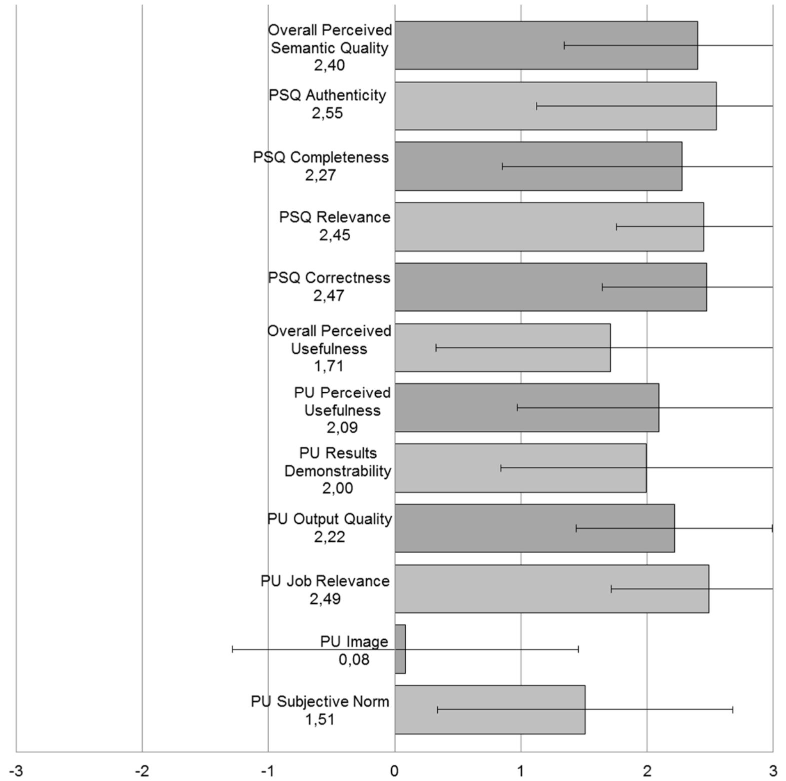

Figure 7: Average and standard deviation of PSQ, PU and their items (normalised, ranging from strongly disagree (-3) to strongly agree (3).

The conduction of the ex-post evaluation of our process model led to some important findings and key learnings:

The application of a web-based survey tool like SoSci Survey proved to be applicable to reach larger populations of experts. We recommend this type of survey platforms. Especially in combination with e.g. the interactive click-through presentation and the introductionary presentation video of our process model, the application of a web-based survey tool worked well. The introduction of our process model in the form of a webinar-like video presentation did not only allow us to reach a higher population of experts and participants but also reduced the potential bias which could have been caused by different and varying process model introduction and presentation styles, formats, durations and interviewers.

An important finding is the benefit of including and planning participant recruitment at an early stage of evaluation approach planning. In the context of this study, we aimed to include experts from the field of innovation and product management, business development and strategic planning. If experts are to be reached by a survey or are to be included in the evaluation approach, we recommend contacting and collaborating with respective groups, organisations or associations in order to address a large population of potential participants. In our context, participants were approached via the Platform of Innovation Management (PFI) and the Product Development and Management Association (PDMA). Additionally, we directly contacted past and current research partners of our university. In this context, we also recommend to contact potential participants (if contact details are available) once at the start of the survey and a second time one or two weeks before the end of it. Looking at the response rates, we could clearly identify the timing and the effect of the second notification respectively reminder mail, which we sent out on September 19th:

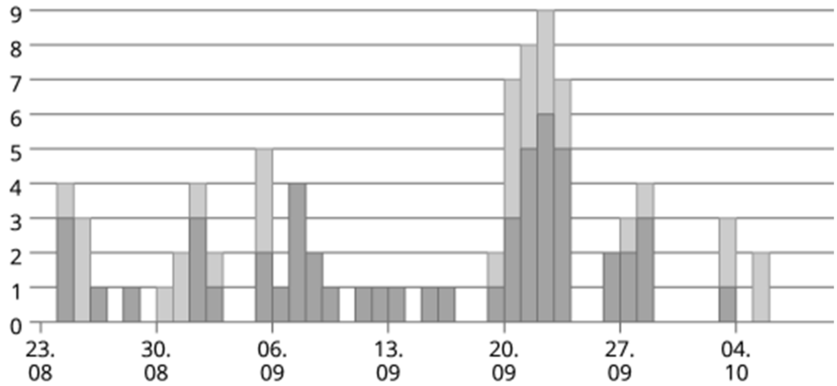

Figure 8: Responses over time.

Another key finding is to keep in mind the total duration of the evaluation and the way of how to communicate duration and timing related aspects to participants. In our case, the web-based survey took participants between 20 to 30 minutes to complete the mandatory parts of the survey, including 10 minutes of watching the video presentation and between 10-15 minutes of filling out the actual questionnaire. Additional time was necessary and further increased the duration of the survey if participants chose to click through the screen-mode wiki presentation after the video. The participant invitations sent out in the course of participant recruitment also included - besides some general survey and contact information - an overview of the single mandatory and optional parts of the survey and the time estimated to complete these parts. Although we tried to keep the introductory video as short as possible, we ended up with a ten-minute video presentation. This duration was necessary in order to not miss important parts and aspects of our process model. However, for future surveys we recommend introductory videos with duration of less than 5-8 minutes. The reason for this is that the drop-out rate of participants was quite high at the first two pages introduction (page 1) and video presentation (page 2) of the survey. In addition, 8 of 52 participants did not watch the full video but skipped on the next part of the questionnaire after 5 to 8 minutes or earlier, although this part of our survey was mandatory. In order to address this issue, we would recommend defining time spans after which the next part of the survey is accessible. In our context, at least the duration of the video should have been defined as the minimum amount of time, which would have to be spent on page 2 of our survey. However, we deliberately decided not to use this feature, due the risk of losing even more participants if we would disable the "next" button at this early part of the survey. In this context, the definition of mandatory and optional questions needs to be tested and well thought through.

The collection of textual comments in addition to the quantitative likert-scale based statements also showed to be helpful and – as expected – provided us with further insight on our artifact and helped us understand participants answer options. The main findings are summarized in the following table:

Table 4: Summary of key learning and recommendations.

Title	Description
Importance of participant recruiting process	Definition of a systematic and structured approach of how to approach and remind potential participants is of crucial relevance for getting a satisfactory response rate.
Consideration of timing and duration aspects	The total duration of a web-based survey should not exceed 20-30 minutes. Otherwise, higher drop-out rates and ultimately fewer responses may be the result. If introductionary presentations are part of the survey, the length of these should be kept as short as possible.
Potential of web-based, interactive and multi-media survey instruments	Web-based survey instruments offer the possibility to reach larger groups of participants and allow for conducting survey independent of place and time.
	The provision of the screen-mode presentation to participants allowed for getting additional information after process model introduction and was easy to integrate in the selected survey tool.
	In order to reduce bias caused by different and varying ways of presenting the artifact and required for online presentation of complex models or evaluands, webinar-like videos can be recommended and proved to be applicable in such contexts.
Collection of textual comments	The collection of textual comments for selected statements allowed for gaining further insights into our model from participants' point of view and helped interpreting results.
Mandatory and optional parts of the survey	The division into mandatory and optional survey parts allows for reducing the risk of too long survey durations on the one hand but bears the risk of missing valuable results on the other hand. Optional survey parts should hence only be applied if the respective part is not of basic relevance for the survey's purpose but would e.g. allow for additional interpretation of results.

5 Conclusion

Selecting and developing appropriate evaluation approaches is a significant issue in DSR and the need for novel strategies is high (Venable et al. 2016). In this paper, we presented an approach to artifact evaluation, which goes beyond the analysis of usefulness of implemented prototypes in the course of case studies or interviews. The web-based survey with interactive and multi-media elements proved to be capable of collecting results from specific expert groups. The evaluation approach developed in order to evaluate our process model from an ex-post perspective provided us with valuable results and showed that there is more to artifact evaluation than just utility of prototypes: based on the three dimensions of syntactical, perceived semantic and perceived pragmatic model quality, we were able to evaluate our conceptual artifact before actually implementing a real-world prototype.

Furthermore, the application of the semi-quantitative web-based survey addressing PSQ and PU items provided us with the possibility to access a high population of experts. The collection of textual statements allowed for gaining further insights and enabled us to derive additional interpretations of survey results. Indeed, our research supports the general observation that the combination of qualitative and quantitative input can lead to new insights and modes of analysis (Venkatesh et al. 2013). However, as our recommendations above indicate, there are important elements for consideration. Besides the elaborated evaluation criteria, this paper also described the methodological steps of developing a multi-media evaluation approach. These can be adopted by other researchers in similar situations in developing appropriate evaluation approaches in their specific settings.

Based on our findings, multi-media approaches can be of great usefulness in settings where either evaluation has to be done remote (i.e. researcher and participants are in different locations) and time-independent (i.e. researcher is not available for questions when participants conduct e.g. the survey) or anticipatory (i.e. there is no real-world prototype of an artifact implemented yet or implementing such would be inadequate or unjustifiable). The findings together with some recommendations are presented in section **Error! Reference source not found.** of the paper. Similarly, the recommendations can also be applied in other research setting, where web-based surveys are to be conducted and applied.

Future research should analyse the applicability of semi-quantitative web-based evaluation approaches similar to ours for e.g. different types of artifacts and in additional research domains.

Acknowledgements

This work was supported, in part, by Science Foundation Ireland grant 13/RC/2094 and co-funded under the European Regional Development Fund through the Southern & Eastern Regional Operational Programme to Lero – the Irish Software Research Center (www.lero.ie).

References

Adipat B, Zhang D, Zhou L (2011): The effects of tree-view based presentation adaptation on mobile web browsing. In *MIS Quarterly* 35 (1), pp. 99–122.

Basu R (2016): *Managing Projects in Research and Development*. New York: Routledge

Bodart F, Patel A, Sim M, Weber R (2001): Should Optional Properties Be Used in Conceptual Modelling? A Theory and Three Empirical Tests. In *Information Systems Research* 12 (4), pp. 384-405.

Böhme C, Hartmann J, Kern H, Kühne S, Laue R, Nüttgens M et al. (2010): bflow* Toolbox-an Open-Source Modeling Tool. In *Proceedings of the Business Process Management 2010 Demonstration Track*, *Business Process Management Conference* 2010 (BPM'10), Hoboken, USA, p. 6.

Bolloju N, Leung F (2006): Assisting novice analysts in developing quality conceptual models with UML. In *Communications of the ACM* 49 (7), pp. 108-112

Brandtner P (2018): Key Principles at the Strategic Front End of Innovation. In *Proceedings of The International Society for Professional Innovation Management* (ISPIM), Jun. 2018, Stockholm, p. 15

Brandtner P (2017): Design and Evaluation of a Process Model for the Early Stages of Product Innovation. PhD Thesis, School of Computing, Dublin City University, Dublin, Ireland

Brandtner P, Helfert M, Auinger A, Gaubinger K (2015a): Multi-Criteria Selection in Design Science Projects – A Procedure for Selecting Foresight Methods at the Front End of Innovation. In *Proceedings of Tenth International Conference on Design Science Research in Information Systems and Technology*, Dublin, Ireland, 2015, pp. 16

Brandtner P, Helfert M, Auinger A, Gaubinger K (2015b): Conducting focus group research in a design science project: Application in developing a process model for the front end of innovation. In *Systems, Signs & Actions* 9 (1), pp. 26–55.

Brandtner P, Gaubinger K, Auinger A, Helfert M, Rabl M (2014): Dealing with Uncertainty in Innovation Management. . In *Proceedings of The International Society for Professional Innovation Management* (ISPIM), Jun. 2014, Dublin, Ireland, p. 13

Brown J A., Serrato C A, Hugh M, Kanter M H, Spritzer, K L, Hays R D (2016): Effect of a post-paid incentive on response rates to a web-based survey. In *Survey Practice* 9 (1).

Burton-Jones A, Gallivan M J (2007): Toward a Deeper Understanding of System Usage in Organizations: A Multilevel Perspective. In *MIS Quarterly* 31 (4), pp. 657-680.

Cleven A, Gubler P, Hüner K (2009): Design Alternatives for the Evaluation of Design Science Research Artifacts. In *Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology* (DESRIST). Malvern, PA, pp. 1-8.

Davis F D (1989): Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. In *MIS Quarterly* 13 (3), pp. 319-340.

Davis F, Bagozzi R, Warshaw P (1989): User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. In *Management Science* (35), pp. 982-1003.

Elbashir M, Collier P, Davern M (2008): Measuring the effects of business intelligence systems: The relationship between business process and organizational performance. In *International Journal of Accounting Information Systems* 9 (3), pp. 135-153.

Featherman M (2001): Extending the technology acceptance model by inclusion of perceived risk. In *Proceedings of AMCIS* 2001. Boston, USA, p. 148

Fishbein M, Ajzen I (1977): *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*: JSTOR

Gemino A, Wand Y (2005): Complexity and clarity in conceptual modeling: Comparison of mandatory and optional properties. In *Data & Knowledge Engineering* 55 (3), pp. 301-326.

Goldkuhl G (2013): Activity Cycles in Design Research: A Pragmatic Conceptualisation of Inter-related Practices. In Helfert M, Donnellan B (Eds.): Design Science: Perspectives from Europe, vol. 388, pp. 49–60.

Greenlaw C, Brown-Welty S (2009): A comparison of web-based and paper-based survey methods: testing assumptions of survey mode and response cost. In *Evaluation review* 33 (5), pp. 464–480.

Gruhn V, Laue R (2010): A heuristic method for detecting problems in business process models. In *Business Process Management Journal* 16 (5), pp. 806-821.

Helfert M, Donnellan B, Ostrowski L (2012): The case for design science utility and quality. Evaluation of design science artifact within the sustainable ICT capability maturity framework. In *An International Journal on Information Technology, Action, Communication and Workpractices* 6 (1), pp. 46–66.

Hevner A R, March S T, Park J, Ram S (2004): Design Science in Information Systems Research. In *MIS Quarterly* 28 (1), pp. 75-106.

Hogrebe F, Nüttgens M, Kern H, Kühne S (2009): Towards an Integrated Product and Process Modelling: oEPC Markup Language (oEPML) for object-oriented Event-driven Process Chains (oEPC). In *GI Jahrestagung*, pp. 3364-3377.

Horst M, Kuttschreuter M, Gutteling J M (2007): Perceived usefulness, personal experiences, risk perception and trust as determinants of adoption of e-government services in The Netherlands. In *Computers in Human Behavior* 23 (4), pp. 1838-1852.

King W R, He J (2006): A meta-analysis of the technology acceptance model. In *Information & Management* 43 (6), pp. 740-755.

Krogstie J, Lindland O I, Sindre G (1995): Defining quality aspects for conceptual models. In *ISCO* 1995, pp. 216-231.

Krogstie J, Nossum A (2014): A Semiotic Approach for Guiding the Visualizing of Time and Space in Enterprise Models. In Liu K, Gulliver S R, Li W, Yu C (Eds.): *Service Science and Knowledge Innovation*, vol. 426. Berlin, Heidelberg, pp. 74–86.

Krogstie J, Sindre G, Jørgensen H (2006): Process models representing knowledge for action. A revised quality framework. In *European Journal of Information Systems* 15 (1), pp. 91–102.

Laue R, Kühne S, Gadatsch A (2009): Evaluating the Effect of Feedback on Syntactic Errors for Novice Modellers. In *EPK 2009, Proceedings of CEUR Workshop*, pp. 110-117.

Lee Y, Kozar K A, Larsen K R T (2003): The technology acceptance model: Past, present, and future. In *Communications of the Association for Information Systems* 12 (1), p. 752-780.

Leiner D J (2014): Convenience samples from online respondent pools: A case study of the SoSci Panel. In *International Journal of Internet Science*, p. 36.

Lindland O I, Sindre G, Solvberg, A (1994): Understanding quality in conceptual modeling. In *IEEE Software* 11 (2), pp. 42-49.

Liu L, Wu, Y, Li X (2012): Current Practice in Measuring the Quality of Conceptual Models: Challenges and Research. In *International Journal of Plant Engineering and Management* 17 (3).

Maes A, Poels G (2007): Evaluating quality of conceptual modelling scripts based on user perceptions. In *Data & Knowledge Engineering* 63 (3), pp. 701–724.

March S T, Smith G F (1995): Design and natural science research on information technology. In *Decision Support Systems* 15 (4), pp. 251–266.

Markus M L, Majchrzak A, Gasser L (2002): A design theory for systems that support emergent knowledge processes. In *MIS Quarterly*, pp. 179–212.

McNaughton, B, Ray, P, Lewis, L. (2010): Designing an evaluation framework for IT service management. In *Information & Management* 47 (4), pp. 219-225.

Mendling J, Neumann G, van der Aalst W (2007a): On the Correlation Between Process Model Metrics and Errors. In *Tutorials, Posters, Panels and Industrial Contributions at the 26th International Conference on Conceptual Modeling* - Volume 83. Darlinghurst, Australia, pp. 173-178.

Mendling J, Reijers H A, Cardoso J (2007b): What Makes Process Models Understandable? In Alonso G, Dadam P, Rosemann M. (eds.): *Business Process Management*, vol. 4714. Berlin, Heidelberg: Springer Berlin Heidelberg (Lecture Notes in Computer Science), pp. 48-63.

Mohagheghi P, Dehlen V, Neple T (2009): Definitions and approaches to model quality in model-based software development – A review of literature. In *Information and Software Technology* 51 (12), pp. 1646-1669.

Montoya-Weiss M, O'Driscoll T M (2000): From experience

Moody D L (2002): Comparative evaluation of large data model representation methods: The analyst’s perspective. In *Conceptual Modeling - ER 2002*: Springer, pp. 214–231.

Moody D L, Sindre G, Brasethvik T, Solvberg A (2003): Evaluating the quality of information models: empirical testing of a conceptual model quality framework. In *Proceedings 25th International Conference on Software Engineering*. Portland, USA, pp. 295-305.

Moossdorff-Steinhauser H F A, Albers-Heitner P, Weemhoff M, Spaanderman M E A, Nieman F H M, Berghmans B. (2015): Factors influencing postpartum women's willingness to participate in a preventive pelvic floor muscle training pro-gram: a web-based survey. In *European journal of obstetrics, gynecology, and reproductive biology* 195, pp. 182-187.

Nair S K S, Paulose H, Palacios Fernández M, Tafur S, José J (2012): Identifying the core competence as a key requirement for business model innovation. The case of Airlines as a service industry. In *Proceedings of Global Innovation and Knowledge Academy Annual Conference*. Valencia, Spain, p. 14.

Nicholas J, Oliver K, Lee K, O'Brien M (2004): Help-seeking behaviour and the Internet - An investigation among Australian adolescents. In *Advances in Mental Health* 3 (1), pp. 16-23.

Niederman F, March S T (2012): Design science and the accumulation of knowledge in the information systems discipline. In *ACM Trans. Manage. Inf. Syst.* 3 (1), pp. 1–15.

Ostrowski L, Helfert M (2012): Design Science Evaluation – Example of Experimental Design. In *Journal of Emerging Trends in Computing and Information Sciences* 3 (9), pp. 253–262.

Peffers K, Rothenberger M, Tuunanen Tuure, Vaezi R (2012): Design Science Research Evaluation. In Peffers K, Rothenberger M, Kuechler B (Eds.): *Design Science Research in Information Systems. Advances in Theory and Practice*, vol. 7286: Springer Berlin Heidelberg (Lecture Notes in Computer Science), pp. 398–410.

Peffers K, Tuunanen T, Rothenberger M, Chatterjee S (2007): A Design Science Research Methodology for Information Systems Research. In *J. Manage. Inf. Syst* 24 (3), pp. 45–77.

Poels G, Nelson J, Genero M, Piattini M (2003): Quality in Conceptual Model-ing - New Research Directions. In Goos G, Hartmanis J, van Leeuwen J, Olivé A, Yoshikawa M, Yu E S K (eds.): *Advanced Conceptual Modeling Techniques*, vol. 2784. Berlin, Heidelberg: Springer (Lecture Notes in Computer Science), pp. 243-250.

Poels G, Maes A, Gailly F, Paemeleire R. (2005b): Measuring user beliefs and attitudes towards conceptual schemas: tentative factor and structural equation model. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. Portland, OR, USA. p. 11.

Poels G, Maes A, Gailly F, Paemeleire R. (2005a): Measuring the Perceived Semantic Quality of Information Models. In Hutchison D, Kanade T, Kittler J, Kleinberg J M, Mattern F, Mitchell J C et al. (eds.): *Perspectives in Conceptual Modeling*, vol. 3770. Berlin, Heidelberg: Springer (Lecture Notes in Computer Science), pp. 376-385.

Prat N, Comyn-Wattiau I, Akoka J (2014): artifact evaluation in information systems design-science research – a holistic view In *Proceedings of 18th Pacific Asia Conference on Information Systems (PACIS)*, Chengdu, China, p. 17.

Pries-Heje J, Baskerville R, Venable J (2008): Strategies for Design Science Research Evaluation. In William Golden, Tom Acton, kieran Conboy, Virpi Kristiina Tuunainen (Eds.): Conference Proceedings of 16th European Conference on Information Systems: National University of Ireland, pp. 12.

Ray G, Muhanna W A, Barney J B (2005): Information technology and the performance of the customer service process: A resource-based analysis. In *MIS Quarterly*, pp. 625-652

Recker J C, Rosemann M (2010): A measurement instrument for process modeling research: development, test and procedural model. In *Scandinavian Journal of Information Systems* 22 (2), pp. 3-30.

Reeder B, Revere D, Olson D R, Lober W B (2011): Perceived usefulness of a distributed community-based syndromic surveillance system: a pilot qualitative evaluation study. In *BMC research notes* 4, pp. 187

Riemenschneider C K, Hardgrave B C, Davis F. D. (2002): Explaining software developer acceptance of methodologies: a comparison of five theoretical models. In *IEEE Transactions on Software Engineering*, 28 (12), pp. 1135-1145.

Rittgen P (2010): Quality and perceived usefulness of process models. In *Proceedings of the 2010 ACM Symposium on Applied Computing (ACM)*, pp. 65–72.

Rosemann M, Sedera W, Gable G (2001): Critical success factors of process modeling for enterprise systems. In *Proceedings of Seventh Americas Conference on Information Systems* (ACIS). Coffs Harbour, Australia, pp. 1128-1130.

Rothe V, Kebriaei A, Pitner S, Balluff M, Salama F. (2010): Effectiveness of a presentation on infant oral health care for parents. In *International journal of paediatric dentistry* 20 (1), pp. 37-42.

Schepers J, Wetzels M. (2007): A meta-analysis of the technology acceptance model: Investigating subjective norm and moderation effects. In *Information & Management 44* (1), pp. 90-103.

Schonlau M, Fricker R D, Elliott M N (2002): *Conducting research surveys via e-mail and the web*. Santa Monica, CA: Rand.

Shanks G, Tansley E, Weber R (2003): Using ontology to validate conceptual models. In *Communications of the ACM* 46 (10), pp. 85-89

Siau K, Wand Y, Benbasat I (1997): The Relative Importance of Structural Constraints and Surface Semantics in Information Modeling. In *Information Systems* 22 (2-3), pp. 155-170.

Siau K, Rossi M (2011): Evaluation techniques for systems analysis and design modelling methods - a review and comparative analysis. In *Information Systems Journal* 21 (3), pp. 249–268.

Sonnenberg C, vom Brocke J (2012): Evaluation Patterns for Design Science Research Artifacts. In Helfert M, Donnellan B (Eds.): *Practical Aspects of Design Science*, vol. 286: Springer Berlin Heidelberg (Communications in computer and information science), pp. 71–83.

Sun Y, Kantor P B (2006): Cross-Evaluation: A new model for information system evaluation. In *Journal of the American Society for Information Science and Technology* 57 (5), pp. 614-628.

Tan X, Siau K. (2006): Understanding the acceptance of modeling methods by IS developers: a theoretical model and an empirical test. In *Proceedings of ICIS* 2006. Milwaukee, USA. p. 937-946.

Venable J, Pries-Heje J, Baskerville R (2012): A Comprehensive Framework for Evaluation in Design Science Research. In Peffers K, Rothenberger M, Kuechler B (Eds.): *Design Science Research in Information Systems. Advances in Theory and Practice*, vol. 7286: Springer Berlin Heidelberg (Lecture Notes in Computer Science), pp. 423–438.

Venable J, Pries-Heje J, Baskerville R (2016): FEDS: a Framework for Evaluation in Design Science Research. In *European Journal of Information Systems*, pp. 77-89.

Venkatesh V, Brown S A, Bala H (2013): Bridging the Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems. In *MIS Quarterly* 37 (1), pp. 21–54.

Venkatesh V, Davis F D (2000): A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. In *Management Science* (46), pp. 186–204.

Venkatraman N, Ramanujam V (1987): Measurement of business economic performance: An examination of method convergence. In *Journal of Management* 13 (1), pp. 109-122.

About the Authors

Dr. **Patrick Brandtner** is Assistant Professor at the University of Applied Sciences Upper Austria since 2018. He earned his bachelor's degree in e-business and his master's degree in Supply Chain Management at the University of Applied Sciences Upper Austria Campus Steyr. He is academic researcher and lecturer in the area of Supply Chain Management, digital business management and marketing and electronic busines. His research interests include digital innovation, strategic innovation management, Supply Chain Management and Logistics 4.0, front end of innovation, IT-based innovation management and corporate foresight, social enterprise and design science. He published and presented his research at numerous conferences and has published several articles. Patrick Brandtner conducted and participated in several research projects and has received national grants from research promotion agencies. His PhD-thesis was funded by the Upper Austrian University of Applied Sciences research promotion scheme, by the Austrian research promotion agency and by Science Foundation Ireland.

Dr. **Markus Helfert** is Director of the Business Informatics Group at Dublin City University, and a Senior Lecturer in Information Systems at the School of Computing, Dublin City University (Ireland). He is senior academic researcher at Lero - The Irish Software Research Centre (http://www.lero.ie/) and a research affiliate at The Open Government Institute at Zeppelin University in Germany. His research interests include Design Science, Information Management, Innovation Management, Cloud Computing, Service Science, Enterprise Architecture and Open Data and Smart Cities. Currently he advises several small and medium sized Enterprise in relation to Innovation and IT Management. Markus Helfert has authored more than 200+ academic articles, journal and book contributions and has presented his work at international conferences. He is member of international programme committees and reviewer and associate editor of several IS journals. Dr. Helfert has received national and international grants from agencies such as European Union (FP7; H2020), Science Foundation Ireland and Enterprise Ireland. Prior to his appointment at Dublin City University, he held a research position at the Institute of Information Management at the University of St. Gallen. Dr. Helfert holds a PhD from the University of St. Gallen (Switzerland), an MSc from the University of Mannheim (Germany) and a BSc from Napier University in Scotland (UK).