Highlights

- There is limited transparency regarding how ITSM process assessments are conducted
- A software-mediated process assessment method was developed from a design science research project.
- International standards were used to validate the design, development and evaluation of the research artefact.
- Three International Standards for process assessment ISO/IEC 15504-330xx series, IT Service Management ISO/IEC 20000 series, and System and Software Quality Models ISO/IEC 25010 were adopted during the research project.
- External validity of an artefact and research relevance to practice can be improved with the use of International Standards.

Benefits and Relevance of International Standards in a Design Science Research Project for Process Assessments

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Abstract. One critical challenge in IT Service Management (ITSM) process assessment is the issue of transparency in the way ITSM processes are assessed. A Design Science Research (DSR) project was executed to design, develop and evaluate an artefact in order to conduct software-mediated process assessments in ITSM. International Standards were used to validate the design, development and evaluation of the research artefact in order to demonstrate that the artefact is relevant to practice. Studies relating to the use of International Standards to validate DSR artefacts are scant regardless of broader adoption of the DSR studies and acceptance of the international standards in practice. DSR studies in particular are required to maintain a balance between research rigour and relevance by reporting artefacts that solve a class of problems based on scientific justification and practical evidence. International standards provide bodies of knowledge that ensure products, services and processes are of acceptable quality and relevant to practice. Our DSR project confirmed that the external validity of an artefact can be improved with the use of International Standards. Using three International Standards, process assessment ISO/IEC 15504-330xx series, IT Service Management ISO/IEC 20000 series, and System and Software Quality Models from ISO/IEC 25010, this manuscript presents an account of a DSR project with three evaluation sites where the artefact was tested in real organizational contexts. The project demonstrated the significant role of International Standards to confirm research relevance during artefact design, development and evaluation.

Keywords: process assessment, International Standards, IT service management, design science research, software quality evaluation

1 Introduction

IT Service Management (ITSM) is an IT management framework that promotes service-oriented best practices to deliver value to organizations. The best practices are transformed into a summary of key requirements and guidelines for process improvement. A major challenge in ITSM process assessment is to enable transparent ways in which ITSM processes can be assessed. It has also been reported that existing process assessment methods are costly and time-consuming [1]. We aimed to develop and evaluate a method as a research artefact to measure the capability of ITSM processes in a more transparent and efficient way in comparison with the current process assessment methods.

The Design Science Research (DSR) approach was chosen as DSR is considered appropriate to develop and test a novel artefact [2, 3]. While DSR efforts focus on the features and functionalities of the artefact, research work must be corroborated with some evidence that the artefact was built and evaluated rigorously. Without the validation of

artefact design, development and evaluation, the research contributions may not be highlighted and the artefacts could be viewed as impromptu with merely unconfirmed propositions. Consequently such DSR projects may not be considered as independent scientific research but a typical consultancy project or an arbitrary case study.

One of the key DSR requirements agreed by all schools of thought [4] is that the artefact development and evaluation must be validated using existing theories and guidelines. In a socio-technical context the artefact is influenced by the environment in which it operates. Previous DSR projects have used kernel theories [5, 6], case studies [7] and systematic literature reviews [8] for the corroboration of artefact design, development and evaluation. This manuscript advocates that guidance on how to validate the artefact build and evaluate cycles in DSR can be obtained from the standards belonging to the International Organization for Standardization (ISO) family, referred as the “International Standards” in the remainder of this manuscript.

International Standards have been credited with facilitating communication in order to make IT artefacts more consistent [9]. Current technology standardization research in the IT industry primarily investigates the impact of standards on innovation, national economic growth and business effectiveness [10]. While ISO standards have been a subject of study in a large number of scientific research projects, the impact of ISO standards has been focused on practices that are associated with the relevant bodies of knowledge. This is not surprising given the aim of International Standards to promote industrial and commercial standards [11] rather than research work. There are a number of statistical, experimental as well as observational metrics of validity that can be used to demonstrate research rigour in quantitative and/or qualitative studies. Scientific studies that need to demonstrate research rigour will not find International Standards applicable to their purpose. However, DSR studies must present a balance between research rigour and relevance [12]. Validity in research relevance is essentially using a quality metric to determine if the research subjects (i.e. artefacts in DSR studies) are closely connected or appropriate for their intended purpose. Research relevance is a significant issue in academic management research [13]. While ISO standards have been extensively used to affirm validity of the research results [10], we believe there are relevant ISO standards that can be used to assert validity towards the *relevance* of the research.

Since International Standards belong to the public domain and are universally applicable for transparent use [14], the role of standards for wider adoption of ITSM process assessments is significant. International IT standards can make the IT service transition less troublesome and help to streamline service operations [14]. We assert that the use of International Standards promotes the validation of DSR artefacts during design, development and evaluation in order to demonstrate research relevance. Our literature review did not find any DSR studies that have used International Standards to demonstrate research relevance. Therefore, we posit that whenever International Standards are applicable and available, DSR researchers should consider their use to promote validity while discussing the relevance of research to practice.

The role of International Standards in artefact validation for research relevance can be demonstrated by its successful application to a real-life DSR project. We report the design, development and evaluation of our artefact in which we used International Standards in a DSR project undertaken over four years (2011 – 2015). An iterative design process was followed to develop a research artefact for process assessment. Process assessment is a disciplined evaluation of an organization unit's processes against a process assessment model (PAM) [15]. Our research artefact is named the Software-mediated Process Assessment (SMPA) method that enables researchers and practitioners to assess ITSM processes in a transparent and efficient way [16]. The four phases proposed in the SMPA method include (a) process identification; (b) process assessment; (c) process capability measurement; and (d) process improvement.

Three International Standards were implemented during the design, development and evaluation of the SMPA method to ensure that the research outcomes are relevant to practice. The International Standard for ITSM ISO/IEC 20000 series [17] provided the foundation in the form of a process reference model (PRM) for the ITSM processes to be assessed. The International Standards series for process assessment ISO/IEC 15504 [18] provided an assessment model in order to conduct a transparent appraisal of process capability. A decision support system (DSS) was also implemented for the SMPA method to demonstrate automation of process assessments. The software quality in use model in the

International Standard for Software Quality Evaluation ISO/IEC 25010 [19] was selected to conduct evaluation of the artefact. Evidence from the evaluation of the artefact at two public-sector IT service providers in Australia indicated that the SMPA method is effective for process assessments [20].

The use of International Standards was a major factor in our DSR project to promote a transparent ITSM process assessment method. In this manuscript, we report details of our DSR project to demonstrate how International Standards supported artefact design, development and evaluation, and thereby present a case for International Standards to be applied by research communities for corroboration of research relevance. The literature review of the DSR approach and the relevant International Standards is presented next. This is followed by a summary of our DSR project on ITSM process assessment. In the following three sections, we present the SMPA artefact design, development and evaluation with key references to the role of the International Standards used. We discuss our research experience highlighting the role that International Standards played in the successful execution of the project and demonstration of research relevance. Finally, we present our conclusions and directions for future work.

2 Literature Review

This section presents an overview on the state of the art in DSR studies relating to Information Systems (IS). DSR school of thought promotes the dual importance of rigour and relevance in IS research. International Standards can promote validity in terms of practical relevance of research conducted. The relevant International Standards that were investigated in our DSR project were ISO and IEC standards for process assessment ISO/IEC 15504-330xx series, ITSM standard ISO/IEC 20000 series, and the software quality evaluation standard ISO/IEC 25010. We also present background information about these standards in this section before we discuss their application to our DSR project.

2.1 Design Science Research

Several DSR authorities have provided critical guidelines that are related to the development and evaluation of artefacts during a DSR project. Baskerville [21] referred to the theory developed by design science as “theory discovery” where the theory is a by-product of the process of developing an artefact. In DSR the design process and design product (resultant artefact) have to be generalized to a class of problem domains [22]. This position corresponds to the definition of meta- requirements and meta-design provided by Walls et al. [6] in their proposed design theory. March & Smith [23] discussed design science and concluded that research artefacts may be constructed in the form of a construct, method, model, or instantiation. There is a general consensus among DSR researchers that the major contribution of a DSR study should be to develop a design theory or at least some components of a design theory must be presented. With the help of design theories, an artefact can be articulated to solve the identified research problems and therefore confirm the utility of the solution.

Over the past decade, the IS research community has accepted DSR as a rigorous research method. A key requirement in a DSR study is the demonstration of relevance of the research – in particular relevance to practice given the scope of the IS discipline as a practice-oriented discipline. However, being a relatively emerging research method, DSR researches in IS have not presented guidelines to measure and demonstrate research relevance. Given that DSR, akin to its companion evolving method Action Design Research, must aim for practice-inspired research [24], we argue for the use of International Standards in order to validate artefact design, development and evaluation towards relevance to practice.

Gregor & Hevner [25] proposed a DSR publication schema with guidance to present DSR projects. Their work provides significant insights in showcasing how DSR makes knowledge contribution and how to publish DSR work. Despite the significance of International Standards for policy making and in practice, there is a shortage of guidance on how to use International Standards for academic research, including for research relevance which is a major objective of any DSR project [2]. Future DSR studies must demonstrate how proposed solutions can address research problems in order to demonstrate relevance to

practice [26]. However, current artefacts reported in DSR studies has been reported to exhibit limited validity in terms of research relevance [27]. Our work is motivated to address this challenge by demonstrating the use of International Standards to validate DSR artefact design, development and evaluation for research relevance.

There are limited number of DSR studies that use International Standards to validate DSR artefacts. Pries-Heje, Baskerville and Venable [28] advocated for the potential use of ISO 9126 during the evaluation of software artefacts in DSR studies. Likewise, a logic model from the program evaluation discipline has featured the use of ISO/IEC standards on software quality to evaluate DSR studies in process assessments [29]. Beyond software artefacts, DSR projects have used International Standards for a human-centered design process in order to assess user experience in the context of Human-Computer Interaction [30] and for information security assessments [31]. However, the application of International Standards to demonstrate research relevance has not been discussed in any of the aforementioned DSR studies.

2.2 International Standard for Process Assessment

We used the International Standards series for process assessment ISO/IEC 15504 during the design of our research artefact in 2013. Since then, this standard has been revised and transformed into a new standard family of ISO/IEC 330xx series [32]. Several parts of the ISO/IEC 15504 standards series that were used in our research have now been withdrawn and new ISO/IEC 330xx standards have been published. The new standards present a generic view with a higher abstraction level for process assessment. Building new measurement frameworks and addressing quality characteristics other than process capability are two significant changes in the ISO/IEC 330xx family [33]. The ISO/IEC 330xx standard family also provides additional process assessment models and guidance in new domains. Readers can follow the Standards Catalogue on the ISO website for the latest standards update under the classification ICS code 35.080.IT > Software [34].

While there have been significant changes in the ISO/IEC 330xx standard series (e.g. new concept of Process Quality Attribute in ISO/IEC 33001), the new standards correspond to related ISO/IEC 15504 content [32]. The measurement framework defined in ISO/IEC 15504-2 that was used in our research has been revised but remains similar to the new ISO/IEC 33020 standard [35]. Moreover, the PAM used in our research – part 8 of the ISO/IEC 15504 – is still available and its transition into ISO/IEC 330xx family as ISO/IEC 33062 is expected to be a straightforward exercise [32]. The foundation of the ISO/IEC 15504 series has been subject of rigorous SPICE trials [36] and these have been published extensively [37]. In this light, we present an overview of the ISO/IEC 15504 standards series to give a better perspective of the artefact since these standard parts were relevant during our project. We believe that the SMPA method can be modified to meet the requirements of the new standards. In fact, the references made to ISO/IEC 15504 standards series in our research can be viewed as a specific and valid instance of the ISO/IEC 330xx family in terms of the terminologies and the measurement framework. Therefore, the underlying concepts of the artefact, including the role of International Standards as highlighted in this manuscript, remain the same.

ISO/IEC 15504-2 defines six process capability levels: CL0 – Incomplete process; CL1 – Performed process; CL2 – Managed process; CL3 – Established process; CL4 – Predictable process; and CL5 – Optimizing process. CL0 suggests a lack of effective performance of the process. At CL1, a single process attribute is defined. There are two specific process attributes defined for all the other process capability levels. Therefore, a total of nine process attributes (PA1.1 to PA5.2) exist in the measurement framework. At a more granular level, a number of explicit process indicators are defined for each process attribute. These process indicators provide criteria to assess process capability in finer detail. Process assessment is conducted in a standard manner when it is compliant with ISO/IEC 15504-2 requirements and where the assessors collect objective evidence against process indicators to determine capabilities of a process. ISO/IEC 15504-2 [18] suggests process assessment can be performed either as part of a process improvement activity or as part of a capability determination initiative.

2.3 International Standard for IT Service Management

The ITSM industry has defined a number of processes as best practices in the IT Infrastructure Library (ITIL®) framework [38]. The British Standard BS15000 was developed based on ITIL in order to describe the ITIL processes in standard terms and more importantly to structure the ITIL processes in order to make them measurable and manageable [39]. Later, ISO/IEC 20000 standard series based on the best practices of ITIL was published as the International Standard for ITSM. Since then it has undergone a number of updates and is currently synchronized with the latest ITIL 2011 edition [11]. ISO/IEC 20000-2 specifies requirements for IT service providers to develop and improve a service management system [40].

Part 1 of the ISO/IEC 20000 standard aims to support conformity assessment of the standard requirements in order to enable IT service providers to be certified based on a list of requirements that needs to be fulfilled [17]. This is valuable for a transparent method of an ITSM standard compliance audit. The ISO/IEC Standards Working Group responsible for ITSM (ISO/IEC JTC1/SC40) has also defined a PRM for the assessment of ITSM processes as Part 4 of the standard “that represents process elements in terms of purpose and outcomes” [41]. The PRM helps to identify activities required to check and maintain ISO/IEC 20000-2 compliance. In order to conduct a standard-based process assessment, the PRM provides all the indicators to determine process performance at capability level 1 (CL1). The PRM for ITSM is scheduled to be renewed in line with ISO/IEC 330xx family in the coming years [32].

2.4 International Standard for Software Quality Evaluation

ISO/IEC 25010 is an International Standard that provides quality models for systems and software quality requirements and evaluation, also called SQUARE, in the discipline of systems and software engineering [19]. Realizing the growing adoption of software-as-a-service, the ISO/IEC 25010 standard was expanded in 2011 to include the quality in use dimension for software quality evaluation. A corresponding standard ISO/IEC 25040 [42] describes how the quality models from ISO/IEC 25010 can be used during the evaluation process.

The quality in use is the degree to which software can be used by specific users to meet their needs to achieve goals in terms of effectiveness, efficiency, freedom from risk, and satisfaction in specific contexts of use [19]. A standard definition of usability is provided in the quality in use model of ISO/IEC 25010, clause 4.2.4 [19]: “usability is defined as a subset of quality in use consisting of *effectiveness, efficiency and satisfaction*, [emphasized] for consistency with its established meaning”. Furthermore, based on the standard, *satisfaction* is the user’s response to interaction with the software and includes four sub-characteristics: *usefulness, trust, pleasure and comfort* [19].

3 Overview of the DSR Project

The project draws on the DSR methodological guidelines for IS research suggested by Peffers et al. [3]. Figure 1 presents our DSR project methodology. The entry point to the DSR project is challenges identified in ITSM process assessments.

Fig. 1. DSR project methodology (adapted from [3])

The SMPA method prescribes four phases to conduct ITSM process assessments. The first phase is process identification: information about the organization profile, processes to assess and assessment participants along with their process roles are identified. The second and third phases survey the process stakeholders according to the ISO/IEC 15504-8 PAM and then measure process capability based on the survey responses. The final phase generates an assessment report that recommends process improvements for continual service improvement based on the ITIL framework. A comprehensive account of the SMPA method has been reported previously [43].

The iterative nature of the artefact design process ensured that the final SMPA method built after several “build-evaluate” cycles has utility and validity in terms of both research rigour and relevance. Assessment goals were specified for each of the process capability levels. A number of assessment questions were related to specific assessment goals and the responses to the questions were calibrated with a metric of process knowledge. The SMPA method addressed transparency issues in ITSM process assessment by following a goal-oriented measurement of ITSM processes using a standard PAM. With this background information on our DSR project, we next describe the artefact design, development and evaluation with reference to International Standards that were applied to demonstrate relevance of research to practice.

4 Artefact Design

In our research, the transparency issue with the ITSM process assessments is addressed with the use of International Standards. Using International Standards, the processes to be assessed were defined as structured activities in the PRM from Part 4 of the ISO/IEC 20000 standard [41]. Likewise, ISO/IEC 15504 Part 8, which was released as the PAM for ITSM [44], provided a model to conduct process assessments in a structured fashion. These two International Standards have an interconnecting assessment framework and therefore they provided a transparent framework for ITSM process assessments.

The ITSM environment is one where best practices and standards guide processes [17]. Therefore, introduction of a novel method to measure ITSM processes that also conforms to International Standards is a natural progression towards the acceptance of the artefact. Based on this premise, the SMPA method is supported by the International Standards series ISO/IEC 20000 and ISO/IEC 15504. Incorporation of widely accepted International Standards also provides justification of the iterative design of the SMPA method.

Two design principles were articulated to develop the SMPA method using the task-technology fit theory [45] as the underpinning kernel theory. According to this theory, technology dimensions to deal with the challenges of a decision task must focus on *process structuring* and *information processing* dimensions of technology to enhance performance [45]. The two research problems in our DSR study, viz. issues regarding transparency and high costs, were mapped to the technology dimensions to articulate the design principles. The two design principles for the SMPA method are (a) Standardize Assessment Workflow, and (b) Automate Assessment Activities. The first design principle of standardizing assessment workflow was executed with the application of International Standards, thereby offering an effective solution to the research problem of transparency challenges in process assessments. The second design principle of automating assessment activities was partially achieved by the use of a DSS tool.

Transparency was demonstrated by aligning the assessment activities with the ISO/IEC 15504 standards series that provides guidance on conducting the assessment process [15]. Part 2 of the ISO/IEC 15504 provides a measurement framework with capability rating metrics [18], however application of the framework to determine process capability is understandably not explicit in the standard. Perhaps this is because most of the assessment data analysis is largely dependent on the subjective judgment of the assessors [46]. The risk of the subjectivity of assessors can be mitigated by ensuring that the assessors undertake training courses and exams, for example, assessor training initiatives by Automotive SPICE and TIPA, which contributes to enhanced assessment skills and competencies as well as experiences. While the qualifications and experiences of the assessors are critical factors for a successful assessment, there is a potential for a DSS to make assessments more transparent and cost-effective. Currently where a software tool is used (e.g. SPICELite Assessment tool [47] and Appraisal Assistant [48]), the tools provide limited functionality,

e.g. an interface to record evidence for standard indicators, rate process capabilities and produce assessment reports. There is limited discussion reported on how the collected assessment data is analyzed, if it is done so, by any software tools.

Likewise, it is reasonable to assume that proprietary software tools and services in the ITSM industry such as PinkSCAN [49] and ITIL assessment services [50] also report alignment with the standard frameworks (ISO/IEC 15504 series, ITIL, CMMI) but they do not disclose their data analysis approach given the commercial nature of such knowledge. Our DSR project demonstrated research rigour by openly presenting our research approach, artefact components and results to the scientific community. The use of International Standards helped to demonstrate research relevance as these relevant standards emerged from practice and have been (and continue to be) revised to reflect current practice.

During artefact design, International Standards were used for objective measurement as well as for the generation of the assessment results. The use of DSR and International Standards demonstrated transparency in the way the SMPA method collects data, performs gap analysis and determines process improvement guidelines.

5 Artefact Development

The SMPA method uses the ISO/IEC 15504 standards series in order to exemplify a transparent method in ITSM process assessments. According to Part 2 of the standard that sets out the minimum requirements to perform an assessment, ITSM process assessment is based on a two-dimensional model: a process dimension and a capability dimension [18]. The process dimension is provided by an external PRM. Likewise, the capability dimension consists of a measurement framework comprising six process capability levels and their associated process attributes [18]. Process assessment is carried out utilizing a conformant PAM that relates to the compliant PRM.

ISO/IEC 20000-4 is a PRM that outlines a purpose and key outcomes for all ITSM processes. Based on these outcomes, base practices are provided in a PAM for the process dimension. Likewise, generic practices in the capability dimension for capability levels 2 to 5 are provided in the final PAM, i.e. the ISO/IEC 15504-8 standard. This PAM was used to develop the questionnaire for each process. All the standard indicators, i.e. base practices for each process and the generic practices, were reviewed. Assessment questions for the survey were generated by analyzing all standard indicators to construct singular, fine grained and close-ended assessment questions. The questions were then reviewed following the iterative design process to ensure industry relevance, standards alignment and academic rigour during their transformation.

Four ITSM processes were initially selected for the evaluation of the SMPA method: Problem Management, Change Management, Configuration Management and Service Level Management. A total of 46 questions specific to the four processes at capability level 1 (PA1.1) and 127 general questions for all processes at capability levels greater than 1 (PA2.1 to PA5.2) were generated. A total of 63 standard indicators (base practices for four ITSM processes and all generic practices) were transformed into a set of 173 assessment questions. The reason for a larger number of assessment questions is they were granular to the level of each criterion specified in a standard indicator. Several indicators had two or more criteria often specified in multiple sentences examining specific aspects of the indicator. In such cases multiple questions were generated from a single standard indicator, and the mean value of ratings from all relevant questions was calculated to determine the overall rating of the final standard indicator.

Next we present an example to illustrate how an assessment question was generated from a standard assessment indicator. For the Problem Management process, one of the indicators of the process is “problems are resolved and closed” (clause 5.13) [44]. In order to address this indicator, the base practice was prescribed as “RES.3.3 Resolve and close problems” which says that the problems should be resolved and closed once resolved. The standard also states that a “problem disposition record” is the input and output for this standard indicator. After analyzing all these requirements from the standard, two questions that align with the standard were developed for the assessment:

- a) Do you know if problems are effectively resolved? *NOTE: problems are effectively resolved when a workaround (or even better a permanent solution) has been found.*
- b) Do you know if resolved problems are successfully closed? *NOTE: problems*

are successfully closed when they are effectively resolved and a known error record is generated.

After a final set of assessment questions were confirmed, the rationale to allocate process roles, viz. process performer (PP), process manager (PM) or external process stakeholder (EPS), to each assessment question was developed based on the scope of the question. While it is clear that a process performer executes the process and a process manager is responsible for the overall process goals, an external process stakeholder is not explicitly associated with the process but is affected by the process and its inputs and/or outputs. A protocol was developed to guide process role allocation to each assessment question as described in Table 1.

Table 1. Protocol for Process Role Allocation to Assessment Question

Process Attribute	Role	Rationale
PA1.1	Primary role: PP Second opinion: PM and/or EPS	Deals with process performance; hence allocate questions to PP as the primary role.
PA2.1 - PA4.2	Primary role: PM Second opinion: PP and/or EPS	Deals with process management, standardization and control, hence allocate questions to PM as the primary role
PA5.1 – PA5.2	Primary role: PM Second opinion: None or PP or EPS	Deals with process innovation, hence allocate questions to PM as the primary role, and mostly exclusively to PM only.

The final list of questions with the defined process roles were implemented as an online survey from a DSS tool that is designed to collect quality data for measurement. With the help of the DSS, the major responsibility to provide information about process capability is transferred directly to the process stakeholders while the assessors can take a more knowledge-intensive role. The role of assessors transforms from data collection and analysis to data validation and contextualizing assessment results to relevant organizational units. This shift from the current practice where assessors are fully responsible to collect assessment data means that using the SMPA method, the assessors may not need to conduct extensive interviews and they can determine process capability assisted by the recommendations from the DSS. However data collected from the DSS cannot be deemed fully reliable as they may be prone to biases, e.g. the level of understanding of the respondents to the online survey, and the quality of contextual data inputted by process stakeholders directly.

In order to cover all the assessment indicators from the standard PAM, no branching logic was applied in the questionnaire design. While the mean value of all responses determines the final rating to a question, all responses have equal weight to the question, i.e. the DSS does not perform any weighted average calculations. However the allocation of the three process roles to the survey questions based on the protocol in Table 1 caused different number of questions for each respondent according to their process roles. In this way all responses are implicitly weighted according to how the process roles are allocated to the assessment questions. In other words, while the responses are not weighted, the questions are allocated differently to each role (see Table 1). Therefore, a larger number of questions to participants who share a particular role implies that this role has a greater “say” towards the relevant standard indicator.

The assessment questions were grouped to determine process capability levels 1-5 and every question was designed to have consistent answer options using the rating scale: Not (N), Partially (P), Largely (L) and Fully (F) – also referred as the NPLF scale – as defined in the measurement framework of the ISO/IEC 15504-2 standard [18]. This rating was designed to capture what ITSM process stakeholders know about the process. Rather than the assessment team making a subjective choice of the indicator rating, the SMPA approach uses the metric to collect and objectively measure feedback from the process stakeholders directly. Every question also featured a comment text box to capture qualitative contextual data. Such textual information can be analyzed by an assessor to validate responses and

provide specific recommendations in the assessment report. The measurement framework of the standard (ISO/IEC 15504-2) was useful to determine the rating from all responses associated with a standard indicator. Moreover, statistical measures of central tendency (mean) and dispersion (coefficient of variation) are used to combine all responses to all questions associated with a process capability level to determine its score. To the authors' best knowledge, such data analysis has not been experimented during any research on process assessments in the past. Figure 2 illustrates a simple workflow of the SMPA method that is built based on the International Standards for process assessment and ITSM, along with the ITIL® guidelines for process improvement.

Fig. 2. Simple workflow of the SMPA method

The availability of the PAM for ITSM in ISO/IEC 15504-8 is one of the driving forces of this research. Although the combination of ISO/IEC 15504 and ISO/IEC 20000 standard series was studied previously [51], there are few studies, e.g. [46], on the use of the combination for ITSM process assessment based on the standard PAM. The standard PAM for ITSM [44] underpins the SMPA method. Following this PAM, the SMPA method provides a structured method to conduct process assessment in ITSM.

6 Artefact Evaluation

Artefact evaluation is necessary to confirm the validity of the contributions of the artefact. Evidence of utility of the artefact assures all stakeholders, including producers and consumers of DSR research that the contributions of the artefact are applicable. The evaluation strategy advocated by Venable et al. [52] was used for evaluation. Using the quality models from the International Standard for software quality evaluation ISO/IEC 25010, the usability and outcomes of the SMPA method were evaluated using quality factors for use of software.

The SMPA method was evaluated with focus group discussions of SMPA survey participants and one-on-one interviews with the assessment facilitators at the two IT service providers. In order to assess if the SMPA method has utility in a real organization, it was essential to ensure that the survey approach was usable. Therefore, usability was determined as the key evaluation factor. The concept of usability as defined in ISO/IEC 25010 software quality in use model [19] was applied to evaluate five quality factors of the online survey. The standard definitions of the five software quality characteristics were transformed into operational definitions of usability characteristics to align their meaning to specific contexts of use, as shown in Table 2.

Table 2. Operational definitions of standard evaluation terms (adapted from [19])

Usability Characteristics	Operational Definition
Effectiveness	Accuracy and transparency of the SMPA method
Efficiency	Time, cost and resources required to organize an assessment
Usefulness	Representative and relevant process assessment questions
Trust	Validity of the assessment results
Comfort	Ease of use of the DSS tool

The data were analyzed by reviewing focus group discussions and interview transcripts for themes or patterns related to the five software quality in use characteristics. The use of the International Standard for software quality in use model, ISO/IEC 25010, ensured that consistent terminologies were used during evaluation data collection and analysis.

As per the evaluation outcomes, participants reported that overall they found the online survey for assessment was trustworthy, comfortable and generally effective. Positive comments were also recorded regarding efficiency of conducting online surveys for assessments. However discussions led to a conclusion that a fully automated online survey that is strictly standards-based is not feasible and human input is critical for the facilitation of online assessment surveys. A full report on the evaluation exercise of the SMPA method has been previously published [20]. Based on the two trials, a consolidated evaluation of research findings that relate to the usability characteristics from the standard is illustrated in Table 3. While there were predominantly positive remarks about the SMPA method, most of the participants found that data collection was not useful since the assessment questions were not representative of what they do and were rather difficult to understand. Future revisions of assessment questions, including adding real-life process scenario examples, have been actioned to address this issue. From the evaluation exercise, it was determined that the standard PAM and guidelines from ISO/IEC 15504 standards series provided critical support to develop the SMPA method that is more transparent than current ITSM process assessment methods.

Table 3. Consolidated Evaluation Findings (based on [19])

Usability Characteristics	SMPA Phase 1 (process identification)	SMPA Phase 2 (process assessment)	SMPA Phase 3 (capability measurement)
Effectiveness	☑	☑	⊙
Efficiency	☑	☑	☑
Usefulness	☑	☒	☑
Trust	☑	☑	☑
Comfort	N/A	☑	☑

☑ Indicates the usability characteristic was strongly supported by participants

⊙ Indicates the usability characteristic was not clear or a neutral position was taken by participants

☒ Indicates the usability characteristic was strongly opposed by participants

7 Discussion

The International Standards referred to in this manuscript are developed on a voluntary basis by domain experts who must reach to a consensus before a standard can be published for global adoption. The experts are represented from the independent bodies ISO and IEC that have national representatives of all United Nations member countries. Therefore, International Standards, by their very nature, are powerful instruments of governance and their use may impact daily activities that we perform. In terms of academic research, while International Standards may not be suitable to guide research activities, they can certainly provide valuable support towards the validation of research work in terms of practical relevance. Therefore such impact will be highly useful for DSR studies.

There are a number of important parallels that we can draw between good research practice and good standardization practice. One can use International Standards as part of

good research practice, for instance, by including International Standards as part of literature reviews and referencing standards to support research actions. The key best practices of International Standards such as openness, transparency, effectiveness, global relevance, consensus and expert opinion [53] relate closely to good research practice. Therefore, researchers can understand and achieve the benefits of using International Standards to support their research activities, particularly to demonstrate the impact of the research for industry and community adoption. Moreover, International Standards embody universally agreed practices, drawing on the experience and expertise of all interested parties internationally. It is therefore plausible to assert that using International Standards could promote good research practice on an international level.

In our DSR project, we used the two International Standards series ISO/IEC 20000 and ISO/IEC 15504 as secondary data sources in order to develop the research artefact. The most relevant documents are the technical report Part 4 of ISO/IEC 20000, i.e. the PRM [41] and Part 8 of ISO/IEC 15504, i.e. an exemplar PAM for ITSM [44]. To the authors' knowledge, few researchers have studied the combined use of ISO/IEC 15504 Part 8 and ISO/IEC 20000 Part 4, e.g. [54]. While there were other relevant competing frameworks for our project work on ITSM process assessments, such as ITIL and CMMI, the choice of the standards series ISO/IEC 20000 and ISO/IEC 15504 is reinforced in this research in recognition of the credibility of the International Standards. Furthermore, it is logical to apply International Standard guidelines for evaluation after the experience of using International Standards for the development of the artefact. Therefore, we used a software quality in use model from the International Standard ISO/IEC 25010 [19] to evaluate the usability of our research artefact.

International standards are widely adopted in ITSM process assessments [55]. For instance, Johnson et al. [56] demonstrated how consistent standards facilitate ITSM with an example of ITIL's configuration management process. It is therefore plausible to use a standard approach in process assessment (ISO/IEC 15504-330xx series) and to apply such an approach to standard ITSM processes (ISO/IEC 20000 series) as both standards have been developed by the same organizations, ISO and IEC, thus fostering greater compatibility and global acceptance [57]. A standard and structured method provides the transparency required to compare outcomes and to measure improvements impartially. In addition, for multinational organizations a standards-based approach grounded on ISO and IEC specifications can make an assessment project feasible to conduct across international borders. The credibility of ISO and IEC is therefore one of the key drivers in this research.

It is worth noting that standards are statements of good professional practice, such as documents of general principles rather than detailing any precise activities to be followed. Such an overarching governance role of International Standards promotes transparency in the way activities can be conducted. The artefact in this research, the SMPA method, provides prescriptive details of activities to be undertaken for ITSM process assessment. However the artefact is scaffolded by the principles of International Standards, thereby incorporating support and validation towards the prescribed activities in order to make it practical for industry and wider community adoption.

We had to face two significant design issues during the DSR project. First, the process assessment models of the International Standards for ITSM and process assessment were in a period of transition during the artefact development phase (2012-2014) of the research. Therefore inconsistency was apparent in the way the process models were structured. The PRM for ITSM [41] was published as a technical report in 2010. This model was based on ITSM processes listed in the ISO/IEC 20000-1 standard published in December 2005. However ISO/IEC 20000-1:2005 was replaced with ISO/IEC 20000-1:2011 in June 2011 along with an updated set of requirements to maintain a service management system. A corresponding PRM based on the updated standard has not yet been published. Therefore the PAM for ITSM is in need of substantial revision. A comprehensive review of PAM and PRM for ITSM process assessment has been planned within the standards community in the future [32]. Even if the latest and consistent versions of standards are used, the quality of the standards vary since the level of consensus reached by ISO delegates can range from a full endorsement to a very weak agreement. When the consensus is weak, the published standards can be of a questionable quality for worldwide adoption, and consequently the transparency advocated by the SMPA method can be challenged.

Secondly, the measurement framework for process assessment is based on the International Standard ISO/IEC 15504-2 [18]. A new framework with updated metrics and

assessment concepts has been released in the ISO/IEC 330xx family [58]. As new sets of stable process models and standard guidelines are published, it is imperative that the research artefact is updated with changes to questions, calculations of process capability scores and recommendations for process improvement. Significant issues were raised regarding the currency and quality of process models in ISO/IEC 20000-4 and ISO/IEC 15504-8 during this research project. Furthermore, practice-oriented ITSM guidelines, e.g. ITIL, can be used to develop standard indicators for assessment, and then incorporated into the SMPA method. One example of such model is the TIPA for ITIL PAM [48]. Nevertheless, we believe the overall SMPA method is a valid assessment approach that is applicable regardless of the use of any current or future compliant PAM.

With the expanding significance and adoption of the newly published ISO/IEC 330xx standard series, the SMPA method is expected to be a useful method for process assessments in any discipline that promotes a compliant assessment model. Using the principles of international standards for process assessment, a research team in Luxembourg has developed an internationally-recognized framework for IT process assessment called the TIPA® framework [59]. The TIPA framework offers resources for assessments, professional certification, and training and it has been adopted in over 20 countries. Research collaboration has commenced with the TIPA team to work on automation strategies for process assessments [60]. We expect to work closely with the TIPA team towards further development and adoption of the new ISO/IEC 330xx series since many researchers are also representatives of relevant ISO/IEC standards national committees. Connecting research work with standards development and review is expected to provide synergy towards research outcomes and relevance to practice.

A fundamental principle that governs the application of International Standards for DSR artefact validity is that all representations of artefacts (meta-artefacts) must be justified using prior knowledge. We advocate that International Standards are a reliable source of extant knowledge based on best practices validated by relevant stakeholders that can justify DSR meta-artefacts. Therefore, we present an account of our DSR project to showcase the application of International Standards, and to illustrate potential benefits for future DSR studies. Table 4 connects the relevant International Standards to our DSR project and thereby demonstrates how International Standards have justified our DSR activities.

Table 4. Mapping of International Standards to our DSR activities

DSR Activity	Description of DSR Activity	International Standard	Mapping
Artefact Design	Address problems that the artefact can solve	ISO/IEC 20000 series	Provides a reference model of processes that needs to be assessed
Artefact Development	State how the artefact was developed	ISO/IEC 15504 – 330xx series	Provides the measurement framework and methodological guidance for process assessment
Artefact Evaluation	Provide proof that the artefact is useful	ISO/IEC 25010	Provides a software quality in use model to determine usability, based on ISO/IEC 25010 [19]

The application of International Standards presented in this manuscript is aimed at promoting transparency for process assessments as well as research work. In our experience, International Standards can guide researchers to demonstrate valid research work and clarify the utility of research outcomes to practice. We believe that the relevant International Standards can provide a viable solution to the majority of researchers who are concerned about developing and evaluating a useful artefact that will be acceptable in practice. This resonates with one of the apparent causes of frustration in DSR that claims that even rigorous research work may not produce practical DSR outcomes [27]. International standards can certainly address some of the concerns about the validity of artefacts and thereby potentially increase the confidence DSR researchers regarding the application of artefacts in practice.

An International Standard is also an applicable research instrument due to its ease of

demonstration. Once researchers understand the structure of the International Standards, it is our understanding that they will find the standard sufficient and parsimonious to capture holistic information relating to an artefact that they must validate. For example, in our experience, building an assessment instrument from the ISO/IEC 20000 processes was simpler and more reliable than using the best practice guidelines from ITIL for assessment. Unlike ITIL as best practices for ITSM, ISO/IEC 20000-2 is minimalistic and tailor-made for assessment with a PRM. While ITSM assessments based on ITIL are certainly possible and more comprehensive, ITIL was designed to suggest improvements rather than assess process capability. International standards provide a global, consensus-driven set of instruments for validation of research efforts, including DSR outcomes.

In order to claim generalization of our research artefact, the SMPA method, there is a significant role of International Standards that provided a consistent structure to conduct process assessments and evaluate assessment results. By developing a method that can partially automate the assessment of ITSM processes using International Standards, we hope that our research helps clarify unique challenges in process assessment activities and furthers our understanding of a consistent method to overcome such challenges in practice.

8 Conclusion

This manuscript discusses the role of International Standards to validate an artefact in a real-life DSR project. The demonstration of this DSR project mapping research activities with International Standards indicates its appropriateness to validate artefacts and demonstrate research relevance to practice. Artefacts validated using universally-acceptable frameworks such as International Standards can also potentially improve the way DSR projects are conducted. Current literature review suggests limited use of International Standards in DSR studies and a lack of discussion on research relevance to practice that is justified by International Standards. Future research can investigate how International Standards have been or could be applied in other DSR projects in different contexts and whether this can promote validity in the way DSR outcomes are presented. Likewise, another example of future study could involve a comparison between the results of the SMPA method and results from the conventional process assessments based on ISO/IEC 15504-3300xx standards series.

This manuscript also makes a contribution to the IS researchers who engage in DSR because prior work has not adequately addressed the role of International Standards to demonstrate validity of DSR outcomes. We have made a contribution to the growing body of guidelines for DSR with a practical example that demonstrates how International standards can promote research relevance to practice. The validation of carefully designed research artefacts has great potential to produce stronger design theories that may be valuable to both researchers and practitioners within and beyond the IS discipline.

We admit our DSR project demonstrates limited evidence of use of International Standards since it only reports one artefact validated using three International Standards at three case study organizations. However it may be plausible for a DSR project that needs to validate its artefact to apply relevant International Standards where available so that practical implications can be demonstrated. Our intention in this manuscript is to present future researchers with an example of how a DSR project can demonstrate validity of the artefact to prove it may work in practice. The design knowledge developed in this research forms a base for subsequent research, implementation and evaluation that may contribute to efforts such as trials for new and upcoming International Standards for ITSM and process assessment. By trialing International Standards in industry, this research also confirms that the standards are useful and supports the transition of new standards for effective industry use.

Note. ITIL® is a Registered Trade Mark of AXELOS Limited.

Funding: This work was supported by an Australian Research Council linkage project [grant number LP100200227].

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Benefits and Relevance of International Standards in a Design
Science Research Project for Process Assessments

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PII: S0920-5489(18)30047-3
DOI: [10.1016/j.csi.2018.04.011](https://doi.org/10.1016/j.csi.2018.04.011)
Reference: CSI 3285

To appear in: *Computer Standards & Interfaces*

Received date: 8 February 2018
Revised date: 23 April 2018
Accepted date: 29 April 2018

Please cite this article as: Anup Shrestha , Aileen Cater-Steel , Mark Toleman , Terry Rout , Benefits and Relevance of International Standards in a Design Science Research Project for Process Assessments, *Computer Standards & Interfaces* (2018), doi: [10.1016/j.csi.2018.04.011](https://doi.org/10.1016/j.csi.2018.04.011)

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