Innovative decision support for IT service management

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Innovative decision support for IT service management

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ABSTRACT
The IT Service Management (ITSM) industry has defined processes as best practices in the widely-accepted IT Infrastructure Library (ITIL®) framework. However, there are few tools available to provide decision support to IT Service Managers who wish to improve service management processes. It is essential to assess the current capability of processes before process improvements are planned. Our research addressed the problems of the lack of transparency and the need for efficiency in ITSM process assessment. Using the Design Science Research methodology, we developed an innovative Software-mediated Process Assessment (SMPA) approach that automates assessment of ITSM processes and supports the decision-making of IT Service Managers. The SMPA approach includes process selection, an online survey to collect assessment data, measurement of process capability and specific recommendations for managers to commence process improvement. We implemented a decision support system (DSS) to automate the SMPA approach and evaluated it at two IT service providers. The evaluations indicated that the SMPA approach supports decision-making on process improvements. In the future, data analytics performed on the assessment data can help IT managers to analyse and visualise the ‘big data’ of process knowledge.

INTRODUCTION
It is important that IT service providers understand their service activities since processes impact service delivery (Walker, Johnson, & Leonard, 2006). However, processes are prone to natural deterioration in the course of their evolution (Juran & Godfrey, 1999). A process must be measurable in order to be controlled and improved (Praeg & Schnabel, 2006). IT service management (ITSM) adopts the process approach principle of quality management (ISO, 2012) in order to manage and improve activities as processes. Existing literature on ITSM has highlighted the lack of research on the topic of ITSM process measurement (Spath, Bauer, & Praeg, 2011). Transparent and cost effective ITSM process assessments can provide baseline and checkpoint assessment information to support managers to make informed decisions on process improvement, thereby contributing to service innovation.

Process assessments determine process capability by checking compliance with a standard (Cortina, 2010). In the ITSM industry, several standards and commercial offerings are available for ITSM process assessments such as Tudor IT Process Assessment (Barafort et al., 2009), ITIL®...
self-assessment services (Rudd & Sansbury, 2013) and PinkSCAN assessments (PinkElephant, 2012). However, lack of transparency and high costs are reported as major barriers to conducting ITSM process assessments (Fayad & Laitinen, 1997; Lloyd, 2011; Peldzius & Ragaisis, 2013). Moreover, there have been several heated discussions in the ITSM community against the use of existing ITSM process assessment approaches (England, 2012; Kane, 2012). There are also challenges in the decision-making process in IT management due to the complexity in assessing the scope of IT systems and in determining the business and technical boundaries for decision-making (Lutz, Boucher, & Roustant, 2013). Therefore the ITSM industry problem we aimed to solve can be stated as follows: There is a lack of a transparent and efficient process assessment method to improve ITSM processes.

We applied the Design Science Research (DSR) methodology to develop a new artefact for ITSM process assessment called the Software-mediated Process Assessment (SMPA) approach. The SMPA approach is a standards-based process assessment method by which organisations can self-assess their processes in a transparent and efficient manner using a Decision Support System (DSS). The DSS produces a tailored process improvement report at the end of an assessment. The system accesses a knowledge base of process improvement best practices based on the IT Infrastructure Library (ITIL) framework. The report can be used by IT service managers to make informed decisions towards improving processes.

The next section discusses current literature on ITSM process assessment and DSS for process assessment. This is followed by a description of the DSR methodology used to develop the SMPA approach. The subsequent sections present the artefact design and evaluation phases. We then discuss the role of the DSS in providing decision support to IT managers, and the contribution of the DSS towards service improvement. Finally, we provide conclusions and implications for future research.

Literature review

An IT service is typically delivered with a combination of people, processes and technology and it should be defined with agreed levels of services to customers (TSO, 2011). Service improvement can be facilitated by the implementation of decisions made on individual process improvements in ITSM. The ITIL framework supports this notion by presenting a service lifecycle approach with emphasis on continual improvement (ISO, 2012). We present an overview of existing ITSM process assessment methods next, followed by an overview of the DSS research that is relevant to build our research artefact.

Existing ITSM process assessment methods

Using a standards-based approach promotes transparency in the way process improvements can be assessed (Hilbert & Renault, 2007). In response to increasing interest in the application of the international standard for process assessment, ISO/IEC 15504, Mesquida, Mas, Amengual, & Calvo-Manzano (2012) conducted a systematic literature review of ITSM process improvement and found 28 relevant studies. One study is linked to the ITSM international standard, ISO/IEC 20000 (Nehfort, 2007), whereas ten studies related to the use of ITIL and ISO/IEC 15504. Combining ITIL processes and ISO/IEC 15504, Barafort, Di Renzo, & Merlan (2002) provided evidence of repeatable and objective improvement in IT service quality. Extensive work on the combination of ITIL
and ISO/IEC 15504 led to the development of an ITSM process assessment method called Tudor IT Process Assessment, or TIPA for ITIL (Barafort et al., 2009). TIPA is also promoted as a commercial framework for ITSM process assessment (Renault & Barafort, 2014).

Several ITSM process assessment methods are discussed as best practice guidelines in the IT industry. Many of the solutions offered for ITSM process assessment are commercially available and aimed at selling organisations either a self-assessment toolkit or providing consultancy services as part of improvement initiatives, for example, TIPA for ITIL (Barafort et al., 2009); SPICE 1–2–1 (Nehfort, 2007); SCAMPI using CMMI®-SVC (CMMI, 2011) and IT service CMM (Clerc & Niessink, 2004). Other approaches emerged from industry best practice, particularly from ITIL (AXELOS, 2014; MacDonald, 2010). The measurement frameworks of ITSM process assessment methods are based on one of two models: CMM/CMMI and ISO/IEC 15504. ITIL is the most used process reference model for ITSM process assessment. Non-ITIL approaches such as CMMI for Services (CMMI, 2010) or eSCM for service providers (Hyder, Heston, & Paulk, 2004) also provide transparent models for assessment.

**Decision support systems research**

Although traditionally associated with strategic decision-making for managers (Alter, 1980), DSS is a general term for any information system that supports the decision-making activities of individuals and groups (Power, Burstein, & Sharda, 2011). A DSS presents the opportunity to eliminate the need for subjective judgment to determine process capability levels and provides process improvement recommendations in the SMPA approach. DSS enables specialised problem-solving based on the knowledge about a particular domain (Power et al., 2011). A knowledge-driven DSS that suggests or recommends actions to managers is at the core of our research. Such a DSS can use technological rules and knowledge bases in which ‘knowledge’ is stored in the form of rules. A knowledge-driven DSS also uses an inference engine to process rules or identify relationships in data. The DSS in the SMPA approach stores knowledge items of process improvements which provide practical recommendations to support decision-making for IT managers (Lutz et al., 2013). The DSS helps process managers make decisions to mitigate process risks and commence process improvement initiatives.

Our review has found only one ITSM process assessment approach (Nehfort, 2007) that reported the use of a software tool to conduct ITSM process assessments and a handful of other tools discussed in the literature. However, these software tools were designed to be used by the assessor in rating process attributes. While these software tools could minimise paper handling and manual work, they did not deliver decision support for ITSM process assessment. In other words, the existing assessment tools cannot be classified as knowledge-driven DSS due to the absence of technological rules and knowledge base to recommend actions for decision support to IT managers.

Several potential drawbacks of employing a DSS approach for assessment need to be overcome, such as high costs, information overload, potential cognitive bias, and the likely transfer of decision authority from an expert assessment team to DSS. Therefore, in the SMPA approach, the DSS was used to automate (a) assessment data collection using online surveys, (b) data analysis to calculate process capability scores, and (c) reporting from a context-based knowledge base of process improvement recommendation items. These opportunities translate to significant cost savings as the use of costly assessors and consultants is reduced while
enabling self-assessments for IT organisations with fast turnaround time. This is even more significant in a discipline such as ITSM where repeatable process assessments are a requirement to evaluate service improvement (Lloyd, 2011). The methodology of the research work is briefly discussed next.

**Methodology**

We designed and evaluated the SMPA method with a demonstration of a DSS to address the transparency and efficiency challenges of ITSM process assessment. We used an iterative design process to develop the SMPA approach and interpretative case studies to evaluate the usability of the SMPA approach.

Our research artefact is a method for ITSM process assessments based on the international standards and implemented using a DSS. The artefact design and evaluation activities that we undertook in this research are illustrated in Figure 1.

As shown in the project timeline in Figure 2, we followed the Design Science Research methodology (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) in our research. DSR has been most commonly used for generating field-tested and theoretically-grounded
knowledge in Information Systems (McLaren, Head, Yuan, & Chan, 2011). The design of the SMPA approach is discussed next.

**Artefact design**

The four most important instruments that were designed for the SMPA approach are: (a) the assessment survey questionnaire; (b) the allocation of assessment questions to process roles; (c) the logic to calculate process capability and reliability; and (d) a process improvement knowledge base containing specific ITIL recommendations.

During the iterative process to develop the final SMPA approach, the four instruments went through several design iterations. After initial discussions with the project sponsor (v0+), checks were carried out for industry relevance (v1+), standards alignment (v2+), and academic rigour (v3+) before v4.0 instruments were released for the final implementation. Figure 3 illustrates the iterative design process and the versioning of the instruments developed for the SMPA approach.

Our research artefact, the SMPA approach, being software-mediated, uses a DSS to automate the ITSM process assessment and to aid decision-making. Before we realise the value of a DSS in decision-making, the purpose of the decision outcome and process must be identified (Carlsson & Johansson, 2011). For process assessments, DSS can be useful to capture all the information that an assessor typically considers to be required for process assessment, to facilitate the entire assessment workflow and produce assessment reports for decision-making on process improvements. The DSS represents a working IT artefact that supports the four phases of the SMPA approach: preparation; survey; measurement; and improvement. The DSS also abstracts the measurement and improvement phases by automating process capability determination and generation of the assessment report for decision support.

Table 1 lists the four phases of the SMPA approach along with its corresponding DSS functionality.

**Figure 3.** Iterative design process with version control of SMPA instruments.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
<th>DSS Functionality</th>
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<tbody>
<tr>
<td>1) Prep</td>
<td>Define assessment goals and scope</td>
<td>Process selection method</td>
</tr>
<tr>
<td>2) Survey</td>
<td>Collect responses to explicit assessment questions directly from participants</td>
<td>Online survey</td>
</tr>
<tr>
<td>3) Measure</td>
<td>Analyse responses to measure process capability using a standard approach</td>
<td>Process capability rating</td>
</tr>
<tr>
<td>4) Improve</td>
<td>Use assessment results to guide process improvement decisions</td>
<td>Knowledge base</td>
</tr>
</tbody>
</table>
Figure 4 illustrates the DSS architecture used in the SMPA approach. This diagram shows the four areas of DSS support and how the DSS facilitates information flow across the four phases of the SMPA approach.

Three types of users operate the DSS for the SMPA approach: (a) process stakeholders provide input to the SMPA approach since they are the source of the assessment data collected in the online survey. One of the most important factors in the design of the SMPA approach is the role of the (b) assessment facilitator. During the process assessment, assessment facilitators are expected to have a clear understanding of the assessment workflow and operate the DSS in order to facilitate the entire SMPA approach workflow. Finally (c) process managers represent the third type of DSS users who receive the output of the DSS in the form of an assessment report that enables them to make decisions on process improvements.

The typical workflow for an assessment facilitator during an assessment is illustrated in Figure 5. The straight lines suggest typical activities performed by the facilitator whereas the dotted lines represent background activities automated by the DSS.

Similarly for all process stakeholders, the DSS provides an online survey to input assessment data. To achieve user satisfaction the online survey had a look and feel that facilitated transition between clear sets of assessment questions that were logically grouped. The typical workflow for a process stakeholder as a survey participant during an online survey is illustrated in Figure 6.

With the application of the DSS within the SMPA approach, managers can focus on the process improvement efforts rather than being concerned about the technique and validity of repeated process assessments. The four DSS components for the SMPA approach are discussed in detail next.

**Process selection method**

The processes listed in ISO/IEC 20000 (ISO, IEC, 2011a) are initially considered as candidates for process assessment. The process selection method is guided by the principles of the Balanced Scorecard (Kaplan & Norton, 1992) and the SERVQUAL model (Parasuraman, Zeithaml, & Berry, 1985). With the input from the process stakeholders and operated by an
assessment facilitator, the DSS assists managers to select critical processes to improve based on business drivers and stakeholders’ service gap perceptions. Comprehensive details of the process selection method have previously been reported (Shrestha, Cater-Steel, Toleman, & Tan, 2014). The four steps of the process selection method that is facilitated by the DSS are listed in Table 2.

Using the process selection method, four ITSM processes were selected by two case study organisations in order to conduct process assessments. The four processes from ISO/IEC 20000 were: Problem Management, Change Management, Service Level Management and Configuration Management.
Online survey

While existing ITSM process assessments rely on process-specific indicators that demonstrate objective evidence of process capability, the SMPA approach facilitates a top-down approach where each ITSM process is defined with a goal and then assessment is guided by explicit questions and metrics that are set to goal attainment. The structure of the survey questionnaire is guided by the Goal-Question-Metric (GQM) approach (Basili, Caldiera, Rombach, & van Solingen, 2002). Following the GQM approach, assessment questions for the survey were composed by analysing all standard indicators to construct singular, fine-grained and close-ended assessment questions. A set of 46 questions specific to the four ITSM 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 written and stored in the assessment questions database of the DSS.

Using the DSS, the responsibility to provide information about process capability is transferred to the process stakeholders. This shift from the current practice where assessors are responsible to collect assessment data means that with the SMPA approach, the assessors do not need to conduct interviews and make subjective judgments on process capability.

Measurement of process capability

The assessment questions are grouped to determine process capability levels 1–5 and every question is 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 standard. This rating is a knowledge metric 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 this metric to collect and objectively measure feedback from the process stakeholders directly.

The ISO/IEC 15504-2 requirements are used for the calibration of process attribute ratings. According to the measurement framework in the standard, a particular capability level (CL) can be achieved if a process meets two conditions: (a) the target level is fully or largely
achieved, i.e. the rating of ‘F’ or ‘L’ for the process attributes at that level; and (b) the lower levels are fully achieved, i.e. the rating of ‘F’ for all lower level process attributes (PA). For example, a process can only achieve CL3 if it obtains a ‘F’ or ‘L’ score in PA3.1 and PA3.2, and all process attributes below CL3 (i.e. PA1.1, PA2.1 and PA2.2) are ‘F’. All responses contribute equal weight to each assessment question. However, responses are implicitly weighted according to how the process roles are allocated to the assessment questions. The number of questions differs according to the process roles, and hence this will subsequently affect the process capability score. The final score of each process attribute is determined by calculating the arithmetic mean value of all the responses using the scale percentage based on the ISO/IEC 15504 standard measurement framework. The DSS in the SMPA approach also computes the coefficient of variation to determine reliability in terms of the spread of responses.

**Improvement advice**

When the process assessment questions were formulated, matching knowledge items were compiled based on the best practice guidelines of the ITIL framework. For the 173 assessment questions stored in the DSS, 151 corresponding knowledge items were developed to address risks associated with the process in question. These knowledge items are stored in the knowledge base. After the survey has been completed by the process stakeholders, the assessment facilitator uses the DSS to generate the assessment report. The DSS extracts relevant knowledge items from the knowledge base to include in the assessment report as recommendations. Knowledge items for each assessment question are selected if the normalised mean of all responses to the question – referred to as the knowledge score for the question – demonstrates risk (i.e. a knowledge score of ‘N’ or ‘P’).

For every assessment question, two components – observation and recommendation – are combined to generate a process improvement knowledge item. The observation component of a knowledge item lists the current state of the process capability. Likewise the recommendation component of a knowledge item is based on the best practice guidelines from the ITIL framework to achieve higher capability levels. For instance, if a question asked ‘Do you know if problems are assigned a priority?’ the associated knowledge item may consist of two components: (a) Observation: ‘Problems are not assigned a priority’; and (b) Recommendation: ‘Problems should be assigned with a priority because not all problems are equally important to fix as soon as they occur. For example, status of a problem could be: emergency, urgent, important, or not urgent. While prioritising a problem, the frequency and impact of the related incidents and the seriousness of the problem in relation to the costs involved, resolution time and impact on mission-critical services should be considered.’

After development and testing, the SMPA approach was trialled and evaluated at two IT service providers to determine its usability to IT managers for decision-making. Evaluation results are discussed next.

**Artefact evaluation**

Because evaluation based on the actual decision quality is time consuming and difficult to measure, soft measures such as perceived decision quality factors have been used in DSS research (Jarupathirun & Zahedi, 2007). Perceived decision quality and efficiency have
been used to assess web-based spatial DSS (Jarupathirun & Zahedi, 2007) and other web-based DSS (e.g. Gu & Wang, 2009). Due to temporal constraints, expected decision quality and expected decision efficiency were used to evaluate the SMPA report generated by the DSS.

The SMPA approach was trialled at the two IT service providers. The assessment data was collected and the assessment facilitators received the SMPA reports. Four phases of the SMPA approach: process selection method; online assessment survey; SMPA approach facilitation; and the SMPA report, along with the underlying DSS platform were evaluated.

After receiving confirmation from the assessment facilitators that the SMPA report has been reviewed by the relevant process managers at both organisations, in-depth interviews were conducted with relevant process managers to evaluate their expectations on the usability of the SMPA report. We used the international standard for software quality evaluation (ISO, IEC, 2011b) and its four attributes: effectiveness, efficiency, usefulness and trust to evaluate the expected usability of the SMPA report generated by the DSS.

We asked two ITSM process managers at Case A and three ITSM process managers at Case B whether the SMPA report was useful to make process improvement decisions. The interviews were recorded and transcribed. We analysed and coded qualitative data sourced from the interview transcripts. Full details of the evaluation and in-depth interviews have been reported previously (Shrestha, Cater-Steel, & Toleman, 2015).

Based on feedback from these five process managers, Table 3 lists a summary of the evaluation findings on the decision support for process improvement.

According to the four usability factors used to evaluate the SMPA report, one of the most significant evaluation findings is that most process managers held the view that the report would enable better quality decisions for process improvement. It was also found that the process managers considered the expected utility and trust of the SMPA report to be highly positive. Despite these positive indications, the process managers thought the SMPA report was time consuming to read and implement.

In response to negative expected decision efficiency from the SMPA report, the structure and content of the SMPA report can be modified for clarity. Changes to the report template, presentation of assessment results and listing of process improvement recommendations have been suggested to address the shortcomings of the SMPA report format. The report must provide clear rationale and directions to the process managers to implement process improvements. Hence, further work is planned to make the SMPA report succinct and targeted to the main audience of the report – the process managers.

<table>
<thead>
<tr>
<th>Usability factor</th>
<th>SMPA Report</th>
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<tbody>
<tr>
<td>Effectiveness</td>
<td>✔️</td>
</tr>
<tr>
<td>Efficiency</td>
<td>✔️</td>
</tr>
<tr>
<td>Usefulness</td>
<td>✔️</td>
</tr>
<tr>
<td>Trust</td>
<td>✔️</td>
</tr>
</tbody>
</table>

☑️ indicates the usability factor was strongly supported by the majority of participants
☒ indicates the usability factor was strongly opposed by the majority of participants
Next steps in development of SMPA approach

Since we completed the evaluation phase of the research project, we have added 2416 assessment questions to the assessment questions database and 2548 knowledge items to the knowledge base to address the additional 27 processes described in the ISO/IEC 20000 standard. With the functionality to assess any ISO/IEC 20000 process, the SMPA approach is able to conduct assessments for specific ITSM processes for organisations seeking ISO/IEC 20000 compliance. Moreover, the SMPA approach has been implemented in Case C, a large foreign exchange trading firm in the US. An initial baseline assessment of four processes has been completed and two more checkpoint assessments are planned as part of an iterative process improvement programme of IT service delivery at the firm.

Discussion

The assessment data collection and validation, measurement of the process capability and report of the assessment results require ITSM information to be gathered, aggregated, evaluated and presented. Therefore, having a sound information processing capability is an important requirement for the SMPA approach. In this scenario, the DSS for the SMPA approach has proven to be a cost effective solution. The DSS can store and analyse data sets from several iterations of targeted stakeholder responses of assessment questions. In this way data analysis can be low cost and happen in real time for each assessment.

The automatic storage of collected information provides an opportunity for validated data to be used to compare process assessment results for benchmarking and demonstration of process improvement over extended time periods. This is an important innovation as currently aggregated analysis could not be carried out with the existing manual process assessment methods. While there are software tools available for assessors to input assessment data, no software tools have been reported that can capture information directly from the process stakeholders and analyse the collected assessment responses in conformance to the international standard for process assessment. This feature is implemented in the DSS employed by the SMPA approach.

Anecdotal evidence suggests that manually entering data and subjective judgment based on interviews and document reviews can be error-prone and requires a longer time commitment from the assessment team. This means that repeated process assessments to build a repository of process improvement recommendations are unlikely to be given a priority due to the significant workload involved in the process assessment effort. The utility of the DSS in the SMPA approach promotes efficient information processing of assessment data, thereby reducing the entire assessment cycle which can subsequently lead to more effective service improvement in ITSM.

The DSS uses a knowledge base compiled from the ITIL library for process improvement recommendations. Without a DSS, compilation of an assessment report with process improvement recommendations would require an assessment team with multi-disciplinary skills and expertise in process assessment and ITSM, working for a considerable period of time to compile relevant recommendations. The knowledge-based DSS can efficiently draw on expert knowledge of process improvement recommendations from its knowledge base.
The SMPA approach can enable organisations to develop a sense of direction about their process improvements. At the same time, the artefact can assist formal process assessments by providing a source of evidence to decide the process capability ratings and provide improvement recommendations.

Conclusion

Academic researchers make valuable contributions to the design and investigation of innovative artefacts but effective transition of these artefacts to industrial use requires their integration into, and evaluation within, the business context. In some cases, the innovation required is not so much the design of a new artefact but its adaptation to the pattern of use within the organisation. From a practical standpoint, the SMPA approach has features to collect assessment data, measure process capability and support process improvement decisions. This research demonstrated how the SMPA approach was applied in practice by developing a DSS to implement the method at the two case study organisations.

This research focused on perceptual outcome evaluation factors (expected decision quality and expected decision efficiency) to examine the impact of the SMPA approach on decision-making for process improvement. Actual decision outcomes from the SMPA approach and factors such as the repeated use of the SMPA approach and the impact of the SMPA approach on process improvement are not empirically evaluated. These constructs require longitudinal data and involve complex causal relationships that are beyond the scope of the current research. It must be clear that the DSS in the SMPA approach provides a useful framework for process improvement but does not dictate or monitor how an organisation should actually improve.

The DSS can store and analyse increasing volumes of data on best practices and risks in ITSM processes. The opportunity to perform data analytics can help IT managers to analyse and visualise the ‘big data’ of process knowledge. Based on the DSS data available, business intelligence techniques can provide insights leading to better informed decisions for IT service delivery, improvement and innovation. Multiple implementations of the SMPA approach across different industries will result in a rich repository of process metrics that can be queried for cross-case, cross-process, cross-industry and longitudinal analysis.

Just as the CMMI made it possible for organisations to contract software services from software providers all over the world with confidence, the expected utility of the DSS in ITSM process assessment is to facilitate, and eventually ‘commoditise’ IT service capabilities to forge successful IT-business partnerships (Davenport, 2005). The SMPA approach supports decision-making for both IT service providers and business managers to plan and execute their service life cycle to innovate and add value to the organisations.

Upon reflection, the DSR method was found to be highly applicable to develop an artefact in order to solve an industry problem and to evaluate the practical utility of the artefact. The SMPA approach is a research artefact that was implemented as a DSS; hence it is readily accessible to practitioners. The focus on practical utility provides researchers with results that are more readily endorsed, thus maximising the impact of the research findings in practice.
Acknowledgements

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Note. ITIL® is a Registered Trade Mark of AXELOS Limited. CMMI® is the Registered Trademark of Carnegie Mellon University.

Disclosure statement

No potential conflict of interest was reported by the authors.

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