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RESEARCH PAPER

# The Impact of Process Visibility on Process Performance

## A Multiple Case Study of Operations Control Centers in ITSM

**Martin Berner · Jino Augustine · Alexander Maedche**

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**Abstract** Successful monitoring is essential for managing security-critical or business-critical processes. The paper seeks to understand and empirically evaluate benefits of the BPM use case "monitor" in the context of Operations Control Centers (OCCs). OCCs create visibility about critical events and statuses in very sensitive processes. In IT Service Management (ITSM) they support the event management process with real-time monitoring and event analysis of critical systems in complex system landscapes. This special focus of OCCs on visibility is a promising context to study fundamentals of process visibility. The paper develops a Process Monitoring Benefits Framework that draws on the Situation Awareness Theory and the Theory of Constraints. The authors conceptualize process visibility and suggest that it is positively related to process performance. A multiple case study in seven organizations is carried out to examine the framework and its propositions. The case study indicates that the impact of process visibility on process performance is mediated by the situation awareness of the process participants as well as the identification of bottlenecks in processes. Moreover, factors are identified that potentially influence process visibility outcome – namely continuous improvement culture, outsourcing quality, and maturity of the software tool used for monitoring.

**Keywords** BPM use case monitor · Process visibility · Continuous improvement · Situation awareness · ITSM event management

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Dipl.-Hdl. M. Berner (✉) · J. Augustine · A. Maedche
Institute of Enterprise Systems (InES), University of Mannheim, L15, 1-6, 68131 Mannheim, Germany
e-mail: berner@es.uni-mannheim.de

J. Augustine
e-mail: jaugusti@mail.uni-mannheim.de

A. Maedche
Institute of Information Systems and Marketing (IISM), Karlsruhe Institute of Technology (KIT), Fritz-Erler-Straße 23, 76131 Karlsruhe, Germany
e-mail: alexander.maedche@kit.edu

## 1 Introduction

Huge benefits are expected from data assets created by advanced information technologies that enable new ways of data capturing, storing, managing, and analyzing (Manyika et al. 2011). In business process management (BPM) such data assets are most important for the use case *monitor* which refers to data measurements for decision support during process execution (van der Aalst 2013). This monitoring of business processes is relevant to supporting continuous improvement as well as day-to-day operations. Accordingly, process monitoring is an essential and common element in lifecycle models that define the managerial practices of BPM, although in these models process monitoring is sometimes also referred to as process control, evaluation, or diagnosis (Morais et al. 2014).

Hence, BPM software vendors and analysts increasingly focus on the monitor use case: for example Gartner (2012) stresses the importance of integrating state-of-the-art analytics into operational processes under the label *intelligent Business Process Management Suites (iBPMS)*, and Russom (2013) proposes the term *Real-time Operational Intelligence* which describes "an emerging class of analytics that provides visibility into business processes, events, and operations as they are happening". The underlying assumption in this discussion regarding sophisticated process monitoring and next generation intelligent BPM is that higher process visibility ultimately leads to higher process performance. However, currently it remains vague how increased process visibility actually contributes to process performance.

The performance impact of visibility is intensively studied in the field of supply chain management (SCM). Visibility is identified as an essential contributor to SCM process performance and its degree depends on the level to which the accessible information is relevant, trustworthy, and timely (Swaminathan and Tayur 2003; Barratt and Oke 2007).

Besides SCM, lean production literature stresses the importance of making information visible during process operation (Womack and Jones 2003). Visual controls that create immediate transparency about abnormalities are a crucial part of lean production systems (Shingo 1989), and they are essential for banishing waste to continuously improve processes (Womack and Jones 2003).

Recent research generalizes the visibility concepts of SCM and lean production to a broader business process context (Klotz et al. 2008; Pidun et al. 2011; Graupner et al. 2014). Based on these foundations, this paper understands *process visibility* as a characteristic of a process that describes the quality of information to support process operation and improvement.

For processes where visibility is of utmost importance, we see the use of *Operations Control Centers (OCCs)*. Most prominent OCCs are the area control centers used to manage the air-space in aviation and control rooms in the energy sector.

To a large degree, visibility has the same importance for IT Service Management (ITSM) because in a growing digitalized world the IT infrastructure is the backbone for every kind of business. ITSM is a process-oriented approach to managing IT services, and the most important element of monitoring in ITSM is referred to as end-to-end visibility (OGC 2007a). System and service downtimes can result in serious regulatory liabilities or accumulate up to multi-million dollar costs (Martinez 2009). Therefore, OCCs are increasingly implemented to support the ITSM event management process by providing visibility via real-time monitoring of business critical systems and processes (EMC 2012; SAP 2013). Such OCCs are typically physical rooms where IT operators jointly carry out this monitoring and big screens show the operational status of the IT environment and the managed processes with the objective to detect and solve issues before business is affected.

The business process under investigation in our study about OCCs is the *ITSM event management process*, which deals with the monitoring and systematic management of alerts originating from the observed IT infrastructure. It is a "loosely framed process" (van der Aalst 2013) where a process model typically describes the standard way of doing things, but actual executions can deviate.

OCCs with their special focus on monitoring in ITSM are a promising research arena to study the impact of process visibility on process performance and its influencing factors. Hence, we empirically examined the ITSM event management process of seven organizations that recently introduced an OCC and implemented a new software package for it. Our paper studies fundamentals of process visibility in the context of OCCs, but is guided by a more general research question regarding monitoring benefits:

*How does process visibility influence process performance?*

Our work contributes to empirical BPM research in the context of the outlined highly relevant use case monitor, which is currently underrepresented in the BPM literature (van der Aalst 2013). We develop a Process Monitoring Benefits Framework that seeks to describe how process visibility impacts process performance. It builds on a conceptualization of process visibility, its impacts, and influencing factors based on existing literature. To empirically examine the proposed framework we carry out a positivist multiple case study in several companies. The results of our empirical examination lead to a refined and extended framework.

## 2 Conceptual Foundations

### 2.1 Process Monitoring Benefit Dimensions

As outlined before, the intended benefit of process monitoring is to gain process visibility with the ultimate objective to increase process performance. Thus, the dependent variable of our study is process performance. We argue that the process as unit of analysis is favorable to evaluate the net benefit of process monitoring, as it chooses the unit that process monitoring affects directly and at which its impact is best observable and measurable. There are two classical approaches to define process performance (Ray et al. 2005): First, based on productivity measures such as throughput time, and second, based on the quality of the process output. The latter is adopted in our study since in OCCs the output is significantly more important than the productivity of the event management. In our context of ITSM event management the quality of the process output is defined by the creation of a reliable service asset and the minimization of system downtimes (Cater-Steel and McBride 2007). In other words, process performance in OCC context can be determined by the service quality of ITSM and the system quality of the managed systems (see online Appendix B for more details about the conceptualization of these qualities in our study).

We argue that the impact of process visibility on process performance is mediated by situation awareness of the process operators as well as bottleneck identification for continuous process improvement. Therefore, we differentiate and introduce the constructs process visibility, situation awareness, and bottleneck identification in the following.

#### *2.1.1 Process Visibility*

We already introduced process visibility as an information quality in respect to operating and improving a process. In our conceptualization we leverage information quality as one of the key constructs of the D&M IS Success Model (DeLone and McLean 2003). It is a multi-dimensional construct determined by accuracy, completeness, currency, and format of information (Nelson et al. 2005). In this regard, visibility should not be confused with visualization because the representation format of information is only one aspect of it.

Information quality in the D&M IS Success Model is a characteristic of an information system whereas process visibility is defined as a characteristic of a process. Processes as unit of analysis are beneficial because the organizational benefits of IT are mediated by business processes (Melville et al. 2004). Therefore, we suggest to derive the process visibility dimensions from information quality dimensions by putting them in a process information context. Information that plays a supporting role in process operation and improvement is called *process information* (Davenport 1993).

In addition, information quality is influenced and interlinked with system quality (Xu et al. 2013). Hence, also several system quality dimensions of the monitoring system itself may contribute to the level of process visibility – namely accessibility, flexibility, and integration (Nelson et al. 2005). Process monitoring systems intend to improve these dimensions explicitly, while other system qualities (reliability and response time) are of generic relevance and therefore no specific dimensions of process visibility. The quality of the monitoring system itself (which is defined here as an antecedent of process visibility) should not be mistaken with the quality of the systems that are monitored by an OCC (which we defined above as a criteria for process performance in the ITSM event management context).

Table 1 summarizes all identified and relevant dimensions of process visibility and defines them based on Nelson et al. (2005) and Berner et al. (2012).

**Table 1** Dimensions of process visibility

| Dimension | Definition (based on Nelson et al. 2005; Berner et al. 2012) |
|---|---|
| Accuracy | The degree to which process information is correct, unambiguous, meaningful, consistent, and trustable (perceived to be valid, reliable and objective and a positive attitude is embraced towards the source) |
| Completeness | The degree to which all possible process states and other information relevant for the process participants are represented |
| Currency | The degree to which process information is up-to-date, or the degree to which the information precisely reflects the current state of a process instance |
| Format | The degree to which process information is presented in a manner that is useful, readily useable, analytically interpreted, and contextualized (centered on process steps and is set into relation with previous and adjacent process steps) |
| Accessibility | The degree to which process information can be accessed by the process participants with relatively low effort |
| Flexibility | The degree to which process information analysis and representation can adapt to a variety of process participants needs and to changing conditions |
| Integration | The degree to which process information is available for the entire process by facilitating the combination of information from various sources to support decisions |

#### *2.1.2 Situation Awareness (SA)*

In the monitoring use case the impact of process visibility on process performance depends on the operators who do the monitoring. They have to permanently classify and understand situations, basically they need to know "what's going on" (Endsley 1995). Cognitive psychology identified situation awareness (SA) as crucial concept for operators' decision outcome: In the context of control rooms the phenomenon of SA in highly dynamic environments is intensively studied based on the SA Theory (Endsley 1995) for the domains of air traffic control (e.g., O'Brien and O'Harea 2007) and nuclear power plants (e.g., Hogg et al. 1995). Similar to IT support team members, "the operator of a nuclear power plant must have knowledge of the current process state at all times, and the ability to use this knowledge effectively in predicting future process states and controlling the process to attain operational goals" (Hogg et al. 1995, p. 2394). SA is defined as "the *perception* [Level 1] of the elements in the environment within a volume of time and space, the *comprehension* [Level 2] of their meaning and the *projection* [Level 3] of their status in the near future" (Endsley 1995, p. 36). These coherent levels of SA are outlined in more detail in Table 2.

**Table 2** Levels of SA

| Level | Definition (Endsley 1995) |
|---|---|
| Level 1 SA (perception) | The degree to which an operator or operation teams perceive the status, attributes, and dynamic of relevant elements in the environment |
| Level 2 SA (comprehension) | The degree to which an operator or operation teams are able to understand the significance of elements in the environment in the light of his/her goals based on his/her level 1 perception |
| Level 3 SA (projection) | The degree to which an operator or operation teams are able to project the (near) future based on his/her level 2 comprehension |

SA can be analyzed on individual as well as on team level (Endsley 1995). The involved teams and individuals in ITSM event management process are the operators and managers of the IT support team who we call subsequently process participants. SA research identified system factors, particularly system design in terms of how the needed information is provided, as an important driver of SA (Endsley 1995). These system factors are reflected to a large degree also in our conceptualization of process visibility, and thus we analogously propose:

*[P1] The higher the level of process visibility, the higher the SA of the process participants.*

SA describes a very important antecedent for operators to make better decisions and take appropriate actions (Endsley 1995). Therefore, we conclude

*[P2] The higher the level of process participants' SA, the higher the process performance.*

#### 2.1.3 Bottleneck Identification

Besides supporting daily process operations, process monitoring additionally aims to provide the informational baseline to improve processes. Existing research recognizes the importance of information visibility of business processes for identification of process bottlenecks (Cotteleer and Bendoly 2006). The concept *bottleneck identification* of Cotteleer and Bendoly (2006) is based on the Theory of Constraints (Goldratt and Cox 1992), which claims that process bottlenecks hinder higher process performance due to physical or managerial constraints (Table 3).

Hence, the level of bottleneck identification of a process is defined by the degree to which physical and managerial constraints of a process are recognized by the process participants. In summary, we suggest:

*[P3] The higher the level of process visibility, the higher the level of bottleneck identification of a process.*

**Table 3** Dimensions of bottleneck identification

| Dimension | Definition (based on Goldratt and Cox 1992) |
|---|---|
| Physical constraint identification | The degree to which physical constraints such as materials, machines, people and demand that limit a process from achieving higher performance versus its goal are recognized |
| Managerial constraint identification | The degree to which managerial constraints in the form of policies, procedures, rules and methods that limit a process from achieving higher performance versus its goal are recognized |

*[P4] The higher the level of bottleneck identification, the higher the process performance.*

### 2.2 Influencing Factors

Neither new monitoring tools nor potentially resulting higher situation awareness or bottleneck identification can guarantee better process performance. There are additional influential factors in key areas where "things must go right" (Iden and Eikebrokk 2013) in order to gain benefits of process monitoring. In our context a systematic literature review by Iden and Eikebrokk (2013) identified several influencing factors for ITSM success. Particularly, staff's skills and knowledge as well as willingness to change might be important for monitoring and are outlined in the following, because they directly link to process operation and improvement.

First, a crucial aspect in ITSM processes are *skills and knowledge* of the IT professionals (Galup and Dattero 2010). Thus, skills and knowledge of operators is one potential factor that moderates the impact of process visibility on process performance in OCC context. Skills are commonly defined as acquired cognitive or metacognitive competency that develops with training and/or practice (McCombs and Marzano 1990). Likewise, SA theory recognizes experience and training as individual factors influencing SA (Endsley 1995). In conclusion, we propose:

*[P5] The lower the skills and knowledge of the operators who monitor the process, the lower is the situation awareness (which lowers the impact of process visibility on process performance).*

Second, successful ITSM requires a *Continuous Improvement (CI) culture* that welcomes changes and improvements (OGC 2007b). The culture of a group manifests itself at three different levels (Schein 2004): artifacts (e.g., structures), values (e.g., strategies), and underlying basic assumptions. The shared basic assumptions on the deepest level are most difficult to observe, but represent the biggest part of an organizational culture.

Organizations with a strong CI culture are more likely to seek out for new bottlenecks as others are solved (Goldratt and Cox 1992). Thus, we conclude:

*[P6] The lower the CI culture of the organization, the lower is the bottleneck identification (which lowers the impact of process visibility on process performance).*

The derived propositions P1–6 are visualized in Fig. 1. In the course of our study the initial conceptual framework was enhanced by additional influencing factors and propositions (P7–8) based on the results of our empirical study which are described subsequently.

## 3 Research Methodology

### 3.1 Introduction

We follow a multiple case study research approach to explore our propositions in multiple firms. This enables us to treat each case as an empirical test of our proposed framework and ensure generalizability by applying replication logic (Yin 2003). We follow the widely accepted positivist case study perspective of theory testing (Dubé and Paré 2003). Additionally, the qualitative approach enables adoption or potential theory extensions in an exploratory manner (e.g., Dibbern et al. 2008).

Our study is done in cooperation with the software company SAP SE. Recently, the OCC concept has been integrated into the *RunSAP like a Factory* methodology which is SAP's approach to operate and continuously improve the operations of SAP and non-SAP IT landscapes (SAP 2013). In this methodology the OCC is positioned as a central IT support entity at the customer sites to monitor the status of business processes and IT landscape components. SAP implements OCCs based on their software tool *SAP Solution Manger* and recommends to set up a physical room for the OCC including large screens (SAP 2013). SAP supported our study by providing assistance in establishing contact to the organizations where such OCCs have been implemented.

### 3.2 Case Selection

We began the case selection by classifying potential companies with finished OCC implementations based on data from a customer database of our industry partner – including organization size, geographic locations, complexity of the event management process, etc. (Table 4).

Additionally, we asked managers in the support organization of SAP SE, who have broad overview of different OCC implementations, to give a rough estimate of the OCC success in the potential cases. These managerial perceptions helped to select a case mixture with more and less successful OCC implementations – potentially resulting in lower and higher process visibility levels. Thus, we applied literal and theoretical replication strategies to ensure external validity of our research (Yin 2003). First, theoretical replication requires a selection of cases that vary in their characteristics and thus in their proposed impact. Therefore, our cases shall have different degrees of process visibility. Second, literal replications refer to similar cases and accordingly leading to similar proposed outcomes. Thus, we need multiple cases with the same process visibility level.

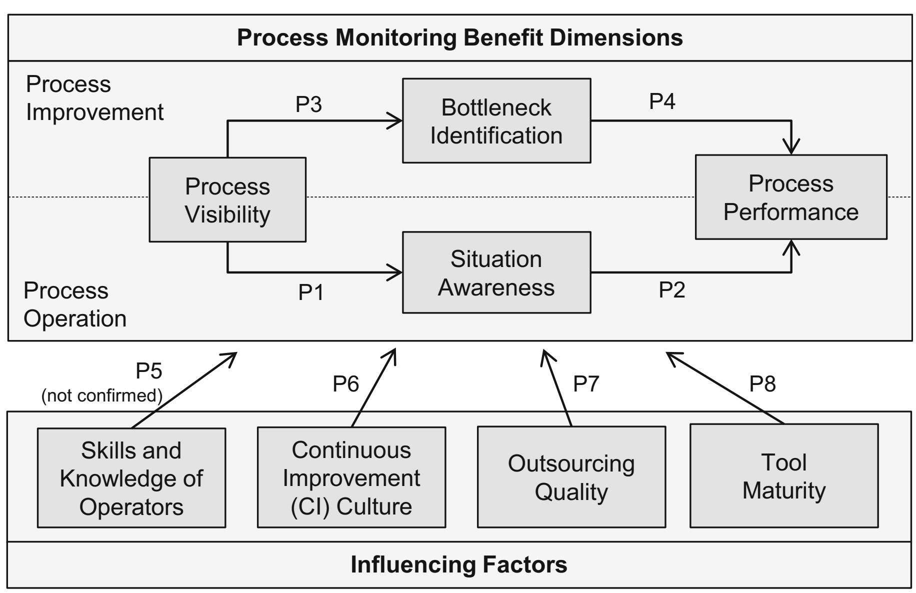


**Fig. 1** Process monitoring benefits framework

**Table 4** Descriptive case data

| Case Company | Industry | Number of employees | Region | Offshore outsourcing partner | Months since OCC go-live | Managerial perception of OCC implementation |
|---|---|---|---|---|---|---|
| A | Retail | >40k | Europe | significant involvement | 20 | Expectations met |
| B | Manufacturing | >60k | North America | No | 15 | Expectations not met |
| C | Finance | >50k | Europe | No | 22 | Expectations not met |
| D | Finance | >20k | Europe | No | 22 | Expectations met |
| E | Manufacturing | >20k | North America | Significant involvement | 23 | Expectations not met |
| F | Manufacturing | >70k | Europe | Significant involvement | 2 | Expectations not met |
| G | Energy | >10k | North America | Minor involvement | 18 | Expectations exceeded |

### 3.3 Data Sources and Analysis

After the case selection based on the customer database and the high-level assessment of the support managers, we conducted 17 semi-structured interviews. Before the interviews a questionnaire with open-ended questions along our conceptual framework was created (online Appendix D). The questionnaire was used as a generic baseline for the interviews, and additional questions were asked during the individual discussions (Myers and Newman 2007).

We executed one comprehensive interview with the OCC team leads (TL) from every case organization and one further interview with the technical quality manager (TQM) from our industry partner who support the respective case organizations. By doing so, we were able to get perspectives on our cases from inside and outside the affected companies. Additionally, for three cases operators were interviewed in order to consider also the perspective of the operational workers. All interviews were conducted by the first two authors of the paper.

Beyond interview data, the authors had access to a customer data base of our industry partner that contained information of the OCC implementations such as implementation challenges, number of alert events, and hours of unplanned downtimes of the monitored systems. These information were used for the detailed preparation of the individual interviews and to triangulate the interview results.

Data analysis consists of examining, categorizing, tabulating, testing quantitative and qualitative evidence to address the propositions (Yin 2003). With this aim, we applied open coding and axial coding techniques (Corbin and Strauss 2008) supported by the coding software MAXQDA.

In order to mitigate potential bias and improve coding reliability, the authors encoded the interviews in an iterative dual coding approach as follows: First, all transcripts were encoded independently by two coders based on a codebook that explained the code system and how the codes should be applied. Second, always after 3–4 dual encoded transcripts the mismatches were discussed by the authors. If inter-coder reliability was below 85 %, the codebook was adjusted and the affected transcripts were encoded again. In total an inter-coder reliability according to Holsti (1969) of 91 % was achieved (Table 5), which is beyond the recommended reliability threshold for textual content analysis of 85 % (Kassarjian 1977).

Hence, in multiple iterations we identified information that is linked to our conceptual framework and adjusted the code system if required. Additionally the weight feature of MAXQDA was used to document whether a coded segment is an indication for a low, medium or high level of a variable in our model (online Appendix C). This helped to assess the overall level of a variable in a case relatively to the other cases.

## 4 Results

The level of process visibility in the ITSM event management process of all the case sites was found to be low prior to the OCC implementation. In fact the motivation for these organizations to opt for an OCC was the high effort required to monitor and assess the system statuses. To compartmentalize the benefits of the enhanced process monitoring, we specifically present results with regards to process visibility, situation awareness, bottleneck identification, and process performance after OCC implementation. Furthermore, we describe influential factors that can explain differences between the cases.

### 4.1 Level of Process Visibility

The results show that there are positive impacts regarding process visibility in the organizations as a result of OCC implementation. It came to light in the process of the interviews that cross-system monitoring was performed manually and sporadically before OCC implementation. With the automation of system monitoring the process

**Table 5** Inter-coder reliability

| Interview transcript | | Total number of coded segments in agreement | Total number of coded segments | Percentage inter-coder reliability (Holsti 1969) (%) |
|---|---|---|---|---|
| 1. | Case A Interview TL | 70 | 77 | 91 |
| 2. | Case A Interview TQM | 24 | 28 | 86 |
| 3. | Case A Interview Operator | 22 | 25 | 88 |
| 4. | Case B Interview TL | 64 | 73 | 88 |
| 5. | Case B Interview TQM | 8 | 9 | 89 |
| 6. | Case C Interview TL | 70 | 73 | 96 |
| 7. | Case C Interview TQM | 20 | 21 | 95 |
| 8. | Case C Interview Operator | 36 | 38 | 95 |
| 9.a) | Case D Interview TL | 38 | 41 | 93 |
| 9.b) | Case D Written Response TL | 32 | 35 | 91 |
| 10. | Case D Interview TQM | 52 | 58 | 90 |
| 11. | Case D Interview Operator | 32 | 35 | 91 |
| 12. | Case E Interview TL | 118 | 129 | 91 |
| 13. | Case E Interview TQM | 28 | 30 | 93 |
| 14 | Case F Interview TL | 62 | 71 | 87 |
| 15. | Case F Interview TQM | 38 | 44 | 86 |
| 16. | Case G Interview TL | 110 | 116 | 95 |
| 17. | Case G Interview TQM | 38 | 43 | 88 |
| Total | | 862 | 946 | 91 |

visibility in event management process increased. After OCC implementation most cases (A, C, D, E, G) show high degree of process visibility examined against dimensions of accuracy, completeness, currency, format, accessibility, flexibility and integration. This is exemplified by the following interview quote (The coding corresponding to the process visibility dimension is added in squared brackets to the quote):

> "We are now able to discuss with our service provider on the same level. This information was not available to us before OCC [Accessibility]… The vendor worked in one direction based on the information they had and we worked in another direction based on the information we had [Integration]… This is a huge gain for us… it was very unaligned and also the root cause analysis deliveries coming from service vendor were taking very long time, perhaps even as long as one to two months, and this is of course not good [Currency]" (TL Case A).

Cases B and F were identified to have a relative lower level of process visibility as they showed more lacks in the dimensions of process visibility. The TL of organization B reported for example the following shortages:

> I think there is more available than what we currently have [Completeness], but then also we have some underlying issues of the reliability of being able to keep the system managed and sending us good alerts… Some of the information on alerts has to be created from manual interventions [Format]… There are scenarios where we get alerts too late [Currency]" (TL Case B).

## 4.2 Level of Situation Awareness

With the OCC some process participants (cases A and G) experienced substantial gains in situation awareness. The information that was formerly not easily available can now be accessed in real-time, which helps the IT support team to raise their perception of critical situations and mitigate issues. Example interview excerpts in this regard are:

> "We have information on the performance, availability, database issues and what not. When you receive an alert, we can investigate instantly to make sure that it is a real alert [Comprehension]" (TL Case G).

> "We can get total information about the alert [Perception] and we can take action [Comprehension] in a short span of time and resolve the issue… which is the main comparison before and after OCC implementation… In the last half quarter the benefit came back to us where we actually – before the system went down, catch the issue… We are extremely

pleased because these are proactive actions, not reactive [Projection]" (Operator Case A).

Whereas in other cases still bigger deficiencies of situation awareness are reported, for example:

"We have missed critical events… if that person doesn't look at that inbox within 15 minutes, that event won't be addressed [Perception]… How do I know the cause…? So, we have a lot of information but putting it together and get one comprehensive picture is not there [Comprehension]" (TL Case E).

### 4.3 Level of Bottleneck Identification

The examined organizations made information available through the OCC which helped them identify issues in their existing processes and streamline operations. Most bottlenecks that were newly identified with help of the OCC relate to physical constraints coming from misconfigurations of the managed systems – for example:

"We were able to identify some capacity issues… and we were able to identify some configuration issues" (TL Case G).

"We got a lot of events around memory utilization… That of course means there's something wrong, something needs to be properly configured" (TL Case E).

Benefits regarding the identification of managerial constraints were reported only for the cases A and G, e.g.:

"What we do… is: refining alerts, identifying new alerts that might need to be created, reviewing and refining standard operating procedures, eliminating those things that we don't need" (TL Case G).

For the other cases (B, C, D, E, F) we observed a lack in the identification of managerial constraints by the IT support team. Therefore, these cases have a lower level of bottleneck identification. Even though some of these organizations have a strong emphasis on the creation of policies and procedures to deal with the different event types, they are still occupied with the initial creation of these "guided procedures" and do not systematically identify and improve managerial constraints.

### 4.4 Level of Process Performance

The performance of the ITSM event management process improved since OCC implementation in most of the studied cases. Our qualitative examination of the interview data indicates that organizations A, D, and G reached relatively high process performance. The exemplified quotes stand testimony to that.

"There are around 9 priority incidents handled internally every month. Meaning we prevented 9 major breakdowns monthly… We had a lot of issues last year with memory and we had three crashes. This year we did not have any issue" (TL Case A).

"The last major incident in production environment was 12 months ago. So the systems have been very stable" (TQM Case G).

Even though in cases B and E good system stability and proactive incident resolution was reported, we rated their overall process performance with medium, because they show a weak perception of their service quality by their stakeholders:

"We struggle within our own management to promote the value of OCC" (TL Case G).

"They [stakeholders] don't remember what used to be… and now it [high service quality] is just an expectation" (TL Case E).

In cases C and F system and service quality still shows a lot of flaws. The potential reasons for these deficiencies are discussed in the next section. However, even cases with low process performance after OCC implementation report some first gains – for example:

"There is already a shift. I would not say that it is proactive now. But at least it has become real-time now, for the reactive approach that was in place earlier… We were able to identify some issues that our service provider chose to ignore or postpone earlier… We were also able to avert a major issue the past weekend" (TL Case F).

### 4.5 Explaining Variations

Table 6 summarizes the high-level evaluation of the process monitoring benefit dimensions of the different cases. It shows that high process performance is only observed, if beside high process visibility also high SA or high bottleneck identification is reached. This is line with the proposed mediating effects of SA (P1–2) and bottleneck identification (P3–4). However, the question remains why there are different outcomes while all case organizations implemented the same software package to realize an OCC. Therefore, Table 6 outlines potential influential factors that might impact process monitoring benefits. The moderating effects of these factors on the observed impacts are elaborated in the following.

**Table 6** High-level summary of case by case analysis

| Case | Process Monitoring Benefit Dimensions | | | | Influential Factors | | | |
|---|---|---|---|---|---|---|---|---|
| | Process visibility | Situation awareness | Bottleneck identification | Process performance | Skills and knowledge of operators | CI culture | Outsourcing (OS) quality | Tool maturity |
| A | High | High | High | High | High | High | High | High |
| B | Medium | Medium | Medium | Medium | High | High | No OS | Low |
| C | High | Medium | Medium | Low | Medium | Low | No OS | Low |
| D | High | High | Medium | High | Medium | Medium | No OS | High |
| E | High | Low | Medium | Medium | Medium | Medium | Low | Low |
| F | Medium | Low | Low | Low | Medium | Low | Low | Medium |
| G | High | High | High | High | High | High | No OS | High |

#### 4.5.1 *Skills and Knowledge of Operators*

Skill and knowledge of operators significantly differ between the cases. In some cases (A, B, G) there are very experienced and knowledgeable experts in the ITSM event management domain – for example:

> "The OCC team comes from our historical basis support team [with deep technical knowledge]. After a few years there, they may move on to the OCC team" (TL Case B).

Whereas in other cases (C, D, E, F, G) the IT support team is staffed by junior level employees. Interestingly the OCC introduction was partially even the reason to assign less skilled employees:

> "Before OCC the monitoring was done by senior analysts. This was a humongous waste of resources… It is part of our cost savings by getting these really junior level resources with just basic SAP knowledge from a two weeks training" (TL Case E).

Altogether, our cross case analysis shows that the influence of skills and knowledge of the OCC team members might be less important than expected. In case B also the highly experienced operators could not reach high process performance, whereas in case D less skilled IT operators could reach high process performance. Thus, we cannot confirm proposition P5 that low skills and knowledge of process operators necessarily have negative impact on process performance.

#### 4.5.2 *CI Culture*

With CI culture there are strong differences between the organizations. Some organizations (A, B, G) have dedicated strategies, functions, and processes for CI. On the other hand, some of the cases (C, F) did not have CI focus at all. Resource issues and internal politics played a role in case C not having any meaningful CI strategy:

> "But now, the next step will be to prevent them. Do some root cause analysis and problem management. For this, you need people. The way we are working makes it impossible to get people's time" (TL Case C).

One important artifact of a CI culture that we recognize in the OCC context is the documentation and continuous improvement of instructions about how to react on events:

> "We are trying to create more guided procedures. We don't have that many but it's our aim to use more guided procedures on alerts… [because] we hope to work on a more efficient way, that's to me also continuous improvement" (TL Case D).

Furthermore, our data indicate that there is a relation between CI culture and the level of bottleneck identification. All cases with lower CI culture achieved also lower levels of bottleneck identification. Or in other words, in an environment where CI is not valued, process visibility is also not leveraged for bottleneck identification. Thus we confirm proposition P6 that low levels of CI culture leads to lower levels of process visibility's benefits regarding bottleneck identification and ultimately to lower process performance impact.

#### 4.5.3 *Further Influential Factors*

In the course of our research we identified two further influential factors that seem to affect the benefits of process monitoring. First, open coding of the interviews showed that *outsourcing quality* partially had strong impact on the OCC outcome, e.g.:

> "It was quite a challenge because our service provider did not have a motivation to change. They did not want to use the new processes and tools to support our business" (TL Case F).

In some organizations (A, E, and F) the OCC is running at external offshore service providers which are operating major parts of the ITSM event management process. For well managed outsourcing relationships we couldn't identify a negative impact on process monitoring benefits (case A). However, outsourcing in cases E and F required a lot of coordination and controlling, which are recognized in IS outsourcing research as potentially expensive activities in labor-intensive offshoring relations (Dibbern et al. 2008). This impacted the overall benefit realization to a large extent and situation awareness as well as bottleneck identification were relatively low. Accordingly, we conclude with an additional proposition:

*[P7] The lower the quality of the relationship to outsourcing partners who are significantly involved in a process, the lower is the situation awareness and bottleneck identification (which lowers the impact of process visibility on process performance).*

Second, the maturity of the monitoring tool in use was found to be another important factor why organizations reached lower performance gains than others as they faced deficiencies in situation awareness and bottleneck identification. We define *tool maturity* as the degree to what extent a software tool is ready for use in its intended operational environment to be validated against user requirements (Tetlay and John 2009). In case C for example the sole focus of the OCC implementation on efficiency resulted in withdrawal of experienced IT professionals from the project before the basic configuration of the monitoring tool was finished. In cases B, E and F we identified issues with the initial setup of the software tool which led to extra efforts in the implementation and running of the solution. These issues were coming from gaps in the implementation procedure, configuration errors, or from functional deficiencies in early versions of the software:

> "One main issue is the overall OCC stability. Some of these issues are related to our personal setup of not having a quality test environment" (TL Case B).

> "There are already lots of things that we can only use now, and, yes, and it's a pity that we didn't have those earlier" (TQM Case C).

Therefore, regarding tool maturity we suggest:

*[P8] The lower the maturity of the monitoring software tool, the lower is the situation awareness and bottleneck identification (which lowers the impact of process visibility on process performance).*

By the identification of this final proposition from our empirical examination, we present the resulting Process Monitoring Benefits Framework in Fig. 1. This conceptual framework summarizes our suggested process monitoring benefit dimensions, its relations, and influencing factors.

## 5 Discussion and Conclusion

Our Process Monitoring Benefits Framework and its propositions were empirically verified in a multiple case study in 7 organizations that had implemented an OCC. An OCC aims to improve monitoring in the ITSM event management process by increasing its process visibility. We conceptualize process visibility as a multidimensional construct on the process level. Drawing on the SA Theory and the Theory of Constraints, our conceptual framework suggests that process visibility increases situation awareness in process operation and bottleneck identification for process improvement. Both, situation awareness and bottleneck identification are proposed to positively influence process performance. Furthermore, we identified influential factors for benefit realization of process monitoring in ITSM event management based on existing literature and our empirical investigation. Our multiple case study data proposes that process visibility increases process performance, mediated by situation awareness and bottleneck identification. The potential benefits of process monitoring in ITSM were influenced by three factors: CI culture, outsourcing quality, and maturity of the monitoring tool. Regarding skills and knowledge of the process operators, it was found that process visibility seems to reduce the impact of this factor on process performance.

Our study is subject to specific limitations: First, the amount of qualitative data is limited as only 2–3 interviews per case have been conducted. However, the interview data were triangulated with information from a customer database of our industry partner. Second, hindsight bias might have influenced our findings as we could not observe process participants inside concrete critical situations, which particularly for SA assessments would have been beneficial and should be considered for future research. Likewise, changes attributed to the OCC implementations were evaluated only in retrospect. Third, for generalizability to a broader process context our Process Monitoring Benefits Framework ought to be studied also outside ITSM operations. Finally, although we acknowledge that the close collaboration with one software vendor bears the risk of being influenced by biases of the industry partner, we also see it as an opportunity to ensure the relevance of our work.

However, we believe to have made significant contributions to theory and practice. From a theoretical perspective, this paper adds to the body of knowledge related to empirical BPM research in the important domain of the monitoring use case. The conceptualization of process visibility offers a generalization of concepts coming from SCM and lean production to a broader process context, which is a promising foundation for more studies of the process visibility phenomenon in and beyond ITSM. Our suggested Process Monitoring Benefits Framework and its propositions helps to guide future research about the impact of process visibility on process performance. From a practitioner perspective, our paper proposes several anchors on how to increase benefits of process monitoring in organizations. Particularly, it describes what influencing factors should be considered while implementing new software for process monitoring. Furthermore, it identifies situation awareness and bottleneck identification as areas where leveraging data assets is of utmost importance for BPM.

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