

# IT-Benchmarking of Clinical Workflows: Concept, Implementation, and Evaluation

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**Abstract.** Due to the emerging evidence of health IT as opportunity and risk for clinical workflows, health IT must undergo a continuous measurement of its efficacy and efficiency. IT-benchmarks are a proven means for providing this information. The aim of this study was to enhance the methodology of an existing benchmarking procedure by including, in particular, new indicators of clinical workflows and by proposing new types of visualisation. Drawing on the concept of information logistics, we propose four workflow descriptors that were applied to four clinical processes. General and specific indicators were derived from these descriptors and processes. 199 chief information officers (CIOs) took part in the benchmarking. These hospitals were assigned to reference groups of a similar size and ownership from a total of 259 hospitals. Stepwise and comprehensive feedback was given to the CIOs. Most participants who evaluated the benchmark rated the procedure as very good, good, or rather good (98.4%). Benchmark information was used by CIOs for getting a general overview, advancing IT, preparing negotiations with board members, and arguing for a new IT project.

**Keywords:** IT-benchmarking, clinical processes, information logistics, information management, visualisation of indicators

## 1. Introduction

Health IT (HIT) has become a production factor that is starting to demonstrate its contribution to the health care value chain [1-4]. Due to its potential for becoming part of the care processes as well as due to the risk for endangering the clinical workflows [5], continuous measurements of the efficacy and performance of health IT are imperative and a part of good health care leadership [6]. Planning, monitoring, and aligning IT resources have to take place at all levels: the strategic, tactical, and operational levels [7-8]. IT-benchmarks are a recognised means for delivering insight into the structure, processes, and outcomes of an organisation [9]. It provides facts for chief information officers (CIO), health care leaders, and other decision makers to govern change [10]. IT-benchmarking thereby embraces a full toolset for measuring performance in small groups of peer organisations (in-depth benchmarking) as well as in large reference groups (statistical benchmarking). In 2011, we conducted an independent, publicly funded statistical IT-benchmark of 59 German hospitals (2011 IT-Benchmarking Healthcare) based on the national surveys of the IT-Report Gesundheitswesen [11]. The hospitals could be assigned to sufficiently large reference groups selected on the basis of factors that were derived from regression analyses [12].

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We showed that the 61 variables represented the implementation status of the structural and functional IT features, IT resources, CIO satisfaction, and context factors rather well that were good predictors for advanced HIT systems [13]. The benchmark demonstrated the feasibility of a scalable and repeatable procedure for continuous measurements and its utility. However, the indicators employed did not cover the features of clinical workflows, as one of the most important yardsticks of meaningful health IT, albeit difficult to capture [14]. We, therefore, aimed at enhancing the existing IT-benchmarking toolset and specifically asked:

- 1. How can the IT support of clinical workflows be statistically benchmarked?
- 2. How can the indicators be properly visualised?
- 3. How do the participating CIOs evaluate the benchmark?

2. Methods

2.1. Initial Situation: 2011 IT-Benchmarking Healthcare Evaluation Results

Advancing the existing procedure of the 2011 IT-Benchmarking Healthcare [11] based on two strands: the results of the 2011 evaluation and the goal to measure the IT support of clinical processes. The evaluation had shown that the large majority of participating CIOs had found the benchmark to be very useful. Improvements were suggested with regard to the inclusion of additional indicators, e.g. costs, follow-ups, and more consolidated presentation of results [11].

2.2. IT-Benchmarking Healthcare 2013

2.2.1. Information Logistics - Concept for Measuring the IT Support of Clinical Workflows

We used the concept of information logistics as the underlying construct for measuring the IT support of clinical workflows, i.e. IT efficacy on clinical processes. Pursuant to this concept “the right information” needs to be provided in the “right amount and quality”, at the “right time”, to the “right place” [15-16]. In order to summarise these demands, they were translated into measurable workflow descriptors (Tab. 1) after in-depth discussions with seven health IT experts and after analysing the relevant literature [8,17-19]. Benchmark variables, i.e. raw indicators, should be mapped to these four workflow descriptors, namely the availability of *data and information* along the processes, availability of process relevant *functions*, depth of *integration* and *distribution* of data and information via mobile devices and exchange platforms.

Measuring the degree of IT support of clinical workflows required representative clinical processes in order to operationalise the clinical workflow concept. These processes had to be IT demanding and sufficiently complex with regard to

**Table 1:** Information logistics’ demands [15-16] predominantly associated with workflow descriptors

“right information”	<i>data and information, functions</i>
“right amount”	<i>data and information, functions, integration</i>
“right quality”	<i>data and information, functions</i>
“right time”	<i>functions, integration, distribution</i>
“right place”	<i>integration, distribution</i>

interdisciplinarity or to spanning departments or settings. Based on these criteria, we chose ward rounds, pre-surgery (from ward to theatre), and post-surgery (from theatre to intensive care unit) processes and discharge to represent clinical workflows in acute care hospitals.

### 2.2.2. From Raw Indicators to Workflow Indicators

The 2013 online questionnaire consisted of 44 main questions, which constituted 86 raw indicators (RI) that were derived from the combination of workflow descriptors and clinical processes plus additional information on factors influencing IT in a hospital. They covered the four main topics *general IT structure and functions* (38 RI), *specific IT support of the four selected clinical processes* (18 RI), *IT governance* (23 RI), and *context factors* (7 RI) including hospital demographics. These questions were similar to the 2011 survey instrument with regard to *IT structure and functions* and *context factors*. The attributes of the raw indicators were given points: A maximum of ten points could be achieved per clinical process (process score) with 2.5 points per workflow descriptor in each process.

### 2.2.3. Additional Performance Indicators

In accordance with the 2011 evaluation results we included new performance indicators, i.e. COBIT 4.1. IT governance maturity items [20] and various cost items in order to measure efficiency. The COBIT process items embraced planning, procurement, implementation, deployment, support, and evaluation processes. Similar to process scores, IT governance attributes were assigned points, which were then added to an IT governance sum score. Information on the costs covered the total costs and the percentage of costs for staff, hard- and software and services. Cost indicators were computed as costs relative to the number of beds and full-time equivalent IT staff. Similarly, service ratios were calculated as beds, users, physicians, and nurses per full-time equivalent IT staff.

### 2.2.4. Dataset

A total of 1,317 chief information officers and other leading IT managers, who were responsible for 1,675 hospitals, were included in the survey, which took place from February to June 2013. The remaining 331 German hospitals either did not employ a person in charge of IT or did not want to take part. All the survey participants received the offer to take part in the benchmark. Out of these 1,317 persons, 259 answered the questionnaire (19.7% response rate). These 259 hospitals represented organisations of all sizes, ownerships, and from all states within Germany. Additional information on the 259 participating hospitals, e.g. clinical staff, was retrieved from publicly available quality reports (Social Security Code Five §137). All data were analysed using IBM SPSS Version 21.

### 2.2.5. Selecting Reference Groups

In accordance with the 2011 IT-Benchmarking Healthcare [11] and with results from regression analyses [12] hospital size and ownership were chosen as factors to build the reference groups. Hospital size was expressed as the number of beds clustered in five classes. Ownership distinguished between private and non-private hospitals. Not all hospitals that participated in the benchmarking had surgeries and intensive care units.

These hospitals were benchmarked based on the scores of the ward rounds and discharge process only.

### 2.2.6. Visualising the Benchmarking Results

Benchmark results were presented in two groups of views, “single indicator” and “multiple indicator” views. Raw indicators, i.e. the answers of the responding hospital to a question were shown as frequency views [11] and performance bars [21], which belonged to the “single indicator” views. Raw indicators were also grouped according to headings such as documentation, provider order entry and decision support. These groups were depicted in “multiple indicator” views, i.e. distance views, which provided a web view, and innovation views, which showed a 2x2 matrix for sorting hospitals into the Roger’s classes of adopters [11, 22]. Accumulated indicators, i.e. the workflow descriptors, were presented in score views, which resembled performance bars. The intention of these views was to increase awareness, improve perception, and increase acceptance [23]. All the views were generated in a semi-automated manner using Microsoft Excel.

### 2.2.7. Evaluation

All the benchmarking participants were asked to evaluate the benchmark in terms of use of the results, comments on improvement, and intention to participate again. The questions were supplemented with items on the comprehensibility and utility of the indicators, their visualisation, and the benchmarking in general. The evaluation took place from the end of August to the end of September 2013.

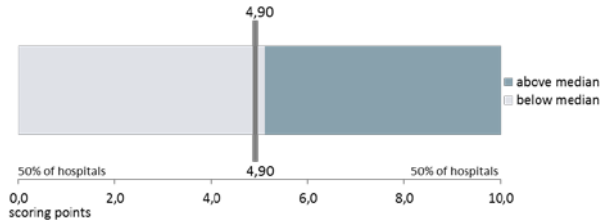
## 3. Results

### 3.1. Participation, Reference Groups, and Feedback to the Participants

Out of the 259 CIOs that answered the questionnaire, a total of 199 CIOs participated in the 2013 benchmarking. Compared to 2011, this meant an increase of 140 hospitals, whereby 40 hospitals took part again. This corresponded to a net increase of 269% and a repetition rate of 68%. 67 CIOs evaluated the benchmarks (34% response rate). Table 2 shows the size of the reference groups.

**Table 2:** Reference groups

		benchmark participants	size of reference groups
ownership	Non private hospitals	161	202
	Private hospitals	38	57
size	Up to 199 beds	59	81
	200 – 399 beds	55	77
	400 – 599 beds	36	43
	600 – 799 beds	20	22
	800 and more beds	29	36



**Figure 1:** Sum score view *IT support of patient discharge* – individual score in comparison to the median of the reference group

Feedback to the benchmark participants was given stepwise. Immediate feedback with 3 indicators was given one month after closing the survey, a short version of the individual results containing 50 indicators and 16 tables and diagrams was sent as paper document by mail after three months and a final report of 106 pages (PDF document) with 117 indicators and 169 tables and diagrams was made available by e-mail after three and a half months.

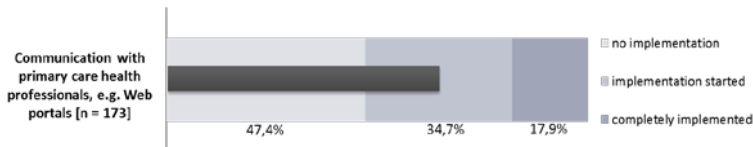
### 3.2. Measuring and Visualising IT support of Clinical Processes

IT support of the clinical processes was represented in a hierarchical way as recommended in the literature [24]. At the top level, the degree of IT support expressed as a sum score was shown for each clinical process as a bar in comparison to the median of the respective reference group (Fig. 1). A similar diagram showed the scores for the four workflow descriptors.

These views were then broken down to the level of raw indicators, which were depicted as performance bars (Fig. 2) that contained information on the implementation status of the individual hospital and the distribution of status groups, i.e. the percentage of reference hospitals within these groups.

In addition to the sum scores and the performance bars, which showed the performance of a raw indicator, participants could also see their own judgement about how well IT supported the clinical processes in relation to the reference group (Fig 3).

Raw indicators were clustered in innovation views, which belonged to the type of “multiple indicator” views and should show the degree of innovation of this hospital with regard to a group of raw indicators (Fig. 4). The degree of innovation was defined by the combination of information on the implementation status of these IT functions in that hospital and the percentage of hospitals in these implementation groups. There were four stages of innovation: innovators, early majority, late majority, and laggards, which resembled the innovation classes of Roger’s [22].



**Figure 2:** Performance bar of raw indicator *Implementation status of web portal for e.g. discharge letters* – individual score as black bar against the frequency distribution in the reference group

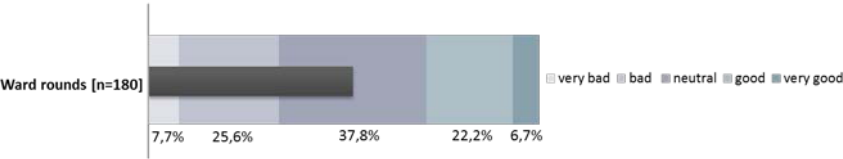


Figure 3: Performance bar *Subjective judgement on quality of IT support of ward rounds against the frequency distribution in the reference group*

3.3. Measuring and Visualising IT Governance and Cost Indicators

The benchmark results of IT governance were shown in comparison to the reference group as performance bars or in comparison to the best of the reference group as web diagrams (Fig. 5). Cost indicators and service ratios were summarised in tables together with the respective medians of the reference groups and their size.

3.4. Evaluation

The overall evaluation of the 2013 benchmark resulted in a general positive judgement (“very good” or “good”) of more than three quarters (77.4%, n = 63) of the evaluating participants. Nearly all of them (98.4%) evaluated the benchmark as at least “rather good”. Moreover, 90.6% (n = 64) stated that they would participate again. The preferred average time between benchmarks was 2 years (median, n = 65). The evaluation of the different types of visualisation (Tab. 3) demonstrated that at least two third of the participants found the diagrams comprehensible or very comprehensible.

The less consolidated the diagrams were the better they were regarded, i.e. at least “comprehensible” for the single indicators (93.9% frequency views, 90.9% performance bars) versus for the multiple indicators (77.6% distance views, 68.2% innovation views). Approximately 80% of the participants evaluated the sum scores for the clinical processes and for IT governance positive. In addition, the utility of *service ratios* and *IT costs* was rated resulting in high agreement of the helpfulness of these indicators (Tab. 4).

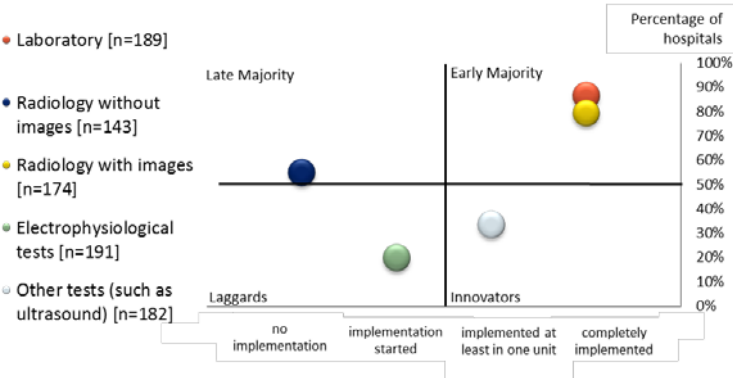


Figure 4: Innovation view *Order entry system* for various tests. Buttons represent implementation status of own hospitals (x-axis) and percentage of hospitals in same status group (y-axis)

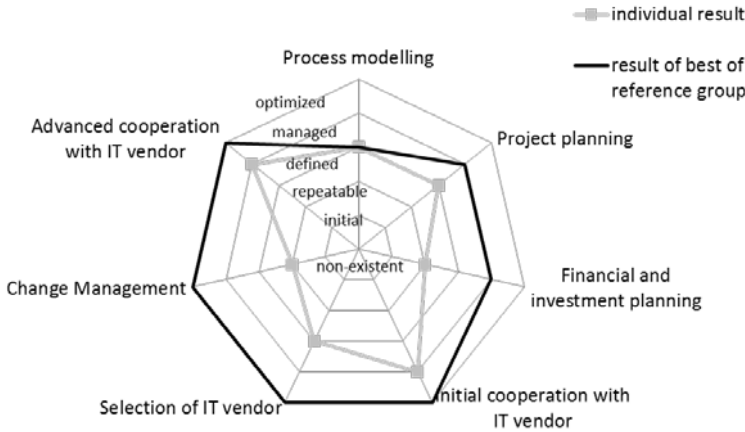


Figure 5: Distance view IT governance – process maturity planning, procurement, and implementation

Reasons for participating in the benchmark and for using the results (n = 65) encompassed the “general overview of the IT in the hospital” (92.3%), “approach for further developing the IT in the hospital” (75.4%), “foundation for discussions and negotiations with board members” (55.4%), and “basis for arguing in favour of new IT projects” (46.2%).

4. Discussion

In 2013, IT-Benchmarking Healthcare could be repeated in an enhanced version that included the measurement of supporting clinical processes with IT and of governing IT in a systematic manner. It also contained more sophisticated types of indicator visualisation. Participation could be more than tripled. 68% of the hospitals that participated in 2011 also took part in 2013. Ample feedback could be given to the participants. An overall and detailed evaluation yielded positive and highly encouraging results. We could thus validate the feasibility, high interest, and usefulness of this approach plus demonstrate the utility of the new indicators.

Table 3: Comprehensibility of the different types of visualisation and scores

types of visualisation	very comprehensible	com- prehensible	less com- prehensible	not com- prehensible at all
performance bars [n=66]	37.9%	53.0%	7.6%	1.5%
frequency views [n=65]	35.4%	58.5%	4.6%	1.5%
distance views [n=67]	22.4%	55.2%	16.4%	6.0%
innovation views [n=66]	22.7%	45.5%	28.8%	3.0%
sum scores for				
clinical processes [n=66]	16.7%	63.6%	18.2%	1.5%
IT governance [n=64]	15.6%	62.5%	20.3%	1.6%

**Table 4:** Utility of additional indicators

indicators	very helpful	helpful	less helpful	not all helpful
service ratios [n=64]	29.7%	56.2%	12.5%	1.6%
IT costs [n=64]	34.4%	54.7%	10.9%	0.0%

Measuring IT performance with regard to clinical processes has recently gained high attention in the Meaningful Use programme in the United States as Stage 2 criteria directly targeting clinical processes [19]. Although there is some overlap of applications, e.g. tracking medication from order to administration, we pursued a different approach that emphasised the role of a sample of clinical processes and the concept of information logistics. We are not the first to benchmark workflow support [e.g. 6, 14, 25], our work particularly contributes to making clinical process support measurable in a statistical benchmarking procedure. This was achieved by incorporating a hierarchy of indicators from sum scores to raw indicators to represent workflow quality. These indicators will become part of the survey instrument, which had been used in a highly consistent and standardised manner over many years [26].

We offered a wide range of different visualisation types from single indicator views to highly consolidated forms of presenting the data. In contrast to the recommendations of the 2011 benchmark, more compact ways of depicting the results seemed less desirable pursuant to our 2013 evaluation results. Frequency views and performance bars received the best marks and thus will be certainly retained in the next benchmarks.

Although cost indicators were regarded as helpful it was not easy to obtain good data from a sufficiently large group of respondents. This is probably a field of indicators where statistical benchmarking reaches its limits. Presenting the results of IT governance maturity received a positive feedback from the participants and will, therefore, be integrated in further benchmarks. Our measures were compliant to COBIT 4.1 and will have to be migrated to the COBIT 5.0 Process Capability Model [20].

There are some limitations in our approach that mainly relate to measuring clinical workflow support at the level of CIOs and IT leaders. They can give the most reliable information on technical features but without being able to appraise the use and usefulness. We are, therefore, currently conducting a survey with similar content that is addressed to clinicians. It is geared to the actual use and clinical user satisfaction. Usability and human computer interaction issues could be included in future studies. The evaluation of our benchmark proved to be an extremely helpful instrument for shaping the next version of the benchmark. Having said that, its results should not be over-interpreted due to the rather moderate response rate. This may have been caused by a small time window, during which the evaluation took place.

There are several open issues of this study. Performance over time has to be analysed and presented to those participants who had taken part for the second time. The sum scores for clinical processes and workflow descriptors need to be further tested for consistency and should be validated against external measures.

In conclusion, there is evidence from the number of participants, the increase in their number since the last benchmark, the number of second time participants and – with some caution – the evaluation results that this benchmark has the potential to provide the continuous measurements stipulated by benchmarking theory.



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