The Competence Center Health Network Engineering: A Retrospective

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Abstract Founded in 2005 at the Institute of Information Systems at the University of St. Gallen (IWI-HSG), the Competence Center Health Network Engineering (CC HNE) represented an association of researchers and practitioners whose goal was to support the transformation of the Swiss healthcare system with models and methods from the St. Gallen business engineering approach. This paper provides a retrospective of the work of the CC HNE. Starting with a motivation for the research focus as well as a classification in the research of the IWI-HSG, the main research results of the Competence Center are presented. This includes in particular work on networkability, performance management and maturity models as well as a Networkability Maturity Model. Subsequently, it will be discussed how the research results have found their way into practice (keyword: relevance). Here, the focus is on established communities of practice, whereby the application of the results in the context of the IT community of practice is examined in more detail. Finally, the results are subjected to a critical appraisal and an outlook on the need for further research is given.

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1 Introduction

In 2005, the Swiss healthcare system appeared to be facing major financial challenges due to changing demographic, health, social, political and economic conditions as well as new pharmaceutical and technical possibilities. A transformation of the hospital landscape and thus of the entire service provision was under discussion. This was the trigger for the launch of the Competence Center "Health Network Engineering" (CC HNE) in spring 2005. Robert Winter had set himself the goal of transferring the methods and models for the transformation of companies and business networks, which had been developed at the Institute of Information Systems at the University of St.Gallen (IWI-HSG) since the mid-1990s, to the healthcare sector. Against this background, he put together a group of young researchers who were to deal with the systematic optimization of services, cooperations, processes, structural organizations, etc. jointly by "business" and "IT". The purpose was to strengthen the strategic freedom of action and operational excellence of Swiss hospitals or their networks.

Between 2005 and 2012, 12 large-scale workshops were held with a total of 260 participants from hospitals (management, clinical staff, employees from medical services, employees from support functions and administration). Surveys (e.g. on the status of cooperation management, on process orientation or on the practice of information management) as well as around 300 individually conducted qualitative and quantitative interviews were used to gain insights. On this basis, it was possible, together with hospital partners, to design and test new methods and models for solving the problems that were supposed to arise soon. The results were directed on the one hand to the practice with the aim of offering good instruments to those responsible for hospitals (management, cadres from the medical profession and nursing as well as in the support services) and on the other hand to the scientific community dealing with the field. The dissertations of the authors of this report, Anke Helmes, Lars Baacke, René Fitterer and Tobias Mettler, as well as the habilitation of Peter Rohner emerged from this.

After a few cycles of research and development, it became clear that the CC HNE methods and models, which were well received at scientific conferences and in journals, were (still) "solutions looking for a not yet identified problem" from the hospitals' perspective. The CC HNE was ahead of the curve in terms of the pressures on effectiveness, quality, and efficiency in hospitals. In addition, the medical and nursing staff, whose personal commitment to patients is arguably the real "treasure" of the health care system, naturally had reservations about the business-driven projects. It was to take several more years before the instruments found the hoped-for acceptance in practice. This makes it all the more gratifying to look back on the

intensive work in the CC HNE from the present time, in which the topics launched by the CC HNE are moving to the center of the development of Swiss hospitals.

2 The Research Focus Health Network Engineering

2.1 Motivation

The Competence Center "Health Network Engineering" (CC HNE) was founded in 2005 at the Institute of Information Systems (IWI) of the University of St. Gallen (HSG). A Competence Center (CC) is understood to be an association of researchers and practitioners who jointly solve practice-related problems in a domain. The CC HNE focuses on various problems in the Swiss health care system [1].

In the early 2000s, the Swiss health care system was faced with major challenges due to the increasingly rapid changes in social, political and economic conditions in conjunction with ever new technical possibilities (see also Sect. 1) [1–3]. In particular, the question of how to shape the transformation process of the Swiss healthcare system to the information age (keyword: e-health) had to be solved. In this context, the focus is on various aspects—from strategy to organizational structure and process organization to information technology: starting with the definition of services, solutions must be found for service provision and quality assurance as well as service recording and billing in the healthcare sector.

The ability of the individual players in the healthcare system to network is seen as a success factor for implementation. These actors include, for example, hospitals and doctors' practices, care facilities, laboratories and pharmacies, medical technology and pharmaceutical suppliers as well as insurers, logistics companies and other service providers [2, 3]. Networking capability is "[...] the ability to connect as quickly as possible and at low cost with other actors in the health care system for joint service provision [...]" [4].

Against the background described above, the Competence Center Health Network Engineering has set itself the task of supporting the transformation of the Swiss healthcare system as a neutral partner. For the implementation of a successful transformation, various focal points have been set in the CC HNE—also through the orientation of the various partners [5]. In addition to the networking capability already mentioned, these include process management in hospitals, performance management in the healthcare system, and maturity models for the further development of the networking of the individual players in the healthcare system.

2.2 Classification in the Research of the IWI-HSG

The research of the Competence Center Health Network Engineering builds on the research results of the IWI-HSG or integrates with various parallel research initiatives.

First of all, CC HNE applies the methods and models of the St. Gallen Business Engineering approach [6–8], which has been developed and refined at IWI-HSG for decades. The St. Gallen Business Engineering approach is a framework that provides methods and (reference) models to systematically design networked, efficient structures at all levels of organizations, i.e., from the strategy to the organizational to the (IT) system level [2–4].

In addition to the St. Gallen Business Engineering approach, the research of the CC HNE also builds on or integrates various fundamental works of the IWI-HSG. This includes, among others, work dealing with fundamental questions on the topics of result types model vs. method [9], situational method engineering [10, 11] or situational maturity models [12, 13].

Finally, in parallel to the CC HNE, there are other Competence Centers at IWI-HSG that deal with application-oriented research in various domains (such as the CC Integration Factory with the topic of Enterprise Architecture Management (EAM)) and cross-fertilize the research of the CC HNE.

3 Research Results of the Competence Center Health Network Engineering

3.1 Networking Capability and Component-Based Modeling

In the wake of rising costs and increasingly restrained budgets for healthcare [14, 15], networking capability (see Sect. 2.1) is a key requirement at the strategic, organizational, and technical levels. It is thus a key design object for benefiting from specialization and collaboration with business partners without incurring greater costs for each partnership initiated.

A representation of the artifacts of a design object, such as the networking capability of the healthcare system, in the form of models pursues the goal of explicating the fundamental structuring of the organization, which serves for analysis purposes and as a basis for making decisions about its design. The basis for modeling a complex phenomenon is a suitable framework. Frameworks are conceptual and heuristic aids to represent an object system. "Conceptual means that they help to conceptualize and structure an object. Heuristic means that they can support the finding of a solution" [16].

Existing frameworks integrate methods and models for the design and development of the respective design object and define corresponding meta-models or vocabularies to ensure an intersubjectively comprehensible description of the

models [17, 18]. However, a corresponding adaptation to the respective concerns of the stakeholders of an organization is usually not methodically supported. As described in Sect. 2.2, numerous frameworks have been defined in EAM in various contributions by researchers and practitioners [19–22]. However, the frameworks described usually only define generic modeling approaches, for example, for coverage analysis [23].

As part of the work on the EU-funded PICTURE project [24], the usefulness of semantically annotated and standardized building blocks for modeling processes was explored. Based on such models, process characteristics can be measured and corresponding potential weaknesses can be identified. The measurement is not limited to the scope of individual processes, but the analysis can be carried out across the entire process landscape, enabling prioritization of ICT investments based on indicators such as process complexity, number of organizational interfaces or media discontinuities. Such rankings also make it possible to prioritize specific modernization projects.

Building on these findings, a comprehensive metamodel of the specific entities from the perspective of a hospital was described in [25]. By means of focus group discussions, a total of 21 influencing factors were identified which lead to an increase in networking capability. These were assigned to one of the five dimensions of consideration (environment, strategy, organization, system, values and culture) of the business engineering approach adapted to healthcare (cf. Sect. 2.2). By means of an explorative survey, the identified influencing factors were given to a broad audience for evaluation. These influencing factors form the basis for deriving rules and norm strategies for the systematic development of networking capability in healthcare organizations.

3.2 Performance Management and Maturity Models

Public sector organizations are different compared to their commercial counterparts in the private sector. There is no focus on profit maximization, little potential for revenue generation, and, generally speaking, no end result against which performance can ultimately be measured [26]. Performance measurement is therefore seen as a somewhat daunting endeavor. However, from a management perspective, performance is defined as a valuable contribution to the achievement of an organization's goals [27].

Mettler and Rohner [28] stated that at the strategic level, key performance indicators (KPIs) must be defined for shaping the economy, efficiency and effectiveness of service delivery (Strategize) and the redesign and operationalization of processes must be initiated (Plan). In addition, the operational level must focus on measuring and reporting performance (Monitor and Analyze) and optimizing and adjusting processes (Take Corrective Action). By linking the strategic and operational levels, performance management (PM) provides feedback based on specifics rather than generalizations [29]. This gives both clinical and administrative decision

makers the ability to know at any point in time whether the strategy they are formulating is actually working, and if not, why.

Building on the findings of this work (see [28] and [29]), the focus was on prioritizing areas for action in terms of a roadmap to optimize PM quality, efficiency, and effectiveness of healthcare organizations, particularly in the area of networking capability and supply chain management.

A particular focus is on the development of maturity models. Maturity assessment approaches originate mainly from the field of quality management. Maturity, "the state of being complete, perfect, or ready" [30], as an assessment criterion for quality management was first introduced in Crosby's Quality Management Maturity Grid (CQMM) [31]. Crosby defines five evolutionary stages of how an organization adopts quality practices based on similar concepts to those of Gibson and Nolan [32], who stated that an organization goes through different stages when adopting technologies.

3.3   Networkability Maturity Model

Initial work by CC HNE already pointed to the need to create "development and maturity stages" [33] to enable an assessment of an organization's current networking capability and to provide recommendations for action for its further development. Based on these initial findings, a total of 24 maturity models were examined for their applicability in creating a maturity model for networking capability [34]. This serves to define a method for identifying and structuring functional and technical design objects that determine the maturity level of networking among healthcare providers. The maturity model of networking capability consists of six components and corresponding factors (cf Fig. 1) and, as described in the following chapter, forms a methodological basis for the benchmarking of the performance of Swiss hospitals used in Switzerland to date.

4   Relevance of Research and Current Trends

Despite the high level of complexity and the rather low pressure to change, digitization has now also picked up speed in the Swiss healthcare system—not only in the core areas of medical and nursing service provision, but also in cross-organizational collaboration and in the area of management and support processes. The models and methods of CC HNE contributed to this.

For every research work, the question arises as to its practical applicability and its contribution to problem solving. The work produced at CC HNE is still used today in various communities of practice, including IT (www.it-benchmark.ch) and procurement & logistics (www.beschaffungsbenchmark.ch). Every year, well over 100 support areas from hospitals, psychiatric clinics, rehabilitation and special clinics as well
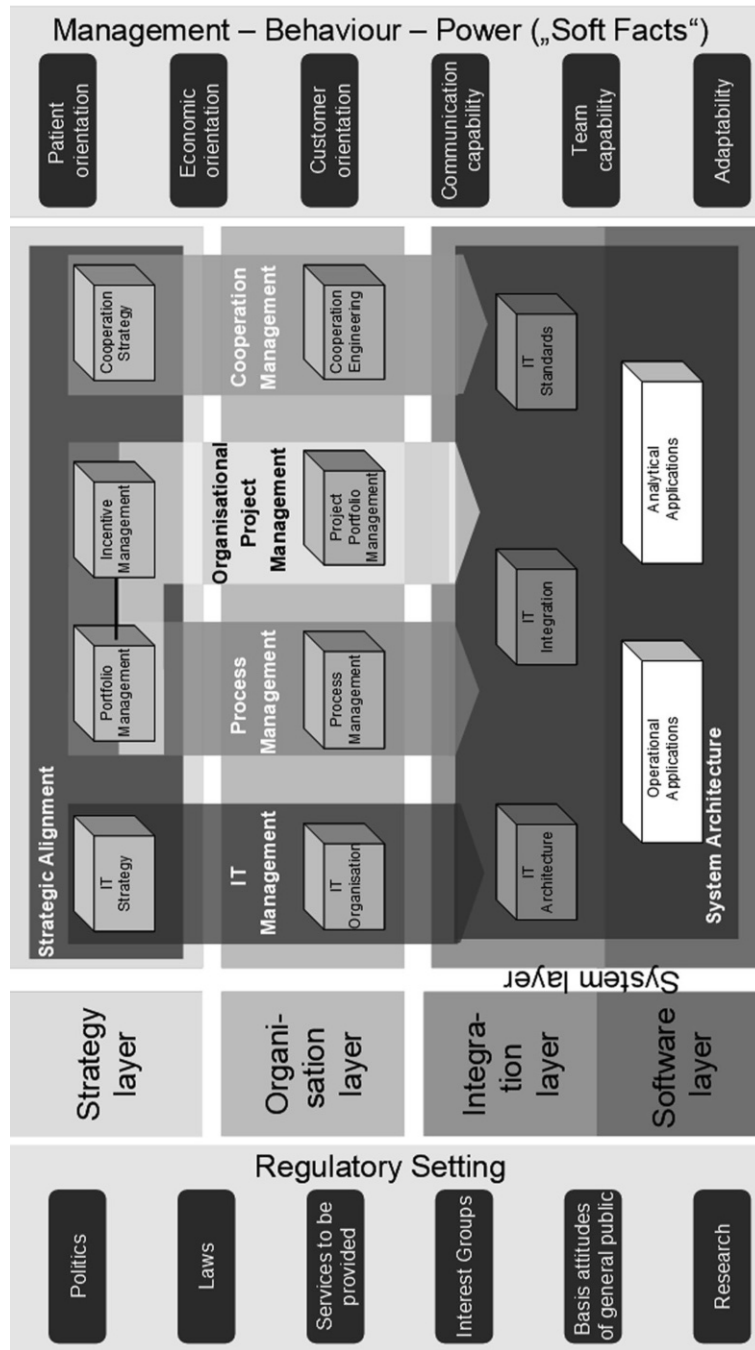
Fig. 1 Networkability maturity model for healthcare providers [34]. © 2010 BEG Analytics AG, reprinted with permission

as retirement and nursing homes in Switzerland and Germany participate in the systematic benchmark comparisons and the associated exchange of experience: In the first step, transparency is created (through own, comparative and historical data). In the second step, knowledge is derived on the basis of the methods used (e.g. maturity models). In the third step, impact is achieved by the companies taking appropriate measures. The effect can be measured in concrete terms in subsequent benchmarks.

The measurement and analysis methods—consisting of key figures on costs and performance (efficiency), information on effectiveness, and qualitative surveys— provide a comprehensive view of the company's own organization. The classification into reference groups and the presentation of trends ensure a high degree of comparability and relevance of the statements, even for companies with different structures. A few examples will be used to illustrate this system and at the same time present some current trends.

The Community of Practice in IT was created in 2008 and has been continuously developed since then. The associated benchmark is based on the assumption that an IT service provider should ensure both high efficiency of the IT organization and high business application benefit. Both efficiency and benefit score are systematically quantified and compared.

For IT as a percentage of total healthcare organization costs, recent values ranged from 2.3% to 6.9%, with half of the participants having values between 3.62% and 4.95%. The median in 2019 was 4.29%, with a mean of 4.42% (see Fig. 2, left). Over time, it has become clear in recent years that IT costs are steadily increasing—not only in absolute terms, but also relative to the healthcare organization's total costs and total revenue (cf. Fig. 2 right). In a benchmark comparison with other companies in the same reference group, these values can be an indication of the need to catch up or an investment backlog (cf. trend lines in Fig. 2 on the right) as well as providing indications of future strategic orientation.

It can therefore be observed that more and more is being invested in IT. The reason for this can also be seen in the benchmark: IT is providing more and more services—from telephony and mobile device management, through logistics and home automation, to medical technology, sensor technology and data analytics. The increase in services is disproportionately high in most organizations, i.e., the scope of services has been growing faster than IT costs have been rising for years (cf. typical scissor shape of the two trend lines in Fig. 3). It can thus be seen that the efficiency of IT—understood as the measurable quotient of performance points (output) and IT costs (input)—is also steadily increasing.

The performance trend can be explained, among other things, by the increasing penetration of IT resources, growing virtualization (servers and clients) and mobility (smart devices), as well as a growing number of small applications (apps) in particular. The rapid growth requires new approaches to manage the complexity of IT architectures and to improve innovation capability (e.g., with agile methods).

While the IT of many healthcare organizations was historically strongly rooted in the infrastructure area, application management and, above all, innovation management are now playing an increasingly important strategic role (see Fig. 4, left).
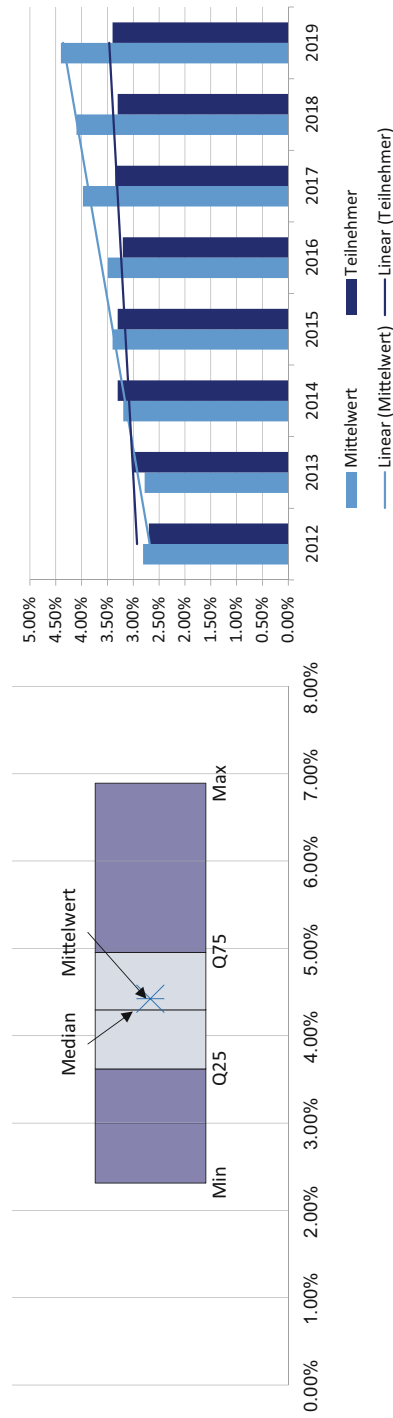
Fig. 2 Share of IT costs in total organizational costs (IT benchmark 2019, BEG Analytics AG, www.it-benchmark.ch). © 2019 BEG Analytics AG, *reprinted with permission*
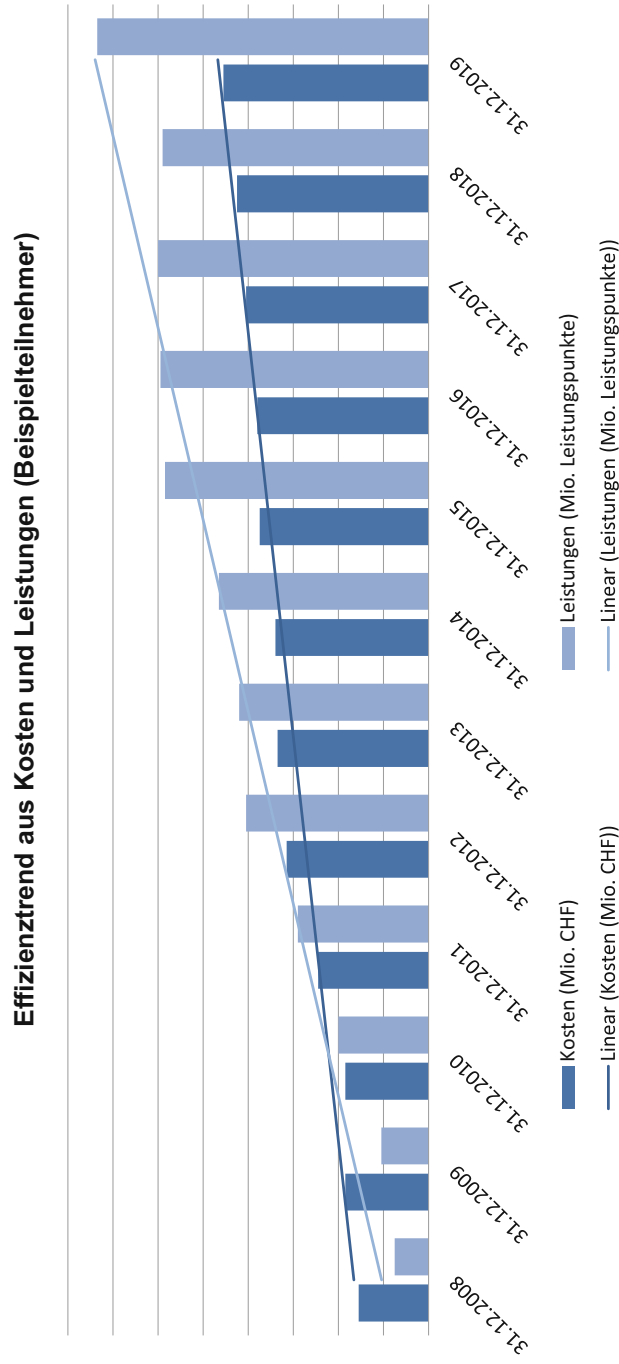
Fig. 3 Development of costs and scope of services (IT benchmark 2019, BEG Analytics AG, www.it-benchmark.ch). © 2019 BEG Analytics AG, reprinted with permission

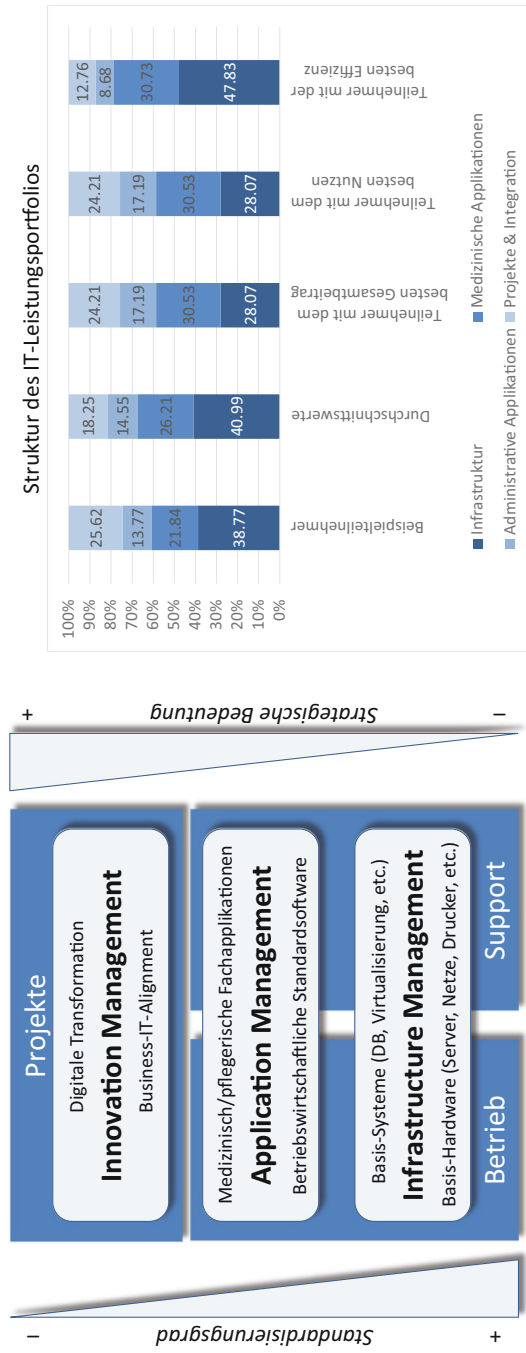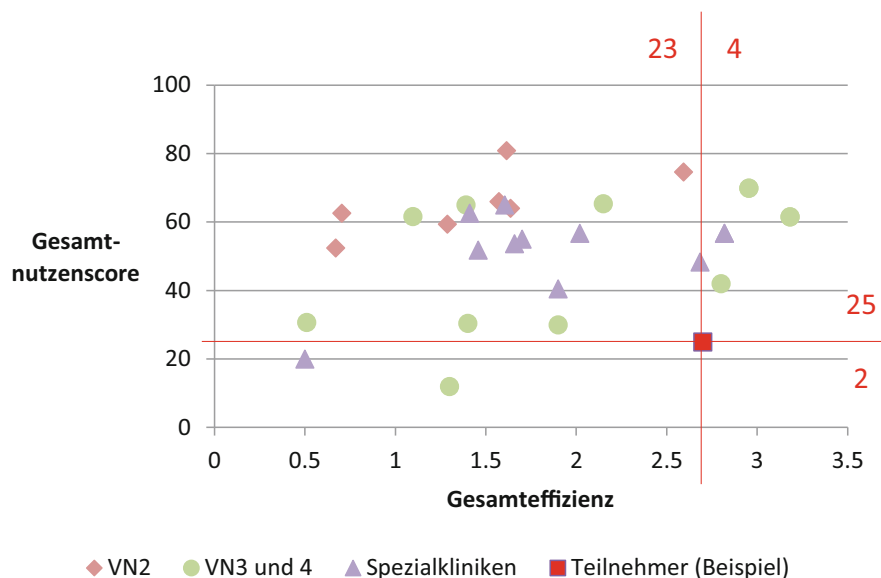**Fig. 4** Structural changes in the IT service portfolio (IT benchmark 2019, BEG Analytics AG, www.it-benchmark.ch). © *2019 BEG Analytics AG, reprinted with permission*

Accordingly, the service portfolio, the role and strategy, the sourcing concepts, and the qualifications, methods and tools of the IT department are also changing. Figure 4 (right-hand side) shows, for example, that benchmark participants with high efficiency often provide a disproportionately high share of infrastructure services. On the other hand, participants with a high proportion of services in application management and innovation (projects, integration, etc.) are able to provide greater benefits and a higher overall contribution to the organization as a whole. These comparisons can also be used in benchmarking with other participants to derive insights for one's own organization and measures for future alignment.

In addition to efficiency, the benchmark also measures and compares the benefit of specialist applications (calculation of benefit scores between 0 and 100% depending on the respective functional maturity and the range of use of the application functions). The measurement methodology was developed in CC HNE [35]. It is used to assess the entire application landscape in an industry comparison. On this basis, potential for improvement and backlog demand in the support of the various business processes can be identified and concrete measures for digitization can be derived.

In addition to a large number of other specific indicators and comparative variables (e.g., personnel structure, support, IT security, business-IT alignment), the strategic orientation of an IT organization in terms of efficiency and benefit can also be derived from the data (see Fig. 5). The following diagram shows the distribution of the benchmark participants (differentiated by reference group) in the area of

Fig. 5 Strategic positioning in the area of tension between efficiency and application benefit (IT benchmark 2019, BEG Analytics AG, www.it-benchmark.ch). © *2019 BEG Analytics AG, reprinted with permission*

conflict between efficiency and benefit. For each individual participant, it can be concluded whether the focus should be on increasing efficiency or benefits in the future, e.g., through higher standardization and consolidation or by increasing investment in digitization and integration projects.

For the participant marked in red in Fig. 5, it can be seen that only two participants have an even lower application benefit, while at the same time only four participants have an even higher efficiency. In this case, the strategic thrust should be aimed at consistent further development of the application benefit.

The community approach also encourages the exchange of experience beyond pure data analysis. Joint annual events and workshops, individual follow-up discussions, presentations and management summaries, as well as annually changing additional surveys on current focus topics (e.g., business-IT alignment, megatrends, or IT security) and further innovation and research projects round out the collaboration of the community members and their business and scientific partners. The findings flow directly into the strategic, organizational and systems development of the support organization.

The community approach has proven to be a sustainable link between science and practice. The key performance indicator and maturity models developed as part of CC HNE's research still form a powerful basis for continuous business engineering and networking in the healthcare sector and are continuously developed along current digitization trends.

5 Discussion and Outlook

5.1 Critical Appraisal

The work of the CC HNE shows that research within the framework of the St. Gallen Business Engineering approach can both be used beneficially in practice and produce new theoretical insights for research [36]. Numerous methods and models, which were developed during the existence of the CC HNE, have passed the so-called "applicability check" [37] and are still being used in practice after the activities of the CC HNE have ceased. In this context, the developed maturity models, benchmarking tools and other artifacts have taken on the function of "boundary objects" [38], which are used to create a common understanding of complex or paradoxical problems in healthcare (e.g. intra- and interorganizational collaboration and coordination of certain activities such as material procurement, digitalization, etc.). The pragmatic research-orientation of the CC HNE has not only produced concrete and tangible results, but has also fostered the establishment of communities of practice [39] and thus created a continuous transfer of knowledge (even after the end of a research project or program). This seems to be a major challenge for many research groups [40].

From a scientific point of view, the research work within the framework of the CC HNE has attracted attention in particular because of its transdisciplinary character

Informationsfluss vom Ärztehaus in das Spital
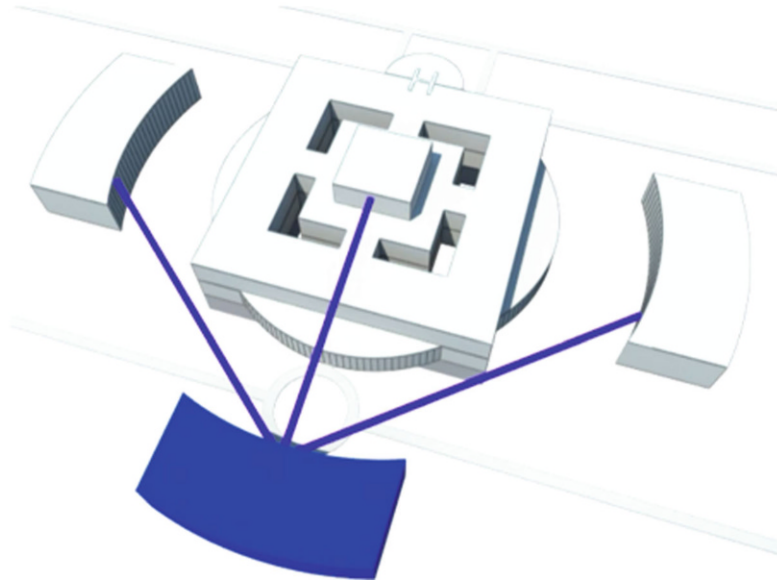
Fig. 6 Merging business process management and architectural design as the basis for hospital construction

[41]. Thus, not only has an intensive exchange between practitioners and researchers been cultivated, but disciplinary divides have often been overcome. Examples include the application of business process management to hospital construction (see Fig. 6) or the networking of hospital pharmacy and logistics. Accordingly, the research results of CC HNE have been widely published in the relevant scientific journals and conferences of different domains (e.g., business informatics, health economics, public administration, medical informatics).

5.2   Outlook on the Need for Further Research

The current Covid 19 pandemic is not the only reason why the healthcare sector will face major challenges in the future. Hospitals are confronted with numerous technological innovations, such as the increased use of process automation and decision-making based on applications in artificial intelligence, Internet of Things or service robots [42]. This requires rethinking and adapting existing structures, processes, and organizational culture, which in turn suggests that designing networking capability will remain a key management task to ensure successful adoption and smooth operations.

The pandemic, however, has shown that not only crisis management but also organizational preparedness is an important issue. The work of the CC HNE at the chair of Robert Winter, in particular the basic research in the field of maturity modeling [3, 12, 34], has made a valuable contribution in this respect and forms the basis of numerous new artifacts for the measurement of maturity or preparedness of hospitals and other health care providers [43–45]. In this respect, the methods and models of CC HNE are not only "boundary objects" for practitioners, but can also be further refined, adapted and extended in the context of research projects.

References

1. Rohner, P.: Den Weg in ein Vernetztes Gesundheitswesen fundiert erarbeiten. SIR Medical - Die Fachzeitschrift für ICT und neue Trends in Medizin & Gesundheitswesen. **2005**, 2–3 (2005)
2. Helmes (née Gericke), A., Rohner, P., Winter, R.: Netzwerkfähigkeit im Gesundheitswesen. Swiss Med. Inform. **59** (2006)
3. Helmes (née Gericke), A., Rohner, P., Winter, R.: Vernetzungsfähigkeit im Gesundheitswesen – Notwendigkeit, Bewertung und systematische Entwicklung als Voraussetzung zur Erhöhung der Wirtschaftlichkeit administrativer Prozesse. HMD – Praxis der Wirtschaftsinformatik **251** (2006)
4. Mettler, T., Rohner, P.: Faktoren zur Steigerung der Vernetzungsfähigkeit im Gesundheitswesen: Herleitung und Empirische Validierung. Gesundheitsökonomie & Qualitätsmanagement. **14**, 311–316 (2009)
5. Back, A., von Krogh, G., Enkel, E.: The CC model as organizational design striving to combine relevance and rigor. Syst. Pract. Action Res. **20**, 91–103 (2007)
6. Österle, H., Winter, R. (eds.): Business Engineering: Auf dem Weg zum Unternehmen des Informationszeitalters. Springer, Berlin (2003)
7. Österle, H., Back, A., Winter, R., Brenner, W. (eds.): Business Engineering—Die ersten 15 Jahre. Springer, Berlin (2004)
8. Winter, R.: Business Engineering Navigator: Gestaltung und Analyse von Geschäftslösungen "Business-to-IT". Springer, Berlin (2011)
9. Winter, R., Gericke, A., Bucher, T.: Method versus model–two sides of the same coin? In: Albani, A., Barjis, J., Dietz, J.L.G. (eds.) Advances in Enterprise Engineering Iii, pp. 1–15. Springer, Berlin (2009)
10. Helmes (née Gericke), A.: Konstruktion Situativer Artefakte: Beiträge zur Konstruktionsforschung Und Zur Artefaktkonstruktion. Institut für Wirtschaftsinformatik, Dissertation. Universität St. Gallen (2009)
11. Helmes (née Gericke), A., Winter, R.: Situational Change Engineering in Healthcare. In: Proceedings of the European Conference on eHealth 2006, pp. 227–238. Fribourg, Schweiz (2006)
12. Mettler, T., Rohner, P.: Situational maturity models as instrumental artifacts for organizational design. In: Proceedings of the 4th International Conference on Design Science Research in Information Systems and Technology, pp. 1–9. Philadelphia (2009)
13. Mettler, T.: Supply Management im Krankenhaus: Konstruktion und Evaluation eines konfigurierbaren Reifegradmodells zur zielgerichteten Gestaltung. Institut für Wirtschaftsinformatik, Dissertation. Universität St.Gallen (2010)
14. Slembeck, T.: Kostentreiber im Schweizer Gesundheitswesen: Eine Auslegeordung. Santésuisse. (2006)
15. Weisbrod, B.A.: The health care quadrilemma: an essay on technological change, insurance, quality of care, and cost containment. J. Econ. Lit. **29**, 523–552 (1991)

16. Schwaninger, M.: Was ist ein Modell? In: Dubs, R., Euler, D., Rüegg-Stürm, J., Wyss, C. (eds.) Einführung in die Managementlehre, pp. 53–63. Haupt Verlag, Bern (2004)

17. The Open Group (ed.): Togaf Version 9 – the Open Group Architecture Framework. The Open Group, San Francisco (2009)

18. Winter, R., Fischer, R.: Essential layers, artifacts, and dependencies of enterprise architecture. In: Proceedings of the 10th IEEE International Enterprise Distributed Object Computing Conference Workshops, pp. 30. Hong Kong (2006)

19. Zachman, J.A.: A framework for information systems architecture. IBM Syst. J. **26**, 276–292 (1987)

20. IFIP-IFAC Task Force on Architectures for Enterprise Integration: Geram: The Generalised Enterprise Reference Architecture and Methodology: Version 1.6.3 (Final). In: Bernus, P., Nemes, L., Schmidt, G. (eds.) Handbook on Enterprise Architecture, pp. 21–63. Springer, Berlin (2003)

21. Goethals, F.G., Snoeck, M., Lemahieu, W., Vandenbulcke, J.: Management and enterprise architecture click: the Fad (E) E framework. Inf. Syst. Front. **8**, 67–79 (2006)

22. CIO Council: Federal Enterprise Architecture Framework (FEAF). United States Office of Management and Budget. (1999)

23. Aier, S., Riege, C., Winter, R.: Unternehmensarchitektur–Literaturüberblick und Stand der Praxis. Wirtschaftsinformatik. **50**, 292–304 (2008)

24. Baacke, L., Becker, J., Bergener, P., Fitterer, R., Greiner, U.: ICT-enabled optimization of government processes. In: Weerakkody, V., Janssen, M., Dwivedi, Y.K. (eds.) Handbook of Research on ICT-Enabled Transformational Government: A Global Perspective, pp. 117–139. IGI Global, Hershey (2009)

25. Mettler, T., Rohner, P., Baacke, L.: Improving data quality of health information systems: a holistic design-oriented approach. In: Proceedings of the 16th European Conference on Information Systems, pp. 1883–1893. Galway, Ireland (2008)

26. Boland, T., Fowler, A.: A systems perspective of performance management in public sector organisations. Int. J. Public Sect. Manag. **13**, 417–446 (2000)

27. Hoffmann, O.: Performance Management – Systeme und Implementierungsansätze. Haupt, Bern (2002)

28. Mettler, T., Rohner, P.: Performance management in health care: the past, the present, and the future. In: Tagungsband der 9. Internationale Tagung Wirtschaftsinformatik, pp. 699–708. Wien (2009)

29. Amaratunga, D., Baldry, D.: Moving from performance measurement to performance management. Facilities. **20**, 217–223 (2002)

30. Simpson, J.A., Weiner, E.S.C.: The Oxford English Dictionary. Oxford University Press, Oxford (1989)

31. Crosby, P.B.: Quality Is Free—the Art of Making Quality Certain. McGraw-Hill, New York (1979)

32. Gibson, C.F., Nolan, R.L.: Managing the four stages of EDP growth. Harv. Bus. Rev. **52**, 76–88 (1974)

33. Helmes (née Gericke), A., Rohner, P., Winter, R.: Networkability in the health care sector-necessity, measurement and systematic development as the prerequisites for increasing the operational efficiency of administrative processes. In: Proceedings of the 17th Australasian Conference on Information Systems, pp. 1–9. Adelaide, Australia (2006)

34. Fitterer, R., Rohner, P.: Towards assessing the networkability of health care providers: a maturity model approach. IseB. **8**, 309–333 (2010)

35. Fitterer, R.: Anforderungsbasierte Bewertung der Informationssystemarchitektur von mittelgrossen gemeinnützigen Krankenhäusern. Institut für Wirtschaftsinformatik. Dissertation. Universität St. Gallen (2010)

36. Nunamaker, J.F., Briggs, R.O., Derrick, D.C., Schwabe, G.: The last research mile: achieving both rigor and relevance in information systems research. J. Manag. Inf. Syst. **32**, 10–47 (2015)

37. Rosemann, M., Vessey, I.: Toward improving the relevance of information systems research to practice: the role of applicability checks. MIS Q. **32**, 1–22 (2008)
38. Abraham, R., Aier, S., Winter, R.: Crossing the line: overcoming knowledge boundaries in enterprise transformation. Bus. Inf. Syst. Eng. **57**, 3–13 (2015)
39. Mettler, T.: Contextualizing a professional social network for health care: experiences from an action design research study. Inf. Syst. J. **28**, 684–707 (2018)
40. Rai, A.: Engaged scholarship: research with practice for impact. MIS Q. **43**, iii–viii (2019)
41. Mettler, T., Rohner, P., Winter, R.: Transdisciplinary and transformative research at the intersection between management, healthcare, and innovation. Gaia. **23**, 272–274 (2014)
42. Mettler, T., Sprenger, M., Winter, R.: Service robots in hospitals: new perspectives on niche evolution and technology affordances. Eur. J. Inf. Syst. **26**, 451–468 (2017)
43. Carvalho, J.V., Rocha, Á., van de Wetering, R., Abreu, A.: A maturity model for hospital information systems. J. Bus. Res. **94**, 388–399 (2019)
44. Gastaldi, L., Pietrosi, A., Lessanibahri, S., Paparella, M., Scaccianoce, A., Provenzale, G., Corso, M., Gridelli, B.: Measuring the maturity of business intelligence in healthcare: supporting the development of a roadmap toward precision medicine within Ismett Hospital. Technol. Forecast. Soc. Chang. **128**, 84–103 (2018)
45. Van Dyk, L.: The development of a telemedicine service maturity model. Stellenbosch University. (2013)