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ServiceBlueprinting as a service management tool in radiology

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ABSTRACT

Purpose: To describe the ServiceBlueprint model as a suitable method of service management in clinical medicine using the example of the routine clinical setting of a radiological department.
Materials and methods: ServiceBlueprinting is a concept for the analysis, visualization, and optimization of service processes. To investigate whether the model will also provide a suitable representation of medical services, particularly the provision of radiological services, ServiceBlueprints were created for the modality computed tomography (CT). To this end, an independent observer analyzed the workflow of 40 consecutive CT examinations.
Results: The ServiceBlueprint provided an analysis of the status quo of the service processes in CT imaging modality. Weak points in the processes thus became immediately apparent. The model could also be used for personnel management in that it helped to define the roles of staff members from different categories in the value-added process. It served as a basis for the implementation of quality management systems according to Total Quality Management (TQM) and DIN-EN-ISO-9001:2000.
Conclusions: The ServiceBlueprint model is a service management concept that is also suitable to visualize medical service processes in routine clinical settings like in a radiology department and has a multifarious potential in process optimization, implementation of quality management systems, and human resources management.

1. Introduction

With increasing financial pressure on healthcare institutions, aspects of cost efficiency are becoming a concern besides service quality. In most developed nations, the introduction of reimbursement based on diagnosis-related groups (DRGs) is one of the factors that have led to fiercer competition among providers of medical services, forcing them to optimize their organizational structures. Radiological services can be crucial for the smooth operation of the clinical departments in a hospital since the diagnostic information provided by radiologists often has a decisive impact on further patient management. Improvements in the provision of radiological services therefore often have beneficial effects on the clinical specialties referring patients for radiological examinations.

In the past, attempts were made to optimize workflow in diagnostic and interventional radiology by applying proven methods from business management and engineering sciences such as concepts from industrial manufacture or the services sector to organizational processes in the hospital. More specifically, different methods of process management such as process simulation and network planning techniques were used [1–3]. The aim of applying such methods was to improve workflow by optimally utilizing equipment and shortening treatment duration, which has become a necessity in the medical sector in response to decreasing financial means [4–6]. However, before processes can be restructured by applying methods of process management, it is necessary to document existing structures and workflow. Written or possibly visual documentation of workflow is often also a prerequisite for the certification or recertification of quality management systems or if one strives to provide services in accordance with Total Quality Management guidelines [7–10].

ServiceBlueprinting is a method for analyzing, visualizing, and optimizing service processes and the individual steps involved in rendering a service. The method was originally developed for service management [11,12] and can be used to map out all activities involved in providing a service in terms of chronological sequence and in terms of interaction between customers and providers.

The purpose of this article is to show that ServiceBlueprinting can also be applied to clinical medicine. The authors first provide a concise general description of the model to then show how it can be used in diagnostic radiology using computed tomography (CT) as a widely used diagnostic tool for illustration. The emphasis is on how the workflow in providing CT examinations differs for inpatients and how the differences can be analyzed and evaluated using the ServiceBlueprint model. The results documented using the model

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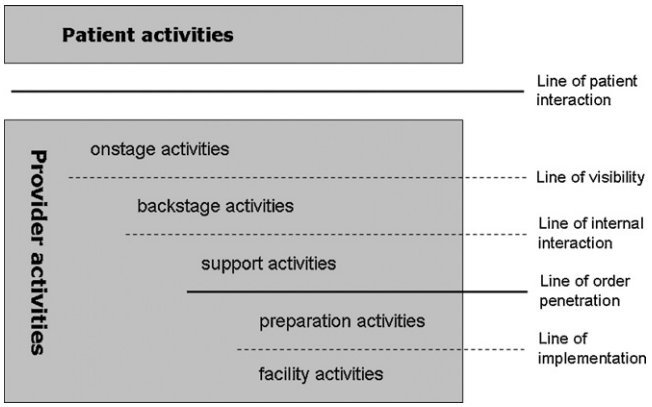

Fig. 1. Overview of the levels of the ServiceBlueprint Model.

will then be discussed to illustrate how daily clinical practice can benefit from ServiceBlueprinting.

2. Materials and methods

2.1. The method of ServiceBlueprinting

ServiceBlueprinting was introduced in the 1980s by Shostack [11] and Kingman-Brundage [12] as a process control technique for services. For display of the steps involved in rendering a service, a ServiceBlueprint combines the visual representation of industrial manufacturing processes with blueprints of floor plans mapping the movements of customers. The ServiceBlueprint represents the final stage of development of the model and also allows distinguishing between autonomous and integrative provision of services [13]. ServiceBlueprinting comprises two steps: first, all activities involved in a service process are identified and represented in chronological order. Second, all activities identified are assigned to one of the five levels of the model, each of which represents a different degree of closeness between the provider and the customer/patient. In the following we explain the five levels of the model for a radiological department (see Fig. 1).

The so-called line of patient interaction[1] separates provider actions from patient actions. The latter comprise all activities to be carried out by the patient such as appearing in the radiological department with a valid referral note, compliance while an examination is being performed with a radiological modality, and leaving the department with the images and the radiologist's report.

Provider activities are divided into four levels. The line of visibility separates onstage activities, which are visible to the patient, from backstage activities, which are not visible to the patient. Activities by contact persons are visible onstage activities such as the acceptance of the referral note by the staff at the reception desk. However, if the person at the reception desk leaves the room to check the availability of a modality or to ask about current waiting time, he or she is performing a backstage activity, which is not visible to the patient.

The line of internal interaction separates backstage activities from support activities, which are performed by other staff members, who do not directly interact with the patient. An example of a support activity is the typing of the report dictated by the physician and is likewise not visible to the patient. A typist usually has no patient contact.

The line of order penetration separates the activities prompted by direct patient interaction from activities carried out at the provider's facility that are unrelated to the provision of a specific service. All activities above this line are directly related to patient interaction, while the activities below the line can be planned independently.

The line of implementation separates the activities below the line of penetration into preparation activities and facility activities. The former comprise activities directly related to a service to be provided such as setting up work schedules for physicians for the different imaging modalities of the department or getting ready sterile materials before an interventional procedure. Facility activities occur logically and chronologically before preparation activities. Examples are the purchase of catheter kits, the acquisition of equipment, and the hiring of physicians.

2.2. ServiceBlueprinting in a radiology department

The ServiceBlueprint model was tested for its suitability for analyzing the workflow of the routine clinical provision of medical services in a radiological department. Altogether, 40 patients referred to our department for an outpatient diagnostic CT examination were accompanied by a radiologist throughout the procedure. The accompanying radiologist documented all activities involved in the procedure from the arrival of the patient at our department until he or she left again after completion of the examination. In addition, the technologist responsible for the CT scanner was interviewed regarding the steps necessary for maintenance of the equipment and the preparations necessary for the different types of CT examinations available.

All steps from the patient's perspective and the staff's perspective were documented in ServiceBlueprint forms for each of the 40 patients accompanied during their CT examinations. The blueprint was created by assigning all activities to one of the five levels outlined above. This was done according to the degree of interaction between patient and staff and taking into account the chronological sequence of the steps. In this way, the CT routines and the points of contact between patients and staff were visualized.

3. Results

3.1. An example of using the ServiceBlueprint model in computed tomography

In the following we give a detailed example of a ServiceBlueprint created for an outpatient CT scan. A chronologic overview of the activities of the patient, the physician, and other staff of the radiologic department is given in Table 1. A patient with a complicated lower leg fracture is referred for a control CT scan to a radiological department by his treating orthopedic surgeon (see ServiceBlueprint in Fig. 2). The patient enters the department and reports to the receptionist (patient activity at the line of interaction). Following registration, the patient is asked to sit down in the CT waiting area. The radiologist checks any previous examinations and the indication for the scheduled CT scan (backstage activity of patient contact person). Next, the patient is asked into the CT scanner room, and the physician informs the technologist about the CT scan to be performed. The technologist explains the procedure to the patient and positions him on the scanner table (onstage activity of a staff member with patient contact). The technologist plans the CT scan on the computer and runs the scan. The resulting image data set is transferred to the physician's workstation (backstage activity of staff member with patient contact). Following the exam-

[1] The term used in the model is line of *customer* interaction. Here and elsewhere we use the term *patient* instead of *customer* since this article deals with the application of service blueprinting to the provision of medical services.

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Table 1
Process steps of a computed tomography examination.

Activity, consecutive number	Description
1	Patient enters the department of radiology
2	Registration
3	Patient walks to waiting room
4	Physician checks case history, previous examinations and current indication
5	Patient enters CT scanner room
6	Technologist explains the procedure and positions patient on scanner table
7	Technologist plans and runs the scan
8	Patient leaves CT scanner room and waits for image printouts
9	Physician interprets exam and dictates a report
10	Technologist prints out images
11	Physician discusses the findings with patient and hands him the images
12	Patient leaves the department of radiology

ination, the patient is asked to wait for the printouts of the images while the physician interprets the images and, if available, compares the findings with prior examinations and then dictates the report. Finally, the physician briefly discusses the findings with the patient and hands him the images (onstage activity of staff member with patient contact). The patient leaves the department.

All of the above-described activities in the example are part of the visible and nonvisible activities of staff members with patient contact (receptionist, technologist, physician). Additional activities that are necessary for performing a CT examination are the calibration of the CT scanner, which is done every morning, the placement of fresh sheets on the scanner table, and, in case a contrast-enhanced scan is performed, the preparation of the injector for intravenous contrast medium administration. Cleaning of the CT scanner before an examination is another preparation activity. Facility activities preceding the preparation activities include the ordering of contrast media or training of technologists for running CT scans.

4. Discussion

4.1. Role of ServiceBlueprinting for the routine clinical setting

ServiceBlueprints have different uses. The creation of a ServiceBlueprint makes it clear that the rendering of a service is a process. Applied to the workflow in a radiological department, it becomes apparent that a CT scan involves more than the activities actually performed while the patient is present. The accurate observation of all activities involved in the rendering of a given service for the creation of a blueprint uncovers all indirectly involved activities, i.e., preparation and facility activities, making the whole process more transparent.

The entire process can then be checked for completeness, which often already reveals disharmonies, sources of error, and friction loss in an established routine. In this setting, a ServiceBlueprint can be used as a basis for making changes to streamline workflow. Our analysis has shown that the procedures for performing CT examinations in outpatients and inpatients are different, especially in terms of complexity and staff involvement. The differences in the blueprints for these two patient groups suggest that staff and equipment can be utilized more efficiently by identifying homogeneous patient groups for whom more or less standardized examination strategies can be defined. This might result in assigning different time slots for CT examinations of outpatients and inpatients.

The visualization of workflow by means of ServiceBlueprinting can also be used as a tool for personnel management. A structured visual display of an entire service process can help illustrate the role and tasks of each staff member in the value chain. This may be an incentive for staff to assume more responsibility for fulfilling their tasks; and newly employed co-workers will find it easier to identify their role in the whole process.

Finally, visualization of process steps also facilitates involvement of patients in the process. Compliance is likely to improve if a patient knows what he or she is expected to do to contribute to optimal results and will also help smooth workflow [13].

All existing working routines and procedures need to be mapped out and then reconsidered to finally identify the potential for improvement when implementing a quality management system

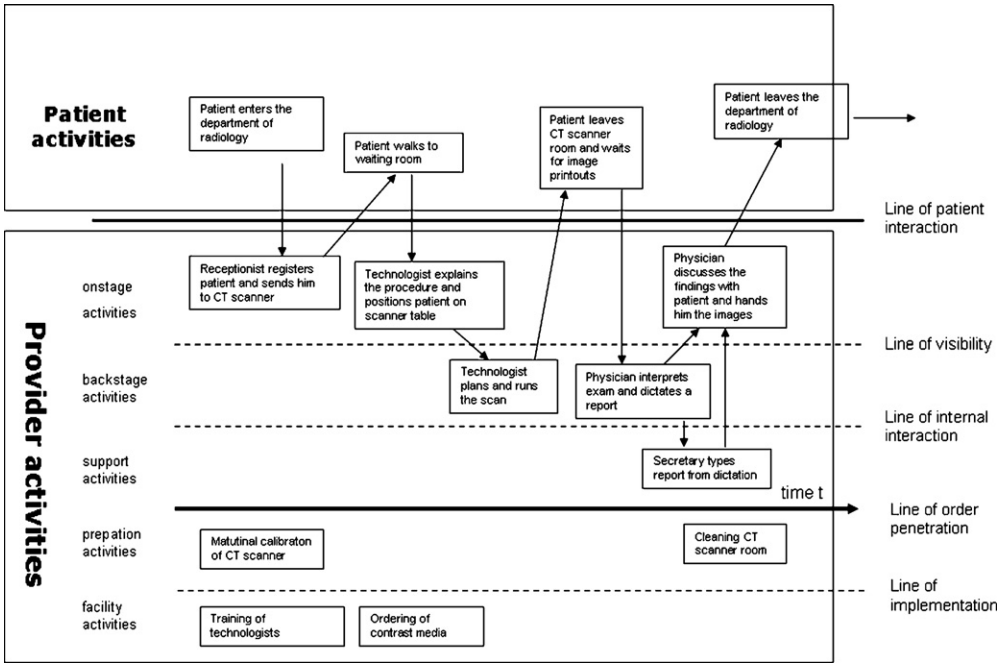

Fig. 2. Example of a ServiceBlueprint: path of an out-patient through a radiology department for a CT examination.

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[7,8]. These steps are also necessary when structures, processes, and results of a service are reorganized with the aim of continual quality improvement in the framework of Total Quality Management [14,15]. If blueprints have already been built for the different services provided by a radiological department, these can be used in the process of implementation and only few changes are necessary. A blueprint can also facilitate the process of recertification because, if a blueprint is available, it only becomes necessary to check whether there have been any changes in process organization compared to an earlier period for which certification was obtained.

Besides the mere graphic display of processes, there have been early efforts to optimize the examination procedures in order to improve cost and process efficiency of radiological departments. Rhea et al. [4] reported the beneficial effects of changing the workflow in the conduct of CT examinations. Also used were methods of process management such as network planning techniques (e.g., Critical Pathway Method, CPM; Program Evaluation and Review Technique PERT) [1,2]. However, when trying to apply established methods of process management to clinical patient management and using computer-aided process management systems, one has to be aware of the greater complexity of hospital procedures [1]. One important factor contributing to the complexity of patient management is the fact that patient care is much less amenable to standardization than industrial manufacturing processes. On the contrary, it is often even necessary to tailor an examination to the individual patient's situation. This means that a diagnostic examination cannot be fully planned and standardized; nevertheless, ServiceBlueprinting may be a suitable tool for establishing a very general outline of the workflow. However, a ServiceBlueprint differs from various instruments of process management in that it does not allow bottleneck analysis, i.e., identification of the most frequently used process step, which may possibly limit the overall procedure. Another drawback is that ServiceBlueprinting allows only a limited temporal analysis and verification of the entire procedure in terms of a critical pathway.

Nevertheless, a temporal component can be integrated into a ServiceBlueprint to some extent by arranging the steps involved in rendering a service along a timeline before they are assigned to the five levels distinguished by the model [13]. The duration of each step can be measured, for example the time of contact between physician and patient during an ultrasound examination or for discussion of the findings following a CT scan.

Since it is desirable to minimize the time required for each step, one can next test alternative workflows to achieve this aim. As in process management, it is not the aim to achieve the mathematical optimum in terms of duration but an approximation by repeated implementation of small changes in the working routine.

Finally, patient satisfaction with a medical service can be measured on the basis of a ServiceBlueprint. The so-called *Sequential Incident Technique* [16] can be used to question patients about their positive and negative experiences regarding individual process steps. This is done by the provider mentally going through the individual steps of a service process with a customer and recording his or her experiences and emotions. Applied to measure satisfaction of a patient with a radiological service, this means that the way the patient experiences the quality of the service is followed and recorded in detail along his or her path through the department. In addition, the *Critical Incident Technique* [17] can be used to ask open-ended questions regarding those aspects of the whole procedure they experienced as particularly positive or negative. The "critical" incidents identified in this way can directly lead to changes in or confirmation of existing procedures.

5. Conclusions

Efficient resource utilization is gaining in importance in an era of increasing financial pressure on healthcare institutions. ServiceBlueprinting is a service management model that can also be applied to streamline workflow in the rendering of medical services. The model facilitates the documentation, visualization, and analysis of clinical diagnostic and therapeutic procedures with the option of restructuring and optimizing existing routines. Application of ServiceBlueprinting to CT examinations in a radiological department has shown that the patient's status has a decisive effect on differences in workflow and should therefore be used as a basis for defining different patient groups for an efficient reorganization of procedures. Moreover, ServiceBlueprints can also be used as a basis for the implementation of quality management systems or for personnel management.

References

[1] Teichgräber UK, Gillessen C, Neumann F. Methods of process management in radiology. RoFo 2003;175(12):1627–33.
[2] Gillessen C, Teichgräber UK, Neumann F, Ricke J, Felix R. Prospective cost-benefit analysis of a fully digitized working environment in an ultrasound division applying process simulation. RoFo 2003;175(12):1697–705.
[3] Guglielmino MG, Celano G, Costa A, Fichera S. Modelling a radiology department service using a VDL integrated approach. J Health Organ Manag 2009;23(4):376–95.
[4] Rhea JT, Thrall JH, Saini S, Sumner J. Improving the efficiency and service of computed tomographic scanning. Acad Radiol 1994;1(2):164–70.
[5] Pearson SD, Kleefield SF, Soukop JR, Cook EF, Lee TH. Critical pathways intervention to reduce length of hospital stay. Am J Med 2001;110(3):175–80.
[6] Clevert DA, Stickel M, Jung EM, Reiser M, Rupp N. Cost analysis in interventional radiology—a tool to optimize management costs. Eur J Radiol 2007;61(1):144–9.
[7] Fleisch M, Hergan K, Oser W. Implementation of the quality management system ISO/CD2 9001–2000 in a radiology institute. RoFo 2000;172(2):195–202.
[8] Adam G, Lorenzen J, Krupski G, et al. Establishing a quality management system according to DIN EN ISO 9001:2000 in an academic radiological department. RoFo 2003;175(2):176–82.
[9] Duvauferrier R, Badonnel S, Vannoorenberghe Y, et al. Process management in a radiology department. Impact on the quality system. J Radiol 2002;83(1):13–25.
[10] Deitch CH, Chan WC, Sunshine JH, et al. Quality assessment and improvement: what radiologists do and think. Am J Roentgenol 1994;163(5):1245–54.
[11] Shostack GL. Designing Services that deliver. Harvard Business Rev 1984;62(1–2):133–9.
[12] Kingman-Brundage J. The ABC's of Service System Blueprinting. In: Bitner MJ, Crosby LA, editors. Designing a winning service strategy. Chicago: American Marketing Association; 1989. p. 30–3.
[13] Fliess S, Kleinaltenkamp M. Blueprinting the service company. Managing service processes efficiently. J Business Res 2004;57(4):392–404.
[14] Dale BG, Lascelles DM, Plunkett JJ. The process of total quality management. In: Plunkett JJ, Dale BG, editors. Managing quality. Oxford: Philip Allan; 1990. p. 3–18.
[15] Kurtz C, Czapp W, Trampe I, Leppek R, Klose KJ. X-rays taken by radiologists! Influence on a continuous quality improvement process? RoFo 2000;172(4):391–6.
[16] Stauss B, Weinlich B. Process-oriented measurement of service quality. Applying the sequential incident method. Eur J Market 1997;31(1):33–55.
[17] Bitner MJ, Booms BH, Tetreault MS. The service encounter. Diagnosing favorable and unfavoralble incidents. J Market 1990;54(1):71–84.

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