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The service-productivity learning cockpit – a business intelligence tool for service enterprises

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1 Introduction

Service-productivity is a topic of rising importance in marketing and information systems research. The literature on service productivity has been rising rapidly [4]. However, the definition of service-productivity still varies among academics and practitioners. The conceptualization of service–productivity in this paper is according to Walther et al. [9], where service-productivity is seen as the ratio of customer value realized by certain value propositions (e.g. reliability, availability, response time, etc.), divided by the inputs which were invested to realize these value propositions. The learning cockpit, which is built on the premise of the previously stated service productivity definition, is part of a research project funded by the German government called BELOUGA.

BELOUGA (translated: Benchmarking of logistical support and service processes in industrial applications) is a research project studying and developing innovative ways to measure productivity in service firms within the health care and logistics sector. This is done by considering the different value–creation logics proposed by Stabell et. al. [7]. In the project, we are specifically working on the supporting service processes in a hospital, for instance *patient transport logistics* (PTL) and *operation theatre personnel deployment planning* (OP-PEP). In this paper we will focus on the patient transport logistics. We are building the *reference processes* (RP) for mentioned cases, and these RPs will incorporate best practices from the surveyed partner hospitals. We believe that by doing so, each hospital in the BELOUGA–cluster will be able to learn from others.

Computer simulation is a way to imitate business processes based on reality. Due to the fact that the environment in hospitals is highly dynamic with local autonomy of stakeholders participating in the business processes, we found an agent–based modeling and simulation (ABMS) approach to be most suitable and it is therefore applied in this context. From an inception to a running simulation, followed by an analysis of the output, we need to keep in mind our user's physical problem as well as their capability of digesting the results. An interface between a computer modeler/programmer's deliverable and a user like a hospital manager who learns from the simulated behavior of physical reality, is a visualization tool. We call this tool a "*Learning Cockpit*" (LC). Although a manager has experience in managing their business and they use personal qualities to positively drive their organization in challenging business environments, a simulation provides them additional support in decision process. With the help of simulation, they should be able to clearly and concisely grasp the information about the current operations, the resources involved and the inherent costs to get an output. They should be able to measure the performance of the current setup, and if necessary, make some changes and bring more value to the organization.

Despite the fact that the learning cockpit will act as an organizational magnifying glass, still there are some issues with it. On the one hand, we have to properly design it, i.e. it being uncluttered and not complicated to comprehend; but on the other hand it necessary to understand what users really require of this cockpit and whether it is easy to use. Assuming that the first prototype of the learning cockpit fulfilling user's requirements and design is delivered to the users, we are interested to improve the cockpit using the user's experiences. Following an iterative approach to improve the learning cockpit, we can expect an adoption of this tool by the managers and let them achieve their strategic objectives with more ease. Also the motive of this cockpit would be to empower the employees of the hospital, not punishing them.

The paper is built as follows. First, the service productivity domain is introduced from an academic perspective. Second, the learning cockpit is described, including development steps, as well as mash–ups of the graphical user interface. Finally, further steps involving validation and user experiences are described.

2 Service productivity

The research on service productivity is a topic of rising importance, as productivity definitions derived from manufacturing contexts fail to capture the relevant aspects of the service sector, where productivity cannot be maximized solely by reducing inputs. Despite the economic relevance of the service sector, there still exists a huge gap of conceptual work on the topic service–productivity. In the following paragraph, a broad overview is given which describes the most important literature within service–productivity.

One of the early papers of service productivity measurement was written by McLaughlin et. al. [5], in which three core problems were discussed when dealing with service productivity: measurement problems, tactical problems and the selection of an appropriate tool to measure productivity. Especially the measurement problem is present in several service–productivity related papers. The difficulty to measure the quality of intangible goods and the timing of demand are two sub–problems of service-productivity measurement. Especially in the context of services the quality is an interesting topic, as in service–industry the quality of service delivery is strongly attached to the perception of the value by the customer as co–creator of value, in contrast to manufacturing, where due to sophisticated manufacturing technologies, quality can be assumed to be constant. This fact is the main difficulty of optimizing service–productivity, as a reduction of inputs can highly change the perception of the value–in–use. The demand variance is another problem, which is not addressed by us in this work.

Johnston et. al. [3] stated the term service productivity has been used as a diffuse concept including utilization, efficiency, effectiveness or quality. They define productivity as the output produced by an operation divided by the inputs within a period of time, distinguishing between operational productivity and customer productivity to cancel out the effects induced by the fact that the customer is always a co–producer of value. Groenroos et. al. [2] highlight the fact that the productivity comes from efficiency steering in manufacturing, and when applied, can lead to negative effects of the perceived service quality, influencing customer value and company profits directly. This consideration leads to their definition, where service productivity is a function of internal, external and capacity efficiency.

Hence, the two biggest problems are including the customer as co–creator of value and capturing what the output of a service is. These problems are addressed within the BELOUGA project.

3 Learning cockpit

The learning cockpit has the goal to create awareness of the managers, how changing the inputs (e.g. number of employees in the transport logistics) will change the values perceived of all the stakeholders involved.

The learning cockpit consists of two functional layers. The first layer includes an a priori view of data, including classical benchmarking figures like costs per transport or quality of transport over time. On top of this classical business intelligence function, the learning cockpit has a second layer, which shows the perceived values of the stakeholders in accordance to the inputs. The graphical layers are fed by an agent simulation based on the reference processes previously designed and modeled. Agents are autonomous actors/stakeholders within a process, with each one having own decision mechanisms (autonomy) and behavior (social activity and reactivity). Agent based simulation is used in this context for four reasons.

1. within the hospitals there is a constant cooperation, coordination and communication between the different process participants
2. within hospitals there are complex supply chains
3. decisions are often made on a decentralized basis
4. a hospital is very dynamic and incoming patients, as well as the severity of illness is difficult to predict

In the following, a brief description of the development process is given, as well as the graphic layers of the learning cockpit are shown as mash–ups.

3.1 Development phases

The development of the learning cockpit (LC) is being performed following *prototype modeling* [6] from software engineering. The whole development of LC from its inception to final delivery to hospital managers would be performed in four main steps. These steps are; identifying basic requirements of learning cockpit, its initial prototype development, a review, and revision of the prototype.

In the *requirements gathering phase*, we first conducted interviews with the stakeholders in the patient transportation logistics (PTL) service and tried to understand the operations they perform. Briefly, in this process the patients who have appointments for diagnostic check–up within the hospital are transported from one point to another and back within the hospital

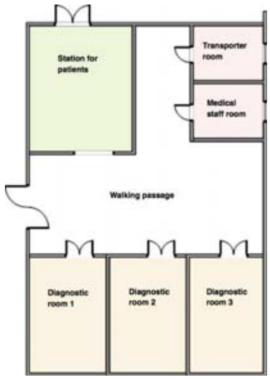

Figure 1: Layout of patient transport in a clinic of hospital

and the nurses make sure that the patients get appointments as well as transportation service. Therefore the stakeholders in the process are nurse, patient, transporter, doctor and the manager who would measure the overall performance of present PTL process. The interviews also led to several insights concerning the perceived values of the distinct stakeholders, as well as bottlenecks and casual problems in the service delivery process. We also physically witnessed the process and is shown a visualization of the transportation space in the hospital under consideration as shown in figure 1. This figure will also exhibit an animation of agents on the floor plan and will inform the users about present set-up in a real hospital, and intention is that they could connect with the physical reality. The transportation map shows the geographical allocation of the relevant localities, including the station for patients, the transporter and medical staff room, as well as the diagnostic departments like x–ray check or a laboratory. This gave us an idea on what will be inputs like number of resources and their behaviors in the PTL process and idea on what can we expect to measure for the output that can be interesting from service productivity's point of view.

Based on the first phase, in the second phase of *developing initial prototype*, we produced an incomplete version of learning cockpit fulfilling only partial aspects of final product as shown in figure 2. We have applied the basic principles of a dashboard design on the learning cockpit and are discussed in design section.

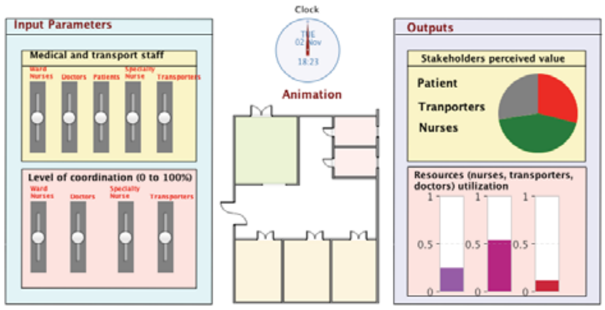

Figure 2: Graphical user interface (GUI) of learning cockpit

In an on–going phase called *review phase*, we will get stakeholder like manager's input to identify and fine tune the present service productivity indicators and ask if something is missing, which is required to evaluate the PTL service. In the last step called *revision phase*, we will accumulate feedback from the intended users, and will improve both the specifications and the prototype of learning cockpit. As per prototype modeling, we will iteratively go through review and revision phases till a sufficient and representative version of learning cockpit is not developed. On the first complete version of learning cockpit, we will apply a TAM2–*based validation* as explained in the following section. In order to be explicit here, TAM2–based validation is different than the simulation program validation, which is performed beforehand. A simulation validation is to validate if the agent–based simulation, on which learning cockpit is based, mimics hospital reality.

3.2 Design

The simulation of PTL is developed using an agent–based modelling approach (ABMS). We have used the AnyLogic software development environment to develop PTL simulation and it is Java based. The program itself is verified and should be validated beforehand to make sure that our simulation mimics reality. The graphical user interface (GUI) of the learning cockpit was built using the development environment provided by AnyLogic [10]. For learning cockpit design, we followed normal conventions by Few [1], which says that the users will scan the information from the left to the right and from the top to bottom, and therefore we kept the simulation input parameter near the top–left. With resource information as basis (including number of employees used in the process, invested resources, etc.), we can calculate *conventional benchmarking* measurements like productivity, quality and costs. These will show up on the right side of the cockpit. As in BELOUGA, we also intend to measure all the perceived values of the stakeholders, including patients, transporters, nurses and hospital management, we provide this information in the upper right corner. The perceived values are calculated according to an empirical analysis including sophisticated statistical methods, which were made by another project group. The perceived values are calculated according to empirical weights, to which extent each output measure (e.g. quality, costs, etc.) contributes to the perceived value experienced by the stakeholder. The color scheme we used is green displaying positive, grey being neutral and red signifying alarming state of service. A bar–chart for resources utilization is also added and can signal if the human resources are used properly. Figure 2 shows the current state of the learning cockpit.

As stated before, the learning cockpit at this stage is not complete and in the review phase. If required, we will also add multiple windows to display more analytics. To manage multiple windows of learning cockpit, and not to miss any portion of analysis, a user will be able to switch between them.

3.3 A TAM2–based validation

The validation process is conducted in a four step approach as shown in figure 3. First of all, a testing sample is selected which has similar characteristics as the final user group. Secondly, the test group is introduced into using the learning cockpit and its functionality. Third, the job relevance, output quality, result demonstrability, perceived usefulness and perceived ease of use are measured via surveys, which are elements of TAM2 by Venkatesh et. al. [8]. In the fourth step, the results are used to change the learning cockpit design. After applying modifications, the learning cockpit is tested again with a new sample group to test whether the system characteristics have improved. This is done until the designer feels sufficiently satisfied with the cockpit.

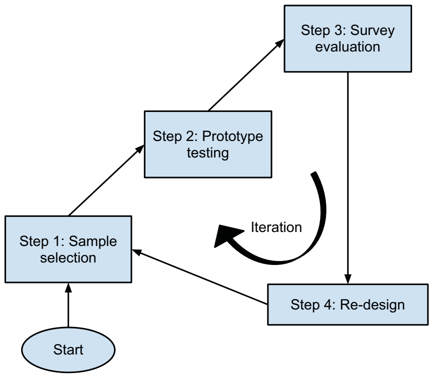

Figure 3: TAM2–based validation procedure

4 Conclusion

The paper described the state of our research in developing the learning cockpit for managers of hospitals. This was done by: 1) introducing into the general topic of service–productivity, which is of interested for either marketing and IS scholars because of its large economic importance, 2) highlighting the development process of the learning cockpit, 3) showing the intuitive graphical user–interface provided by us. The research process shows several difficulties, among them the difficulty to model all relevant stakeholders within the agent-based simulation, as well as a meaningful calculation of the customer values perceived.

Further steps of our development will be the inclusion of other processes, like capacity planning for hospitals. This is especially important, as different areas within the company are highly interlinked, enlarging the predictive power of the tool by including additional inter–dependencies. A major goal will then be to provide an overall model of the hospital, including as many functional areas as possible.

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The paper describes the development of an agent-based simulation tool for hospital managers to manage their productivity of services, especially in the context of supporting services like patient transport logistics. The learning cockpit allows hospital managers to see how the change of inputs changes the overall perceived customer values of all stakeholders and therefore to get a visualization of the impacts their decisions cause. The paper introduces the general research domain service-productivity, followed by a description of the development steps of artefact creation. The learning cockpit is part of a research project called BELOUGA, which is funded by the German government.

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