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REVIEW

Enterprise resource planning for hospitals

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Summary Integrated hospitals need a central planning and control system to plan patients' processes and the required capacity. Given the changes in healthcare one can ask the question what type of information systems can best support these healthcare delivery organizations. We focus in this review on the potential of enterprise resource planning (ERP) systems for healthcare delivery organizations. First ERP systems are explained. An overview is then presented of the characteristics of the planning process in hospital environments. Problems with ERP that are due to the special characteristics of healthcare are presented. The situations in which ERP can or cannot be used are discussed. It is suggested to divide hospitals in a part that is concerned only with deterministic processes and a part that is concerned with non-deterministic processes. ERP can be very useful for planning and controlling the deterministic processes.

1. Introduction

Hospitals in Europe and in the USA are transforming their organizational structure. There is a clear tendency towards corporatization (transforming the hierarchical bureaucracy into corporations that are exposed to marketing pressures [1]). Also there are tendencies both towards integrated delivery systems and focused healthcare services (organizations characterized by a homogeneous product range and a primary process geared to this product range, [2]). Hospitals that constitute an integrated healthcare system or are part of it (in a managed care system) typically were able to control costs ([2], p. 105), probably sometimes with loss of quality of care. Integrated healthcare systems show tendencies both towards integration of the same type of organizations as well as towards the integration of chains of organizations that cover different aspects of patient care, following the ''big is beautiful'' adagium. ([2], p. 128—154).

Integrated hospitals need a central planning and control system. By planning we understand the decision process that determines what should be done, and by control we understand the process that assures that the planned results are obtained. Restructuring of healthcare sectors and the implementation of case-mix reimbursement systems forced hospitals to organize their services around patients' needs. This led to a certain extent of decentralization and to the development of 'mini' hospitals within these integrated healthcare systems. The Mayo Clinics are an example of a diversified hospi-

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tal with some horizontal integration and a set of focused 'mini'-hospitals. The focus is toward patient groups. The staff is specialized in a certain patient group and has a fully integrated operational system at its disposal.

Focused healthcare services, like Shouldice in Ontario, focus on single procedures or patient groups. Because of this focus the staff develops an in depth knowledge and experience, resulting in a high quality, fully integrated operational organization. These focused organizations should be distinguished from (often big) hospitals that claim that they are an integrated system, but that are in practice only vertically integrated systems with fragmented patient processes.

Given the changes in healthcare one can ask the question what type of information systems can best support these healthcare delivery organizations. In industry ERP (enterprise resource planning) systems were introduced to enable organizations to react flexibly to changes in the environment. In this contribution we focus on the potential of ERP systems for healthcare delivery organizations. We will consider the potential of ERP not only for planning and controlling resource use but also for the primary process. ERP should support the delivery of care based on evidence, with ''best practice'' increasingly encoded in the form of clinical guidelines and protocols that drive the delivery of health care.'' ([3], p. 60). This means that Knowledge Management systems should be considered too: through improved knowledge sharing and knowledge creation, the quality of patient care can be enhanced, and more responsive customer service can be delivered while reducing the cost of healthcare.

In the following section we introduce the ERP concept. Then we will discuss a predecessor of ERP: hospital resource planning To determine what the requirements for ERP in hospitals are we will discuss the planning and control function in hospitals. We agree with Roth and Van Dierdonck who claim that by integrating the planning and control of resources into one system and by providing feedback from controlling modules to planning modules the patient care process can be coordinated to a large extent. ([4], p. 9). Finally we will discuss what problems ERP implementations will meet in the practice of the hospital.

2. Characteristics of ERP software

The ERP concept originated from the material resource planning (MRP) concept. MRP was developed to support scheduling and inventory control. Before MRP was used the production of products or components was initiated when the inventory for that product or component fell below a certain level without taking into account that components have a causal relation to the products in which they are used. Although the demand for products is determined by the market and therefore is uncertain, the demand for components can be determined from the number of products to be produced. Once the production schedule is known, it is exactly known how many components are needed when. The number of components and when they have to be available are contained in the so-called bill of materials.

A disadvantage of MRP is that it does not take available capacity into account. Manufacture Resource Planning, abbreviated as MRP II, corrects this deficiency. To make the planning more accurate other functions are used, like demand forecasting, rough-cut capacity planning, capacity requirements planning, etc. (see e.g. Krajewski and Ritzman, [5]).

MRP II was succeeded by ERP. ERP systems provide solutions for enterprises addressing the continued emphasis on controlling costs through improved resource management. An ERP system minimally contains a central database, a common control system and process models. ERP systems are multi-functional in scope, tracking a range of activities, such as supply chain management, human resources and general financials. The functions are integrated meaning that when data are entered into one of the functions, these data are immediately available to all related functions. ERP is modular in structure and usable in any combination of modules. ERP links different parts of the organization by coordinating all business processes (purchasing, logistics, financial and staff). ERP controls the entire enterprise to support goals like ([6], p. 1).

- Improving organizational performance.
- Increasing responsiveness to customers.
- Integration of data.
- Providing data access across common data systems.

In principle, all business applications of the organization should be integrated into a uniform system environment in which a centralized database resides on a common platform ([7], p.31). The ERP systems plan demand and capacity on an aggregate level for the long term. To plan for the short term the aggregated estimates are disaggregated to individual products and capacities. This disaggregation is only possible for deterministic processes. Deterministic processes are processes for which all parameters describing the process are known and constant. Breakdowns in the deterministic processes are taken care of by planning more capacity then is actually needed (slack). ERP systems can therefore disaggregate the estimates only to a certain extent.

ERP systems are however not without problems. Problems can be divided into two classes: implementation problems and structural problems. Implementation problems concern the transition from the pre- to post-ERP implementation. Mistakes made during implementation may, however, show up much later. Typical problems encountered after the implementation are:

- Members of the organization are unwilling or unable to upgrade to a new technology (Markus and Tanis, 2000, cited in [8], 181).
- ERP systems are not flexible enough to adapt to the processes of the particular organization. To implement ERP the organizations usually need to go through a major reengineering process ([9], p.72).
- ERP requires that processes be described very precisely. Often the formal information is not complete, and the implementers do not know where the different types of process knowledge reside in the organization ([8], p. 194).
- Organizational memory mismatches. This problem relates to the previous one. In the past often a match developed between the formal and informal knowledge systems. ERP systems require that not only organizational data but also knowledge is stored in a structural way. If this is not the case part of the organizational memory content is located in the ERP system and part of the content is stored in other organizational media (e.g. process manuals, knowledge in the heads of individuals, etc.) ([8], p. 182). Such memory mismatches cause underperformance of the ERP system, leading to a need for coping, for example through further enhancing the ERP system. ([8], p. 182). As a result, processes may also fail in unpredictable ways and may be difficult to trouble-shoot and correct. ([8], p. 184).

Structural problems relate to the mismatch between the structure of the ERP system and the structure of the organization. Problems here are:

- ERP systems assume that supply lead times (the time between placing an order for an end item and receiving it in inventory) are known and do not vary with demand and flow ([10], p.16), but in practice these lead times are either not known or, what is more difficult, they do vary with utilization.
- ERP systems require fixed processes or routings and ignore alternative processes. ([10], p. 16). In many organizations processes and routings are not fixed and alternatives may be attractive to evaluate.
- ERP systems do not have the possibility to optimize in (nearly) real time the use of capacity and thus assume either infinite capacity or may cause substantial disoptimal use of capacity ([10], p.16).
- No single vendor ERP system provides all required functions for all parts of the organization ([9], p. 75). Implementing one 'single ERP system' will either lead to missing functions or to suboptimizing parts of the organization.

In addition the implementation of ERP systems takes quite a time and can be rather expensive. Because ERP systems bring with them a new set of process requirements, business process redesign must be included in the planning of ERP implementations.

3. Resource planning in hospitals

Roth and Van Dierdonck introduced a framework for hospital-wide operations planning and control: Hospital Resource Planning (HRP) ([4], p. 3). HRP can be regarded as a step into the direction of ERP systems for hospital application. The HRP framework is based on the concept of diagnosis related groups (DRGs) and the concept of manufacture resource planning. Classification systems, like the DRG system divide the heterogeneous demand for health services into a manageable (limited) set of products provided by the hospital.

On the basis of an exploratory study in two hospitals Roth and Van Dierdonck conclude that although the manufacture resource planning concept as used in industry can be transferred to hospitals, the traditional materials driven planning logic has shortcomings. In hospitals capacity resources, in terms of costs, dominate materials resources. In manufacturing, processes can be understood as consisting of a gradual build-up around a bill of materials, with work orders related to stock keeping units. The hospital delivery process instead is more like building a project. If there are stages in the project, the stages are more like milestones in the progress of the project. Roth et al apply the term treatment staging to designate major milestones of patient care or episodes of resource utilization throughout a patient's hospital stay. Their HRP considers DRGs as products (also called end items) with a ''bill of resources'' (BOR) structure that simultaneously incorporates both capacity and materials resources. It allows hospital-wide (instead of functional) planning and control. The availability of a classification system makes hospital-wide operations planning and control a better alternative than control on the level of the department. Since often several departments are involved in the management of patients, their activities have to be coordinated.

Since DRGs are associated with length of stay and with treatment staging as defined by a patient care plan, the expected timing of resource utilization by patients with different DRGs can also be partitioned in reasonable time spans. The earlier mentioned concept of treatment staging connotes the routings through work areas (work centers) that are linked with the levels in the BOR.

The treatment stages include the use of diagnostics, drugs, involvement of physicians, nurses, etc., as a function of time. In Fig. 1 an example is given of the skeleton of a BOR for the treatment of an aneurysm (DRG 111). In this case the aneurysm treatment process can be divided into seven stages. Patients progress from stage 1 upon admission to stage 7 upon discharge. Each stage corresponds with a major and logically different step in the hospitalization process, with a different physical location of the patient and a different organizational unit in charge, except for the primary physician and case manager who are retained during all stages. The seven treatment stages correspond to seven BOR levels. By convention the ''final product'' (a discharged patient) is defined at the so-called BOR level 0. Therefore the treatment stages 1—7 correspond with the BOR levels 6 to 0.

The primary process of the patient is increasingly supported by guidelines. When guidelines are available, they can be formalized and also used to inform ERP systems about resources needed (providing information for the BOR). But the information contained in guidelines can also be made available in Knowledge Management systems or guideline support systems that are integrated with electronic patient record systems. In this case also the management of the patient (the primary process) is supported [11].

4. Planning and control in hospitals

In this section we discuss the planning and control process in hospitals in order to determine the requirements for ERP systems. Vissers et al ([12], p. 592) defined a planning framework for hospitals consisting of a number of levels. The goal of this framework is to identify the different types of decisions that have to be taken in an organization and to order them in a way that optimal decisions are taken. This framework applies to production systems that are characterized by a homogeneous product range and a primary process that is geared to this product range (a focused healthcare service). Homogeneity concerns both the market performance and the production process. Homogeneity in terms of market performance implies similar criteria for urgency, acceptable waiting times, etc. Homogeneity in terms of process implies that the products within the patient groups use the same constellation of resources. If this is not the case

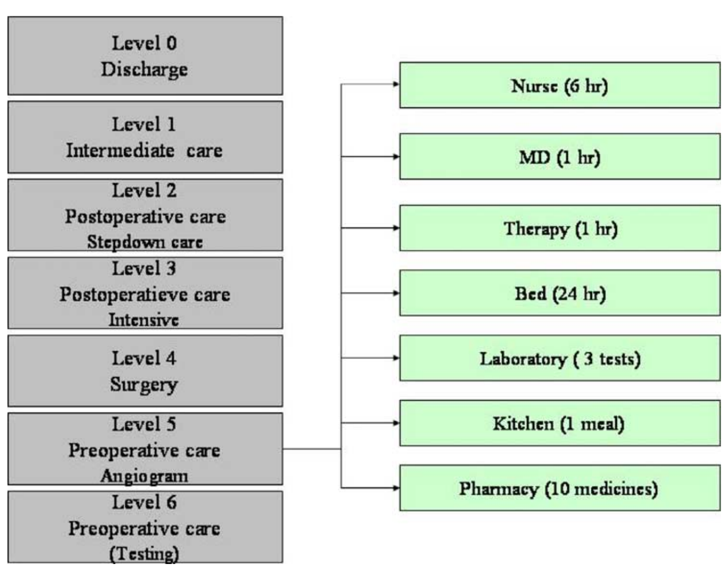

Fig. 1 Example of a bill of resources for aneurysm (DRG 111) (source Roth and Van Dierdonck [4], p. 19; Krajewski and Ritzman [5], p. 762).

a different control system should be designed for each product-market combination. Often this leads to splitting up the organization into a number of business units.

4.1. Planning framework

The first level of the planning framework concerns the single patient group. At this level a diagnostic and a therapeutic phase can be distinguished. This separation is an example of an application of the production control principle of decoupling production phases that have to deal with different levels of uncertainty. Some resources that are required in the diagnostic phase, which shows the most uncertainty, are the outpatient department capacity (units, personnel), diagnostic departments' capacity and specialist capacity. In the treatment phase the uncertainty in demand and routing is much less, due to the fact that a specific treatment path will be followed that can be translated into programmed activities for a patient. Resources needed in this phase are in case of hospitalization amongst others specialist capacity, operating theater capacity, and ward capacity. This level therefore is concerned with the processes used in facilitating the day-to-day activities that need to be performed to run the patient group. These activities consist of rules, procedures, forms, and other devices that govern the performance of specific tasks. At the patient group level (now all groups are considered) there must be a management function for defining the market performance to be delivered (patient mix, urgency criteria, acceptable waiting times, etc.), the acquisition of the resources required for each patient group, the control of the patient flow and the utilization of resources by each patient group. At this level some resources are dedicated to a certain patient group while others are shared between patient groups (specialty resources, hospital resources). Structural coordination will require a way of control that will combine efficient use of resources with the demand uncertainty of the patient group. Essentially there are two ways to influence the efficiency of resource use: batching (e.g. an operating theatre that is prepared for a number of surgical procedures by a specialist) and buffering (which prevents idle-time of service providers). Batching and buffering is a way to cope with variability and stochasticity. Variability is defined here as variations in parameters due to events like breakdowns, planned maintenance, rework etc. Stochasticity is caused by random fluctuations. Batching and buffering are the result of a lack in flexibility. If we would e.g. schedule patients to be operated in a first-in first out order way much time would be lost of staff and rooms due to switching and set up costs. With batching and buffering the order of ''processing'' patients is changed in such way that switching and setting up costs are reduced and possibly optimized. The necessity for batching and buffering is the result of choices made in the past. Other choices could have been made like constructing operating rooms and buying equipment with no or less switching costs or to enlarge the operating room capacity so that it is no longer a bottleneck. These choices would have reduced the necessity for batching and buffering. Batching and buffering may also be the result of a lack of integration. The available capacity is not sufficient compared to the other phases of the diagnosis and/or treatment process.

The next level concerns resources planning and control. At the aggregate level one determines the amount of resources of each type required for a production period of a patient group. This is necessary to determine whether the resources required by the different patient groups are available in the hospital. A second reason is that many resources are shared by patient groups and that it will be necessary to check if resources can be made available to a patient group at the time required. These decisions are taken approximately once or twice each year or possibly each quarter of a year.

Patient volumes planning and control and strategic planning are the last two levels in the framework. Patient volumes planning and control is the level where the trade-off is being made between service level and resource utilization level for the hospital as a whole. Decisions are made regarding the patient mix (determining the number of patients per group). In order to determine the number of patients in each group, the demographic characteristics of the population surrounding the facility, historical data regarding the number of patients in each group and patient volumes agreed upon with the health insurance companies are used as input data. At the strategic level it is determined what range of services will be offered.

The last level sets the scene for ERP. At this level the strategy is spelled out providing the necessary data with which ERP can predict the various patient volumes (fourth level) and then allocate resources and materials to the various patient groups and to control the capacity utilization of each patient group at an aggregate level. The ERP system has to disaggregate the estimates to provide more detailed information needed at the lowest two levels. The model of Vissers does not provide insight in the question how to disaggregate and how to schedule patients for the short term.

4.2. Planning uncertainty

As is the case in industry the demand in terms of the number and distribution of patients over the various diseases (case mix) and the number of elective and emergency patients is uncertain. To deal with this uncertainty we need, as in industry, demand forecasting ([7], p. 44). The remaining uncertainty in the results of forecasts has to be dealt with by operational planning. Because this type of planning is done almost in real time, the uncertainty is minimal. ([7], p. 44). Existing ERP systems do not or only partly support this type of planning: as was stated before ERP systems start with aggregated data and can only to a certain extent disaggregate the estimates.

When people make decisions they have expectations about the outcome but unexpected events or surprises may and will happen ([13], p. 36). Nevertheless according to Harper ([14], p. 165), the current practice in hospitals ''is to plan and manage hospital capacities through a simple deterministic approach using average needs, average length-of-stay, average duration of surgical operations, etc.'' ([14], p. 165). Such plans provide very incomplete information to balance workforce and demand on a daily basis. Surprises are common in daily practice: fluctuations in demand are very characteristic in healthcare ([14], p. 165). The use of averages leads to the misconception that the situation is under control. As Vandaele and De Boeck ([15], p. 213) observe even if average circumstances are under control, stochasticity causes the systems to demonstrate waiting (either capacity has to wait for patients or vice versa).

Since not everything can be planned in advance, healthcare workers will need 'planning freedom' ([16,17]). Therefore the commonly applied deterministic approach for planning and managing the hospital can be expected to be inadequate: the models should reflect the complexity and stochasticity of patient flows, patient needs and utilization of hospital capacity. The existing literature highlights many concerns regarding the adopted methodologies and stated assumptions of various proposed Operations Research models. In the light of the needs of hospitals, some of the common themes of concern with respect to the models include their oversimplicity, lacking flexibility, deterministic nature, lack of integration and user-friendliness ([14], p. 166). This criticism also concerns ERP, because in ERP deterministic processes are assumed with parameters equal to the average of the corresponding distributions.

Planning should take into account stochasticity and variability. Also average parameters (of demand and capacity) behave stochastically and have their own distribution. An example is the length of stay. This parameter may vary enormously between and within different hospital specialties. ([14], p. 165). This stochasticity is also present in the actual demand for care within patient categories, e.g. within a certain DRG class the demand for care may be different for various patients. A planned patient that does not show up is a source of variability. It is important to model these events explicitly (and separate from the stochasticity as introduced above), because only then their impact can be quantified and corrective action can be directed. Their main impact is that they artificially increase the utilization and therefore deteriorate lead-time performance.

Stochasticity and variability make planning difficult. To deal with them one has to plan either late (short-term planning) or react to the, probably unexpected situation. The latter we call reactive decision-making. Some hospitals use admission systems that plan patients weeks (or sometimes even months) ahead. Although these booking systems, as they are called, provide the service of early informing patients about their hospital admission, if there is a high chance that admissions have to be cancelled, the effect on patient satisfaction may be negative. Gallivan et al. [18] studied the effect of stochasticity in the length of stay on cancellation rates and concluded that if it is substantial, as is common, admission systems may require considerable reserve capacity to keep cancellation rates low [18]. Although in the above case a kind of reactive decision making approach can be followed (cancelling admissions), this is preceded by a detailed planning phase. Reactive decision making usually follows a much less detailed planning phase and therefore probably is preferable in the above-mentioned situation.

Besides the problem of patient scheduling there is the problem of staff scheduling: the assignment of staff to departments and units. In many hospitals a substantial part of the workforce is structurally attached to departments. One of the reasons to do this is to provide high quality care by means of specialization. Another staff assignment policy could be to assign nurses to units depending on the expected workload. To assign staff the required workload should be known.

Because of the stochasticity and variability discussed above a planning and control system should include short-term planning and reactive decision functions. Therefore it is only successful when data about monthly, daily and hourly demand and meaningful statistical distributions that capture the inherent stochasticity in length of stay and operation times are available ([14], p. 173).

Organization theory argues that there is a trade-off between efficiency and flexibility: managers ''must choose either an organization design suited to routine, repetitive tasks or one that is suited to nonroutine, innovative tasks.''([19], p. 43). Efficiency requires a bureaucratic form of organization with high levels of standardization, formalization, etc. Indeed organizations will also be more effective if they are designed to fit the nature of their primary task. Organizations, according to contingency theory, should adopt a mechanistic form if their task is simple and stable and their goal is efficiency, and they should adopt an organic form if their task is complex and changing and their goal is therefore flexibility. Organizations may also choose to construct a hybrid organization in the sense that one part of the organization is of a mechanistic nature suited for rather deterministic processes and another is a more organic part, directed to nonroutine, innovative tasks. Hospitals could also use this approach by separating the highly deterministic processes from the variable and stochastic ones. From the above description of planning uncertainty it is clear that hospitals cannot use an ERP concept for the whole organization. However, the part of the organization that has a mechanistic nature offers many possibilities for detailed planning and in that part ERP has potential utility.

5. Discussion and conclusion

ERP systems are advocated because they allow organizations to better react to changing environments. Indeed due to the fact that all processes are represented in a parameterized way, the ERP system can be relatively easily accommodated to changing circumstances. However, a dynamic environment needs also organizational changes. In bureaucratic organizations the ERP system takes care of providing the top with the necessary information. Because in dynamic environments the top management has to make many more decisions because of the encountered changes another type of organization is needed, one in which decisions can be made at lower levels. In this case much less information is needed. ERP systems on the other hand will try to combat a changing environment by using more information in order to better be able to cope with changes. It may then appear that ERP systems are not the best-suited systems under dynamic circumstances.

Many patients' processes in hospitals differ substantially in their degree of variability and stochasticity. As a result the logistic processes supporting the patients' processes may differ to the same degree. To conclude that because of this ERP systems are not suited for hospitals would not be correct, however. ERP may not be suitable for planning processes that are variable and stochastic, but there are always more stable processes. Processes with a high degree of variability should be positioned in another organizational part than rather stable processes. The above-discussed framework of Vissers et al. [12] should therefore be altered. According to them the first two levels of the planning framework (the single patient group and patient group level), the operational level, will require structural coordination by batching and buffering to guarantee efficient use of resources. However these coordination methods are not necessary for deterministic processes. For these processes the production line concept is applicable. In a product line diagnostic and treatment stations have a (logistical and possibly a geographic) fixed position in the patient process. The product line approach can be used when the capacity of these stations is balanced, meaning that no queuing or batching is required. At the first two levels of the framework of Vissers et al. [12] it is not only necessary to construct organizational units on the basis of patient groups. It is much more important to divide the organization on the basis of the variability and stochasticity of processes. Hospitals like the Mayo clinics developed 'mini' hospitals that are focused towards certain patient groups and in this way minimized shared capacity between these units, making the planning process less complex and more deterministic.

Deterministic processes should be carried out in separate units. This may for example imply that within a certain patient group (with the same type of diagnosis) a distinction is made between complex and non-complex cases. The non-complex cases can be planned in a more bureaucratic manner because of the deterministic nature of their processes. This does not mean that we should create a bureaucratic organization in which for example no learning how to cope with new situations takes place (in a bureaucratic organization one has to follow orders given by the top management and the top management adapts the orders when the environment changes). The examples mentioned in the introduction show that in practice hospitals specializing in deterministic patients' processes have excellent quality systems offering a lot of learning opportunities. The organizational part where the variable and stochastic processes are positioned has to be planned in a more organic way. This makes it necessary also to physically separate these different organizational parts to avoid conflicts about e.g. operating room usage. The deterministic processes are planned, using ERP, whereas the variable and stochastic processes are run much more by reactive decision making.

ERP can help to better coordinate activities concerning individual patients, thus shortening the time that the patient stays in the hospital. However, if the primary process is characterized by a high variability and reactive decision-making, the length of the diagnostic and treatment phase can vary considerably among patients and then there will be no fixed patient routing. As was stated earlier one of the shortcomings of ERP is that it needs fixed routings. Therefore ERP cannot be used here.

High utilization levels will increase lead times considerably. However, ERP systems assume that lead time remains constant independent of the utilization rate. To solve this problem advanced planning systems (APS) have been developed to support short term planning. The input to the APS is aggregate information for example provided by an ERP system.

Advanced resource planning uses detailed hospital capacity models that incorporate time-dependent demand profiles and meaningful statistical distributions that capture the inherent stochasticity in a number of patient factors, such as length of stay and operation times to optimize planning decisions. Therefore an APS cannot only cope with the above-mentioned lead time problems that for example occur in deterministic processes but also provide the necessary scheduling information for non-deterministic processes. Because of the complexity and number of calculations only the short-term planning can be optimized by an APS.

The parts of the organization where the non-deterministic processes are positioned will have capacity allocated on the basis of aggregated demand estimates. Since for non-deterministic processes ERP cannot disaggregate these aggregated estimates, APSs are useful. In this case a less complex and less expensive planning tool can supply the aggregated information.

Vandaele and De Boeck [15] discuss an APS based on queuing networks and the use of the concept of effective capacity to capture all capacity losses to reformulate the input parameters (like processing times), with the output of the APS expressed in terms of a total lead-time characterization, optimized lot sizes, utilization levels, etc. APSs go through numerous iterations of production schedules, adjusting them to accommodate constraints each time, until they produce an optimal schedule for meeting delivery dates while also making the most efficient use of all resources ([10], p.16). Shapiro calls such a system a production scheduling optimization modeling system which has as objective to minimize avoidable short-term costs while satisfying the customer requirements. ([7], p.44).

To conclude: both deterministic and non-deterministic processes need short term planning and optimization. Therefore Advanced Planning Systems are always required. Only in those cases where the processes are totally deterministic and lead times for example are not dependent on the utilization ERP alone will suffice. The use of ERP systems to plan processes on a longer than short-term basis makes only sense for deterministic processes. For planning capacity of non-deterministic processes ERP systems are not suitable, because they are not able to disaggregate their estimates to individual patient characteristics. However, they are also not needed. A planning tool to forecast the needed aggregate capacity would suffice.

A hospital considering the development and implementation of an ERP system should realize that an ERP system could also be used to create and maintain a common database containing all diagnostic and treatment procedures. This database can be used for standardization purposes and for enabling process redesign. In industrial applications these procedures are based on best practices. In healthcare this is equivalent with evidence-based medicine. Protocol information can be used for planning purposes. The protocol then functions as a kind of BOR. The protocol information can also be made available to physicians and nurses via knowledge management systems.

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