

Advanced services in hospital logistics in the German health service sector

Johannes Kriegel · Franziska Jehle ·
Marcel Dieck · Patricia Mallory

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Abstract Decision-makers in hospital management are currently facing the challenge of improving hospital services with respect to the equity, efficiency, costs and quality of health care. This entails ensuring that the required resources are available at each point of care while taking qualitative and economic criteria into consideration. Hospital decision-makers have certain priorities regarding the supply of resources to the different departments of a hospital, and the question is as follows: What are the developmental options to expand the current capabilities of the hospital contract logistics service providers on the basis of the priorities of the decision-makers in the German hospital sector? Therefore, it is necessary to identify the different needs and perspectives of the hospital, the management and the health professionals. Additionally, factors important for the design of supply chains provided by external contractors need to be identified and possible further developments described. Structured interviews with German hospital management and logistics service providers were carried

out as part of a long-term study from 2004 to 2010. The demands, aims and strategies of both the providers and customers were a particular focus. It was found that the wide range of different goods supplied and the various hospital objectives require different varieties of logistics services design. It also became clear that particularly logistics fields seen by the management as having middle-to-low priority are contracted out. At the same time, external contracted logistics service providers also strive to offer a wide range of comprehensive services.

Keywords Hospital logistics · Medical devices · Customer oriented contract logistic services · German health service

1 Introduction and problem statement

Hospital logistics are at present characterised by a high level of division of labour, non-standard processes and a lack of relevant information [36]. But not only do the cost-intensive acute medical- and patient-related sectors need optimal supply services, the health professionals working at the points of care also have to be supplied with the resources they need (e.g. patients, staff, information, medical devices, medical products and medicines). However, the opportunities for improvement offered by different models and approaches in logistics are currently not used to the full extent. In particular, contract logistics services to hospitals could be further developed and adapted to improve flexibility, quality and costs [2]. Hospital contract logistics services include the planning, implementation and control of a logistics system provided through a third-party logistics provider under a contract. The particular challenge here is to design services for each

J. Kriegel (✉) · P. Mallory
Fakultät Gesundheit und Soziales,
FH Oberösterreich, Linz, Austria
e-mail: johannes.kriegel@fh-linz.at

F. Jehle
Fraunhofer Arbeitsgruppe für Supply Chain Services (SCS),
Fraunhofer Institut Integrierte Schaltungen (IIS),
Nuremberg, Germany

M. Dieck
Hellmann Worldwide Logistics GmbH & Co. KG,
Osnabrück, Germany

sector and to consider the multitude of needs and wishes of health professionals and patients.

1.1 Change to a demand-oriented market in health services

The present health systems in the developed world are facing similar challenges, no matter whether they are publicly or privately funded. They all need to optimise their services to provide added value to the main goals of medical care as well as to improve the equity, efficiency, effectiveness, costs and quality of health care. The aim is to provide needs-oriented medical care for the patient [59]. Currently, the various health service systems, particularly in Europe, are attempting to redesign and improve their services, whereby three factors are decisive—firstly, the costs, secondly, customer needs, and thirdly, the quality of the services provided [55].

It is difficult to identify or provide a generally valid description of these factors owing to the overall lack of transparency and the government regulation of present-day health services. This makes it necessary to examine each factor according to the conditions applicable. The hospital supply sector is a complex domain of the health service system and has high material costs, needs much capital and lacks transparency concerning information and the quality of outcomes [8].

1.2 Hospital logistics in health care

This complex task of ensuring that the necessary resources and production factors are available at the point of care in hospitals is made possible by hospital logistics. Recently, different definitions and explanations have been found for hospital logistics which either transfer the classical transport—handling—storage approach of logistics to a hospital setting [21], or see the different forms of hospital logistics as a separate value and management field [41, 48, 57]. However, the different definitions overlap, particularly in the areas of procurement, materials and process management [26].

In its comprehensive meaning, hospital logistics includes order management and all the tasks involved in planning, execution and administering contracts and methods which lead to the goal-oriented flow of objects, values and information concerning the goods and services needed within the hospital [40]. This process ranges from the procurement of production factors, through their production and processing right up to distribution and waste management. The ‘objects’ in a hospital can either be people or goods. These two groups of objects can be further sub-divided according to various criteria (e.g. medical,

non-medical, visitors, patients, employees) and again into various logistics fields (e.g. medical device logistics, sterile goods logistics, catering logistics) [26] (Fig. 1).

1.3 Hospital logistics and supply chains in the German health care

A further dimension of the division of logistic services in hospitals is the differentiation between medical and nursing processes as the core processes and supporting processes which provide the relevant goods and services for the core processes to be carried out. These supporting processes can be patient focused (e.g. patient escort services), patient related (e.g. medical device supply chain) and patient remote (e.g. waste management) [25, p. 335]. The basic difference between the primary processes and the supporting processes is that the primary processes are carried out in value creation networks [53] and near the patients. In comparison, the supporting processes are carried out more or less near the patients in value creation chains [46, p. 86]. This differentiation between value creation networks and value creation chains allows various options for the administration and organisation of these processes to be used, for example, bundling, standardising and governance.

1.4 Customer needs and logistics perspectives for health services

To ensure efficient and effective supply chain services for and in hospitals, it is necessary to identify the specific needs and perspectives of the hospital, the management and the health professionals. Supply chain services are, in this connection, support and delivery services which enable the necessary production factors to be available as needed at the point of use. In a hospital, this means primarily the patients and health professionals, medical devices and goods as well as medicines. It is a characteristic of hospitals that various people can influence what the hospital requires—for example, various managers and professionals such as the heads of purchasing, consultants, health professionals, CEOs—all have their own preferences and therefore influence what is purchased and how this is organised. This means that there are numerous different interfaces to the supply market [11]. On the supply side, there is also a wide range of actors with different products and distribution channels, and these also follow their own individual aims and strategies [15].

Not only do the different perspectives of the customers and suppliers affect the supply chains, they are further influenced by the diverse demands in hospitals arising from the kinds of product, how the processes are set up, and, of

Fig. 1 Characteristics of hospital logistics [26, p. 119]

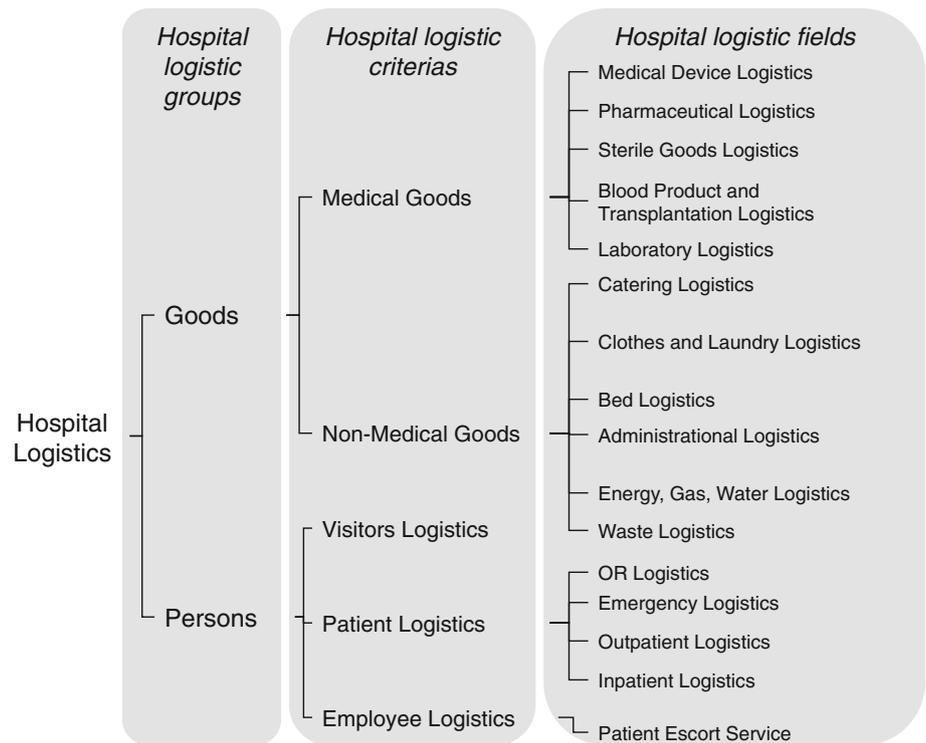


Table 1 Standardised questionnaire categories

Category	Number of Items	Items chosen
Basic information	5	Position of Interview partner Size of company Turnover
Logistics structure	21	Customers Suppliers Process design
Market situation	24	Legal conditions Competitive position Trends
Services concept	4	Range of services Customer segmentation Price Unique features
Logistics parameters	15	Number of health facilities supplied Delivery distance Frequency of deliveries Employees Warehouse capacity Additional services Information and communication technology used

course, economic considerations [5]. For the supplier, the design of the supply chain is affected by the different dimensions and characteristics of the extended marketing

mix [39]. On the customer side, the supply chain is determined by the goals of procurement and logistics—that the right product is in the right place at the right time for the right customer, in the right quantity, of the right quality and at the lowest cost [43]. In particular, in hospitals, other aspects play a role, such as the right ethical and emotional considerations, the right employees as suppliers and recipients and the right legal regulations must also be considered. This extended efficient consumer response (ECR) guideline illustrates the complexity of the task of organising the supply chain to provide the necessary resources in hospitals in general and for medical products and medical devices in particular. This focus on the special customer needs in health services is also found in the efficient healthcare consumer response (EHCR) approach [52]. To provide EHCR corresponding hospital logistics services, it is relevant to ensure first a wide range and second specific know-how towards offered hospital logistics services.

Today’s management and market participants on the hospital supply market in the German health service have to ask the question: What are the development options to expand the current capabilities of the hospital contract logistics service providers on the basis of the priorities of the decision-makers in the German hospital sector? It is necessary to examine the demands and priorities of hospital decision-makers on the one hand, and on the other to identify the different designs of external offered logistics services in German hospitals and compare them.

2 Methods

2.1 Priorities detection using a paired comparison matrix

A paired comparison matrix was used to find the individual priorities in the different fields of hospital logistics; however, general trends can also be identified with this method. The fields are individual to each hospital, and the relevant target values are evaluated by direct comparison of all possible pair characteristics [44]. Through the systematic comparison of all possible hospital logistic fields, intuitive paired comparison enables priorities to be found using qualitative criteria (because of the sum of the subjective values of a number of people) and quantitative criteria (because of the number of points received) [20, pp. 256]. The intuitive method of paired comparison and its use is very complex and time-consuming. Filling in the comparison form takes a lot of time and requires the participants to consider the subject area very carefully. [6, p. 228] An example of the matrix (Fig. 2) and the results (Fig. 3) of such a paired comparison of hospital logistics shows the different priorities of hospital decision-makers concerning the different hospital logistic fields.

Relevant fields for optimal hospital logistics were identified using a paired comparison form. In 2010, 120 management-level decision-makers (hospital managers, medical directors and heads of care services) in German hospitals were asked to participate in a written survey. They were asked to fill in a suitable paired comparison form where the different fields for optimal hospital logistics were shown in a paired comparison matrix. The participants were asked allocate points according to priority (more important = 2; the same = 1; less important = 0). Twenty-four participants completed the form (response rate 20 %). For each assessment, the relevant median of the 24 assessments was taken. As $n = 24$ is an even number, the arithmetic mean of both central values was used to define the median [24, p. 80].

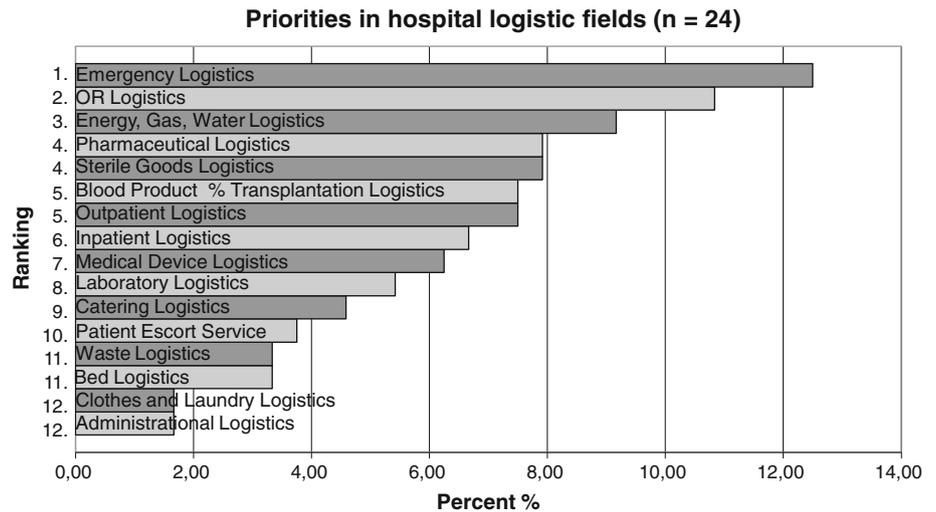
2.2 Long-term evaluation of different logistic designs

In order to gain an overview of the current market situation and to see the opportunities and risks for logistics services, a Fraunhofer study [27] of 26 (2004) and 17 (2008) different logistics service providers was used. These companies had been identified as active service providers to German hospitals through Internet research, participation

	Medical Device Logistics	Pharmaceutical Logistics	Sterile Goods Logistics	Blood & Transplantation Log.	Laboratory Logistics	Catering Logistics	Clothes and Laundry Log.	Bed Logistics	Administrational Logistics	Energy, Gas, Water Log.	Waste Logistics	OR Logistics	Emergency Logistics	Outpatient Logistics	Inpatient Logistics	Patient Escort Service		%	#
More important than = 2 Equivalent = 1 Subordinated = 0																			
Medical Device Logistics	■	1	0	0	1	1	2	2	2	0	2	0	0	1	1	2	15	6,25	7.
Pharmaceutical Logistics	1	■	1	1	1	2	2	2	2	1	2	0	0	1	1	2	19	7,92	4.
Sterile Goods Logistics	2	1	■	1	1	2	2	2	2	0	2	0	0	1	1	2	19	7,92	4.
Blood Product % Transplantation Log.	2	1	1	■	1	2	0	0	0	2	2	1	0	2	2	2	18	7,50	5.
Laboratory Logistics	1	1	1	1	■	1	2	2	2	0	0	0	0	0	0	2	13	5,42	8.
Catering Logistics	1	0	0	0	1	■	2	1	2	0	2	0	0	1	1	0	11	4,58	9.
Clothes and Laundry Logistics	0	0	0	2	0	0	■	0	1	0	0	0	0	0	0	1	4	1,67	12.
Bed Logistics	0	0	0	2	0	1	2	■	1	0	1	0	0	0	1	0	8	3,33	11.
Administrational Logistics	0	0	0	2	0	0	1	1	■	0	0	0	0	0	0	0	4	1,67	12.
Energy, Gas, Water Logistics	2	1	2	0	2	2	2	2	2	■	2	1	0	1	1	2	22	9,17	3.
Waste Logistics	0	0	0	0	2	0	2	1	2	0	■	0	0	0	0	1	8	3,33	11.
Operation Room Logistics	2	2	2	1	2	2	2	2	2	1	2	■	0	2	2	2	26	10,83	2.
Emergency Logistics	2	2	2	2	2	2	2	2	2	2	2	2	■	2	2	2	30	12,50	1.
Outpatient Logistics	1	1	1	0	2	1	2	2	2	1	2	0	0	■	1	2	18	7,50	5.
Inpatient Logistics	1	1	1	0	2	1	2	1	2	1	2	0	0	1	■	1	16	6,67	6.
Patient Escort Service	0	0	0	0	0	2	1	2	2	0	1	0	0	0	1	■	9	3,75	10.

Fig. 2 Paired comparison matrix in hospital logistics

Fig. 3 Priorities in hospital logistic fields



in conferences and consulting projects, and market knowledge. The survey was carried out using a standard questionnaire which had previously been designed and tested by Fraunhofer SCS. It was carried out in 2004 and 2008 both electronically and by telephone. Data was also collected from the home pages of each company and by the comprehensive literature research.

The standardised questionnaire consisted of 5 categories (basic information, logistics structures, market position, service design and logistics parameters) which were collected using closed and open questions/items. The survey of specialists in 2004 was preceded by a pre-test in December 2003 with the market leader which led to a complete redesign of the questionnaire. In 2004, this redesigned instrument was used to survey 15 further specialists and the category ‘logistics parameters’ was added. In 2008, the survey was repeated in the form of an outline also containing 5 categories (Table 1).

3 Results

3.1 Priorities of the decision-makers in hospitals

It is possible to compare the different fields of hospital logistics systematically with each other. The paired comparison matrix serves here to structure and prioritise, as the different fields do not follow each other, but are simultaneously set opposite each other. The ranking of each hospital logistic field is given by the sum of the subjective evaluation along each row. For example, if one compares the importance of medical product logistics in hospitals to the importance of pharmaceutical logistics (1), to sterile goods (0), blood and transplant logistics (0), laboratory logistics (1), food and catering logistics (1), laundry and clothing logistics (2), bed logistics (2), business and

administration logistics (2), energy/gas/water logistics (0), waste logistics (2), operation room logistics (0), emergency logistics (0), outpatient logistics (1), in-patient logistics (1) and patient escort/transport services (2), there is a sum of 15 points. In comparison with other hospital logistic fields, it has a middle ranking of 7.

It becomes evident that particularly acute medical, patient-focused and cost-intensive domains of primary services are the main interest of decision-makers when considering hospital logistics. Such a result cannot be the sole basis for decisions on the strategic planning of hospital logistics, but it gives a hint or a trend for final decision-making. Particularly, the patients’ perspective should also be considered (e.g. through quantitative indicators, such as waiting times, or qualitative, such as patient satisfaction) [29].

With this ranking as a basis, it seems useful to look at how the various hospital logistic fields are contracted out by the hospitals and consequently examine the design of external logistics services to the German health services.

3.2 Design options for logistics services in hospitals

The results of the paired comparisons emphasise the importance of the patient-focused and acute medical sectors of primary care services in hospitals (e.g. emergency logistics, operation logistics) for the hospital decision-makers. The primary processes focus on value creation for medical care and services to the patient as a customer. This involves basically the sequence of case history, diagnosis, therapy and care which are all accompanied by the activities communication, co-ordination and decision-making [46, p. 80]. These primary service and business processes are borne by various patient-focused, patient-related and patient-remote support processes. Patient-focused support processes are those activities which have directly to do

with the patient or require the patient's participation, although they do not actually cure or relieve the patient's ailment [25]. These activities do not receive a very high ranking. Patient escort services, catering and laundry services are such processes. Nevertheless, these non-medical, non-care services are important because they greatly influence how the patient views the quality of the hospital services (e.g. as a hotel, particularly concerning the condition and accessibility of the sanitary facilities, whether they are shared, if the rooms are clean, the media, the opportunities for pastimes) [12, 37].

As well as the patient-related services, there are many patient-related or patient-remote activities which have a considerable effect on the quality of care the patient receives. These logistical processes should also be offered and provided at optimal cost and service oriented. Examples of these activities, which are essential for the immediate care of the patient, are laboratory logistics, pharmaceutical logistics and medical device logistics. Further from the patient and the primary services, there are the patient-remote processes, on which the primary services do not directly depend (emergency care can take place without management processes). However, maintaining hospital activities such as finance, administration and organisation is not possible without these remote processes. Management and waste disposal processes are examples of these [25, p. 335].

3.3 Contract logistics in the hospital services

Several trends can be seen in current supply chain configuration development across industries. First, there is the vertical and horizontal integration of market and supply chain actors [32, pp. 8]. This also includes the integration of intermediary logistics service providers (3PL-/4PL) [17, p. 10]. These logistics service providers act independently of manufacturers and offer a wider range of different services. There is also a tendency for these contract logistics service providers to expand regionally and enter new markets [23, pp. 281]. Additionally, the actors who are already on the market or who are acting within existing supply chains attempt to optimise these. These attempts are often supported by a more intensive use of information technology (e.g. auto ID) [1, p. 53] or by setting up cross-company networks and supply chain co-operations [50, p. 531].

Supply chain management can be defined as a range of different approaches to integrating suppliers efficiently. The aim is to have goods made and distributed according to ECR principles so that the costs can be minimised throughout the whole system and customers and service level requirements can be satisfied [49]. The supply chain management approach for hospitals, which integrates

external and internal logistics, is currently only partly established in the German hospital system. A study carried out by Fraunhofer SCS found out that only 12 % of hospital beds are supplied by an external logistics service provider in the course of extensive contract services [27, p. 11]. This is extraordinary, because hospitals, especially smaller ones, lack the necessary know-how, the capacity and the critical logistics dimensions to organise logistics departments efficiently and effectively. Supply chain management aims to provide a maximum level of service for the lowest cost and a high level of interaction between the actors involved. This philosophy requires a change to closer interaction and long-term partnership agreements to ensure highly competitive supply chains [9, 54, p. 29].

It is generally assumed that increased collaboration between supply chain participants will have a positive impact on overall costs and improved service performance. Ideally, the collaboration will begin with the end-customer-requirements and include the various internal and external departments and stakeholders in the supply chain. However, the integration of both internal (intra-organisational) and external (inter-organisational) is required for this [56, p. 358].

The study carried out by Fraunhofer SCS was able to identify current business models and customer needs, for example, the range of products, ownership, commissioning, depth of added value and billing options. External hospital logistics focuses currently on medical device supply. In 2008, all of the 17 contract logistics providers dealt with medical devices, 16 with office supplies, 11 with implants, 11 with stoma equipment, 12 with laboratory equipment, 8 with pharmaceuticals, 5 with chemotherapeutic agents, 8 with technical equipment and 7 with sterile goods [27, p. 78].

Currently, the sections of medical device logistics (e.g. implants logistics, catheter kit logistics) exhibit different features. Hospital employees already spend more than 20 % of their time on logistical work [3]. On average, they have to manage between 2,000 and 6,000 medical products from up to 600 suppliers [27, p. 30]. Contract logistics is concentrated mostly on small hospitals and has only about 10 % market coverage. Furthermore, only about 20 % of the hospitals supplied by regional logistics centre use an external supplier (free cabinet). In the light of the increasing pressure on services and costs, it can be expected that particularly materials and logistics will play a decisive role for the development of the health services and ability of hospitals to survive. Particularly here, it is estimated that there is the potential to reduce costs by between 0.5 and 1.1 billion Euros, or 1,000 and 2,000 Euros per bed by making hospital logistics more efficient. As well as the usual outsourcing of laundry, catering, cleaning and technical services, hospitals are reducing their costs further by outsourcing medical product supplies (pharmaceuticals and medical devices) and office/business supplies [28, p. 38].

4 Discussion

4.1 Designing supply chain logistics services for hospitals according to customer needs

The results of the study make it clear that on the one hand, the present supply chain services to German hospitals primarily involve hospital logistic fields which have a middle-to-low ranking in priority from the point of view of hospital decision-makers. On the other, it shows that the external service providers are concentrating more on offering comprehensive contract services. This is in contrast to the past, when market entry was sought and found by building up relationships with individual customers through the classic transport, turnover and warehousing services. It can be supposed that through long-term cooperation in contracted logistics services, the range of services supplied externally will increase [60]. In hospital supply chain logistics, this would mean that more highly ranked hospital logistic fields (e.g. pharmaceuticals, sterile goods) would be outsourced.

Next to the emergency logistics and operating room logistics, the current focus of internal logistic solutions in the German hospital system is on the hospital logistics fields: inpatient logistics, laboratory logistics, patient escort services, bed logistics, waste logistics and administrative logistics [26]. In addition, the hospital logistics sector is characterised by a number of external specialists that have a particular expertise towards the respective logistic objects (e.g. catering, laundry logistics, energy logistics) [13, 22, 41]. In contrast, the focus of contract logistics service providers in the hospital system is among others in the fields of medical device logistics, laboratory logistics and administrative logistics [26]. Starting from the premise that the decision-makers in German hospitals are currently and in the future mainly focused on their core competencies, they will increasingly outsource secondary and tertiary services. This will create an extended range of services of contract logistics service providers in the German hospital sector (see Table 2), which can be offered and provided. Furthermore, it will lead to a bundling of previously separated parts of the hospital logistic fields. In addition, various functions such as procurement, facilities management and quality management will be united under a comprehensive contract logistics service.

4.2 Conceptual service engineering in hospital supply chain services

As hospital supply chain design has been unsatisfactory up to now, it will be necessary to design new concepts starting from point of care needs. This new service development should be based on the problem solving cycle and

Deming's Plan-Do-Check-Act cycle [10]. This must include the following steps (1) current state analysis, (2) identification and analysis of requirements, (3) organisational optimisation (4), technological support (5), economic assessment (6) prototype implementation and finally (7) market launch. The aim is for good or best practice and thus to develop the next practical solutions for the design of supply chains in hospitals. This should be done against the background of conceptual new service development [51].

4.3 Quality and cost benefits through hospital logistics services in hospitals

From the hospital point of view, hospital logistics services to the point of use or point of care should be reliable, flexible, economic and of good quality. Today's challenges and the future use of current chances and risks in hospital logistics will have a considerable effect on the competitive position of hospitals in the future. Externally contracted hospital logistics services hold the following opportunities and risks [27, p. 11]:

- At present, few hospital logistics processes are standardised or visible.
- Fewer than 12 % of all hospitals are supplied by regional decentralised logistics centres.
- The increasing number of regional hospital subsidiaries, which enjoy a higher level of confidence in comparison with other contracted supply services.
- The reduction in length of stay in hospitals through the DRG standard payment system produces an increasing demand for cost-efficient transparency (e.g. through cost-unit accounting).
- There is an increasing development of long-term relationships which have a great need for financial investment.
- In particular, hospitals with fewer than 400 beds are increasingly prepared to enter into contracts with regional decentralised logistics centres.
- Hospitals are becoming more prepared to optimise their procurement and logistics departments.
- In future, more of the patient-related and priority fields of hospital logistics services (pharmaceuticals, sterile goods) will be outsourced.
- In order to offer an extended spectrum of logistic service solutions, contract logistics service providers will be increasingly competitors to the current external specialists.

A number of aspects will therefore have to be considered in the design of hospital supply chains in future. Firstly, more customer orientation is needed, and there is also a demand for it. Secondly, innovative information technology should be used to provide more transparency and better

Table 2 Main logistic service providers in the different hospital logistics fields

Hospital logistics fields	# Priorities	Current internal logistic solutions	Current external logistic solutions by specialists	Current logistic service solutions by contract logistics service providers [27]	Development potential for an extended spectrum of logistic service solutions by contract logistics service providers
Emergency logistics	1	X [58]			
Operation room logistics	2	X [38, 47]			
Energy, gas, water logistics	3		X [14, 34]		X
Pharmaceutical logistics	4		X [35]	X	
Sterile goods logistics	4		X [22]	X	
Blood product/ transplantation log	5		X [33]		
Outpatient logistics	5		X [31]		X
Inpatient logistics	6	X [30]			X
Medical device logistics	7			X	
Laboratory logistics	8	X [42]		X	
Catering logistics	9		X [13]		X
Patient escort service	10	X [16]			X
Bed logistics	11	X [57]			X
Waste logistics	11	X [45]			X
Clothes and laundry logistics	12		X [19]		X
Administrational logistics	12	X [57]		X	

knowledge management. The design and improvement of overlapping processes in the supply chain will also promote market growth [4, 7]. As there is more pressure on hospitals because of costs and competition, there will be an increase in services provided through third- and fourth-party logistics providers (3PL and 4PL), whether these providers are connected to manufacturers and other hospitals or not. More cross-organisational supply chain collaborations (e.g. vertical or horizontal integration, including brand images) will be established which will have effects on scale and size or create brand images [18]. Finally, it is obvious that there is no single good or best solution for hospital supply chains because of the product-specific requirements and the different set-ups. Nevertheless, the logistics service providers will be able to fulfil the requirements of their customers and satisfy the expectations of the hospitals and their decision-makers as well as provide competitive logistics services.

4.4 Resource availability at the point of care

The primary processes determine the quality of service required for the supporting services. Therefore, the requirement criteria of the secondary processes are quality, time, flexibility and economy towards the provision at the point of care [22, p. 39]. To ensure the needs-oriented availability of production factors at the point of care, the supporting processes must be carefully aligned with the primary processes. This means standardising, steering and evaluating these processes according to the criteria of

quality, time and economy. There must be an adjustment and alignment of the customer needs in the pull strategy of the service recipient with the modular and standardised services offered by the provider of hospital logistics services. Particularly when services are contracted out, this makes great demands on the parties involved concerning communication, interface management and transparency of information. These special demands should be identified and addressed when designing advanced services in hospital logistics.

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