Evaluation of Automatic Identification Technologies (Auto-ID) to be Implemented in the Health Care Sector

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Abstract. The tasks and objectives of automatic identification (Auto-ID) are to provide information on goods and products. It has already been established for years in the areas of logistics and trading and can no longer be ignored by the German health care sector [3, 9]. Some German hospitals have already discovered the capabilities of Auto-ID. Improvements in quality, safety and reductions in risk, cost and time are aspects and areas where improvements are achievable. Privacy protection, legal restraints, and the personal rights of patients and staff members are just a few aspects which make the heath care sector a sensible field for the implementation of Auto-ID [4]. Auto-ID in this context contains the different technologies, methods and products for the registration, provision and storage of relevant data [6] With the help of a quantifiable and science-based evaluation, an answer is sought as to which Auto-ID has the highest capability to be implemented in health care business.

1 Introduction

The German health care system can be devided into three main branches [13]:

− Ambulatory Treatment, assured by 43'000 medical practitioners

− Clinical Treatment, assured by 2'200 hospitals and

− Post-operative Treatment, assured by 1'400 rehabilitation centres.

It is financed by the compulsory health insurance and not like in the USA by an optional health insurance [10]. With health services assured through the insurance system, current demographic changes are resulting in a steadily increasing demand for medical and nursing care.

Cost pressure, reforms and quality requirements are three keywords which are mentioned in the current debate about German health care. The financial framework of health care in the Federal Republic of Germany is at its limits [8].

Most of the 2'200 German hospitals are community owned and regulated by public law. These hospitals are in competition with an increasing number of privately financed hospitals. For the regulated hospitals it is difficult to make big financial investments within the normal budget. The IT budget is regulated for one year and

includes e.g. labour costs, IT maintenance and small investments in hard- and soft-ware. Large IT projects can hardly be implemented by regulated hospitals without additional external financial support [3]. In accordance with a survey by McKinsey & Company, a quarter of German hospitals won't be able to hold out against cost pressure and will have to close by the year 2020 [10]. For the affected hospitals it is necessary to develop concepts and reforms to save costs and to work more efficiently. As it has in the fields of logistics and trading, Auto-ID can become an important component for the solution of operational planning and optimization of processes in health care, with the resulting cost reductions [11]. Primarily, Auto-ID can be help to optimize and support the business processes in the medical and non-medical areas of a hospital [7]. Nurses and doctors will be freed from avoidable and time-consuming activities - there will be more time for patients. For example nurses are wasting 30% of their time by organising their workflow and 40% with administrative duties, so that the time for patient care is reduced to 8 minutes per patient and day [10].

Currently, various technologies are coming into operation. Wireless Local Area Network (WLAN) is already firmly established in German hospitals. Other systems are still at the trial stage, such as Radio Frequency Identification (RFID) as a procedure for automatic identification (Auto-ID).

2 Goals of this Study

The evaluation of Auto-ID shows a professional approach to structured, rational selection and procurement of a system in accordance with the requirements of the health care sector. Various Auto-ID procedures are evaluated on the basis of health care requirements and their resulting use criteria. The requirements definition is based on practical experiences of the author and personal interviews with Chief Technology Officers (CTO) of six German hospitals with experience in the implementation of Auto-ID in different business contexts. Their experiences have been very different. Some implementations had the status of fundamental research in small, autonomous environments and others are funded by Auto-ID producers so that a clear consideration of costs and needs cannot be made. The focus of this work is a general list of requirements and makes no claim to be complete. The list will need adaption to a concrete business context in a hospital. The aim, after the evaluation process, is to make a valid and objective statement regarding which procedures are appropriate for application in the health care sector.

3 Scientific Approach and Automatic Identification (Auto-ID) Technologies Analysed

The following approach to evaluation was executed [12]:

1. Defining requirements. A structured catalogue with wishes and demands on the Auto-ID was created with the help of the operating and IT department of the hospital. If necessary additional expert knowledge can help to channel

the requirements process. The operating department uses relevant medical knowledge about the internal processes of the hospital or department where the Auto-ID should be implemented. The IT department is responsible for the technical input and uses knowledge for example in the fields of systems integration, project management or functional range of medical equipment.

2. Establishing criteria. Based on the defined requirements for the Auto-ID, a list of criteria was created. The different criteria are grouped into levels which contain on the lowest level qualified and measureable questions with clear origin which can be answered by the responsible department members. For a rational and objective execution of the evaluation the criteria will be weighted.

3. Benefit analysis. The collected detailed information for every technology is the basis on which every criterion is evaluated in terms of their degree of performance [12].

4. Conclusion. Based on the result of the benefit analysis a concrete proposal was developed. The selected Auto-ID has the optimal capability of being implemented in health care in terms of the weighted criteria. The single Auto-ID technology with the highest value in the benefit analysis is not necessarily the exclusive optimal proposal. Under certain circumstances it can be reasonable that two or more Auto-ID technologies can be combined.

3.1 Fields of Application and Requirements to Auto-ID in the Health Care Sector

The motivation to implement Auto-ID in heath care business ranges from marketing purposes and advancement of clinical pathways to automatisation of clinical business processes [3]. The following scenarios have a deep impact on the functional range of the technology and shows that field of application for using Auto-ID in German health care may be different [5], [9]. This list of scenarios may not be complete, but it provides an understanding of the different fields of application in health care business for the reader. E.g.

− Documentation support in patient treatment processes

− Automation of staff authentication processes

− Completely transparent supply chain process (inventory management)

− Patient identification and location assistance to ensure patient safety (patient tracking and prevention of baby theft.

− Control of cleaning intervals of medical devices

− Optimisation in terms of finding the right clinical assets at the right time (asset tracking)

– Control of temperature throughout blood supply chain (Auto-ID in combination with sensors)

Process engineering/Process control means the logistics business processes in a hospital, such as inventory control, with mechanisms for automatic tracking of goods or medical products.

The documentation of time, date and cleaner of medical equipment which was used, for example, in a surgery, is regulated by law and statutory regulations. Authorisation and documentation processes supported by Auto-ID can help to make these standard processes easier to handle by combining them with authentication mechanism [9]. The result is a fully automated and paperless process.

Tracking in the health care business initiated a public dispute in Germany. The technology tells us what asset is in which room or part of the building at what time. The result is that valuable time previously spent searching for an asset can be reduced or even eliminated [9]. But data protection officers objected that tracking a patient or a staff member is an intrusion into privacy which cannot be tolerated by law.

Auto-ID can help to control the 'viability' of a patient. If the Auto-ID systems register a value below or above a defined reference value, for example, a message will be sent automatically by mobile phone to the next emergency department. Another possibility is the combination of Auto-ID with a sensor system, which controls the temperature throughout the supply chain of a blood bottle [9].

Depending on the scenario in which Auto-ID will be implemented, the requirements on the functional range differs. The following list of questions gives the reader an understanding of the defined requirements on Auto-ID but may not be complete.

– How can Auto-ID hardware be affixed to medical equipment?

– Is the Auto-ID equipment resistant to water, temperature and chemical substances in medical treatment processes?

– Are there ways to integrate the technology into the existing hospital information systems (HIS) via HL-7 or CORBAmed interfaces?

– How safely can personal data be handled (Security features)?

– How does the Auto-ID fulfil the requirements for fire protection in the health care sector?

– What is the maximum data rate and what data volume can be handled by the technology?

– How can be guaranteed that the data is valid, persistent reliable and available?

3.2 Auto-ID Analysed

Auto-ID contains the different technologies, methods and products for the registration, provision and storage of relevant data [6]. Auto-ID can play a part in the im-

provement of processes in health care business. With the help of real-time processing and automatic stock detection, for example in the supply chain, and with its ability to trace goods, the efficiency of a hospital can be sustainably impoved [4].

The following Auto-ID technologies were the basis for the evaluation [6], (Fig. 1):

− Bar Code

− Optical Character Recognition (OCR)

− Chip Card

− Biometric Methods

− RFID

A distinction is drawn between four basic principles [2]:

− Mechanical and electromechanical identification systems, which use mechanical components like pins as binary storage. They are based on capacitive and inductive mechanisms for scanning.

− Magnetic identification systems, which use magnetic fields e.g. of permanent magnet (magnetic card) as storage. They require small distances for accurate scanning.

− Opto-electronical identification systems, which are able to detect the shape of an item or markings like colours, OCR or bar code.

− Electromagnetic identification systems, which use inductive waves for a touchless carrier of information. They use electrically programmable microchips to store data.

Biometric methods are additionally separated into iris identification, fingerprint and voice identification. The detailed description of every Auto-ID is left out and can be gleaned at Finkenzeller [6].
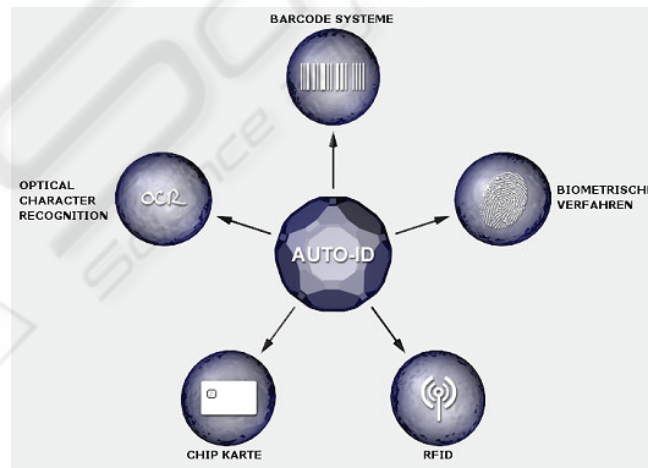

Fig. 1. Defined Auto-ID technologies [6].

4 Established Criteria and Benefit Analysis

4.1 Established Criteria

To provide an efficient way of using the list of criteria from both, the IT department and the operating department of the hospital, the collected wishes and demands are assigned to four criteria levels (level 1 - 4). The highest level (level 1) is divided into the following and aggregates the lower criteria (Fig. 2):

− Functional range

− Systems integration

− Health care

− General criteria

The criteria in these categories are not directly measureable or rateable and have to be separated into detailed subcriteria (level 2 & 3), (Fig. 2). Level 4 deals with quantifiable questions, measureable by the department members and relating to the requirements in the systems specification [12]. By defining one category just for the requirements of heath care we focus on the aim of finding a valid Auto-ID which is appropriate for application to the health care sector specifically.
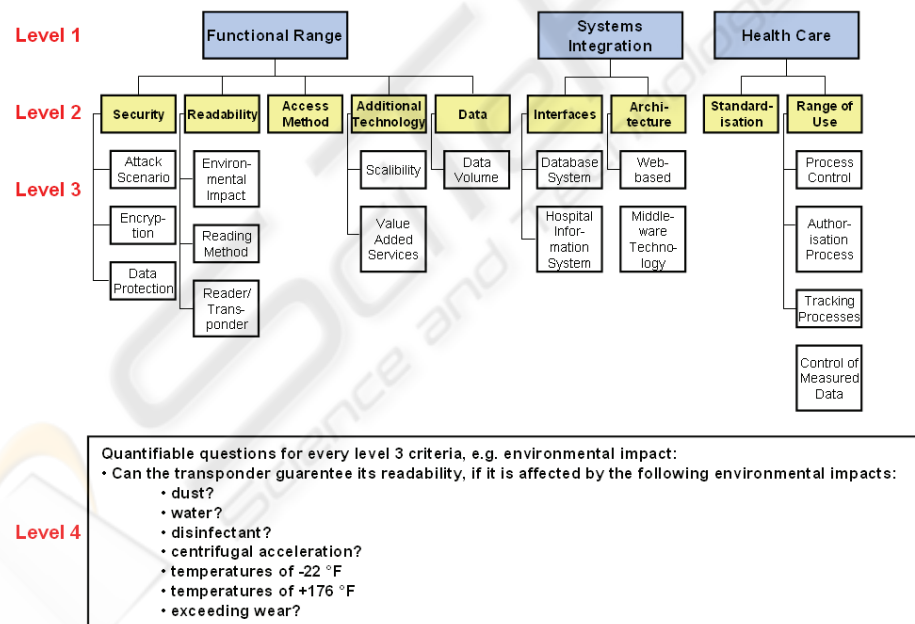

Fig. 2. Level 1, 2, 3 & 4 of the established criteria for Functional range, Systems integration and Health care.

The general criteria are consciously left out of this consideration. This criteria level deals e.g. with general information about cost for the Auto-ID technology (hard & software) and support or criteria concerning the know-how of the producer in the health care sector.

4.2 Benefit Analysis

The method of the paired comparison was used to give a valid weighting on every criterion (table 1). It was used for levels one to three (level 1 - 3). Table 1 shows the paired comparison carried out for the first level. Every sum of the comparison between two criteria has the result 10. In this example the 'general criteria' are less important (expresses by '1') than criteria concerning 'heath care' (expressed by '9'). In this evaluation, the significance of the criterion 'heath care' can be seen (42%). The score in this category is influenced by the ability of the Auto-ID process to live up to context-specific expectations and its ease of integration into existing infrastructure. The weighing of the criteria was made by the author. It should be mentioned that no concrete project with predefined requirements has been the basis for the weighing decisions and the result of the paired comparison is just valid for this work and has to be reviewed and adapted if the requirements and the field where the project takes place should change. It is possible if the evaluation takes place in another context, for example when Auto-ID should be implemented in an existing environment in a hospital the criteria of 'systems integration' should get more emphasis.

Table 1. Result of the paired comparison for the first level (level 1).

Criteria (Level 1)	1 Functional Range	2 Systems Integration	3 Health Care	4 General Criteria	Points (absolute)	Relative weight %
1 Functional Range		5	2	7	14	23
2 Systems Integration	5		2	7	14	23
3 Health Care	8	8		9	25	42
4 General Criteria	3	3	1		7	12
Sum (absolute)					60	100

The second step, after carrying out the paired comparison, is to calculate the value of benefit. In this calculation, the weight of a level obviously determines the influence of the next level down. This method guarantees that all relevant criteria are rated and aggregated to the level above. The detailed description of this method is left out and can be gleaned at Schreiber [12].

5 Conclusions

The conclusion presents an interpretation of the most important results of the evaluation and makes no claim to be complete.

The aim of the evaluation was to find a valid statement as to which procedure, in accordance with requirements, is appropriate for application to the health care sector. RFID shows the highest benefit value in every aggregated level of achievement on level 1 and has good potential to place lasting emphasis on clinical processes and pathways (Fig. 3).
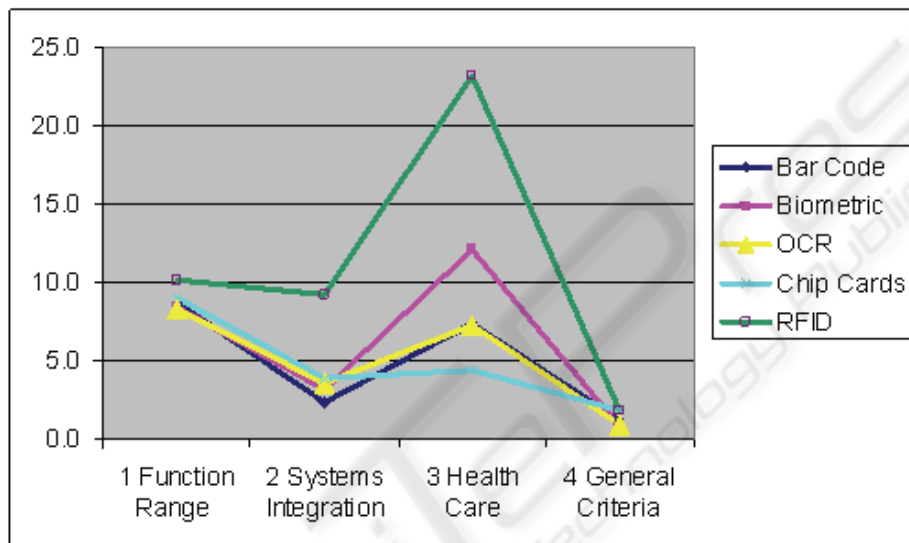

Fig. 3. Conclusion of the evaluation (Level 1).

It became clear that for a concrete project a new arrangement of the weightings has to be devised to cover all relevant project requirements as well as the context in which the project is to be implemented in the hospital. But the evaluation showed as well that it is not possible to make a single statement as to which method is the most useful for every field of application in the health care sector and should generally be implemented. If we take a look at level 2, RFID in authorisation (security and data) processes is not the only useful solution (Fig. 4). Biometic methods have the highest benefit value in these fields. Based on this awareness a useful combination of two methods - RFID and biometric methods - could guarantee a holistically successful, sustainable and well-accepted project in health care. The developed list of criteria is an important orientation guide for decision making but has to be reengineered if the requirements are changed.
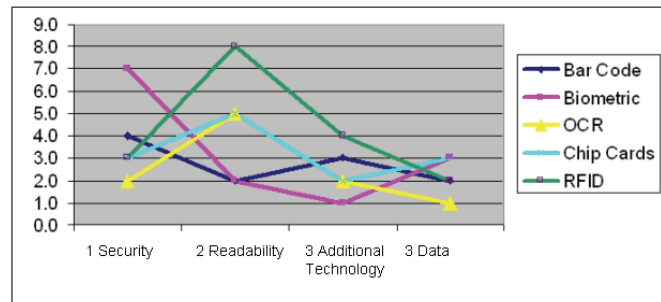
Fig. 4. Conclusion of the evaluation (Level 2).

If we take a look at level 3 - RFID has by far the highest impact in the field of applications for controlling measurable data and tracking items (Fig. 5). If the field of application 'Process control' is concerned, the bar code has nearly the same impact and can have a lasting effect in areas of logistics in a hospital. That result shows that RFID keeps its relevance for the area of logistics as well for the health care business.
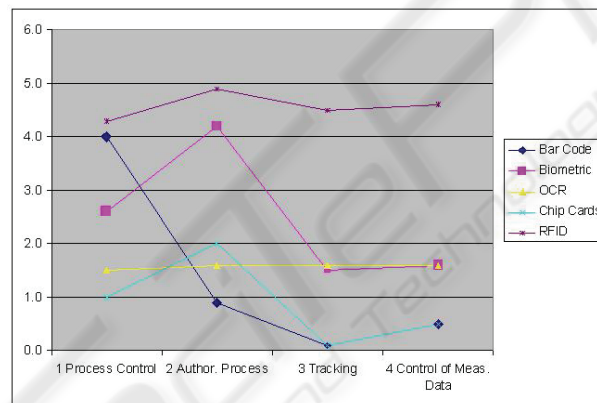

Fig. 5. Conclusion of the evaluation (Level 3).

The evaluation showed that RFID offers significant benefit potential in terms of supporting quality processes and saving money and time. It is not, however, a technical view on RFID. It should be treated as an instrument to accelerate administrative and clinical business processes and to design them in a more efficient way.

Most of the German health care institutions implementing RFID projects have the status of "early adopters". This denomination will soon no longer be applicable, as German hospitals are forced to make their services more attractive to patients. The increase of cost pressure in the health care system leads managers to lay more emphasis on return on invest (ROI) and repayment strategies. Processes have to be optimised so that costs can be saved. In this regard RFID can play an important role.

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