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**Abstract**
*In 2012, an audit held by the Netherlands Institute for Accreditation in Healthcare (NIAZ) at the 'Rivierenland' hospital in The Netherlands, concluded that their processes were not sufficiently standardised. One of the suggested improvements was to develop and implement a hospital-wide method for analysing and standardising care processes. This paper focuses on the standardisation of the risk screening process, which is used to assess a number of patient risk factors prior to treatments or hospital admissions. By separating the decision logic of the risk screening processes into a set of business rules, the screening process was standardised to be identical for each risk factor. This allows for the decision logic and the process to be changed independently of each other. Additional business rules were introduced to serve as constraints, thereby limiting the number of performed screening processes depending on the age of the patient and the duration of the treatment or admission. Based on historical data from the year 2013, a retrospective analysis demonstrated potential time savings of around 1600 hours on a yearly basis thanks to the introduction of the new standardised process incorporating business rules. Similar standardisation methods may be useful to other hospitals facing increasingly stringent demands for quality, safety and efficiency.*
**Keywords:** Healthcare, business process management, standardisation, risk screening, business rules

# 1 Introduction

In The Netherlands, reforms in the healthcare sector are increasing pressure on healthcare providers to provide high quality care in a decentralized and competitive market (Øvretveit, 2000). The variety of specializations and therapies is on the rise, while patients demand higher quality services and shorter waiting times. In response to requirements imposed by the government and accreditation bodies, hospitals must be able demonstrate transparency in the safety and quality of their healthcare processes (Government of The Netherlands, 2012). Adequate process management is included in current accreditation frameworks for the Dutch hospital sector (Netherlands

Institute for Accreditation in Healthcare, 2013). International accreditation bodies such as the Joint Commission International (JCI) take an even more rigorous approach by demanding continuous process improvement for ensuring patient safety and efficient, standardised healthcare.

To transform into process-driven organisations, hospitals must continuously adapt and improve processes according to market demands. Information systems needed to support these processes are found to be relatively underdeveloped when compared to other sectors (Helfert, 2009), particularly in terms of low technological sophistication and integration sophistication (Paré & Sicotte, 2001). However, technology itself cannot provide a solution without taking the process into account (Jaana, Tamim, Paré, & Teitelbaum, 2011). The Rivierenland hospital studied in this paper was struggling with a similar situation. In 2012, the hospital's accreditation by the NIAZ (The Dutch institute for accreditation in healthcare) was extended, but a critical note in the accreditation report was that the hospital's processes were not sufficiently standardised. Some of the necessary technology to support the processes, such as a business rules engine, were already available but not utilised due to a lack of a process-driven approach.

While an accreditation by NIAZ is not legally required to be able to provide care in The Netherlands, it serves as a mark of quality for healthcare providers and may be demanded by insurers. Accreditations are granted for a period of four years, after which a new accreditation is performed. At the Rivierenland, processes and their related activities were described in different formats and there was a lack of coherence between processes. One of the improvements suggested by the accreditation body was the analysis and standardisation of these processes.

The hospital's primary process is the examination and treatment of patients. One of the first activities performed when a patient is admitted is risk screening. Patients may be exposed to a number of risks, both during admission and treatment. For example, A patient lying still in a bed for too long may develop decubitus (pressure ulcers). If a patient is found to be at high risk for developing decubitus, measures are taken such as frequent repositioning of the patient or the installation of a special mattress. All activities related to the identification of risks, as well as the introduction of measurements to prevent these risks are labelled as the 'risk screening and prevention process'.

In this study, literature, documentation, interviews and observations are used to assess the current state of the risk screening and prevention process and to introduce a new and standardised process, which adheres to the quality requirements of the accreditation body. Potential time savings are expected, as a standardised process will lead to a more efficient execution of activities related to risk screening and prevention.

The next section describes literature studied to gather insight into process standardisation in healthcare. In section three the research approach is described followed by an overview of the standardized process with the use of business rules in section four. The possible efficiency gain is shown in section five. In the final section a conclusion and discussion are provided.

# 2 Literature Review

In order to identify which requirements and benefits are related to standardisation of processes in healthcare, a number of previous studies are reviewed. Standardisation has been applied with positive results in many different specialisations of healthcare. A study performed by Rozich et al. (2004) showed that the introduction of a standardised protocol for insulin administration in diabetes patients lead to a reduction in hypoglemic episodes from 2,95% to 1.1% over a period of 30 months, as well as a decrease in medication errors from 213 errors per 100 admissions to fewer than 50 per 100 admissions. The protocol was developed as a joint effort by various medical specialists, and includes a number of measurements such as the patient's weight and the number of insulin units the patient takes in one day. Based on this patient data, the amount of medication needed can be determined on a sliding scale. In essence, the protocol ensures that patients are treated according to an agreed-upon set of business rules. Rozich et al. (2004) posit that standardisation of this process lead to reduced complexity, increased safety and possible cost savings. They recommend similar efforts to be taken in other clinical areas.

A study by Arora & Johnson (2006) identified and standardised the hand-off process, which is concerned with care transitions such as patients going from one department of a hospital to another or shift changes of nurses. The hand-off process is critical to patient safety, as inadequate communication of patient information in care transitions may lead to the unintentional discontinuation of essential medication (Bell et al., 2011). Arora & Johnson (2006) show that the first step in standardising the process is identifying the process and its possible variations. By creating awareness, possible vulnerabilities can be detected and corrected. Building a standardised checklist was found to be instrumental in improving patient care.

In the aforementioned studies, the importance of an agreed-upon protocol is established. These protocols usually consist of a certain process or procedure, prescribing the order of activities to be performed. Additionally, checklists or measurements provide information needed to support decisions. This knowledge can also be described as a set of 'business rules'. A business rule is defined by Ross (2003) as "An atomic piece of re-usable business logic, specified declaratively". As per the Business Rules Group (2015), a business rule is "a statement that defines or constrains some aspect of the business. It is intended to assert business structure, or to control or influence the behaviour of the business." In the case of healthcare organizations, business rules are found to be present in deciding the type of medication given to a patient, for example.

Another motive for the use of Business Rules is flexibility. By separating the order of activities (the process sequence) from the knowledge needed to support decisions in the process, these can be changed independently to respond to internal or external demands (Spreeuwenberg, 2004). The process models are often modelled using UML activity diagrams or the Business Process Modelling Notation (BPMN) (Goedertier & Vanthienen, 2006). BPMN is a standard for modelling business processes in a graphical manner using a business process diagram. This is done to clarify the management of business processes and in such a way that it is both understandable for technical users and non-technical users (Weske, Hofstede, & van der Aalst, 2003; White, 2004). Both

BPMN and Business Rules will be used in this study to aid the standardisation of the risk screening process.

# 3 Approach

To assess the current situation concerning the execution and documentation of the risk screening process, different methods were used. The current documentation regarding the risk screening process was studied and a number of interviews and observations were conducted to assess how the process is executed in practice. While interviews provide insight into the experiences of the staff, observations will enhance our understanding by looking at what actually happens in the clinical setting (Fox, 1998)

The Rivierenland hospital stores its documentation on an intranet portal accessible to staff within the hospital. This portal hosts four types of documents that relate to the risk screening process, namely (1) process models, (2) standards of care, (3) decision trees and (4) care protocols. The standards of care are imposed by external in regard to certain quality standards to which the process must adhere. Care protocols are developed internally and provide a more detailed step-by-step description of procedures that must be taken in providing care. The risk screening process is subdivided into the risk factors decubitus, delirium, falling, malnutrition and physical disability. The researchers were granted access to this internal portal for the duration of this study.

To gather more information about the current (as is) situation within the hospital as well as the desired (to be) situation, interviews were held with staff from the quality management department. This provided further information on the boundaries within which the risk screening process must be executed as well as contacts with people in the workplace for our observations. The information provided by the quality management department serves as the guidelines to which the process must adhere. In addition, the quality management department provided historical data for the previous year, which were subsequently used for benchmarking and estimating the potential efficiency gain in utilising a standardised process.

In the workplace, observations were made to assess the execution of the process in practice. In this process a nurse normally conducts anamneses during the intake of a patient prior to treatment or admission. During the observation, the time taken to screen the patient for each risk was recorded so that an estimate can be made for the total time spent screening all patients. The observation also provided information about the questions that are asked to the patient during their intake and revealed if there are any deviations from the documented protocols.

The abovementioned information was be combined to create (1) a standardised process model for the risk screening process that includes all five risk factors and (2) a set of business rules that serve as directives on the decisions taken during the process.

# 4 Results

Through the use of a BPMN diagram, this section demonstrates the differences between the as-is situation and the to-be situation regarding a standardised risk screening process. This is followed by the presentation of a set of business rules to constrain the risk screening process depending on patient characteristics. Following the

demonstration of the process model and the business rule set, the potential timesavings resulting from an implementation of the standardised process are estimated.

In previous research conducted at the Rivierenland hospital (Hau and Ilbey, 2014), a first step was made towards documenting a standardised process model. This process model is shown in Figure 1.

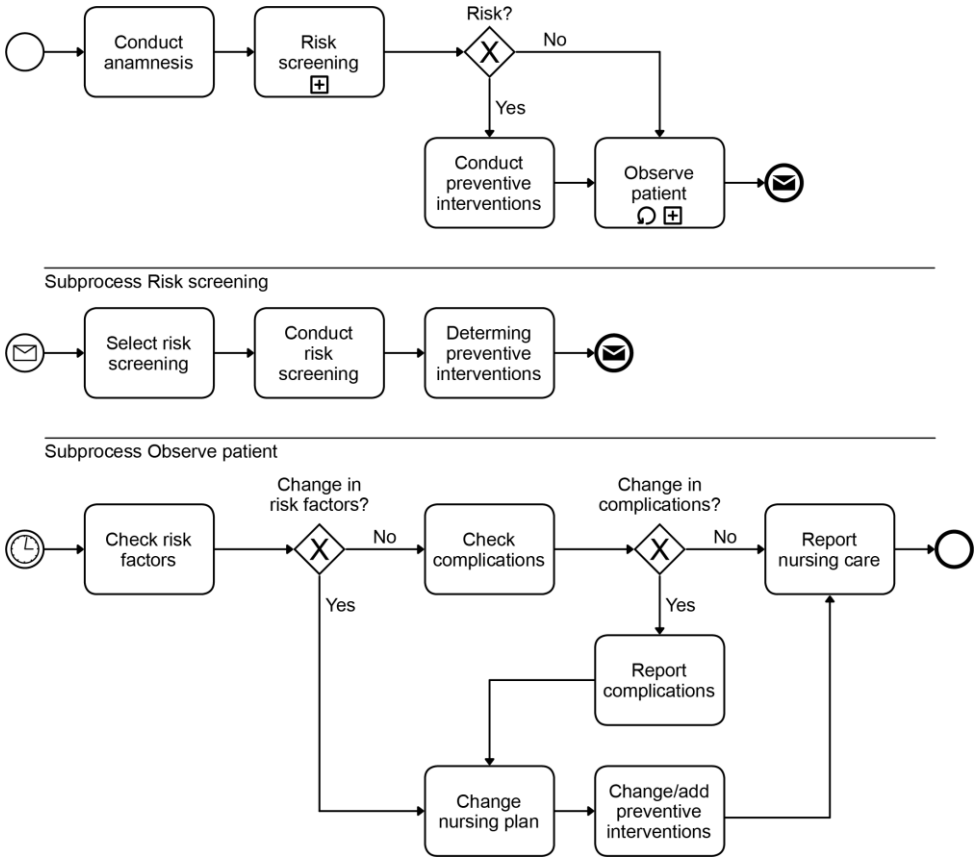


**Figure 1:** The as-is process model for the risk screening process (Hau and Ilbey, 2014)

The process model shown in Figure 1 consists of one high-level process containing two sub processes. The high level process encompasses the activities conduct anamnesis, risk screening, conduct preventive interventions and observe patients. The 'risk screening' activity constitutes a sub process for specific risks. The 'observe patient' activity is a repeating process (indicated by the circular arrow) in which changes in risk factors are observed for a patient who is undergoing care. The process model demonstrates that preventive interventions are applied when a patient is found to be at risk for developing complications. Patients who are at risk are then continuously monitored for changes in their risk factors.

Based on the interviews with staff from the quality management department, it was found that this process could be further simplified. The sub process 'risk screening' was found to be redundant, as the risks are already screened for during the 'conduct anamnesis' activity. It therefore not necessary to explicitly mention these activities in a sub process and it was removed. The second sub process, 'observe patient' was also simplified by merging the activities 'change nursing plan' and 'change/add preventive

interventions'. This was done because preventive interventions are described within the nursing plan, and therefore a change in interventions already implies a change in the nursing plan. Based on these changes, the simplified process model as shown in Figure 2 was created.

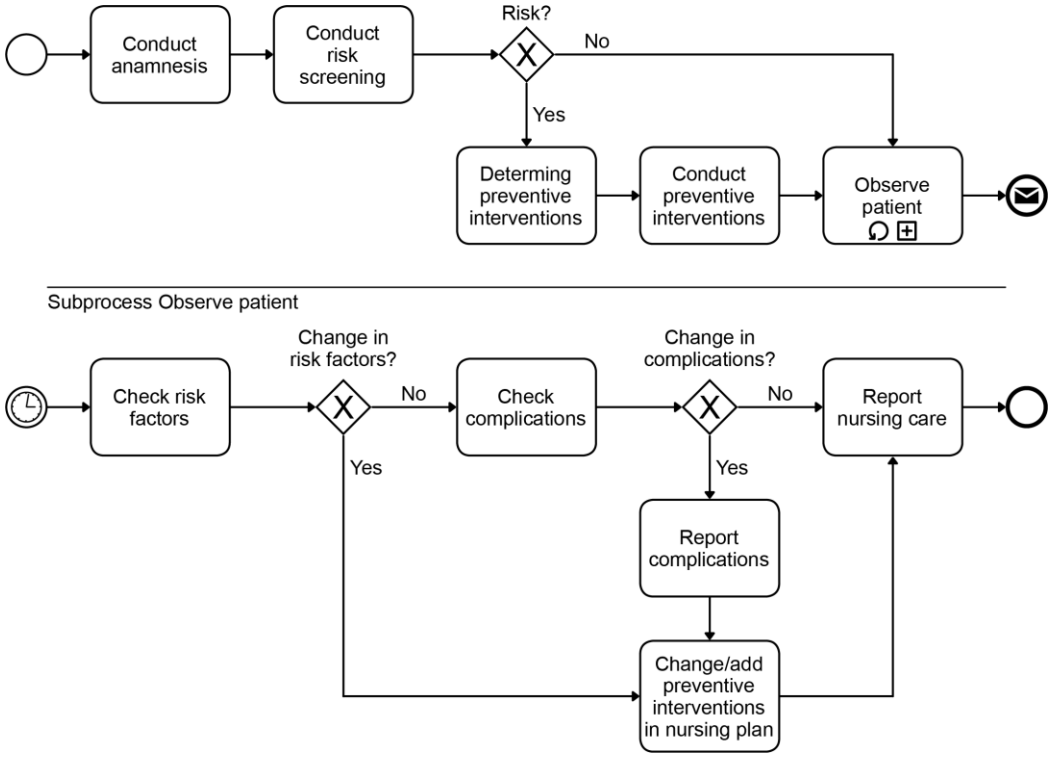


**Figure 2:** The to-be process model for the risk screening process

To achieve a standardised process, the process must incorporate the five risk factors decubitus (pressure ulcers), delirium, falling, malnutrition and physical disability. While the activities for each of the risk factors remain the same, the variations in measurements that need to be performed for each risk factor are different (based on care protocols) and can therefore be supported by business rules. These business rules are captured in a decision tree specific to each risk factor. The decisions trees incorporate industry-standard rating scales for determining the severity of the risk. In the case of decubitus, this is done according to the Braden scale (Bergstrom, Braden, Laguzza, & Holman, 1987). Based on the severity of the risk, the decision tree prescribes the use of a specialised mattress or frequent movement of the patient.

Apart from the business rules related specifically to the risk factors, a new set of business rules was introduced to constrain when certain risk factors should or should not be screened for. According to current protocols each patient needs to be screened for all risk factors, despite some risk factors not being relevant to the patient, depending on their age, the duration of their treatment or admission and other characteristics.

Patients have a higher risk to develop complications if they are present for a longer time in the hospital. In the case of an admission with a maximum duration of one day (day treatment) or treatment in the policlinic, the duration of the admission is too short to develop pressure ulcers, for example. Based on interviews with the quality management department and observations in the workplace, it was determined that

only clinical admissions lasting longer than one day should incorporate risk screening. These rules are represented in Table 1.

| **Rule pattern** | **Conditions** | | **Conclusion** | |
|---|---|---|---|---|
| | ***Admission type*** | | ***Conduct risk screening?*** | |
| 1 | = | Policlinic | Is | No |
| 2 | = | Day treatment | Is | No |
| 3 | = | Clinical | Is | Yes |

**Table 1:** Business Rules constraining the risk screening process based on admission type

Based on the patient's age, the risk screening process is further constrained. Younger patients are deemed to be of low risk for developing certain risks factors. The business rule set represented in Table 2 shows which risk factors are screened for depending on the age group of the patient.

| **Rule pattern** | **Conditions** | | **Conclusion** | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***Patients age*** | | ***Conduct risk screening?*** | | | | | |
| | | | | *Malnutrition* | *Decubitus* | *Physical disability* | *Delirium* | *Falling* |
| 1 | [ ] | 0-18 | Is | X | | | | |
| 2 | [ ] | 18-70 | Is | X | X | | | |
| 3 | ≥ | 70 | Is | X | X | X | X | X |

**Table 2:** Business Rules constraining the risk screening process based on patient age

Based on these business rules, a nineteen-year-old patient coming in for clinical treatment must be screened for the risk factors malnutrition and decubitus. This is then done according to the decision trees specific to each risk factor.

# 5 Efficiency through standardisation

In this section an analysis based on historical admission data of the Rivierenland hospital over the year 2013 is presented. Based on this data, the potential efficiency gain when implementing the proposed standardised process was calculated. The admission data in Table 3 shows a total of 27,290 admissions over all age groups and admission types. For each admission, it is assumed that in the current situation (and according to protocol) patients are screened for the five risk factors. This amounts to a total of 126,450 risk screenings.

| Age category | Day admissions | Clinical admissions | Total admissions |
|---|---|---|---|
| 0-18 y | 1,512 | 1,772 | 3,284 |
| 18-70 y | 8,320 | 8,159 | 16,479 |
| >70 y | 3,759 | 3,768 | 7,527 |
| **Total** | **13,591** | **13,699** | **27,290** |

**Table 3:** Ziekenhuis Rivierenland admission data 2013

By applying the business rules proposed in the previous section it may be possible to reduce the number of redundant risk screenings that are performed, thereby improving efficiency. First off, the risk screening process can be eliminated for day admissions, thereby reducing the total number of admissions by 13,591. The clinical admissions will include risk screening for specific factors based on the patient's age.

Table 4 presents a summary of the number of risk screenings with and without the proposed business rules. The number of risk factor screenings is calculated by multiplying the number of admissions times the number of risk factors. In the as-is situation, this includes risk screenings for all admission types. In the to-be situation, this includes only risk screenings for clinical admissions. By reducing the number of risk factors screened for according to age category and by only performing risk factor screenings for clinical admissions, a total reduction of risk factor screenings of 72.94% is achievable.

| | As-is | | To-be | | |
|---|---|---|---|---|---|
| **Age category** | **Risk factors** | **Total Risk Factor Screenings** | **Risk Factors** | **Total Risk Factor Screenings** | **Reduction percentage** |
| 0-18 y | 5 | 16,420 | 1 (clinical only) | 1,772 | 89.21% |
| 18-70 y | 5 | 82,395 | 2 (clinical only) | 16,318 | 80.20% |
| >70 y | 5 | 37,635 | 5 (clinical only) | 18,840 | 49.94% |
| **Total** | | **136,450** | | **36,930** | **72.94%** |

**Table 4:** Summary of conducted RSP's

To calculate the potential timesaving's associated with the reduction of risk factor screenings, a calculation is presented in Table 5. Based on the observations conducted in this study, the assumption is made that each risk factor screening takes approximately one minute of time and that all risk factors screenings are conducted according to protocol. This implies that an anamnesis for one patient including all five risk factors takes approximately five minutes. Table 5 summarizes the amount of time taken to execute al risk screenings in the as-is situation compared to the to-be situation. It is concluded that this leads to potential time savings of more than 1600

hours on a yearly basis.

| | **Admissions with risk screenings** | **Time taken (hours)** |
|---|---|---|
| As-is situation (all age categories) | 27,290 | 2,274.14 |
| To-be situation | | |
| 0-18 years | 1,772 | 29.53 |
| 18-70 years | 8,159 | 271.97 |
| > 70 years | 3,768 | 314 |
| To-be situation (total) | 13,699 | 615.5 |
| **Potential time saving** | | **1,658.67** |

**Table 5:** Time reduction by using Business Rules

# 6 Conclusion & Discussion

The standardised process model proposed in this study has been shown to successfully include all five risk factors by separating the business logic from the process model using sets of business rules. This has improved the transparency in the hospitals business processes and also made them more manageable. Business rules used to further constrain the risk screening process based on type of admission and patient age category help to improve efficiency by eliminating redundant risk screenings.

Currently, the protocols used in the workplace are contained in an intranet portal used by hospital staff. The documentation hosted on this portal will need to be updated to reflect the proposed standardised process and to be able to determine the practical efficacy. At the time of writing, this change has not yet been achieved. The actual implementation of the new standardised process is expected to be a challenge. Firstly, IT systems have to be configured to support and enforce the prescribed business rules. Secondly, it remains to be seen to which extent the prescribed process will align with the activities in practice.

As was seen in the observation, not all risk factor screenings are performed for all patients, despite this being required according to protocol. Nursing staff do also use their own insights to determine which risk factors are unnecessary to be screened for, depending on the characteristics of the patient and the admission or treatment. In this regard, the paper provides a very 'black and white' comparison between a very inefficient 'as-is' situation and a potentially very efficient 'to-be' situation. In reality, the differences may be much smaller. Despite these facts, the hospital will still need to consider the application of IT systems to gain better control of and insight into processes into the organization. Without these efforts, a true process-driven organization cannot be achieved. This study provides a starting point for the transformation into a standardised, process-driven organization.

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