

Hospital performance dashboards: a literature review

Abstract

Purpose: The main aim of this literature review is to give a comprehensive and updated analysis of the available literature on hospital dashboards.

Methodology: A search of the current literature was performed by searching electronic databases, including Google Scholar, EBSCO and Medline, as well as books.

Findings: 48 manuscripts consisting of peer reviewed articles, conference proceedings, case reports and text books were included in this review.

Practical implications: Despite the numerous advantages of performance dashboards, several authors have mentioned a number of challenges. It was evident from the literature that any setting requires significant effort, especially to ensure the quality of data being collected. In fact, significant investment, both in terms of financial and human resources, is required to achieve an effective dashboard. Furthermore, most of the studies available in the literature were individual case reports or anecdotal accounts rather than empirical studies. Thus, further research is required to ascertain the effectiveness of performance dashboards. In view of these findings, each organisation should make its own decisions whether or not to adopt performance dashboards.

Originality: Most of the literature is fragmented as it reports the use of different types of dashboards, namely strategic, tactical and operational, as separate tools. This literature review contributes to knowledge as it brings together the different types of dashboards and the cascading effect of one dashboard onto another in order to achieve and retain organisational alignment with the overall strategic goals.

Keywords: hospital dashboards, strategic dashboards, tactical dashboards, operational dashboards, benefits of dashboards, challenges of dashboards

Introduction

Many hospitals across the world are facing the same threats and opportunities; the phenomenon of the aging population together with the spread of severe illnesses. All these are translating into an increase in demand for medical services and more treatment. At the same time, patients are demanding better quality of service. The increase in demand and higher patients' expectations has led to financial strains in all European countries (von Eiff, 2012).

Healthcare organisations have come up with many projects and tools in order to overcome these challenges as well as to improve performance and quality of care (Walburg, 2006). Tools which are being widely used by several healthcare organisations are known as performance dashboards (Dowding *et al.*, 2015).

Performance dashboards summarise the wealth of strategic information that many organisations possess in a meaningful and intuitive manner so that users can use these data to allocate scarce resources and steer organisational change towards the organisation's strategies and objectives (Wadsworth *et al.*, 2009). In the same way a pilot uses the display of indicators in the cockpit to monitor and navigate a plane, dashboards provide relevant information to users to steer an organisation (Joint Commission, 2008).

Performance dashboards are tools which are gaining more popularity (Dowding *et al.*, 2015; HIMSS, 2009; 2010; NHS, 2008; 2014). Furthermore, these tools have been advocated by different institutions including the National Health System (NHS) in the United Kingdom (UK) (2008; 2014) and the Healthcare Information and Management Systems Society (HIMSS) in the United States (US) (HIMSS, 2009; 2010).

In view of their increased popularity, the main aim of this literature review is to give a comprehensive and updated analysis of the available literature on hospital dashboards. Thus, this paper aims to be a primer, both for policy makers as well as clinicians, on hospital dashboards. In addition, this review contributes towards knowledge as most of the literature is fragmented as it reports the use of different types of dashboards, namely strategic, tactical and operational, as separate tools. This literature review discusses the different types of dashboards and the cascading effect of one dashboard onto another in order to achieve and

retain organisational alignment with the overall strategic goals. This in turn should enhance visibility of relevant information from bedside to board.

Method

Current literature was retrieved by searching electronic databases, including Google Scholar, EBSCO and Medline, as well as books. The literature included in this article consists of peer reviewed articles, white papers, conference proceedings and text books. Search strategies were developed using the term ‘healthcare dashboards’ and combining this term with other relevant terms such as ‘clinical’ and ‘performance’. The search process was limited to articles which were written in English and published between 2000-2016. Duplicates were removed and then records were screened for relevance. Screening was carried out by reading the titles and abstracts of articles. Articles were deemed relevant if they focused on performance dashboards that facilitated managerial and clinical decision-making within hospitals. Articles which were not relevant were excluded. Finally, 48 articles were included in the study. This strategy which was used to include literature is highlighted in the algorithm found in Figure 1.

Figure 1. Algorithm for searching literature (Moher *et al.*, 2009)

Historical context of performance dashboards

The concept of the performance dashboard was originally derived from the balanced scorecard, which was developed by Robert Kaplan and David Norton (Cleverley and Cleverly, 2005). A balanced scorecard is a

‘performance measuring method that focuses on tracking key metrics grouped according to a set of broad performance areas (e.g. internal processes, financial performances and customer satisfaction) that constitute a balanced view of the organisation’ (Wyatt, 2004: 78).

Dashboards are a natural subset of balanced scorecards (Cleverley and Cleverly, 2005). The main difference between scorecards and dashboards is that dashboards monitor the strategic goals as well as the performance of operational processes, whereas scorecards chart progress towards achieving strategic goals. Dashboards enable mainly supervisors and specialists to

monitor and act on events as they occur. Dashboards visualise data in the right time as users need to view them, usually on a daily basis. On the other hand, scorecards are mainly designed to enable executives and managers to review performance in line with the organisational strategy with subordinates. Scorecards usually display weekly, monthly or snapshots of data (Person, 2013). Eckerson (2011) emphasises that at the end it does not really matter what term is used as long as the tool enables users to focus on critical areas that affect the performance of the organisation.

Dashboards were developed in the business industry (Eckerson, 2011). It is not evident from the literature when performance dashboards were initially applied in healthcare, however, most research related to dashboards within this setting date back from 2000.

Definition of performance dashboards

In 2012, Yigitbasioglu and Velcu reported that there is no standard definition of performance dashboards in the available literature. The authors defined dashboards as (p. 44)

“A graphical user interface that contains measures of business performance to enable managerial decision-making.”

This definition encompasses the main characteristics of dashboards that are a visual summary of decision related information displayed in a single view and the extensive use of graphical information displays, such as graphs and charts (Dolan *et al.*, 2013). It also mentions the contents of the tool which are performance data measured against metrics (Dowding *et al.*, 2015).

Furthermore, this definition also highlighted the purpose of dashboards, which is to assist managers in decision-making. Dashboards assist it users in decision-making by structuring the information, highlighting factors that merit consideration while making data easier to evaluate and so help users to process and analyse information (Dolan *et al.*, 2013).

Dashboards structure information in different layers. Eckerson (2011) describes these layers as an onion. Same as the cook peels the onion layers, a dashboard may allow users to peel back layers of information to get to the root cause of the problem. Each subsequent layer

gives further information to help understand a problem better and identify actions needed to address the problem.

Eckerson (2011) uses the acronym of MAD, which stands for (1) monitor, (2) analyse and (3) drill to detail. That is, dashboard users first monitor key metrics for exceptions, then analyse the information to obtain a better picture of the exception and then drill into detailed reports before taking action.

The outer layer represents graphical and metric data, which are often used to monitor performance. Often these are presented as graphs, charts and alerts. When performance exceeds a threshold, the dashboard alerts users. The traffic light colours are the most commonly used as they provide an assessment of the actual to targeted results by displaying red, yellow or green. Other alerts consist of a pop-up message, an animation, or through an e-mail, which is automatically sent by the system (McKinney, 2012). Practical examples of KPIs found in the outer layer and presented as graphical data may include mortality rate and hospital incidents (Infosys, 2009).

The middle layer usually consists of dimensional data, which allows users to analyse data across many dimensions and organisational hierarchy, to ascertain the root cause of the exception which was highlighted in the outer layer (Eckerson, 2011). In the above examples, this functionality would allow the user to explore the mortality rate by department, whereas for hospital incidents the user can view this KPI by category, such as number of bed sores, hospital acquired infections, as well as post-operative haemorrhages (Infosys, 2009).

The inner layer consists of the detailed data. Most data in this layer are delivered as reports or lists. This function is known as drill-down, where performance dashboards provide the ability to go from summary to detailed information (Eckerson, 2011). An example of drill down information would be that the mortality rate can be viewed per physician.

Despite the fact that Yigitbasioglu and Velcu's (2012) definition includes the main characteristics of these tools and the fact that information is presented in a way that assists decision making, the authors (2012) mention management as the sole users. However, this is not always the case as there are different types of dashboards, namely strategic, tactical and

operational dashboards which have different functions and are targeted for different users ranging from executive management to frontline clinicians (Rasmussen, 2009; Person, 2013).

The next section will describe the main functions of each dashboard together with their target users.

Types of performance dashboards

According to Rasmussen (2009) and Person (2013), there are three types of performance dashboards: strategic, operational and tactical. Organisations utilise one or more of the various types of dashboards according to their needs.

Strategic dashboards

Strategic dashboards are used by top management to monitor the execution of strategic objectives and emphasise management, more than monitoring and analysis. Strategic dashboards are usually shared on every level of an organisation to ensure that the strategic goals of the organisation are apparent to everyone. Many performance dashboards are designed to support executive meetings that review strategies and operations (Rasmussen, 2009; Eckerson, 2011; Pearson, 2013).

A practical example of a strategic dashboard is found in a study by Pace and Buttigieg (2017) where executive management had set the objective that 95% of patients who visited emergency (A&E) had to be discharged from this department in less than 4 hours. The executive managers reviewed this Key Performance Indicator (KPI) during monthly meetings. This had a cascading effect on the tactical and operational dashboards.

Tactical dashboards

Tactical dashboards, which would be used by departmental managers, track processes and emphasise analysis. The analysis application enables users to investigate data across many dimensions to ascertain the cause of a highlighted situation. It also enables users to monitor performance and charts progress against budget and other goals (HIMSS, 2009). Tactical dashboards are usually updated periodically, normally on a daily or weekly basis (Karami *et al.*, 2013).

In Pace and Buttigieg's (2017) study, the tactical dashboard consisted of daily information about the accomplishment of the goal which was set at a strategic level. Managers could analyse whether or not the target, that is 95% of patients had to be discharged within 4 hours from the A&E, was attained. Furthermore, since the managers could track the process, they could analyse the factors that were affecting waiting times within the department.

Operational dashboards

Operational dashboards enable users, mainly frontline clinical, to monitor the performance of core operational processes in real-time. Monitoring delivers critical information at a glance using relevant and timely data (Eckerson, 2011). Within the health care setting, these operational dashboards are known as clinical dashboards as these are used by clinicians. Dashboards provide clinicians with access to relevant and timely information which assist them in their decision-making and thus improve the quality of patient care (Daley *et al.*, 2013; Dowding, 2015).

The operational dashboard in Pace and Buttigieg's study (2017) consisted of a screen in the A&E department which was mainly viewed by the clinicians. Each patient was tracked from the time of registration until discharged from A&E. The patient's status during A&E admission, such as 'patient waiting for radiology', together with the name of the physician and nurse who were in charge for the patient were visible on screens and were updated in real-time.

According to the authors (Pace & Buttigieg, 2017), although there was an improvement in performance related to waiting time following the implementation of strategic, tactical and operational dashboards, these tools did not enable managers to improve quality in terms of cost reductions, clinical effectiveness, patient safety and satisfaction. The authors emphasise the need to have balanced KPIs that take into account other facets of quality of care, apart from time.

The different dashboards should not be seen as separate tools. Instead the strategic dashboard should have a cascading effect onto the tactical and operational level in order to attain the alignment towards the organisational goals (Rasmussen, 2009). Weiner *et al.* (2015) in their case report mention that the greatest benefit following the implementation of the three types

of dashboards was the alignment between planning and implementation, that is from strategic and tactical levels to operational.

Once the organisation has defined the need and the type of performance dashboard required, the next step is to go through the process of identifying what information will be included on the dashboard, hence which KPIs will be displayed.

Key performance indicators

KPIs are usually defined as metrics which have a profound effect on the organisation and help organisations to measure progress towards organisational goals (McKinney, 2012).

The terms metrics and KPIs are often used interchangeably; the key difference between the two terms is that KPIs refer to the metrics which are included on the dashboard (HIMSS, 2009). Furthermore, there is another crucial difference between metrics and KPIs. Metric is a measurement of activity such as ‘average mean time between admission and allocation of a bed’. KPIs should measure much more than activities, they should measure how well the organisation is executing its strategy. To measure strategy, the organisation’s activity is compared to a goal defined in a plan to achieve the strategy. In the example just listed, a goal would be ‘4 hours waiting time from admission to allocation of bed’ (Eckerson, 2011).

In healthcare, performance dashboards can display different KPIs from a patient’s vital signs to the financial health of the organisation depending on its users. KPIs used in the healthcare sector are often divided into three types: clinical, operational and financial (HIMSS, 2009; McKinney, 2013; Karami *et al.*, 2013).

Clinical indicators

A practical example of a clinical indicator is the reporting of the prevalence of pressure ulcers. Documentation of an initial skin assessment, which should be automated as part of the Clinical Information System (HIMSS, 2009), would enhance monitoring of any risk factors and also inform the concerned clinicians of any required follow-up actions. The same information can be available to the nursing manager to see if there are any pending skin assessments, so that he or she can ensure a timely intervention. The director of nursing will then review the KPIs with the departmental nursing managers to identify any trends with the

number of pressure ulcers present on admission and the number of hospital acquired pressure sores (HIMSS, 2009).

Operational indicators

The dashboard should consist of key operational indicators with the aim of improving operational effectiveness and efficiency. Examples of operational indicators include staff productivity and bed turn-around time (McKinney, 2012).

In any healthcare setting and department, the visualisation of prioritised clinical quality and operational KPIs can enhance continuous improvement in the quality of care and safety. In return, an enhancement in patient care and safety will feed into financial health and stability of the entire organisation (Dunn, 2009).

Financial indicators

Financial performance indicators address the financial health of the organisation. They should highlight areas of growth, as well as areas which need attention, and most importantly they should enable decision making (McKinney, 2012).

Financial KPIs are crucial for allocation of resources. For example, at the managerial level the KPI procedures by day, week and month is a crucial indicator. This indicator assists the manager in allocating the required resources, including workforce and supplies. For example, the manager can adjust the staffing level to meet the patients' needs according to the number of procedures. The manager can also adjust the supply inventory of the department by the growth or decline in activity reflected on the dashboard (HIMSS, 2009).

According to Dunn (2009), financial dashboards alone do not tell the whole story. Quality of care should also be part of the performance dashboard. The two are intertwined as by enhancing the quality of care, costs may be reduced. A practical example is the decrease in costs when falls are prevented or pressure sores are decreased.

A threat known as organisational myopia may arise if a performance dashboard emphasises only one set of indicators (Curtright *et al.*, 2000). Performance dashboards should consist of financial, clinical and operational indicators. An organisation needs to choose a limited set of

indicators that are in line with its strategic goals, which measure performance across the entire spectrum (Curtright *et al.*, 2000)

Key performance indicators found in the literature

Table 1 consists of an overview of financial, clinical and operational KPIs found in the literature. The table also displays the design and a brief description of the intervention carried out within the study.

Clinical KPIs were pertaining mainly to Emergency departments (ED) (NHS, 2011; Stone-Griffith *et al.*, 2012) and Gynaecology departments (Crofts *et al.*, 2014; Simms *et al.*, 2013; Sprague *et al.*, 2013).

This could be explained as in the US, there has been an enormous strain placed on A&Es, since between 1996 and 2006 annual A&E visits increased by 32%, whilst the number of hospitals decreased by 5% (Stone-Griffith *et al.*, 2012). Following this strain on the system, there have been serious calls for improvement in efficiency and effectiveness in the A&E (CFEC, 2006). One of the various projects, implemented in reply to this call, was the design and implementation of the A&E dashboard (Stone-Griffith *et al.*, 2012).

Similarly, in the UK, the Royal College of Obstetricians and Gynaecologists (RCOG) recommended the use of dashboards for all maternity units (Arulkumaran *et al.*, 2008). This had a cascading effect, as many hospitals have followed their recommendations and implemented dashboards to improve performance and quality of care within Obstetrics and Gynaecology departments (Guha *et al.*, 2013; Simms *et al.*, 2013; Crofts *et al.*, 2014).

A gap in the literature has been identified as there is less available research concerning other departments, such as orthopaedics and cardiology. The lack of promotion by important institutions in other departments, could explain the gap which was found in the literature, where less KPIs have been identified.

Table 1. Financial KPIs used in performance dashboards

Geographical differences in performance dashboards

As highlighted in Table 1, healthcare organisations from different geographical locations are introducing dashboards in order to measure and improve performance and quality of care. Even though many countries have realised the benefits of performance dashboards and advocate the development and implementation, there seems to be a geographical difference in financial metrics.

Clinical, operational and financial metrics are all relevant in Canada and in the US, whereas in the UK financial metrics are not mentioned in the literature. This is not only observed in the UK but also across Europe. For example, no financial metrics were included in the PATH project, which aimed to develop and disseminate a performance assessment tool all over Europe (Veillard *et al.*, 2005). Furthermore, most literature pertaining to financial metrics originates mainly from the US (Dunn, 2008; HIMSS, 2009; HIMSS, 2010) and Canada (Cleverley, 2001; Cleverly and Cleverly, 2005).

A second gap in the literature that has been identified is a lack of research in financial metrics used in countries where the National Health Model applies, since the state is the main provider of healthcare funds. In the US and Canada, where the Private Mixed (Buttigieg and Gauci, 2015) and Social Insurance Model (Kulesher and Forrestal, 2014) are respectively applied, there are more financial KPIs since the healthcare system is mainly privately funded. Further research should be conducted on widening the scope of financial KPIs over different healthcare models.

The use of benchmarks, targets and thresholds

Following the identification of KPIs to be included in the dashboard, it is important to benchmark against other hospitals. Benchmarking will facilitate the establishment of targets of the organisation which are critical to help organisation to attain their goals. The thresholds of each target should then be set up (HIMSS, 2010).

Benchmarks

Benchmarking is fundamental to interpret trends and variations between similar units and wards in a single hospital and also between different hospitals (Donaldson *et al.*, 2005).

Several authors emphasise the importance of using benchmarks within performance dashboards (Bakos *et al.*, 2012; Donaldson *et al.*, 2005).

HIMSS (2010) recommends that before targets are established it is important to benchmark against other organisations of similar size and function.

Targets

The target is the numeric value, which is defined for the KPIs and should reflect the performance standard that can be achieved based on previous available data. Targets can be set either as fixed or variable. They are set as fixed when there are no changes in trends, whereas variable targets apply when certain KPIs are different during certain times of the year. For example, in orthopaedic surgeries it is important to take note when the orthopaedic surgeons are away for a conference as this would certainly lower the number of operations being carried out (HIMSS, 2010).

Thresholds

In addition to the target value, the thresholds need to be identified as the values of KPIs may fluctuate. Threshold values are articulated as a percentage of the target and include both the upper and lower threshold limits. It is customary to set the upper and lower thresholds at 5% above and 5% below the target value (HIMSS, 2010).

It is important to note that thresholds may not apply to certain KPIs, such as mortality rate and surgical site infection. This is because there is zero tolerance for any deviation from the target since this may implicate safety issues in the quality of care (HIMSS, 2010).

Benefits of performance dashboards

The benefits yielded following the implementation of dashboards within healthcare organisations are widely reported in the literature. The following paragraphs are an overview of these benefits within healthcare organisations.

Improved performance

Performance dashboards support organisations in assessing their performance, question their own results and translate them into actions for improvement. The timelessness of the information presented on the dashboard enables users to closely monitor performance and

evaluate the effectiveness of interventions (Veillard *et al.*, 2005; Wadsworth *et al.*, 2009; Clark *et al.* 2013).

Stone-Griffith *et al.* (2012) gave a practical example of how the implementation of a dashboard in the A&E improved performance. Through the dashboard, users could monitor the time from arrival to A&E discharge, identify specific problems within certain actions, such as arrival to triage, and target improvement accordingly. Similarly, various other authors reported a reduction in waiting time in A&E (Veillard *et al.*, 2005; Wadsworth *et al.*, 2009; Stone-Griffith *et al.*, 2012; Ghazisaeidi *et al.*, 2015; Pace and Buttigieg, 2017) and a decrease in number of patients who left emergency without being seen (Weiner *et al.*, 2015).

The results of the above-mentioned studies should be interpreted with caution as the relationship between dashboards and improvement in performance may be casual. When measuring performance, Bockerman *et al.* (2012) highlight that most of the time employees are not randomly assigned to workplaces as jobs that are more demanding require higher mentally and physically resilient employees than less demanding ones. Therefore, failure to account for sorting of employees may bias any estimated effects on performance.

Another form of bias exists when subjective measurements of performance are used. Subjective measures, such as managers' self-perceptions of organisational performance, can be prone to bias whereby spurious results are obtained. This could be explained as individuals consistently overrate the level of performance within their organisation (Meier and O'Toole, 2013). In order to limit this bias, Meier and O'Toole (2013) suggest avoiding the use of managers' self-perceptions of performance. Dashboards limit this bias as they measure objective data rather than subjective measures of performance.

Enhanced visibility and integration of information

Performance dashboards give their users greater visibility and integration of information regarding the performance of the organisation, by collecting relevant data in a timely fashion. Furthermore, because of the ease of access to information this is made more readily available (Koopman *et al.*, 2011; Clark *et al.*, 2013; Tan *et al.*, 2013; Pace and Buttigieg, 2017).

HIMSS (2010) outlined that many organisations have an asset of pertinent data in their various information systems however this information is often kept in silos. The 'disparate

and disjointed data silos' across various hospital departments constitute the biggest 'decision making bottleneck' (Infosys, 2009:1). They hinder the aggregation of real-time, actionable information about the organisation's performance with regard to clinical, operational and financial KPIs. Dashboards gather data on KPIs from varied resources, which are then converged and presented as a holistic view. With such an aggregation of data collection, users can take a proactive decision (Infosys, 2009). Furthermore, divisional and departmental silos of data can be mitigated through the use of performance dashboards as information is spread more effectively over an organisation (HIMSS, 2010).

In addition, performance dashboards are becoming more horizontally integrated (Egan, 2006), that is, integrated across traditionally separate hospital systems (Ghazisaeidi *et al.*, 2015). Users can access data electronically from one screen rather than accessing multiple systems. The increased visibility and integration of data has made it much more convenient for people to use performance dashboards (Egan, 2006; Koopman *et al.*, 2011).

For example, Koopman *et al.* (2011) reported that the mean time required by physicians to access data about diabetes was reduced from 5.5 minutes to 1.3 minutes following the implementation of a diabetes dashboard. Furthermore, the dashboard had improved the accuracy of the required data. It was common practice that if physicians had to spend too much time looking for data, they would either reorder the tests again or else continue without it. Thus, the dashboard has helped to improve both patient care as well as efficient use of resources.

Even though as discussed above, several authors claim that performance dashboards enhance data visibility and integration, there are different schools of thought regarding accessibility of information between different departments and different managerial levels. HIMSS (2010) states that ideally all levels of users should be given access to data so that departmental silos are mitigated. On the other hand, Karami *et al.* (2013) report that different dashboard views should be designed for employees based on their role in the organisation. Information that is displayed on dashboards should be formatted to the user's needs, depending on the area of responsibility and the hierarchical level (von Eiff, 2012).

A third gap in the literature has been identified with regard to information visibility across different departments. On one hand, if information is visible to everyone it will give a holistic

view of the situation (HIMSS, 2010). In contrast, one of the main functions of performance dashboards is that at a glance a dashboard displays all the salient information needed for decision making (Dolan *et al.*, 2013). If all information is present, the dashboards may lose their effectiveness, as it would add to the complexity of the visual display and so would no longer facilitate decision making. Further research is required in this area.

Increase communication between different departments

Enhanced visibility and integration of data helps to foster collaboration as users start to see information in a way that was never presented before. In fact, many authors report that following the introduction of dashboards there was increased communication between different departments and professions (Bakos *et al.*, 2012; Tan *et al.*, 2013).

Dashboards should be designed in line with the strategic goals in such a way that each department facilitates the achievements of the strategic goals of the entire organisation (Karami *et al.*, 2013). Furthermore, dashboards encourage employees to work more closely together, and they foster dialogue between managers and employees regarding performance improvement (Eckerson, 2011).

For example, a clinical dashboard was implemented to facilitate coordination between inpatient nursing staff and the radiology department. The dashboard allowed both the nurses and the radiology department to indicate all the relevant information on the screen, thus eliminating the need of various phone calls in order to obtain various patient details, such as the availability of an intravenous cannula for contrast (Tan *et al.*, 2013).

Raise awareness of a problem

One of the functions of performance dashboards is to report trends, and hence any exceptions to trends will raise awareness about a problem. Wyatt (2004) gives the example of an early warning sign that the organisation's admitting process has considerably slowed. Other KPIs, such as an increase in A&E transfers and a decrease in discharges together with static inpatient levels, could be reviewed to identify any related changes. Further analysis could help managers identify the root of the circumstances and take action before it causes a problem. Similarly, Clark *et al.* (2013) reported that following the implementation of a dashboard, users could identify and confirm patient flow problems, identify root causes and it enabled evaluation of patient flow solutions.

Delivery of actionable information

Dashboards give users immediate access to data, allowing them to take action immediately (Jack *et al.*, 2014). Managers do not need to ask someone to write a report about a problem or to wait for the monthly report. Managers have the information at hand to tackle the matter before it becomes a problem (Wyatt, 2004; Eckerson, 2011).

Furthermore, performance dashboards provide access to actionable data throughout the organisation and so increase accountability (Jack *et al.*, 2014). Users can make effective informed decisions and contribute to the organisational strategy only if they have access to timely, accurate and readily available information (Wyatt, 2004).

Enables informed decision making

The immediate access to information enables users to make informed decisions (Veillard *et al.*, 2005; Clark *et al.* 2013). KPIs captured on the performance dashboard can provide important information for decision making, for example changes in staffing or capital required (Wyatt, 2004).

The aim in Guha *et al.*'s (2013) study was to implement an acute gynaecology dashboard. They gave the practical example of enabling an informed decision by justifying the purchase of a second ultrasound machine and refurbishment of a second consultation room because the dashboard demonstrated the increased workload of the unit.

Accelerate organisational change

Performance dashboards provide organisations with the means and methods to engage clinical, financial and operational processes, to steadily refine and improve them, thus making processes more effective. The on-going cycle of integrating, presenting and analysing KPIs on a regular basis fuels on-going transformational change of the organisation (HIMSS, 2009; Wadsworth *et al.*, 2009).

Reduction of costs

Wadsworth *et al.* (2009) reported a reduction of costs in blood products. A blood utilisation dashboard was implemented after Cleveland Clinic recognised that it was consuming excessive blood products. The dashboard enabled managers to identify physicians ordering bloods and the haemoglobin level of the patients for whom blood transfusion was ordered. When blood products were ordered for patients who had haemoglobin levels of more than 9,

in other words, for patients who their need of a transfusion was dubious, questions were raised. The transparency of specific data raised consciousness when blood products were ordered, and in turn this has led to a reduction in costs. The authors emphasised that dashboards do not replace professional judgment, and that there may be cases where blood transfusion is recommended even if the haemoglobin is higher than 9.

Improve patient care

Performance dashboards have several benefits; however, the ultimate and most important one is to improve the quality of patient care. Dowding *et al.* (2015) conducted a systematic review of eleven studies that researched the impact of clinical dashboards in healthcare settings. They concluded that implementing clinical dashboards, which provide readily available access to information, can improve adherence to quality guidelines and hence improve patient outcomes and the quality of care.

Despite the several literature on performance dashboards, only one systematic review (Dowding *et al.*, 2015) could be identified by the authors. Hence, there is still not enough empirical evidence to determine the effectiveness, including cost-effectiveness of these tools. Thus, further research is required in this area. Furthermore, a lot of studies highlight the improvement in terms of organisational performance, such as cost reduction (Wadsworth *et al.*, 2009) and reduction of waiting time (Stone-Griffith *et al.*, 2012), however, few studies have discussed how these improvements have affected the quality of patient care (Koopman, 2011; Dowding *et al.*, 2015).

Challenges to implementation of performance dashboards

Even though performance dashboards produce several benefits, there are several challenges that implementers might encounter.

Resistance to change

According to the HIMSS (2009), the greatest challenge that an organisation faces is not defining the technology and the KPIs, but rather the resistance to change. HIMSS (2009) has outlined strategies, such as involving dashboard users as early as possible, which can be used to overcome this resistance to change.

Crofts *et al.* (2013) adapted and implemented a maternity dashboard to drive clinical improvement. They encountered resistance from some employees as their concern was that someone would be blamed whenever a poor outcome was identified. Furthermore, change was limited by poor cooperation between different professions. They overcame these challenges by simultaneously introducing multidisciplinary training and maternity dashboards. This overcame the initial inertia and broke down the boundaries between different professionals. The training also created a sense of responsibility and a desire for quality improvement.

High financial and human resources required

Dashboard adoption and implementation in any setting requires significant input to ensure the quality of the data being collected. Dashboards are not effective if the data used are not accurate. Significant investment, both in terms of financial and human resources, is required to achieve an effective dashboard (Simms *et al.*, 2013).

Furthermore, apart from the substantial resources required, gathering accurate, reliable and valid data on a timely basis is a complex process. Financial measures tend to be more straightforward and therefore easier to manage. However, data to measure quality of care are less tangible and are not as clear cut (Healthcare Compliance Association, 2008).

Data collection

Simms *et al.* (2013) included twelve maternity units within a UK region to study the development of a maternity dashboard. There was recognition amongst all the units that it was very labour intensive to input the data manually. Data collection required significant effort even though the data were already available in digital form, but were not automatically uploaded into the dashboard. Therefore, the authors mention that considerable advantages can be gained when there is automation of data collection, and transference of data into the dashboard. In congruence with Simms *et al.* (2013), several authors emphasise the need for an automated Information Technology (IT) system to serve this purpose (Ghazisaeidi *et al.*, 2015; Stadler *et al.*, 2016).

Furthermore, responsible parties for collecting data, updating it from month to month and manually inputting data into a presentation may lead to 'fat fingering' (HIMSS, 2010: 9). This implies that the responsible party may challenge the numbers while manually recording

and calculating data into a presentation. HIMSS (2010) advocates that the inputting of data should be automated into the dashboard.

Real-time versus latent information

KPIs that measure current performance may collate more useful information than ones that have a lag of time. With advancement in technology and the introduction of Health Information Technology (HIT), the information displayed by performance dashboards can be as real-time as possible (Bennett and Glasziou, 2003). A sound business intelligence is required so that performance dashboards display real-time or almost real-time information.

According to Eckerson (2011), without a strong technical foundation most performance dashboards will not survive as data collection will be a tedious and costly process which produces inaccurate and untrustworthy data. Best performance dashboards automate the collection and delivery of information, so that users spend more time to analyse and act upon the information rather than manually updating the data.

The importance of real-time data is important, however not all KPIs require up to date monitoring. Some KPIs, such as the ones used for strategic performance dashboards, are not required on an hourly, daily or weekly basis and can be aggregated for review over months or so (HIMSS, 2010).

Setting standards

Another challenge which Guha *et al.* (2013) faced was the setting of standards or targets, in the absence of national or other benchmarks. For example, the authors were unable to find the reasonable and acceptable time that a woman should wait for a procedure called Evacuation of Retained Conception Products (ERCP), which is a minor procedure done to remove any pregnancy tissue remaining in the womb following a miscarriage.

Similarly, Simms *et al.* (2013) compared twelve different maternity units. Their findings reinforce the statement that there are no core standards regarding which KPIs to use in maternity and gynaecology dashboards, and this disables comparison between different entities.

Limitations of performance dashboards

Even though there are various benefits, performance dashboards also have some limitations. One limitation is that certain behaviours may be incentivised to the expense of others. For example, tunnel vision is encouraged where users of dashboards only focus on the aspects of performance which are being measured, while at the same time putting aside important but unmeasured aspects of performance. Another example is measurement fixation, where the emphasis is on meeting the targets rather than the overarching purpose of the organisation (Dowding *et al.*, 2015).

Future research

The authors of this review identified three gaps in the literature which require further studies. The first gap was the need of research in different departments, such as Orthopaedics and Cardiology, as most literature is pertinent to A&E and Obstetrics and Gynaecology. The second gap which was identified was a lack of research in financial metrics used in countries where the National Health Model applies, where the state is the main provider of healthcare funds. The last gap consisted of visibility of information across different departments. On one hand, if information is visible to everyone it will give a holistic view of the situation (HIMSS, 2010). In contrast, if all information is present, the dashboards may lose their effectiveness, as it would add to the complexity of the visual display and so would no longer facilitate decision making. Further research is required in these areas.

Implications for practice

The main objective of performance dashboards is to help organisations monitor, analyse and manage performance (Joint Commission, 2008). From the perspective of a hospital manager, who has to make many decisions, a dashboard displays all the relevant information, which is necessary to steer the performance of the organisation (von Eiff, 2012).

Performance dashboards yield several benefits including performance improvement (Veillard *et al.*, 2005; Wadsworth *et al.*, 2009; Stone-Griffith *et al.*, 2012), raising awareness of a problem (Mahendrawath *et al.*, 2010; Wyatt, 2014), delivery of actionable information (Wyatt, 2004; Veillard *et al.*, 2005; Guha *et al.*, 2013), enhance data integration (Infosys, 2009; Tan *et al.*, 2013), accelerate organisational change (Wadsworth *et al.*, 2009), reduce costs (Wadsworth, 2009; Eckerson, 2011) and increase co-ordination between different

departments (Bakos *et al.*, 2012; Tan *et al.*, 2013). However, the ultimate and most important benefit is to improve the quality of patient care (HIMSS, 2009; HIMSS, 2010; Baker, 2015; Dowding *et al.*, 2015).

Despite the numerous advantages of performance dashboards, several authors have mentioned a number of challenges while adopting, implementing and maintaining these performance management tools. It was evident from the literature that any setting requires significant effort, especially to ensure the quality of data being collected. In fact, significant investment, both in terms of financial and human resources, is required to achieve an effective dashboard (Simms *et al.*, 2013).

Without a strong technical foundation most performance dashboards will not survive. Performance dashboards will be crushed by the weight of tedious and costly data gathering processes, inaccurate and untrustworthy data, poor performance and inadequate functionality. (HIMSS, 2010; Eckerson, 2011; Guha *et al.*, 2013; Simms *et al.*, 2013). However, the reality is that not all organisations have the financial and human resources to acquire this technology (Crofts *et al.*, 2014).

Furthermore, most of the studies available in the literature are individual case studies. One of the main limitations of case studies is generalizability, which can be more confidently secured with the higher levels of research evidence. In case studies, results may not be representative of the population since the research design often involve only one hospital (Yin, 2009). Also, most of the literature consists of anecdotal accounts rather than empirical studies which measure outcomes in a robust way. In fact, the authors of this paper could identify only one systematic review related to dashboards within the healthcare setting (Dowding *et al.*, 2015). Dowding *et al.* (2015) conclude that there is some evidence that because dashboards enable immediate access to information, these tools can improve adherence to quality guidelines, and thus, may help improve patient care. However, the authors also state that high quality research studies are required to ascertain their effectiveness and to establish guidelines for their design (Dowding *et al.*, 2015). Further empirical research is required in this domain in order to ascertain the effectiveness of dashboards especially because of the high financial and human resources required to implement this tool.

In view of the various benefits that dashboards have, whilst at the same time the different challenges that implementers encounter, in particular due to the lack of empirical studies, Shaw *et al.* (2012) recommend that each organisation should make its own decisions whether or not to adopt performance dashboards. If the organisation decides to adopt a dashboard, an ad hoc formal review panel should be set up to determine which areas should be targeted. In addition, dashboards should be frequently evaluated using both top-down, as well as bottom-up approaches so that the information displayed continues to be meaningful to its users with the aim of improving clinical and hospital performance.

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Figure 1. Algorithm for searching literature (Moher *et al.*, 2009)

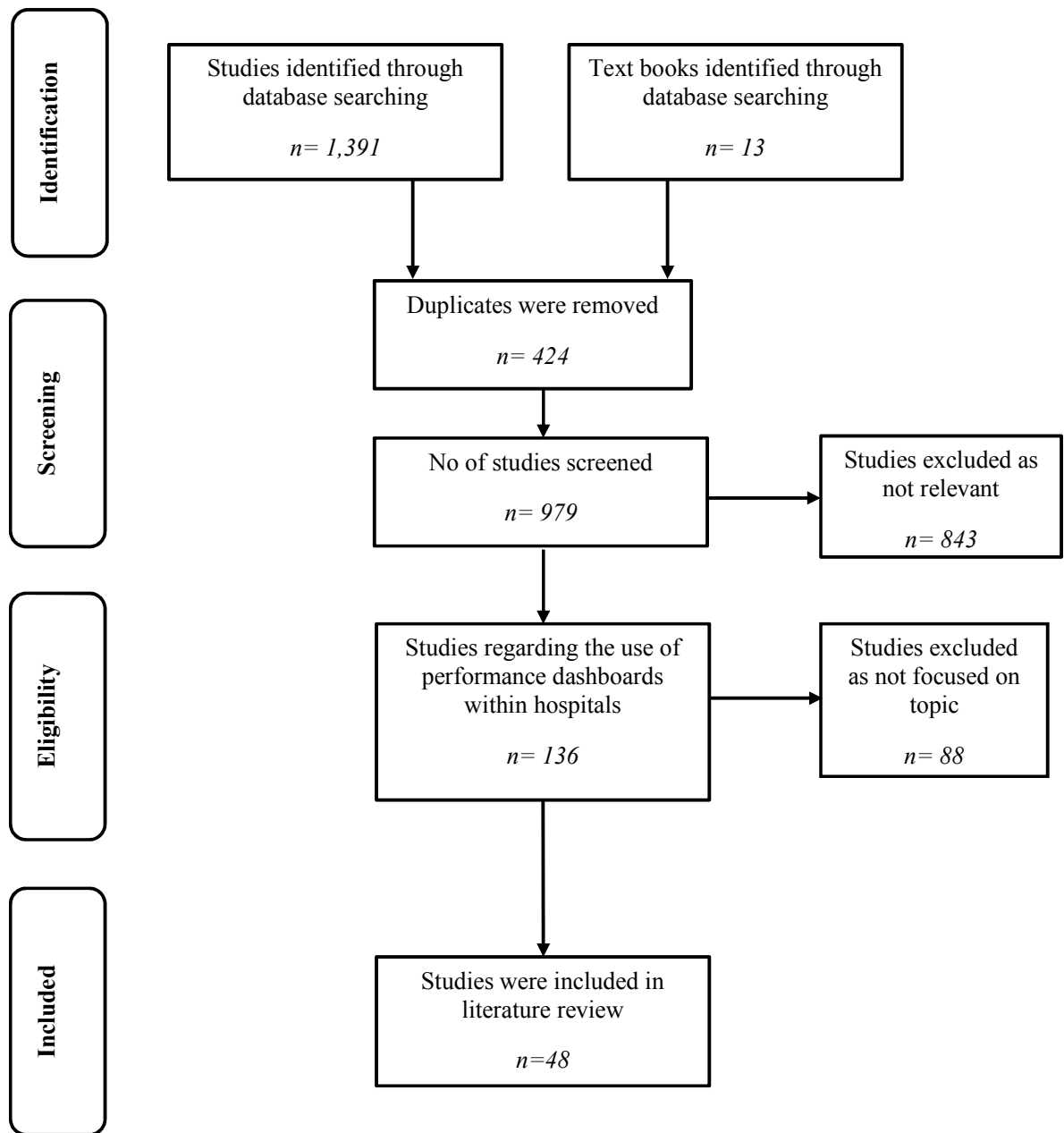


Table 1. KPIs used in performance dashboards

Financial				
Study	Design	Intervention	KPIs	Comments
Cleverley and Cleverley (2005) Canada	Feature story	Discussion on financial measures to assess the financial health of a hospital.	Financial strength index	Nongovernment payers percentage
			Profit (Total margin)	
			Liquidity (Day cash on hand)	Overall cost index
			Debt financing percentage	
			Accumulated depreciation percentage	Net revenue per full-time-equivalent
			Overall charge index	
			Surgical cases percentage	Medicare length of stay
			Market share percentage	
			Change in Medicare care mix percentage	Overhead cost percentage
				Time interest earned
				Executive managers should monitor these KPIs on an annual basis.
HIMSS (2009) US	Executive dashboard development guide	Designed a guide for the development and implementation of executive dashboards in hospitals.	Executive level:	Middle management level:
			Average daily census	
			Average length of stay	Admissions, discharges ad transfers
			Case mix index	
			Payer mix	Inpatient cost per discharge
			Inpatient cost per discharge	
			Inventory cost per adjusted discharge	Case mix index
			Cash position of organisation	
			Days in accounts receivable	Procedures by day, week, month to date
			Admissions/procedures by various services	
			Average daily revenue	Visits per day, week month-to date
			Actual revenue versus budgeted revenue	
			Operating expenses in relation to budgeted revenue	Labour costs per visit
			Middle management level:	Overtime hours
			Actual revenue versus budgeted per department	
			Operating expenses versus budget	Cash position of organisation
				Staff level:
				Unit census
				Admissions, discharges ad transfers
				Visits per day, week month-to date
				Cash position of organisation
				Procedures by day, week, month to date
Infosys (2009)	White paper	Highlighted the most common KPIs that executive managers should be monitoring.	Payer performance	Infosys is a company offering Business Technology Consulting, IT solutions and IT Services. KPIs are targeted towards executive managers.
			Physician performance	
			Hospital performance	
			Referrals to outside centres	
			Expense incurred by hospitals	

Table 1. Clinical KPIs used in performance dashboards (Continued)

Clinical					Comments
Study	Department	Design	Intervention	KPIs	
Clark <i>et al.</i> (2013) Australia	Throughout all the wards at The Prince Charles Hospital	Case study	A dashboard was developed that displayed relevant hospital and state-wide metrics that informed daily clinical decision making. The data reported on the clinical dashboard was driven from patient journey board in real time as well as other data sources.	Patients that have been accepted for admission from the Emergency Department and the length of time waiting for a bed.	Bed availability across the General Medicine Program. The location and number of patients who are currently in an acute bed awaiting subacute care.
				Patients who are awaiting an expected discharge date to be documented Patients who are awaiting notification of discharge. Patients scheduled for discharge with medication scripts that have been not been written or dispensed.	Consultant workload. Outstanding electronic discharge summaries to be completed. Percentage of all patients that are at risk of falls and/or pressure injuries
Crofts <i>et al.</i> (2014) Zimbabwe	Gynaecology	Case study	A maternity and maternal mortality dashboard were designed and introduced at a public hospital	Maternity dashboard Number of neonates born after 20 weeks' gestation Number of women who gave birth Percentage of women who gave birth preterm (i.e. before 37 weeks' gestation) Percentage of women who died Caesarean section rate Assisted delivery rate Percentage of women with a third- or fourth-degree perineal tear Percentage of women who had a postpartum haemorrhage > 500 mL Percentage of women with eclampsia Percentage of neonates with an Apgar score < 7 at 5 minutes Percentage of neonates admitted to the special care baby unit Total stillbirth rate Fresh stillbirth rate Macerated stillbirth rate Perinatal mortality rate	Maternal mortality dashboard Percentage of women who died Percentage of avoidable maternal deaths Percentage of maternal deaths due to the third delay (i.e. delay in receiving adequate treatment at a health facility) Percentage of maternal deaths that occurred in women not scheduled for antenatal care Percentage of maternal deaths secondary to: <ul style="list-style-type: none">• postpartum hemorrhage• pregnancy-induced hypertension or eclampsia• sepsis• ectopic pregnancy• abortion• placenta praevia• placental abruption• retrovirus infection• anaesthetic complications• other causes

Table 1. Clinical KPIs used in performance dashboards (Continued)

Clinical					
Study	Department	Design	Intervention	KPIs	Comments
Department of Health, Urgent and Emergency Care NHS (2011) UK	A&E department	Best practice guidelines	This document sets out best practice guidance for A&E clinical dashboards.	Ambulatory Care Unplanned re-attendance rate Total time spent in ED Left without being seen rate Service experience Time to initial assessment Time to treatment Senior consultant sign-off	This clinical information is aimed to improve decision making processes; identify emerging issues and areas where immediate targeted decisions can benefit patients; improve the quality and coverage of local data through the frequent use of real-time information; and facilitate improvements in patient care through comparison with the best performing providers.
Griffiths <i>et al.</i> (2008) in Foulkes (2011) UK	Nursing care	Article		Safety Failure to rescue (death among patients with treatable complications) Falls Healthcare-associated infection Healthcare-associated pneumonia Pressure ulcers	This article provides an introduction to nursing metrics, including some of the nurse-sensitive indicators and application of nursing metrics into clinical dashboards.
				Effectiveness Staffing levels and patterns Staff satisfaction Staff perception of the practice environment Compassion Patients' experience of care Patients' experience of communication	
NHS (2014) United Kingdom	Orthopaedics	Pilot project	2012/13, NHS England approved the creation of a Quality Dashboard pilot program to provide assurance on the quality of care.	Revision hip redo rate at 5 years Revision knee redo rate at 1 year Revision knee redo rate at 5 years Shoulder replacement re do at 1 year Elbow replacement re do at 1 year Ankle replacement re do at 1 year Mean redo hip and knee PROMS improvement standardised by age, sex and Charlson	This clinical dashboard is a graphical display of data that providers have to submit to NHS England each quarter.
				Average cost post procedure of inpatient care up to 30 days post discharge from initial spell for relevant activity Return to theatre within 30 days for all relevant activity Proportion of specialist service patients managed with an enhanced recovery protocol Proportion of all orthopedic activity that is specialist	

Table 1. Clinical KPIs used in performance dashboards (Continued)

Clinical			
Study	Department	Design	Intervention KPIs
Simms <i>et al.</i> (2013) UK	Gynaecology	Mixed method study	12 maternity units participated in a survey and semi-structure interview to investigate methods employed in the development of a maternity dashboard.
			<div><div>Activity indicators: Ethnic group reps on labour ward forum Labour ward forum lay reps Births Bookings Instrumental delivery Caesarean section Induction of labour Multiple births Normal birth Transfers (in and ex utero) Admissions Discharges Neonatal readmissions Maternal readmissions Place of birth Homebirths</div><div>Workforce indicators: Weekly hour of consultant cover on labour ward Midwife to birth ratio Midwife ratio Training Staff sickness 1:1 care in labour</div><div>Clinical indicators: Eclampsia ICU admissions in obstetrics Blood transfusions (4 units) Postpartum hysterectomies Postpartum haemorrhage Neonatal outcomes • Meconium aspiration • Hypoxic encephalopathy • Birth trauma • Neonatal mortality • Low Apgar score • Babies in SCBU Risk management • Number of SUIs • Incident reporting • Failed instrumental delivery • Massive PPH >2 l 7 • Shoulder dystocia • 3rd/4th degree perineal tears Complaints Unit closures Stillbirths Maternal morbidity</div></div>
			The authors concluded that there has been a wide adoption in clinical dashboards, however there was a wide variation in both the KPIs measured and in their definition. There is an urgent need for national and international core set of KPIs.

Table 1. Clinical KPIs used in performance dashboards (Continued)

Clinical	Study	Department	Design	Intervention	KPIs	Comments
	Sprague <i>et al.</i> (2013) Canada	Gynaecology		Authors have drafted 6 KPIs, sought feedback via survey for their feasibility and relevance and examined current data and literature.	Proportion of new born screening samples that are unsatisfactory for testing	Women not in labour at term, with no medical or obstetrical complications, prior to 39 weeks of gestation Proportion of women included with an indication of post-dates, who are at less than 41 weeks' gestation at delivery
					Rate of episiotomy in spontaneous vaginal births Rate of formula supplementation in term infants, whose mother intended to breastfeed Rate of repeat Caesarean section in low-risk	
	Stone-Griffith <i>et al.</i> (2012) US	A&E department	Case study	Development and adaption of a system for ED data capture, storage and analysis.	Arrival date/time Triage date/ time Placed in bed/time Medical doctor/Physician assistant/Nurse Practitioner initiates contact/greets patient date/time Date/time patient physically leaves A&E	Investing in a dashboard has supported operational management decisions, gains in A&E efficiency and improvement in patient care.

Table 1. Operational KPIs used in performance dashboards (Continued)

Operational					
Study	Department	Design	Intervention	KPIs	Comments
HIMSS (2009) US	Performance dashboards intended for corporate executives, hospital executives and departmental managers	Dashboard development guide		Average length of stay	Average inpatient daily census
				Number of patient days or discharge	Percentage of patients discharged by target time
				Patient wait times (e.g. scheduling)	Bed turnover rate
				Employee turnover rate	ED length of stay-admitted patients
				Lost film rate	Average Acuity – by unit
				Patient turnover rate	Sick time utilisation
				Nursing hours per patient day	Percentage of contract hours
Mahendrawath, <i>et al.</i> (2010) Malaysia	Logistics	Case study	Developed a prototype of a dashboard for logistics management in hospital.	Inventory stock out (amount of items shortage over a certain period)	The use of the dashboard had identified problematic areas that the hospital needed to investigate further. For example, an item that contributed highly to the inventory value, performed badly as the amount of item coming in was lower than the demand.
				Inventory service level (percentage of stock out occurrence over the number of times demand occur in a certain period)	
				Inventory fill rate (percentage of stock out over the total demand)	

