COMMUNICATING PERFORMANCE MEASURES: SUPPORTING CONTINUOUS IMPROVEMENT IN MANUFACTURING COMPANIES

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ABSTRACT

Manufacturing enterprises are a key driver of economic growth (Eurostat, 2016). Implementing continuous improvement (CI) is commonly used to increase competitiveness (Hyland et al., 2007), but despite the well-known theory of CI, many manufacturing companies fail in implementing it (Bhasin, 2012; Nordin et al., 2012; Tiwari et al., 2007).

An identified critical success factor in CI implementation is the evaluation of performance, including the performance evaluation system itself, the linkage between targets at different company levels, and continual evaluation of performance (Bakås et al., 2011; Scherrer-Rathje et al., 2009; Ukko et al., 2009). Another critical success factor in CI implementation is the communication of performance measures (Bakås et al., 2011; Ukko et al., 2009).

This research explores the communication of performance measures. The aim is to support CI by improving the communication of performance measures, and to this end, this thesis concentrates on identifying the main challenges in the communication of performance measures supporting CI. The research scope is manufacturing companies in general, and manufacturing SMEs in particular. The relevant literature concerning the communication of performance measures in manufacturing companies is identified and summarized. Also, current practice is explored, focusing on how performance measures are communicated in manufacturing companies, and whether and how the communication supports CI. This has been done to identify divergences between current practice and theory. Finally, theory and empirical
findings are synthesized to identify some of the main challenges to be addressed in order to succeed in CI.

The main task is to support CI efforts in manufacturing SMEs, eliminating the identified divergences in the communication of performance measures by adapting these measures to these manufacturing SMEs. These challenges can be summarized as follows:

- using both financial performance measures as well as objective and subjective, non-financial performance measures
- aligning performance measures with strategy and targets
- integrating all performance measure communication, as related to both daily performance and CI, in the same communication loop.
- forming two-way communication channels between managers and operators
- aligning oral and written communication channels
- exploring how information systems can facilitate the communication of performance measures
- using and optimizing the visual communication of performance measures
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PUBLICATIONS

PUBLICATIONS WITH HIGH RELEVANCE


PUBLICATIONS WITH LOWER RELEVANCE

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CHAPTER 1
INTRODUCTION

This chapter introduces the research area of this thesis, including the background and problem description. It also explains the aim of the research, and derives two research questions from this aim. Finally, this chapter explains the organization of the rest of this thesis.

1.1 BACKGROUND

There are two million manufacturing enterprises in Europe. Employing 30 million people, manufacturing enterprises are a key driver of economic growth (Eurostat, 2016). Implementing or improving the implementation of continuous improvement (CI) is a common way to increase competitiveness (Hyland et al., 2007). CI entails, for example, improving productivity, ensuring quality, and increasing delivery reliability (Hyland et al., 2007). Despite the well-known theory of CI, many manufacturing companies fail in their CI implementation (Bhasin, 2012; Nordin et al., 2012; Tiwari et al., 2007). Manufacturing companies use various improvement methods, but no matter what improvement method is chosen, the success factors are almost the same (Kumar et al., 2009). In the present research, CI is used as an umbrella term for improvement methods, and results of research in areas such as lean production, six sigma and lean six sigma are also taken into consideration.

When implementing CI, the start of the implementation phase is quite obvious, but the end is vaguer. Discussing the Toyota production system, Ohno (1988) used the word “improvement” instead of “implementation”. Liker et al. (2009) stated that implementation would never end, but is an ongoing process. Åhlström (1998) emphasized that managerial efforts and resources must be implemented in parallel throughout the CI implementation process. The present research focuses on supporting CI, examining the process in general and not any specific phase.

To succeed in CI, several critical success factors (CSFs) have been identified in research. The most common CSFs are leadership and management (Achanga et al., 2006), but skills and training at all company levels have also been identified as CSFs (Hilton and Sohal, 2012; Jayaraman et al., 2012), as has cultural change (Jayaraman and Teo, 2010). One identified CSF for CI implementation that is relevant to this research is performance evaluation, which can be divided into three parts. The first part is the performance evaluation system, comprising various performance measures in a system used as a communication platform (Bakås et al., 2011). The second part of performance evaluation is the linkage between targets at different company levels in order to improve understanding (Ukko et al., 2009), and the third part is the ongoing evaluation of performance, yielding a constant analysis of the progress, obtaining feedback, and reacting to the feedback (Scherrer-Rathje et al., 2009). Communication in general is identified as a CSF (Hilton and Sohal, 2012; Jayaraman et al., 2012), with effective and open communication between employees and stakeholders seen as improving performance (Amaratunga and Baldry, 2002). The communication of performance measures is also specified as a CSF in CI, using the performance
measurement system that has been set up (Ukko et al., 2009), and communicating goals and objectives in order to involve employees in the CI work (Bakås et al., 2011).

Similar phrases recur regarding performance measurement, such as performance management (Ates et al., 2013), performance improvement (Oliver et al., 2002), change management (Nordin et al., 2012), process management (Amaratunga and Baldry, 2002), and management in general (Dombrowski and Crespo, 2008), which are not always defined by the researchers using them. An important part of performance measurement is the performance measurement system, which is the means to communicate performance measurement. Performance measurement systems have been well researched and several frameworks have been developed, including the balanced scorecard by Kaplan and Norton (1996) and the performance prism by Neely et al. (2002). Cocca and Alberti (2010) proposed a framework for the self-assessment of performance measurement systems, and several general frameworks have also been developed (Jamil and Mohamed, 2011; Sousa and Aspinwall, 2010). A performance measurement system for small and medium-sized enterprises (SMEs) was developed by Anand and Kodali (2008) and a performance measurement system for the operational level was proposed by Ukko et al. (2009). Finally, a list of performance measurement system features was proposed for SMEs by Cocca and Alberti (2010).

Some researchers have addressed the performance measures themselves. According to Tupa (2013) a performance measurement system should be based on lean metrics, and Karim and Arif-Uz-Zaman (2013) stated that it was crucial to measure performance. Other researchers have explored what measures to use (Dombrowski and Crespo, 2008; Amaratunga and Baldry, 2002), while Bourne et al. (2000) identified the need for further research into the development of performance measures. Anand and Kodali (2008) considered what performance measures to use for SMEs in particular.

The importance of the communication of performance measures has been identified by many. Communication and information management are enablers of the implementation of lean six sigma (Kumar et al., 2013). Jayaraman and Teo (2010) identified CSFs for lean six sigma implementation, finding that the frequent communication and assessment of lean six sigma results constitute the fourth most important factor. They also concluded that poor communication causes teams to lose momentum and interest in CI. Also, Timans et al. (2011) looked into the implementation of lean six sigma in manufacturing SMEs, identifying communication as one of the four highest ranked CSFs. Biron et al. (2011) discussed the importance of a system for performance measurement, stating that “clear communication helps employees understand what is expected from them, and why their efforts are important” (p.1295).

Performance measures can be communicated at and between organizational levels. The communication of performance measures by top management was examined by Nordin et al. (2012), while the interaction and effectiveness of performance measure communication were explored by Ukko et al. (2009) and Puvanasvaran et al. (2009). A literature review regarding the communication of performance measures found that the area has not been the subject of much research. Worley and Doolen (2006) demonstrated that the relationship between communication and lean production is complex and asked for more research in the area, while Robson and Tourish (2005) believed that there was a need for better rather than more communication.
SMEs play a significant role in the European economy (European Commission, 2015). Many manufacturing companies are defined as SMEs by their number of employees, but do not fit the SME turnover or profit profile. Many of these manufacturing companies share characteristics with manufacturing SMEs, which is why companies outside the SME specification can also match the SME characteristics (Säfsten et al., 2007; Säfsten and Winroth, 2011). In this work, the concept SME is used, but with the knowledge that occasional criteria may not be met by some companies. From the lean production implementation perspective, Ukko et al. (2006) explored target communication in SMEs, and concluded that how companies put communication into practice has not yet been studied. Ates et al. (2013) explored the gap between theory and practice in CI performance management in SMEs. They concluded that in SMEs, communication of change, communication of strategic objectives and communication in general are less common in current practice than in theory. They also concluded that more than half of the SMEs they investigated lacked effective management communication with stakeholders. Ates et al. (2013) argued that there was a clear need to reinvent the SME management style to move towards information-based organizations. Finally, Ukko et al. (2006) stated that because many companies today apply performance measurement at the operational level, a major challenge facing managers was the understandable and accessible communication of performance measures at the operational level.
1.2 PROBLEM DESCRIPTION

Given the importance, and lack of knowledge, of performance measure communications in CI success, filling that research gap might help manufacturing companies succeed in implementing CI. Succeeding in CI implementation is a significant factor in business success (Hyland et al., 2007).

The knowledge gap regarding the communication of performance measures encompasses manufacturing companies, including manufacturing SMEs (Timans et al., 2011). Manufacturing SMEs have specific characteristics, and might need to adapt how they implement CI to these characteristics (Cagliano et al., 2001). Very little research has examined performance-supporting CI in SMEs (Anand and Kodali, 2008), and according to Taticchi et al. (2010), the literature has significantly neglected performance measurement and performance management in SMEs. A key barrier facing SMEs in the internal communication process is, according to Ates et al. (2013), developing performance measures, following up results, making decisions based on performance information, and providing feedback to the organization.

This research considers manufacturing companies in general, focusing on manufacturing SMEs in particular, aiming to fill the identified research gap and help these manufacturing SMEs succeed in CI. This scope is based on author’s 20 years of experience in manufacturing. The particular emphasis on manufacturing SMEs is motivated by the lack of research in the area (Anand and Kodali, 2008) and by research claiming that SMEs often fail in CI implementation (Achanga et al., 2006) and that larger companies have more resources and better skills in CI than do SMEs (Ates et al., 2013). The present research also builds on the hypothesis that the capacity of information systems to support communication in general can be used to explore how the communication of performance measures in CI can be supported by information systems.

1.3 RESEARCH AIM

This research explores the communication of performance measures, with the aim of supporting CI by improving the communication of performance measures. The research scope is manufacturing companies in general, and manufacturing SMEs in particular. The aim of the research can be expressed in two research questions (RQs), the first of which is addressed in this thesis.

RQ1: What are the main challenges in the communication of performance measures supporting continuous improvement?

In answering the first research question, the relevant literature concerning the communication of performance measures in manufacturing companies was identified and summarized. Also, current practice was explored to learn how performance measures are communicated in manufacturing companies, and whether and how such communication supports CI. This work was done in order to identify divergences between current practice and theory. Finally, theory and empirical findings were synthesized into some of the main challenges to be addressed in order to succeed in CI.
Future research will address RQ2.

RQ2: How can information systems be used to improve the communication of performance measures supporting continuous improvement?

This second research question identifies how to meet the challenges identified in answering RQ1. It also explores theory and current practice concerning the contribution of information systems to the communication of performance measures supporting CI in manufacturing SMEs. Finally, answering RQ2 would point in the direction of guidelines for manufacturing SMEs’ use of information systems to improve the communication of performance measures to support CI.

1.4 THESIS ORGANIZATION

This thesis starts by summarizing existing literature in the area, establishing a theoretical foundation for the present research. The following chapter discusses the research approach, which is both theoretical and empirical, and how research quality is ensured. The results of previous research are discussed, and related conclusions are drawn. Finally, a plan for future research is drawn up.
CHAPTER 2
THEORETICAL FOUNDATION

This theoretical foundation chapter summarizes and discusses existing theory on the communication of performance measures. This chapter presents essential terms used in this thesis, as well as a summary of existing literature. The studied literature concerns five identified elements of the communication of performance measures: 1) SME characteristics, since the case-study companies are manufacturing SMEs and these characteristics might influence how these companies communicate performance measures; 2) the performance measures themselves, as these constitute the basis of what is communicated; 3) performance measurement systems, because how the performance measures are communicated might depend on these system; 4) communication channels, which allow the performance measures to be communicated between organizational levels in a company; and 5) an overview of how to visualize the performance measures, because how measures are presented affects how they are perceived. At the end of this chapter, a synthesis of existing theory is presented, combining CI, performance measures, and information systems, providing a basis for future research.

2.1 ESSENTIAL TERMS AND RESEARCH DELIMITATIONS

Researching into the communication of performance measures has introduced various relevant terms, sometimes defined in different ways, sometimes not defined at all. This chapter gives an overview of the terms to be defined in order to understand all parts of this research, together with delimiting what is not addressed in this research.

Communication can be defined as “the imparting or exchange of information by speaking, writing, or using some other medium” (Oxford University Press, 2017). The focus of this research is not theory of communication, but how performance measures are communicated internally in manufacturing companies. The focus is also internal within the companies, so communication of performance measures with external shareholders or stakeholders is not addressed. For practical reasons, the research is limited to the formal internal communication of performance measures, for example when performance measures are discussed in internal meetings planned for this purpose. Other, unplanned internal discussions of performance measures are difficult to capture, and are therefore excluded from this research.

There is no common definition of the term performance measures in the literature. For example, Forza and Salvador (2000) defined performance measures as information about the performance of people, activities, processes, products, business units, etc., while Lebas (1995) stated that performance measures could be key success factors, measures detecting deviations, measures tracking past achievements, measures of output, measures of input, etc. Bititci and Nudurupati (2002) identified two types of performance measures, calling them indicators: control indicators and improvement indicators. Control indicators are needed to monitor and control processes, while improvement indicators are needed to measure CI. A literature review in the area found no specification of whether or not CI measures are included
in performance measures. In this thesis the term “performance measures” is used as an umbrella term for all types of measures communicated internally in following up and/or improving production, i.e., the term also covers CI measures. However, the empirical findings indicate two types of performance measures, i.e., as related to daily performance and to CI. The performance measures researched here are largely operational, not focusing on strategic-level performance measures. However, in SMEs the difference between operational and strategic performance measures is often vague or even nonexistent. The scope of this research is thus performance measures connected to operational performance, with strategic performance measures sometimes being within this scope.

A performance measurement system can be defined as a set of metrics used to quantify the efficiency and effectiveness of actions (Neely et al., 1994), as a two-way communication system to incorporate the strategic vision into the organization (Lynch and Cross, 1992), or as “a multi-dimensional set of performance measures for the planning and management of a business” (p.4., Bourne et al., 2003). In this thesis, performance measurement system means a set of performance metrics and how they are related to each other. Close to the performance measurement system is the information system, which is “a work system that uses information technology to capture, transmit, store, retrieve, manipulate, or display information” (p.42, Alter, 1999). This thesis is interested in the information system focus as a means by which people communicate performance measures. The internal structure of such systems is outside the scope of this research.

Commonly used improvement method terms in manufacturing include lean production, six sigma, lean six sigma, and CI. There is no consensus in defining lean production (Pettersen, 2009), though one well-known definition says that it is “a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow” (p. 481, Liker, 1997). Several researchers have identified lean production as closely associated with CI (e.g., Bicheno et al., 2011; Liker, 2004; Womack and Jones, 1996), sharing much of its basis and using the same tools. Six sigma was defined by Schroeder et al. (2008), based on quality management, promoting control and exploration in improvement efforts. Lean six sigma is a combination of lean production and six sigma, designed as a framework for ongoing process improvement (Maleyeff et al., 2012). CI is a translation of the Japanese word kaizen, where kai means change, and zen means good, giving kaizen the meaning of “change for the better” (Kaizen Institute, 2017). CI thus refers to a process of incremental improvement of the standard way of working (Chen et al., 2001).

2.2 CHARACTERISTICS OF SMALL AND MEDIUM-SIZED ENTERPRISES

This thesis focuses on manufacturing companies in general, and on manufacturing SMEs in particular. SMEs often have several typical characteristics distinguishing them from bigger companies. The European Union defines SMEs as companies having fewer than 250 employees and a turnover of less than or equal to EUR 50 million or a total balance sheet of less than or equal to EUR 43 million (European Commission, 2005). However, according to (Säfsten and Winroth, 2011), “a small unit within a large
international company group could very well face the same problems as an independent company” (p.4).

SMEs have certain typical characteristics (Huin, 2004), such as short-term priorities, an internal operational focus, lack of external orientation, tacit knowledge, desire for flexibility, poor managerial skills, entrepreneurial orientation, command and control culture, and limited resources (Ates et al., 2013). Zach et al. (2014) identified typical SME characteristics that could affect system implementation, concluding that ownership and limited resources were two of the most influential. Wong and Aspinwall (2004) summarized typical SME characteristics in six areas, five of which concern internal characteristics: ownership and management; structure; culture and behaviour; systems, processes, and procedures; and human resources. These five areas are used to organize the typical SME characteristics summarized in Table 1.

<table>
<thead>
<tr>
<th>Ownership &amp; management</th>
<th>Owned by entrepreneur or multi-tasking owner-manager</th>
<th>Centralized, short-term, intuitive decision making by few decision makers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Directive and paternalistic management style, command and control culture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top management highly visible on the shop-floor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor managerial skills</td>
</tr>
<tr>
<td>Structure</td>
<td>Simple, flat structure with few layers of management and hierarchy</td>
<td>Flexible structure and information flows</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Division of responsibilities is limited and unclear; low degree of specialization</td>
</tr>
<tr>
<td>Culture &amp; behaviour</td>
<td>Unified, organic, and fluid culture extending across department boundaries</td>
<td>Operations and employee behaviour influenced by managers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Result-oriented, short-term operational focus</td>
</tr>
<tr>
<td>Systems, processes, &amp; procedures</td>
<td>Simple planning, evaluating, reporting and information systems</td>
<td>Flexible and adaptable processes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Informal, unclear rules and procedures and low degree of standardization and formalization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Limited knowledge of and management attention to information systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packaged information system applications subordinated to the accounting function</td>
</tr>
<tr>
<td>Human resources</td>
<td>Modest know-how with tacit knowledge and few experts; limited resources; ad hoc and small-scale training and employee development</td>
<td>Close, informal working relationships</td>
</tr>
</tbody>
</table>
Low incidence of unionization  
Low resistance to change  
Modest financial resources

Table 1. Typical SME characteristics (Ates et al., 2013; Wong and Aspinwall, 2004; Zach et al., 2014).

2.3 PERFORMANCE MEASURES

Performance measurement is researched in many academic disciplines, for example operations management, strategic management, management accounting, and organizational behaviour (Srimai et al., 2011), and is used in manufacturing and other sectors. Extensive operations management; research examines performance measures and performance measurement systems (Folan and Browne, 2005; Neely, 2005). Research on performance measures considers three phases, i.e., the: design, implementation, and use of performance measures (Bourne et al., 2000). This thesis covers all three phases, but emphasizes the communication of performance measures. The performance measures area has evolved from measurement to management, from static to dynamic, and from a shareholder value to a stakeholder focus (Srimai et al., 2011), all commonly encompassed by performance measurement systems. One of the best-known performance measurement systems is the balanced scorecard (Kaplan and Norton, 1992). The balanced scorecard divides the performance measures into four perspectives, i.e. financial, customer, internal, and learning and growth, all of which must be balanced (Kaplan and Norton, 1992). Research demonstrates that companies using both financial performance measures (e.g. earnings or return on assets) and non-financial performance measures (e.g. product quality or employee satisfaction) attain better performance (Lingle and Schiemann, 1996). In addition companies with both objective non-financial performance measures (e.g. product quality) and subjective non-financial performance measures (e.g. employee satisfaction) also attain better performance (Van der Stede et al., 2006). In contrast to theoretically identified types of performance measures, SMEs often emphasize financial performance measures (Hynes, 1998).

In considering the design of performance measures, the need for alignment between strategy, targets, and the performance measures themselves has been demonstrated by several researchers (e.g. Bourne et al., 2000; Garengo and Biazzo, 2012; Hudson et al., 2010; Kaplan and Norton, 1992). SMEs have a good understanding of financial performance measures, but these measures often lack a strategic alignment (Hudson et al., 1999). In communicating targets it is important to grasp the linkage between employee and company targets, because this linkage fosters a better understanding of employee targets, thus improving performance (Ukko et al., 2009). Managers must communicate to employees which performance measures are the most important and clarify the alignment between performance measures and stakeholder value (Neely et al., 2002). Performance measures must have specified purposes and be relevant (Bititci and Nudurupati, 2002; Neely et al., 1997); they also must have clear titles, clear definitions, and appropriate targets (Lohman et al., 2004; Neely et al., 1997). Performance measures must be visual and easily understood and used (Bititci and Nudurupati, 2002), as SMEs in particular need performance measures that are easily understandable and obviously useful (Ukko et al., 2007a). The accuracy and reliability
of performance measures are also important (Bititci and Nudurupati, 2002). SMEs need reliable, dynamic, and flexible performance measures (Hudson et al., 2001; Ukko et al., 2007a).

Summarizing the literature on performance measures, it can be concluded that there are clear guidelines for what kind of measures to communicate and that a clear relationship between the performance measures is important.

2.4 COMMUNICATION CHANNELS

The communication of performance measures can be categorized according to the communication channel used (Biron et al., 2011), for example, oral versus written communication (Tenhälä and Salvador, 2014) and one-way versus two-way communications, or it can be categorized according to the direction of the communication, i.e. vertical versus horizontal. Oral communication channels are also called rich communication channels (Byrne and LeMay, 2006) and include face-to-face information meetings. Oral communication builds relationships and confidence, enables early identification of conflicts, discusses and clarifies ambiguities, and satisfies common human needs for communication, safety, acknowledgement, and power, thereby promoting performance efficiency (Raisiene, 2012). Oral communication is the richest medium and is preferred by employees, as it allows nonverbal communication and immediate feedback, reflecting manager willingness to listen to employees (Byrne and LeMay, 2006; Men, 2014). Oral communication can be either one-way or two-way, with two-way communication between blue-collar employees and middle managers enabling improved operational performance (Anh and Matsui, 2011). Oral communication has drawbacks, however: it leaves no permanent record (Hertzum and Pejtersen, 2000) and requires the simultaneous presence of senders and receivers.

Besides oral communication channels there are written communication channels (e.g. written information appearing on bulletin boards or video monitors), also called lean communication channels (Byrne and LeMay, 2006). Byrne and LeMay (2006) claimed that employees prefer written communication channels for company information, and Daft et al. (1987) claimed that managers also prefer written communication channels for unambiguous communication that must not be misunderstood. Written communication also has drawbacks, for example: giving an incomplete account of the context surrounding the issues treated (Hertzum and Pejtersen, 2000). Focusing on SMEs, Ukko et al. (2006) stated that all internal communication channels positively affect performance, that oral communication is the best type of communication for performance measurement, and that oral communication can be supported by written communication (Ukko et al., 2007a). High-performing managers have the skills to choose the most appropriate communication channel depending on the richness of the message (Daft et al., 1987).

The communication of performance measures can also be vertical or horizontal in the organization. The one-way communication of performance measures can be top down or bottom up vertically oriented (Malina and Selto, 2001), for example, from managers to employees concerning strategy or targets. One-way top down strategy communication helps improve performance (Bourne et al., 2013; Rapert et al., 2002), and it is proposed that senior or top managers specifically become involved in such
communication to improve performance management (Ferguson et al., 2013; Psychogios, 2012). Such vertical, one-way, top down communication of performance measures gives employees access to information about targets, how well they have been addressed, and how employees can help achieve them (Biron et al., 2011). One-way communication from managers to employees might also negatively affect the organization as it is passive, and could cause unproductive conflicts or tensions (Malina and Selto, 2001). The communication of results from employees to managers can be seen as vertical, one-way, bottom up communication (Bititci and Nudurupati, 2002). Engagement improves if the communication of performance measures runs both ways (Abdel-Maksoud et al., 2005), so two-way communication is important and should be used as often as possible (Ukko et al., 2007b). Two-way communication includes discussions or other interactive discourse between managers and employees (Ukko et al., 2007b), and employee participation in decision making facilitates performance because increased participation increases work motivation (Ukko et al., 2008). The importance of participation in decision making concerns mainly individual or team-level decisions, but also concerns company-wide decisions (Ukko et al., 2008). Vertical two-way communication can be seen as part of an evaluation and target-setting process improving performance measures (Biron et al., 2011), for example, the important activity of investigating existing performance measures and their usefulness (Bourne et al., 2000; Wouters and Sportel, 2005).

Looking into communication channels for performance measures from the information system perspective, Alter (1999) framework depicting the work system in an organization (Figure 1) is one of several models that could be used in analysing and thinking about how information systems can support an organization (Alter, 2013). Work is here defined as the application of resources to produce products or services. The internal processes in this model consist of processes and activities, participants, information, and technologies, and can be identified as those used in communicating performance measures. In Alter (1999) terms, in the communication of performance measures, participants in various processes and activities need information, the flow which is supported by an information system. In this research, the concept of information systems that support the communication of performance measures has not been explored; this matter will, however, be the subject of future research towards a doctoral thesis.
Figure 1. The work system framework (Alter, 1999).

The communication channels are also related to communication models, because communication models define how the information is transferred, i.e., how the communication is undertaken. Ever since Aristotle divided communication into the speaker, subject, and person addressed (Keyser, 1922), various communication models have been developed. Shannon et al. (1950) developed a mathematical communication model, identifying source, transmitter, signal, and recipient, a model that has been further developed by several other researchers. One example is the “SMCR” communication model of Berlo (1960), which includes the elements source, message, channel, and receiver (Figure 2). Berlo (1960) also added the encoding and decoding of the message as distinct communication processes not included in Shannon et al.’s (1950) previous communication model. The Berlo (1960) model is a general communication model not specifying the organizational direction in which the communication goes, i.e., whether from managers to employees or from employees to managers.

Figure 2. Berlo’s (1960) communication model.

In summary, the studied literature on communication channels identifies a clear need for two-way communication involving all employees. The literature is not completely clear about how to communicate, but written communication supported by oral communication seems to be the most successful strategy. The literature also demonstrates that there is a need for a single communication process for all types of performance measures, a matter discussed later in the thesis.
Information systems can provide real-time data collection and cross-platform communication, which enhances the ability of performance measurement systems in data collection, storage, and manipulation (Wan and Chen, 2004). An IT-supported performance measurement system can thereby improve several business processes, such as providing managers with proactive decision-support, and facilitate CI (Nudurupati and Bittici, 2005). CI and information systems are interdependent and complementary to each other (Cottyn et al., 2011). The literature also demonstrates that knowledge developed in information system research can be applied in research on performance measurement systems (Marchand and Raymond, 2008). SMEs started to use information systems quite late compared with bigger companies, which is why little research into information system adoption and success focuses on SMEs in particular (Caldeira and Ward, 2002).

There are several guidelines for how to take full advantage of a web-based environment for performance measures. According to Wan and Chen (2004), the following functions should be developed: automatic data collection and interpretation, distributed data storage with a centralized index to capture more detail, distributed computational ability to analyze complex data, and automatic information grouping and display. For SMEs implementing information systems to support performance measurement, the two most important success factors are management’s perspectives and attitudes regarding information system adoption and use, and the development of internal information system competencies (Caldeira and Ward, 2002). Regarding obstacles to implementing information systems supporting performance measurement, data accessibility is identified as important (Bourne et al., 2002).

Still, not all aspects of performance measurement information systems have been explored, and much remains to be learned about current practice (Marchand and Raymond, 2008). This research addresses this lack by illustrating how information systems can be used to improve the communication of performance measures in CI. Only the user perspective is applied when considering the advantages and disadvantages of information systems in communicating performance measures, with a particular focus on SMEs.

The physical communication context refers to the physical place in the manufacturing company where the communication of performance measures is executed. The physical communication context might be, for example, the office area where managers and other white-collar employees have their offices, the shop-floor where blue-collar employees work, or a common area where both white-collar and blue-collar employees spend time. Communication on the shop-floor is important, leading to quick decisions based on facts (Formánek and Maxan, 2015). In addition, shop-floor involvement has proven to be important for performance management, and companies with considerable shop-floor communication execute management practices more effectively than do companies with little such communication (Abdel-Maksoud et al., 2005; Zeng et al., 2013). Shop-floor communication also advances the company’s quality performance (Zeng et al., 2013). Communication on the shop-floor is an
2.7 VISUALIZATION OF PERFORMANCE MEASURES

In communicating performance measures, the visualization of the measures is part of the communication, because how these measures are visualized affects how they are perceived. There are different definitions of visualization, but in this thesis visualization is defined as a visible expression, intended to be shown to a group and not just an individual (Greif, 1991). For example, visualization can be used to present production output as a measure of daily performance, or graphs of the past year’s output can be used to illustrate increasing productivity as a result of CI. Such visualization could show the target, whether output is above or below the target, and the trend of the output.

Visualization has been used for communication for a long time (Lindlöf, 2014). Properly used, it can support problem solving as well as knowledge transfer (Nonaka, 1994; Rieber, 1995). In communication models, such as that of Berlo (1960) shown in Figure 2, visualization can be an important part of both encoding and decoding messages. Visualization supports CI because it can be used as an integral part of the management system to guide the company on its CI journey (Jaca et al., 2013). Through using visual tools and techniques, companies can create powerful and effective guidance systems for production and improvement (Jaca et al., 2013; Parry and Turner, 2006). Guidelines for visualizing performance measures in order to support CI are summarized in Table 2.

| Performance measures should be visualized in all parts of the company |
| CI should be communicated visually |

Table 2. Guidelines for visualization of performance measures supporting CI (Al-Kassab et al., 2013; Jaca et al., 2013; Parry and Turner, 2006).

Although visualization is a powerful tool supporting CI, performance measures need to be visualized in the right way. Bresciani and Eppler (2015) recently undertook a thorough literature review of visualization pitfalls, which they divided into cognitive, emotional, and social pitfalls. While the social and emotional pitfalls are beyond the scope of this paper, the cognitive pitfalls they identified were used to derive guidelines for visualizing performance measures. These guidelines addressed what to visualize, the format of the visualization, and the presentation of the visualization (Table 3).  

| What to visualize: |
| Be aware that visualization generally presents information less precisely than do numbers or tables |
Be aware that a visualization cannot be used in as many ways as can more precise presentations

Be aware that complex relationships may be difficult to understand when presented visually

Be aware of visual conventions (e.g., not everyone reads from left to right, and some visualization might evoke harmful responses)

Only use visualization if the time needed to create the visualization is proportional to the output of the visualization

Group related information together (proximity principle)

Ensure an appropriate fit between the task and the visualization

<table>
<thead>
<tr>
<th>Visualization format:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visualize as simply as possible</td>
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<tr>
<td>Use a clear overall logic or a clear accompanying text</td>
</tr>
<tr>
<td>Use explicit visualizations</td>
</tr>
<tr>
<td>Use colours consistently</td>
</tr>
<tr>
<td>Use colours that all people (including the colour blind) can distinguish</td>
</tr>
<tr>
<td>Do not use cluttered or disturbing patterns (e.g., striped or flickering patterns)</td>
</tr>
<tr>
<td>Use a format that is understandable to the target audience</td>
</tr>
<tr>
<td>Use a format that fits the information</td>
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<tr>
<td>Present only one item per visualization; do not distract from the main goal</td>
</tr>
<tr>
<td>Present data graphically in the same way (i.e. retain the same height, width, and aspect ratio)</td>
</tr>
<tr>
<td>Use simple, understandable, common visual rules and symbols to make the visualization easy to interpret, or signal that the function of the visualization has changed</td>
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<tr>
<td>Use symbols consistently, with the same symbols being used to convey the same kind of information</td>
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<tr>
<td>Point out changes in pictures</td>
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<table>
<thead>
<tr>
<th>Visualization presentation:</th>
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</thead>
<tbody>
<tr>
<td>Include all essential elements in the visualization to avoid misunderstanding</td>
</tr>
<tr>
<td>Omit inessential elements that can make the information cluttered</td>
</tr>
<tr>
<td>Make the presentation interesting to the target audience</td>
</tr>
<tr>
<td>Make it clear that the presentation is open for discussion and improvement</td>
</tr>
</tbody>
</table>

The theory of visualization is a huge area, and this thesis is not intended to add any new knowledge to this area. However, from a brief overview of the visualization of performance measures; it can be concluded that theory gives clear guidelines for what to visualize, what format to use in visualization, and how to present visualizations, all of which can be adapted to the visualization of performance measures. One question in this context is how information systems supporting the communication of performance measures should be designed with these guidelines in mind. This is a question for future research.
CHAPTER 3
RESEARCH APPROACH

This chapter deals with the approach in both the theoretical and empirical parts of this research, and describes how the research has been set up. It also describes how research quality has been ensured. The approach to be applied in planned, future research is described in chapter 7, Future research.

3.1 OVERVIEW OF THE RESEARCH PROCESS

The research summarized here was based on theoretical and empirical studies undertaken within research projects, exploring the communication of performance measures. The basis of the research is performance measurement specifically, identifying communication relating to performance measurement (delimitation arrow 1 in Figure 3). CI is directly addressed in some parts of the research (delimitation arrow 2 in Figure 3), and is sometimes treated as part of the general performance measurement area. This was done because research sometimes includes CI in the general performance measurement area.

![Figure 3. Research delimitation steps.](image)

For each project or part of project in the research, literature reviews and empirical studies together with earlier knowledge have contributed to new understandings of different aspects of the communication of performance measures. The research started in the Pre-study project with a literature review of the communication of performance measurement in general. This was done to obtain basic knowledge in the area, and to set the scene for further research. The focus of the Pre-study project was on getting an overview of the area and of current practice (Figure 4).
Based on the knowledge gained in the Pre-study project, more detailed studies of communication channels and physical communication contexts were undertaken. The focus here was the communication of performance measures, so communication models were addressed in the research. These concepts were reviewed and empirically explored in the 4-company project, part one (Figure 5). The 4-company project, part one also had a theoretical focus on the follow-up of performance, later redefined as part of the communication channels.

In part two of the 4-company project, both theoretical and empirical studies were more detailed as they concerned communication channels and models. This part was complemented by exploring the visualization of performance measures, adapting it to the communication of performance measures (Figure 6).
3.2 THEORETICAL RESEARCH APPROACH

The theoretical part of the research has so far been based on one systematic literature review and several traditional literature reviews.

3.2.1 SYSTEMATIC LITERATURE REVIEW

A systematic literature review (Jesson et al., 2011) was undertaken to cover the theoretical area of the follow-up of performance measures. The systematic review approach was chosen for studying the follow-up of performance measures because it initially appeared to be difficult to gain an overview of this topic, and an objective overview was desired. The systematic review was done in six steps according to the model of Jesson et al. (2011), as follows: 1) scoping review and review plan, 2) comprehensive search, 3) quality assessment, 4) data extraction, 5) synthesis, and 6) write-up.

The first step was a scoping review in the Scopus database, searching for papers on the communication of performance measures by using the terms “performance measurement” and “manufacturing” in any parts of papers since 2000, in order to identify recent papers, and excluding the subject areas “life science” and “health science” as they were outside the target area. The results were divided according to source and, together with two recent literature reviews concerning relevant journals in the area, the four most relevant journals for this area were identified. The next step in the systematic literature review was to formulate the review plan, identifying relevant search words based on the topic. The terms identified were:

- “Performance measurement”, “performance management”, “performance measure” OR “performance measures” searched for in all parts of the paper

- AND “follow-up”, “performance evaluation”, “performance valuation”, “performance assessment” OR “performance communication” searched for in all parts of the paper
• AND “manufacturing” OR “production”, searched for only in the abstract in order to exclude papers not addressing manufacturing.

The search was limited to papers from after 1999 in order to identify recent papers. Based on the results of the first step, the second step was a literature search of identified journals, ending up in a total of 840 papers.

The third step was the manual culling of papers outside the research scope but that had not been excluded during the search. This culling was done in three steps: reading the title of the paper; reading the abstract if necessary; and finally reading the whole paper if necessary. Papers were excluded if they did not address performance measurement, did not address follow-up, or did not address manufacturing. If it was not obvious that the paper was to be excluded, it was passed on to the next step. After this culling, 35 papers remained.

Steps four to six of the systematic literature review were data extraction, synthesis, and writing-up (Jesson et al., 2011). Identified papers were categorized according to three identified differences in the papers: the phase of the performance measurement process on which the paper focused (Bititci and Nudurupati, 2002); whether the paper focused on the performance measurement system, the input to the system, or the output of the system; and whether or not the paper concerned CI.

Many irrelevant papers were identified in the systematic review, probably because many papers concerning information systems and information technology use the key word “communication” while focusing on the technical aspect of information systems. Also, many relevant papers were overlooked in the search, partly because papers in the performance measurement area are published in many different journals and not limited to the four identified journals.

3.2.2 TRADITIONAL LITERATURE REVIEWS

Due to the weakness of the systematic review, the remaining literature reviews were conducted as traditional reviews, in order to explore existing literature on the communication of performance measures (Jesson et al., 2011). Traditional reviews are less rigorous than systematic reviews, but were perceived to find more relevant papers concerning the communication of performance measures. The traditional reviews were conducted by snowballing the results in three ways: following, in one or two steps, where identified papers had been cited; following, also in one or two steps, where identified papers had been cited; and identifying the authors of the identified papers, exploring all other papers by these authors in order to cover the area.

The main sources for the traditional literature reviews were Scopus and WorldCat Beta. Scopus was chosen because it is a database of peer-reviewed research literature in, among others, the scientific, technical, and social science fields, areas relevant to performance measurement. The search results in Scopus were limited to three areas: engineering; business, management, and accounting; and decision science. Results not in any of these areas were deemed not relevant. WorldCat Beta is a broad search engine covering many areas, which is why it was chosen as a complementary database for the literature searches. All search results were also limited to peer-reviewed articles written in English, in order to strengthen reliability and readability.
The search terms were chosen according to the specific aspect of the communication of performance measures that was explored. Search terms used in the theoretical part of each paper are specified in Table 4. A more specific description of the combinations used can be found in appended papers.

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<td>Continuous improvement</td>
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<td>Lean production/lean improvement</td>
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<td>Implementation</td>
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<td>Visual management</td>
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<td>Visual communication</td>
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<td>Visual information</td>
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<td>Strength</td>
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<td>Opportunity</td>
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<td>Enabler</td>
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<td>Advantage</td>
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<td>Challenge</td>
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<td>Problem</td>
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<td>X</td>
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<td>Pitfall</td>
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<td>Hinder</td>
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<td>X</td>
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</table>

Table 4. Summary of search terms used.
All searches were limited to papers published after 1999 in order to identify recent papers; the search results were then snowballed.

### 3.3 EMPIRICAL RESEARCH APPROACH

A qualitative case-study method was used in the empirical part of the research. A case-study “allows investigators to focus on a case and retain a holistic and real-world perspective” (p.4, Yin, 2014). This research sought a holistic perspective on how to support CI efforts in manufacturing SMEs by improving the communication of performance measures, which is why case studies were deemed an appropriate empirical research method. The unit of analysis for this research was the communication of performance measures, and the research was limited to formal communication, i.e., communication between positions within an organization through officially designated channels (Oregon State University, 2017). Three research techniques were used in the case studies: observations, interviews, and a survey:

- **Observations:**
  The purpose of the observations was to collect information that was as objective as possible about what and how performance measures were communicated in the case-study companies. Boards (e.g., bulletin boards or whiteboards) for the communication of performance measures were studied concerning four things: media, content, presentation, and placement. It was studied what kinds of media used for the communication of the performance measures, for example TV screens and whiteboard. The content studied was the specific performance measures that were communicated. The presentation of the performance measures was studied by examining the type of visualization used and how it was used, as well as the placement of the identified communication boards, for example, whether they were placed in a production area, office area, or common area. A risk of observations is that they might intrude on the participants (Williamson, 2002), but because the present research observed only information, that risk could be disregarded.

- **Interviews:**
  Interviewing is a qualitative research technique for gaining an understanding of people from their own point of view (Williamson, 2002), which is why it was important to interview people from different parts of the organization, i.e., both managers and operators. The interviews conducted were semi-structured, consisting of open-ended questions in order to capture the opinions of the interviewees. The interviews were based on a case-study protocol, which was used in order to increase reliability (Yin, 2014). The interviews concerned three topics: performance measurement information, perceived current practice of the communication of performance measures, and the employee’s opinions about current practice. Specifically, information was sought concerning the performance measures used, how they were communicated, and how frequently they were communicated. The first topic was explored in interviews with selected employees in each company, until a complete picture of the topic was achieved. Topics two and three were explored in all interviews, and the questions were adapted to the particular aspect of the communication of performance measures addressed in the particular interview.
Survey:
Surveys are used to collect data from all or part of a population (Williamson, 2002). In this research, surveying was used to collect data from all employees in a specific department of a company. The survey consisted of three parts: scaled questions concerning employee perceptions of different parts of the communication of performance measures; open-ended questions about how employees thought measures should be communicated; and two questions testing the understanding of the performance measures communicated.

In this research, two case studies were conducted: one case-study (the Pre-study project) of eight participating manufacturing SMEs; and one case-study (the 4-company project), conducted in two steps, of four participating manufacturing SMEs.

The Pre-study project was to have been the pre-study of a research project that was ultimately not realized as a full project. To capture companies that were or had been implementing lean production, the Pre-study project was undertaken in collaboration with the Industrial Development Centre West Sweden (IDC) and Produktionslyftet. These organizations support manufacturing companies in their lean production implementation. The study was carried out in eight manufacturing SMEs that, were or had been working with lean production. The data collection techniques used was semi-structured interviews with both managers and operators.

The 4-company project, part one, was conducted as a case-study following the structure advocated by Yin (2014) and applied a two-way communication model based on theoretical findings (Figure 7). The participating companies were manufacturing companies with SME characteristics, selected from a group of companies that were or had been participating in a lean implementation programme. This selection criterion was chosen because these companies were assumed to be likely to measure performance. Four case companies were chosen for the case-study, all manufacturing companies situated in the countryside or in small cities in Sweden, giving them similar geographic contexts. The four case companies are here called Agriculture, Boat, Car, and Home. All companies had fewer than 250 employees; two were privately owned while the other two were parts of bigger corporate groups. The case-study used two data collection techniques: observations and interviews (Yin, 2014). The observation technique was chosen to collect information on existing performance measures that were communicated and on how they were communicated. Interviews were chosen as a data collection technique in order to gain a detailed understanding of how current performance measure communication practices were perceived.

The 4-company project, part two was a case-study carried out using observations, interviews, and a survey. The aim of this case-study was to identify divergences between current practice and theory concerning the communication of CI in manufacturing companies. The case-study was performed at a Swedish manufacturing company with SME characteristics that had been one of the four companies participating in the first part of the 4-company project. The company was chosen because it was the company in the first part of the project that had implemented CI throughout the company, and was also a company that communicated performance measures throughout the company. The case-study was conducted following the suggestions and procedures proposed by Yin (2014), including the use of observation, interviews, and a survey for data collection. The observations were conducted to study the information from the 4-company project, part one in greater depth. Based on the
findings and conclusions of the previous study, a case-study protocol was worked out and interviews were conducted to deepen knowledge of two particular aspects: the visualization of performance measures, and the connection between daily performance measures and CI measures.

3.4 ANALYSIS OF RESULTS

In all projects the empirical results were compared to the literature results, looking for three things: patterns of or ways to categorize current practice, similarities between current practice and theory, and differences between current practice and theory. Based on the patterns and categories identified in current practice, and on similarities and divergences between current practice and theory, the results were conceptualized in the form of conclusions concerning the communication of performance measures, and two models were proposed concerning such communication. The constituent papers of this thesis are mainly related to the projects and to different aspects of the communication of performance measures as presented in Table 5.

<table>
<thead>
<tr>
<th>Project</th>
<th>Contribution, current practice of:</th>
<th>Paper</th>
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<tbody>
<tr>
<td>Pre-study project</td>
<td>Communication of performance measures in general and for CI</td>
<td>Paper 1</td>
</tr>
<tr>
<td></td>
<td>Visual communication of performance measures in general and for CI</td>
<td>Paper 2</td>
</tr>
<tr>
<td>4-company project, part one</td>
<td>Communication channels for communication of performance measures in general and for CI</td>
<td>Paper 3</td>
</tr>
<tr>
<td></td>
<td>Communication channels for communication of performance measures, with a specific CI focus</td>
<td>Paper 3</td>
</tr>
<tr>
<td>4-company project, part two</td>
<td>Visual communication of performance measures, with a specific CI focus</td>
<td>Paper 4</td>
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<tr>
<td></td>
<td>Communication of performance measures in general and for CI</td>
<td>Paper 5</td>
</tr>
<tr>
<td>-</td>
<td>Only theoretical contribution</td>
<td>Paper 6</td>
</tr>
</tbody>
</table>

Table 5 – Contribution of the research projects to the papers.
3.5 RESEARCH QUALITY

To ensure empirical research quality, tests can be conducted of external validity, reliability, construct validity, and internal validity (p. 45, Yin, 2014). For each of these four tests, different case-study tactics were required in order to ensure research quality, adapted to this research as follows:

External validity:

- Use theory in single-case studies
  The 4-company project, part two was a single case-study in which the interviews and the survey were based on theory. The observations were based on the same topics as in the 4-company project, part one, which was a multiple case-study using replication logic.

- Use replication logic in multiple-case studies
  The Pre-study project and the 4-company project, part one were multiple-case studies, both set up in the same way and studying the same things.

Reliability:

- Use a case-study protocol
  For all case studies, case-study protocols were set up to ensure that all parts of each case-study were alike. For the interviews, similarity was striven for concerning the theoretical basis for the interviewers, the questions, how and in what order the questions were asked, and what follow-up questions could be asked concerning certain answers.

- Develop a case-study database
  Results of the observations, interviews, and survey were documented in an Excel spreadsheet. Answers to a question or groups of questions, from a specific company or group of employees, could then be compared and similarities and differences among them could be found.

Construct validity:

- Use multiple sources of evidence
  In all case studies both observation and interviews were undertaken. In the 4-company project, part two, these data collection techniques were complemented with a survey.

- Establish chain of evidence
  The theoretical recommendations for how performance measures should be communicated were the basis for formulating the case studies, observations, interviews, and the survey. Based on the results documented in the case-study database, the results of the empirical study were compared with theory, and conclusions concerning similarities and divergences were drawn.

- Have key informants review the draft case-study report
  Before the results and conclusions were published, the results were presented to the companies. In the 4-company project, part two, the publications were also sent to the company for approval before publication.

Internal validity:
• Pattern matching
The empirical results of the case studies were compared in three ways: 1) with theory, 2) between different case-study companies, and 3) in the 4-company project, both parts, with earlier case studies done.

• Explanation building
This specific variety of pattern matching was not used in the present case studies.

• Address rival explanations
This alternative way of interpreting the findings was not used in the present case studies.

• Use logic models
Based on identified theory, a communication model was presented (Figure 7). The results of the empirical studies were used to formulate a model of the current practice of communicating performance measures (Figure 9). The communication and current practice models were compared and discussed.

Summarizing these research quality tests, it can be concluded that the research has followed a structured methodology throughout. However, the external validity displays some weaknesses. All case studies were conducted in similar companies, and the second part of the 4-company project was conducted in only one company. No similar case studies of manufacturing were found, but one-way to strengthen the external validity in future research would be to look for similar cases in other companies or organizations and conduct further case studies. The results of this research could also be presented to other similar companies not involved in the case studies, to elicit feedback.
CHAPTER 4
SUMMARY OF INCLUDED PAPERS

This chapter summarizes the results of the papers included in this thesis, which mainly addresses research question 1. The research began by looking into the performance measures themselves, and considering how they were communicated. The communication channels were divided into written and oral communication, and were categorized according to the direction of the communication in the organization. The physical communication context was also explored. To gain an overview of the area, visualization theory was explored, applying existing theory of the communication of performance measures. The main contributions of the papers to the different aspects of research question 1 are presented in Table 6. Because the papers trace the development of theoretical and empirical knowledge, different terms are used in the papers, some of them later redefined.

<table>
<thead>
<tr>
<th></th>
<th>State of literature</th>
<th>Current practice</th>
<th>Main challenges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance measures</td>
<td>Papers 1, 5</td>
<td>Papers 1, 5</td>
<td>Papers 1, 5</td>
</tr>
<tr>
<td>Communication channels</td>
<td>Papers 1, 3, 5, 6</td>
<td>Papers 1, 3, 5</td>
<td>Papers 3, 5</td>
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<td>Physical communication context</td>
<td>Papers 5</td>
<td>Papers 5</td>
<td></td>
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<tr>
<td>Visualization of performance measures</td>
<td>Papers 2, 4</td>
<td>Papers 2, 4</td>
<td>Papers 2, 4</td>
</tr>
</tbody>
</table>

Table 6. Contributions of papers to research question 1.

4.1 PAPER 1 (PUBLISHED)

“Performance measurement communication supporting lean production in SMEs”

The first paper established the basis of this research, presenting an overview of existing theory and current practice concerning the communication of performance measures. In this paper, the communication of performance measures in SMEs is divided into three aspects: performance measurement content (i.e., performance measures), performance measurement communication process (i.e., communication channels), and performance measurement communication guidelines (i.e., general theory). This is comparable to the categorisation of a management information system by Nudurupati et al. (2011), who divided the system into three parts: deciding the indicators, implementing the measures, and exploiting the information. In addition, performance measurement systems can, according to Neely et al. (2000), be divided into several parts: designing, implementing, using, and finally maintaining the systems. Looking into product development, Frishammar and Ylinenpää (2007) stated that the information management capability consists of: acquiring, sharing, and using information. The empirical results in the present paper are categorized in the same way as are the theoretical results, highlighting improvements in the different categories of performance measurement communication. By providing concrete
guidelines for each category, this categorization could help SMEs improve their performance measurement communication so that it fits together as a unified entity.

The review also showed that there are frameworks, guidelines, and conclusions regarding specific topics in each area, but that there is a lack of knowledge of the three parts of performance measurement communication as a whole. An empirical study of eight manufacturing SMEs that implemented lean production found that almost all of the case-study companies improved different parts of their performance measurement communication when implementing lean production. The ways performance measurement communication improved differed, but the performance measures and the ways of communicating performance measurements and results became more structured in almost all cases. However, most of the companies were uncertain as to how many or what measures to use, and there was no common way of choosing measures.

In one company the improvement efforts had stopped, and the improvement had consequently deteriorated. This company had not maintained the improvements made in their performance measurement communication, despite taking part in an improvement programme. In this company, management did not prioritize the improvement work, but became stuck in day-to-day business. This indicates that no matter what the improvement programme, management must be engaged in the improvement work to make and maintain improvements in performance measurement communication.

It can be concluded that, despite the existing research into performance measurement and communication, there are no operational guidelines for how to communicate performance measurement, and there is no common way of communicating performance measurement in SMEs. Performance measurement communication guidelines might therefore be useful in supporting lean production in SMEs, which is why it is an area meriting further research.
4.2 PAPER 2 (PUBLISHED)

“Visual communication of performance measures supporting continuous improvement: challenges and opportunities for manufacturing SMEs”

The second paper explores the visualization of performance measures in order to identify relevant aspects that could contribute to research into the communication of performance measures. The theoretical part of this paper highlights a connection between visually communicating performance measures and driving CI, together with the significant strengths using visual communication (Jaca et al., 2013; Eppler and Platts, 2009). The empirical findings presented in this paper, based on a case-study of four manufacturing SMEs, indicate that many manufacturing SMEs do not use visual communication throughout the company and that they do not communicate CI visually. The empirical findings also indicate that not including all essential elements, such as targets, explanations of target line such as if the target is to be above or below, or explanations of axes in graphs, is a common weakness in all four case-study companies. Other identified weaknesses, present in at least two of four case-study companies, are over-complex and cluttered visualizations and guiding conversations in specific directions. Visual communication without any identified weakness was done using whiteboards for daily follow-up in one company. This indicates that daily visual communication can be a strength of SMEs. On the other hand, and even if visual communication is used throughout the same company, the visual communication of company information displays three weaknesses, indicating that visual company communication might be a weakness in SMEs. These identified weaknesses can be seen as challenges, to be overcome in order to succeed in visual communication. The identified strength can be seen as an opportunity for SMEs to succeed in visual communication.

The identified challenges and opportunities were compared with SME characteristics. A typical SME characteristic concerning ownership and management is that SMEs have poor managerial skills. This might negatively affect the use of visual communication, including of CI, throughout a company. Another typical SME characteristic concerning ownership and management is a directive and paternalistic management style, which might have a negative effect in terms of guiding conversations in specific directions. On the other hand, SME managers are highly visible on the shop-floor, which might support the daily visual communication often conducted at the departmental level. Concerning structure, SMEs often have a simple, flat, flexible structure with few layers and flexible information flows. This might support daily visual communication. In the terms of culture and behaviour, SMEs typically have, among other things, a short-term operational focus. This might discourage the use of visual communication throughout the company, and discourage the visual communication of CI. On the other hand, it might strengthen daily visual communication having an operational focus. Concerning systems, processes, and procedures, SMEs often have a low degree of standardization, which might discourage the use of visual communication throughout the company. Finally, concerning human resources, SMEs often have limited resources, which could exaggerate all the identified weaknesses, but also strengths, in visual communication. It can be concluded that all the identified weaknesses and strengths in the visual
communication of performance measures can be connected to specific characteristics of SMEs.

In summary, this paper identifies five challenges and one opportunity facing manufacturing SMEs using the visual communication of performance measures. The identified challenges are: 1) using visual communication throughout the company, 2) communicating CI visually, 3) avoiding over-complexity and cluttered visualization, 4) having a clear logic, and 5) not guiding conversations in specific directions. The only identified opportunity in the visual communication of performance measures in manufacturing SMEs is that of daily visual communication. Being aware of these challenges and opportunities might strengthen manufacturing SMEs in their visual communication of performance measures, supporting CI.
4.3 PAPER 3 (PUBLISHED)

“Communicating continuous improvement in manufacturing SMEs: divergences between current practice and theory”

In the third paper of this thesis, the communication channels for the communication of performance measures are explored in both theory and current practice. Based on the knowledge thus gained, models of the communication of performance measures are defined. From the literature, one can conclude that the communication of CI measures needs to be integrated with the communication of daily performance measures (Figure 7). The empirical findings of this paper, based on a case-study of a manufacturing SME, indicates that such integration was not implemented in the case studied company. Based on these empirical findings, it is postulated that current practice in the communication of performance measures related to daily performance and to CI are two different loops between operators and managers, not integrated with each other (Figure 9).

The results indicate a divergence between theory and current practice concerning how CI is communicated in manufacturing SMEs. Theory recommends that communication of all performance measures be integrated, while the empirical findings of this paper indicate that the communication of performance measures concerning CI and daily performance are not integrated but performed in different communication loops. This divergence could explain why many manufacturing companies fail in their CI implementation. The indications from this case-study need to be tested further to either strengthen or disprove them. In addition, it is interesting to note that all communication of performance measures was conducted using analogue rather than digital communication techniques. The paper also demonstrates that it would be interesting to study whether and how digital IT technology could facilitate communication and potentially alleviate the impact of communication problems.
“How to visualize performance measures in a manufacturing SME”

This paper continues paper 2, further exploring the visualization of performance measures in manufacturing SMEs. The paper identifies strengths and weaknesses in the communication of performance measures and proposes guidelines for the visualization of performance measures supporting CI in manufacturing SMEs, based on a case-study at Boat, an SME that communicates performance measures and that was identified in an earlier case-study in the 4-company project. The goal was to help manufacturing SMEs improve their communication of performance measures, thereby improving performance, and strengthening the company.

Four strengths were identified in the use of whiteboards for daily follow-up: visualizing as simply as possible, using a clear logic, using symbols consistently, and including all essential elements in the visualization. One weakness was identified in the use of whiteboards for monthly follow-up: symbols were not used consistently. When it came visualizing performance measures to support oral presentations, four weaknesses were identified: the visualization was not as simple as possible; colours were not used consistently; symbols were not used consistently; and not all essential elements were included.

The plant is quite small and employees walk past whiteboards for many different departments, which probably increases the need for standardization. Many operators have been working at the plant for a long time. For example, the mean length of service in the department where the survey was conducted was fourteen years. The plant also exhibits SME characteristics such as tacit knowledge, few experts, and close, informal working relationships. These factors probably increase the need for simple visualizations with the clear logic and consistent use of symbols and colours.

Drawing on theoretical guidelines for visualizing performance measures to support CI, the results of the survey were summarized in the form of practical recommendations for improving the visualization of performance measures at the plant:

- Support the visual presentation of performance measures with an oral presentation every time it is updated. The presentation should be substantial, as simple as possible, and short.
- Explain all written elements well, but keep the explanations as simple as possible by avoiding too much information.
- State the topic using simple words that are understood by everyone.
- If mean value results are included, they need to be explained.
- Chose a few visualization tools, for example happy and sad “smileys” and use them consistently.

Manufacturing SMEs can use visualization to strengthen their communication of performance measures, and to support CI. At the studied company there was a need to simplify the visualizations without compromising employee understanding. Possible simplification measures included using symbols and colours consistently, using simple words, and not conveying too much information at any one time.
4.5 PAPER 5 (SUBMITTED)

“Communicating performance measures: current practice in manufacturing SMEs”

This paper takes a holistic view of the communication of performance measures, exploring it as a whole instead of as individual parts. Performance measures are an important part of performance measurement research, being identified as a communication element. Previous studies have established that financial as well as objective and subjective non-financial performance measures improve performance (Lingle and Schiemann, 1996; Van der Stede et al., 2006). This paper identifies current practice in the communication of performance measures in manufacturing SMEs. Identifying this could help fill a knowledge gap, and improved communication of performance measures is a key factor in the successful implementation of performance measurement (Kaplan and Norton, 2001; Ukko et al., 2007a), which in turn is an important factor in improved performance (Davis and Albright, 2004).

The empirical studies presented in this paper were conducted at four manufacturing SMEs, where exploration of the first communication element indicated that these SMEs mainly used financial performance measures. This suggests a divergence between current practice and theory in the use of both objective and subjective non-financial performance measures in manufacturing SMEs. Based on the previously established need for alignment between performance measures and strategy (Bourne et al., 2000), a divergence between current practice and theory is identified concerning clear alignment between targets and strategy in manufacturing SMEs. Previous studies have established that performance measures should have a purpose, relevance, a clear title and definition, and an appropriate target as well as being conveyed visually and in an easily understood way (Bititci and Nudurupati, 2002; Lohman et al., 2004; Neely et al., 1997; Ukko et al., 2007a). The empirical results indicate that many performance measures lack these characteristics, indicating a divergence between current practice and theory concerning the presentation of performance measures.

The second communication element explored in this paper is communication channels. Previous studies have established that oral communication is preferred by employees but lacks permanence (Hertzum and Pejtersen, 2000; Men, 2014), and that written communication is recommended for conveying company information (Byrne and LeMay, 2006). The present empirical findings indicate that manufacturing SMEs use oral communication channels frequently, but that they lack written communication channels aligned with the oral channels. Theory indicates a need for such an alignment (Ukko et al., 2007a), so further exploration of the matter is warranted. Theory also indicates a need for two-way communication in order to improve performance measures (Biron et al., 2011; Bourne et al., 2000; Wouters and Sportel, 2005; Ukko et al., 2007b). The present empirical findings indicate that manufacturing SMEs do not use two-way, vertical communication channels. This suggests a divergence between current practice and theory in using two-way vertical communication channels between managers and employees to improve performance measures in manufacturing SMEs.
The third communication element explored in this paper is the physical communication context. According to previous studies, shop-floor communication improves performance and makes management practice more effective (Zeng et al., 2013). The empirical findings of this paper indicate that manufacturing SMEs engage in considerable communication of performance measures on the shop-floor and have vague boundaries between the shop-floor and office areas. This marks an alignment between current practice and theory.

Poor managerial skills, a result-oriented and short-term operational focus, and limited resources are typical SME characteristics (Ates et al., 2013). The empirical findings do not clarify whether these characteristics might influence the theory-practice divergences in how performance measures are communicated in manufacturing SMEs. Concerning the physical communication context, the alignment between current practice and theory is possibly attributable to typical SME ownership, management, and structural characteristics. However, it should be noted that the communication of performance measures in Boat deviates from that in the other case-study companies. Boat was owned by a corporate group and was steered by many centrally determined guidelines. The present case-study suggests that an SME steered by centrally determined guidelines might not fit ordinary SME specifications concerning the performance measurement area.

The theoretical part of the paper proposes a two-way communication model (Figure 7) exploring three communication elements: performance measures, communication channels, and the physical communication context. The proposed two-way communication model might be used for the further exploration of performance measurement communication.

In this study, three divergences concerning the performance measures communicated are identified: the use of both objective and subjective non-financial performance measures; having a clear alignment between targets and strategy; and the presentation of performance measures. Concerning communication channels, this research indicates a divergence in the use of two-way, vertical communication channels between managers and employees for improving performance measures. Furthermore, also concerning communication channels, this research identifies a need for further exploration of the alignment between written and oral communication channels. In addition, one area of consistency between current practice and theory is identified, concerning the physical communication context.

Typical SME characteristics might influence the identified divergences and the identified consistency between current practice and theory in communicating performance measures in manufacturing SMEs. However, the present research suggests that an SME steered by centrally determined guidelines might not fit ordinary SME specifications concerning the performance measurement area.
**4.6 PAPER 6 (PUBLISHED)**

“Performance measurement follow-up supporting continuous improvement in manufacturing companies: a systematic review”

The last paper explores theory regarding the follow-up of performance measures (i.e. bottom up communication and top down feedback arrows, both shown on the left side of Figure 7). This paper provides a systematic review of existing research into performance measurement follow-up, which so far has been under-examined. The identified papers were analyzed, and then categorized in three ways: where in the performance measurement process according to Bititci and Nudurupati (2002), each paper focuses on; the relationship to the performance measurement system; and whether each paper focuses on performance measurement in general or specifically on CI.

Of the huge amount of performance measurement research, few papers concerning the follow-up phase of the performance measurement process were identified in this systematic review. When further investigating papers on the follow-up phase, it became apparent that the performance measurement system itself is the most examined part of the process, followed by the output of the system. In comparison, Choong (2013) treated inputs and outputs as constituting an information system communicating with the performance measurement system, but did not further examine the matter. The result of paper 6 indicate that relatively few papers explore performance measurement follow-up, and that there is a lack of research into recommendations for the follow-up phase. This finding supports the conclusions of Taticchi et al. (2010), who stated that, for larger companies, future research should address the process of translating information into effective tasks. It can also be concluded that most of the research into the follow-up of performance measurement does not explicitly address CI, but concerns performance measurement follow-up in general. This result might support the opinion of Bititci and Nudurupati (2002) that performance measurement is a CI tool.

This systematic review confirms that there is a lot of research into performance measurement systems (Neely et al., 2005). However, it was very challenging to find research into performance measurement follow-up using a systematic review. This difficulty might be because the wide range of terms used in follow-up, and because the follow-up of performance measures is also treated in, for example, performance management and general management research. Based on this systematic review, it can be concluded that there is a lack of operational level work treating performance measurement follow-up. Although both performance measurement and CI are well-researched areas, research onto performance measurement follow-up supporting CI for manufacturing companies is rarer. This paper contributes by presenting a systematic review summarizing and analysing existing research. The outcome identifies areas for further research, which could help manufacturing companies succeed in CI, increasing their efficiency and strengthening their competitiveness.
CHAPTER 5
RESULTS

In this chapter, results of literature reviews and empirical research are summarized.

5.1 THEORETICAL FINDINGS

Despite all existing research into performance measurement and communication, it can be concluded that there are no operational guidelines for how to communicate performance measurement, and there is no common way of communicating performance measurement in manufacturing SMEs. Performance measurement communication guidelines addressing both the process of communication and the means of communicating, including information systems, could therefore be useful to support CI in manufacturing SMEs. This is clearly an area meriting further research.

To adapt general communication models (e.g., Figure 2) to the communication of performance measures in manufacturing SMEs, a two-way communication model based on theory is proposed in Figure 7. Globerson (1985) stated that performance measures should be communicated in a loop in order to act on divergences between targets and outcome, and Neely et al. (1997) proposed a framework incorporating the follow-up of results based on this loop. This loop of communicating performance measures should focus on and stimulate CI (Kaplan and Norton, 1992; Lynch and Cross, 1992; Medori and Steeple, 2000). The model includes the following two communication channels:

- Performance measures as well as targets concerning all performance measures, both those related to daily performance and those related to CI, can be communicated one-way top down from managers to employees (Bourne et al., 2013; Rapert et al., 2002), as illustrated by the larger top down arrow on the right side of Figure 7. Communication from managers should be complemented with questions and discussions communicated bottom up, making the communication run two ways (Ukko et al., 2007b), as illustrated by the smaller bottom up arrow on the right side of Figure 7.

- Results of performance measures, related to both daily performance and to CI, are communicated from employees to managers one-way bottom up (Bititci and Nurdurupati, 2002), as illustrated by the larger bottom up arrow on the left side of Figure 7. The communication of results should be complemented by discussions, making the communication run two-ways (Ukko et al., 2007b), as illustrated with the smaller top down arrow on the left side of Figure 7.
Figure 7. Theoretical model of communication supporting CI.

This model can be used, in theory, to summarize how performance measures are communicated, and in practice by manufacturing SMEs to show what to strive for when developing or improving the communication of performance measures supporting CI.

5.2 EMPIRICAL FINDINGS

The empirical findings are presented grouped in the same way as was the theoretical foundation: Performance measures; Visualization of performance measures; Communication channels, and Information systems supporting the communication of performance measures. The last part concerning information systems, however, only briefly introduces the area, as it will be the focus of future research.
5.2.1 PERFORMANCE MEASURES

Performance measures were explored mainly in papers 1 and 5, being the parts of the research with an overview of the communication of performance measures. The empirical findings were thus taken from both the Pre-study project and the 4-company project, part two.

All twelve participating companies in both projects had financial measures, and all but one company communicated them. All companies but three also had non-financial measures, although some of the companies had some of these measures even before the lean production implementation. In some companies, the non-financial measures had been extended by typical lean production measures, such as 5S, lead-time, and number of improvement proposals. Most of the companies were uncertain as to what measures they should communicate, or were working on changing what measures to communicate at different levels. A summary of the performance measures used in each company in the Pre-study project is presented in Table 7, and in the 4-company project in Table 8.

<table>
<thead>
<tr>
<th>Company:</th>
<th>A</th>
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<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Non-financial measures</td>
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<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
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</tbody>
</table>

*Table 7. Performance measure content in participating companies*

<table>
<thead>
<tr>
<th>Company:</th>
<th>Home</th>
<th>Agriculture</th>
<th>Boat</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial performance measures were communicated</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Non-financial objective performance measures were communicated</td>
<td>√</td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Non-financial subjective performance measures were communicated</td>
<td>√</td>
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<td>√</td>
<td></td>
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</table>

*Table 8. Financial and non-financial performance measures communicated in the four studied companies.*

The 4-company project looked into whether strategy, targets, and results were communicated and, if so, whether they were aligned. In Home there was no clear strategy, but an overall focus on producing as much as possible. Two case-study companies, i.e. Agriculture and Car, communicated strategy but not targets, while Boat communicated strategy and targets, which were aligned. All companies communicated results. In Agriculture and Car, the managers saw a need to improve the communication of targets, while the managers in Home had divergent opinions on this matter. The communication of strategy, targets, and results is summarized in Table 9.
<table>
<thead>
<tr>
<th>Company:</th>
<th>Home</th>
<th>Agriculture</th>
<th>Boat</th>
<th>Car</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy was communicated</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Targets were communicated</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Results were communicated</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Alignment between strategy and targets</td>
<td></td>
<td></td>
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</table>

*Table 9. Communication of strategy, targets, and results in the four studied companies.*

Additionally, in the 4-company project, part two, all operators in one department were surveyed. Two questions were asked: 1) In your view, are the CI targets connected to the daily performance targets at the company level? 2) In your view, are the CI targets connected to daily performance targets at the department level? The responses ranged from 1 to 6, with 1 being “No, not at all” and 6 being “Yes, clearly”. Of the 22 potential respondents, 20 answered the questions. The resulting mean value concerning the connection between improvement targets and control targets was 2.9 at the company level, and 3.7 at the department level. The conclusion is that the operators see some connections, but not clear ones, between CI targets and daily performance targets. The results are presented in Figure 8.

*Figure 8. Survey results concerning the connection between CI targets and daily performance targets at the Boat plant.*

The empirical findings indicate that manufacturing SMEs communicate performance measures, but that these measures are mainly financial. In addition, the findings
indicate that manufacturing SMEs do not communicate a clear alignment between strategy and targets, or between CI targets and daily performance targets.

5.2.2 COMMUNICATION CHANNELS

Communication channels are connected to many aspects of the communication of performance measures, which is why they were treated in all empirical studies and in the empirical parts of papers 1, 3, and 5. The first paper gave an overview of different types of communication channels used in the companies, while papers 3 and 5 explored the communication channels in greater depth.

In the Pre-study project, all but one of the studied companies had production bulletin boards installed where meetings were held to discuss production information and follow-up. All bulletin boards but one were in the production areas, and the last company was about to move its bulletin board there. Three of the companies also provided written information to their employees by other channels, either via TV screens, Intranet, or information papers. The communication channels explored in the Pre-study project are summarized in Table 10.

<table>
<thead>
<tr>
<th>Company:</th>
<th>A</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Production bulletin boards</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Production bulletin boards in the production area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Other written performance measurement information</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</table>

Table 10. Written communication channels in the companies examined in the Pre-study project.

Five of eight companies in the Pre-study project had daily follow-ups, often consisting of short-term follow-ups, actions addressing deviations, and other near-time information. Four of the companies held weekly production meetings, while one company held a production meeting every second week. Five of the companies also held monthly meetings in larger groups for the one-way dissemination of information. One company held no structured meetings, but gave its employees information orally and sporadically. This company had started holding monthly meetings, but after some months the meetings lapsed. The meeting frequency for the communication of performance measures in the Pre-study project is summarized in Table 11.

<table>
<thead>
<tr>
<th>Company:</th>
<th>A</th>
<th>B</th>
<th>C</th>
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<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily production meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Weekly/every other week production meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Monthly information meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Table 11. Communication meetings in the companies in the Pre-study project.

In studying communication bulletin boards in the 4-company project, the focus was on Boat, because it had developed channels for communicating performance measures that merited study. At Boat, one information board for control indicators and one
information board for improvements were identified in each department. A middle manager at Boat said that they focused on one information board at a time during the meetings. This indicated that improvement indicators and control indicators were followed up and communicated in separate loops. The company communicated a CI target for the number of improvements per employee and year, following up on it monthly. This CI target was chosen in order to direct attention towards CI and get CI activities started. The company also followed up on the cost saving resulting from CI, although this was not frequently communicated. The connection between CI and control indicators was identified as weak. There was a company CI target, which was the same target as at the department level. No connections between other company targets and CI could be identified.

When conducting a survey concerning the connection between CI and control indicators, answers from managers were univocal: CI improved performance, but the connection between CI and control indicators was unclear, and the control indicator results could not be clearly traced back to CI. The main contribution of CI, according to a middle manager, had been in the area of quality improvement. Both upper and middle managers believed that the connection between CI and control indicators was weak, and needed to be strengthened. According to the plant manager, the main reason for not integrating the measures was to make it simple to work with and follow up on CI.

In the 4-company project, part two, all companies conducted oral one-way, top down communication of performance measures. In two companies, i.e. Home and Agriculture, there were no connections between the one-way oral communication channels and the written communication channels, and in those companies the written communication channels were used by managers but less frequently by other employees. Agriculture had almost no written communication channels. Boat had simultaneously designed oral and written communication channels for performance measures, and its employees frequently used both these channels. Boat also had two-way communication to improve performance measures, while the other companies, i.e., Home, Agriculture, and Car, had no two-way communication for improving performance measures.

The empirical findings indicate that most manufacturing SMEs had daily or weekly follow-ups of performance measures. They also indicate that two-way communication for improving performance measures is rare, and that oral and written communication channels for communicating performance measures are not aligned with each other. Finally, the empirical findings indicate that different communication channels are used for the communication of performance measures concerning daily production and CI, respectively, as illustrated in Figure 9.
5.2.3 INFORMATION SYSTEMS SUPPORTING COMMUNICATION

Empirical studies targeting information systems for the communication of performance measures were not included in the Pre-study project. In the 4-company project, parts one and two, these information systems were addressed, but were not the focus of the project. The 4-company project found that all four studied companies wanted performance measure follow-up to be simple, which is why they mostly conducted it manually. One of the companies was very strict about not having any information system that could serve as a barrier blocking operators from communicating results or getting information. When asked about how an information system could act as a barrier, examples such as having to log into or start up systems, or not knowing how to handle programmes were cited. In another company, a manager claimed that the operators were not skilled enough to handle information systems for the communication of performance measures. In all four companies, oral communication between managers was cited as an example of current dissemination practice concerning the results of performance measures. The empirical findings thus indicate that information systems do not seem to be used for the communication of performance measures, and that there seems be a fear of complex systems not adapted to all employees. An information system supporting the communication of performance measures should retain the simplicity of a manual system, while incorporating the potential strengths of an information system.
5.2.4 PHYSICAL COMMUNICATION CONTEXT

The physical communication context of the communication of performance measures in manufacturing SMEs was explored in the 4-company project part one and reported in paper 5.

In Home, the oral and written communication of performance measures was executed both on the shop-floor and in the office area, and managers were highly visible on the shop-floor. In Agriculture, the oral and written communication of performance measures was executed in the common lunch-room. Managers in Agriculture often visited the shop-floor, and blue-collar employees often visited the office area. In Boat, most oral and written communication was executed on the shop-floor or in an office area next to the shop-floor; managers often visited the shop-floor and blue-collar employees sometimes visited the office area. Both the oral and written communication of performance measures in Car was executed on the shop-floor. The empirical study found almost no boundaries between the office area and the shop-floor in the case-study companies, and found that managers and other white-collar employees frequently visited the shop-floor. Current practice was thus found to be in accordance with the literature, in that performance measures were communicated near the operators’ work locations. Because this was not identified as a challenge in the paper, the matter was not explored further.

5.2.5 VISUALIZATION OF PERFORMANCE MEASURES

The visualization of performance measures was the focus of two papers from the 4-company project, papers 2 and 4. Four manufacturing SMEs were explored, Agriculture, Boat, Car and Home.

In Home, performance measures were visually communicated in two ways: on-line on screens in the production area and on computers in offices, and on whiteboards in the production area. The on-line communication of performance measures was presented as written sentences conveying the outcome, with the figures being highlighted in ten different colours. Production results were presented as the remaining percentage of the daily target, divided into different parts of the production, with alternating rows of text presented in white and grey. Production lines not producing at the moment were shown in red, and one line was yellow (it was not explained why and the employees interviewed did not know why). In the on-line computer presentation it was possible to explore the data in greater depth and get more information. A middle manager said that the on-line visual communication of performance measures was not used by operators and middle managers, and that it did not add anything. An operator claimed that the on-line communication of performance measures did not actually convey anything.

Production results were posted on whiteboards in the production area in Home, five tables and four graphs being presented on a single A4 sheet. The tables presented production results per shift and per day, and some of the data were also presented as graphs. One manager thought that the communication worked well, another thought that not everyone needed to know everything, and yet another saw a need to communicate targets via the visual communication of performance measures, which was not done at the time of the study. The identified weaknesses of this visual communication, in Bresciani and Eppler (2015) terms, were that the presentations...
were over-complex and cluttered, showing both tables and graphs for the same performance measures, and presenting too much information on the same page. The visualization also omitted essential elements, in that it did not visualize targets in the graphs and tables posted on the whiteboards. Based on the strengths of visual communication (Bititci et al., 2015; Jaca et al., 2013; Eppler and Platts, 2009), two main weaknesses were identified: visual communication was not used in all parts of the company, and CI was not communicated visually (Table 12).

<table>
<thead>
<tr>
<th>Area</th>
<th>Identified strengths</th>
<th>Identified weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-line communication</td>
<td>Possible to get more information from the computerized information</td>
<td>Production results presented as the remaining percentage of the daily target; very unclear</td>
</tr>
<tr>
<td>What to visualize</td>
<td></td>
<td>Not used throughout the company</td>
</tr>
<tr>
<td>Visualization format</td>
<td></td>
<td>Unclear and inconsistent colouring</td>
</tr>
<tr>
<td>Visualization presentation</td>
<td></td>
<td>No targets included</td>
</tr>
<tr>
<td>Whiteboards in production area</td>
<td></td>
<td>Unclear headings</td>
</tr>
<tr>
<td>What to visualize</td>
<td>Production results</td>
<td>Disagreement among managers about the need CI not visualized</td>
</tr>
<tr>
<td>Visualization format</td>
<td>Tables and graphs</td>
<td>Very small graphs and tables</td>
</tr>
<tr>
<td>Visualization presentation</td>
<td></td>
<td>Over-complex and cluttered</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not all essential elements included (i.e. targets)</td>
</tr>
</tbody>
</table>

*Table 12. Identified visualization strengths and weaknesses in Home.*

In Agriculture, performance measures were visually communicated one-way: visual communication supporting the oral communication of performance measures, also posted on a whiteboard in the lunch-room. The visual communication was presented in figures and graphs. A manager thought that the communication “should not be too complicated”, and white-collar workers and operators thought that it was simple to understand the monthly presentations. Style, colours and language varied between the graphs. A manager commented on the visual communication, saying “I would like it a bit stricter and more formalized, actually”. Three of the company targets were followed up in graphs. On the whiteboard, there was also a list of the company’s financial targets, certain topics also covered in the graphs, and some other topics. Besides the financial targets, there was a list of improvement activities. Identified weaknesses in Agriculture, in Bresciani and Eppler (2015) terms, were the omission of essential elements (i.e., specification of axes of graphs), visual communication not being used throughout the company, and CI not being communicated visually (Table 13).
<table>
<thead>
<tr>
<th>Area</th>
<th>Identified strengths</th>
<th>Identified weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteboards in the lunch room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What to visualize</td>
<td></td>
<td>Not used throughout the company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CI not communicated visually</td>
</tr>
<tr>
<td>Visualization format</td>
<td>Simple</td>
<td>Inconsistent style and colours</td>
</tr>
<tr>
<td>Visualization presentation</td>
<td></td>
<td>Not all essential elements included</td>
</tr>
</tbody>
</table>

Table 13. Identified visualization strengths and weaknesses in Agriculture.

In Car, performance measures were visually communicated in one way only, in a visual presentation posted on an information board at the entrance to the production area. It was a follow-up on discarded products presented as a graph. One operator saw a need for discarded products in relation to production that was not presented, while another saw no need for any written communication at all. Managers focused on improving performance measures, and did not have any opinion about the visual communication of performance measures. Based on visual communication theory (Bititci et al., 2015; Jaca et al., 2013; Eppler and Platts, 2009), three weaknesses were identified: not including all essential elements in the visualization (i.e. the target), visual communication not being used throughout the company, and CI not being communicated visually (Table 14). The visualization format was impossible to evaluate due to the lack of visualization.

<table>
<thead>
<tr>
<th>Area</th>
<th>Identified strengths</th>
<th>Identified weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information board at the entrance to the production area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What to visualize</td>
<td></td>
<td>Not used throughout the company</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CI not communicated visually</td>
</tr>
<tr>
<td>Visualization format</td>
<td>(Impossible to evaluate)</td>
<td></td>
</tr>
<tr>
<td>Visualization presentation</td>
<td></td>
<td>Not all essential elements included</td>
</tr>
</tbody>
</table>

Table 14. Identified visualization strengths and weaknesses in Car.

In Boat, performance measures were visually communicated in three ways; whiteboards for daily visual communication, whiteboards for monthly visual communication, and on-line visual communication supporting the monthly oral presentation of performance measures. All performance measures were communicated visually, divided at the company, department, and working-group level. This company was chosen for a deeper study of the visual communication of performance measures.

The whiteboards used for daily visual communication in Boat visually presented each target per day, with green indicating that the target had been reached, and red that it
had not; and if the colour was red, a comment was added. One manager said that “we are explicit when we communicate, at least on our whiteboards”. Employees were well aware of this visual communication and found it easy to understand, simplified but not simplistic. The visualization quality was kept in mind when preparing the presentations, and resources had been put into logically organizing the visualized performance measures in a clear, simple way. The templates and organization of the visual communication on whiteboards were the same for all performance measures. Several strengths were identified in this visual communication, in Bresciani and Eppler (2015) terms, such as simple visualization, including all essential elements in the visualization, using symbols consistently, and having a clear logic.

The whiteboards for the monthly visual communication of performance measures in Boat included more information than did the daily boards. They presented graphs showing the trends over the year, including the targets. The same template was used for all graphs, but some graphs used a smiley to explain on what side of the target line the results should be, some graphs used an arrow to show it, and in some graphs it was not shown. Operators said that they were not used to read such visual communication, and did not see any need for it. Middle managers and managers appreciated the monthly follow-up and the fact that it showed trends (facilitating actions if results were declining), seeing it as a complement to the daily visual communication. Based on the theoretical guidelines, several strengths were identified in the monthly visual communication, such as visualizing as simply as possible, using a clear logic, and including all essential elements in the visualization. One weakness was identified in this visual communication, in Bresciani and Eppler (2015) terms, i.e, not using symbols consistently.

The last type of visual communication used at Boat was visual communication supporting the oral communication of performance measures. The template for the visual presentation had a coloured line and the company name in three places on each page. In the presentation, both a table and a graph concerning the same topic were shown on the same page. Targets were shown in some of the tables and graphs, and the colours red, green and yellow were used in the tables (the rationale was unexplained). Smileys and coloured “thumbs-up” or “thumbs-down” symbols were used to visualize on what side of the target line the results should be, and middle managers, white-collar workers and operators believed that these symbols increased the understandability. Operators said that they did not understand the pictures themselves, but needed an explanation of what to look for and what conclusions to draw. One operator explained that the understandability came from the manager giving the presentation and not from the visual communication, while another operator admitted “I actually have a very hard time understanding this”. Among the managers, middle managers and white-collar workers, the opinions were divergent. One said that the visualization was good, while another claimed that it was far too complex and should be much simpler. Yet another said that the visual communication was understandable, but that it was probably too complex for the operators. The weaknesses identified were over-complex presentations with cluttered visualization (in the template and use of colours), not including all essential elements (e.g., targets and specifying the axis in graphs), and inconsistent use of symbols (e.g., smileys and thumbs) (Table 15).
The opinion of Boat employees was that the visual presentations were understandable and easier to follow than purely oral presentations. However, they indicated that joint oral and written presentations would improve understanding. The same point was made in response to the open-ended questions, with the most common answer being that all performance measures (i.e., both important performance measures and the performance measures management wants workers to understand) should be presented both orally and in writing. Concerning the understanding of performance measures, the most common answer was that the presentation should be simple, clearly explained, and not include too much information. However, many employees also said that they did not know how to make the visualizations of performance measures easy to understand. Concerning understanding the performance measures, the targets and the target achievement were well understood, while the topic that the presentation was about was not as well understood.

<table>
<thead>
<tr>
<th>Area</th>
<th>Identified strengths</th>
<th>Identified weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteboards for daily visual communication</td>
<td>Used throughout the company</td>
<td></td>
</tr>
<tr>
<td>What to visualize</td>
<td>Simple visualization</td>
<td>Symbols not used consistent</td>
</tr>
<tr>
<td>Visualization format</td>
<td>Symbols used consistently</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clear logic</td>
<td></td>
</tr>
<tr>
<td>Visualization presentation</td>
<td>Includes all essential elements</td>
<td></td>
</tr>
</tbody>
</table>

| Whiteboards for monthly visual communication | Used throughout the company          | Symbols not used consistent            |
| What to visualize                        | Simple visualization                  |                                        |
| Visualization format                     | Clear logic                           |                                        |
| Visualization presentation               | Includes all essential elements        |                                        |

| Visual communication supporting monthly oral communication | Over-complex                          |
| What to visualize                                     | Cluttered                             |
| Visualization format                                  | Inconsistent use of symbols           |
| Visualization presentation                             | Not all essential elements included   |

Table 15. Identified visualization strengths and weaknesses in Boat.
Summarizing the results concerning the visualization of performance measures, it can be concluded that there is a divergence between current practice and theory. Many manufacturing SMEs do not use visual communication throughout the company, do not communicate CI visually, use over-complex and cluttered visualization, and do not always have a clear logic.
CHAPTER 6
DISCUSSION AND CONCLUSIONS

This chapter discusses the results of the research and presents conclusions divided into two areas: identified divergences between current practice and theory, and main challenges for manufacturing SMEs wanting to succeed in the communication of CI.

6.1 DISCUSSION

Succeeding in CI is important for manufacturing companies, so that they can gain or sustain competitive edge in a highly globalized world. Implementing or improving CI is a common way to increase competitiveness (Hyland et al., 2007). This means, for example, improving productivity, ensuring quality, and increasing delivery reliability (Hyland et al., 2007). To succeed in CI, the communication of performance measures that support CI is an important factor (Bakås et al., 2011; Dora et al., 2013; Zhou, 2012).

Based on literature and empirical findings, seven deviations concerning the communication of performance measures supporting CI in manufacturing SMEs were identified, divided according to the theoretical communication model presented in Figure 7:

1. **Performance measures - using both financial performance measures as well as objective and subjective, non-financial performance measures**
   This research identifies divergences between current practice and theory concerning the use of both objective and subjective non-financial performance measures. The literature demonstrates that both financial performance measures and objective as well as subjective, non-financial performance measures should be used, while this research indicates that financial measures are still dominant in manufacturing SMEs.

2. **Performance measures - aligning performance measures with strategy and targets**
   The literature identifies the need for a clear alignment between performance measures, targets, and strategy, while this research notes that manufacturing SMEs often do not align performance measures with targets and strategy.

3. **Performance measures & communication channels – integrating the communication of performance measures concerning daily performance and CI**
   The literature identifies the for a clear alignment between performance measures concerning daily performance and concerning CI, and notes that the communication of performance measures concerning daily performance needs to be integrated with the communication of performance measures concerning CI. This research indicates that the performance measures and the communication of them are not integrated, but are implemented without clear connections between them. This divergence could explain why many manufacturing companies fail in their CI implementation.
4. **Communication channels - two-way communication channels between managers and operators**
   This research indicates a divergence between managers and employees in the use of two-way communication channels to improve performance measures. The literature identifies a need for two-way communication, while this research finds that much performance measurement communication between managers and operators is one-way.

5. **Communication channels – Aligning oral and written communication**
   This research indicates a need to align the oral and written communication of performance measures. The literature recommends clear communication which is supported by an alignment, and the empirical studies supports the need of it.

6. **Information systems supporting communication – Exploring ways of using information system to support communication of performance measures**
   This research finds that the communication of performance measures is mainly analogue, and that manufacturing SMEs might be avoiding information systems supporting the communication of performance measures due to a fear of complexity. Exploring ways of using information systems to support the communication of performance measures, and exploiting the potentials of such systems without losing the advantages of analogue communication, could be a way of supporting CI in manufacturing SMEs.

7. **Visualization of performance measures - Using and optimizing visual communication**
   For manufacturing SMEs using the visual communication of performance measures, four challenges are identified: 1) using visual communication throughout the company, 2) communicating CI visually, 3) avoiding over-complex and cluttered visualization, and 4) having a clear logic. These challenges are identified as needs in theory, and at the studied company there was a need to simplify the visualizations without compromising their understandability. Possible simplification measures included using symbols and colours consistently, using simple words, and not including too much information.
6.2 CONCLUSION

SMEs have different characteristics from those of larger companies (Table 1) and therefore need to adapt their working methods to their characteristics. The main challenge in this may be supporting CI efforts in manufacturing SMEs, by improving the identified divergences in the communication of performance measures and adapting these efforts to these companies. Having concluded that the current communication of performance measures in these companies is largely analogue, and in order to facilitate the communication of performance measures, in future research we will study whether and how information systems can support the communication of performance measures in manufacturing SMEs.

Research question 1 was: ”What are the main challenges in the communication of performance measures supporting continuous improvement?” Answering this question requires identifying the challenges facing manufacturing SMEs concerning the communication of performance measures supporting CI. The main such challenges can be summarized as follows:

1. Using both financial performance measures as well as objective and subjective, non-financial performance measures
2. Aligning performance measures with strategy and targets
3. Integrating all communication of performance measures in the same communication loop; incorporating communication related to both daily performance measures and to CI.
4. Forming two-way communication channels between managers and operators
5. Aligning oral and written communication channels
6. Exploring how information systems could facilitate the communication of performance measures
7. Using and optimizing the visual communication of performance measures

By identifying these challenges, the research question is regarded as having been answered.
CHAPTER 7
FUTURE RESEARCH

This chapter describes a possible avenue for ongoing research in this area.

7.1 CONTINUATION OF THIS RESEARCH

The research performed for this thesis has mainly endeavoured to answer research question 1, while research question 2 remains to be addressed. Future research will explore how information systems (IS) can be used to improve the communication of performance measures in CI, still in the context of manufacturing SMEs. A literature review of how IS could support such communication will be carried out, to build theoretical knowledge. This will then be related to current practice, which will be explored in a case-study deepening current knowledge of current practice. The aim of this future research is to propose how IS could improve the communication of performance measures in manufacturing SMEs, a matter that will also be validated. The plan is to improve our knowledge of the communication of performance measures supporting CI, as supported by IS. Together with improved knowledge, this work will yield practical guidelines for the communication of performance measures, connecting this with process level information flow. A visualization of the research plan is shown in Figure 10.

Figure 10. Plan for future research.
7.2 CONTRIBUTION

The proposed research will improve our knowledge of how to overcome challenges in the internal communication of performance measures, and of how IS can support such communication in manufacturing SMEs. These findings will take the form of practical guidelines on how such companies can overcome the identified challenges. The intended theoretical contribution is an improved understanding of how general knowledge of performance measurement and internal communication might be adapted to the communication of performance measures in manufacturing SMEs, supported by IS.

7.3 NEED FOR FURTHER RESEARCH

This thesis focuses on the communication of performance measures supporting CI in manufacturing SMEs. As described, the use of information systems, as well as the challenges facing other types of companies or organizations, merit exploration. These other companies or organizations might be larger manufacturing companies or even companies outside the manufacturing sector.
CHAPTER 8
REFERENCES


continuous improvement: Are they linked to manufacturing strategy?", 


Psychogios, A. G., Atanasovski, J., Tsironis, L.K. (2012), "Lean six sigma in a service


Ukko, J., Karhu, J. and Rantanen, H. (2007a), "How to communicate measurement


INCLUDED ARTICLES
CHAPTER 9
INCLUDED ARTICLES
The following articles have been published during my licentiate studies or are under review


ABSTRACT
PURPOSE
The aim of this paper is to provide an overview of the current status of performance measurement communication to support lean production in SMEs.

DESIGN/METHODOLOGY/APPROACH
The paper is based on theoretical and empirical studies. A literature review of existing research in performance measurement communication, focusing on lean production in SMEs, was carried out. The empirical part is based on interviews with both managers and operators in SMEs in the south of Sweden working with lean production. Twenty-four interviews in eight companies/plants were carried out.

FINDINGS
The paper provides a structured overview of current research in performance measurement communication. Performance measurement communication was categorised into three parts, which taken together could support lean production implementation in SMEs. It can be concluded that, although all existing research in performance measurement and communication, there is no operational guideline of how to communicate performance measurement. From the interviews it can be seen that the companies have improved their performance measurement communication during the lean production implementation, but that there is no common way of communicating performance measurements in SMEs.
1. INTRODUCTION

There are over 20 million small and medium-sized enterprises (SMEs) in Europe which represent 99% of business and are a key driver for economic growth (European Commission, 2013). The headcount criterion for an SME is according to the European Commission (2005) a company with less than 250 employees. A popular way for SMEs to meet the tough competition on the global market is to implement lean production, but despite the well-known theory only a few SMEs succeed in their lean production implementation (Bhasin, 2012, Nordin et al., 2012, Tiwari et al., 2007).

Matt and Rauch (2013) mean that there is a need to do research in lean production specifically for SMEs, since these have other prerequisites then bigger companies. The likelihood for lean production implementation is strongly affected by the plant size, where smaller plants are less likely to implement lean production (Shah and Ward, 2003). The authors also conclude that implementation of lean production practices contribute substantially to the operating performance of plants, and that not implementing lean production is likely to put plants at a performance disadvantage.

There are several different factors that have shown to be important for a successful lean production implementation, where two of them are performance evaluation and communication (Bakās et al., 2011, Hilton and Sohal, 2012, Kumar et al., 2009). Performance measurement is a well-researched area, and several performance measurement system (PMS) frameworks are proposed (Anand and Kodali, 2010, Cocca and Alberti, 2010, Jayaraman et al., 2012). Communication is identified as important for lean production implementation both in general and as communication of specific topics (Alaskari et al., 2013, Bakās et al., 2011, Jayaraman et al., 2012, Laureani and Antony, 2012). The combination of performance measurement and communication, i.e. performance measurement communication, is an area where increased knowledge could support lean production in SMEs.

The research in performance measurement communication on operational level is rare concerning SMEs (Ukko et al., 2006), and SMEs need to develop their internal communication process (Ates et al., 2013). This article tries to increase the knowledge in performance measurement communication for SMEs, focusing on current status of performance measurement communication in SMEs, in research as well as in companies. This paper tries to answer the question: What is the current status of performance measurement communication in SMEs? An answer to that question will support lean production in SMEs, and strengthen SMEs on the global market.

2. METHOD

The theoretical part of this paper consists of a traditional literature review (Jesson et al., 2011), covering performance measurement communication with a focus on SMEs. The review consists of peer-reviewed articles from four different databases: Google Scholar, WorldCat Beta, Scopus and Inspec. The search terms chosen from the beginning were performance measurement and communication. Since these are well-researched areas, they gave a huge amount of search hits. Therefore they were complemented by either one or both of the terms lean production and implementation. For even more specific hits the term SME was added, which gave few but very relevant hits. All terms were also used in different forms, and complemented with synonyms.
The result was then categorised based on content. The papers were summarised and papers and themes were compared and contrasted.

The empirical study was made in the research project PEXiSME, production excellence in SMEs. To reach companies that are or have been implementing lean production the empirical study was done in collaboration with Industrial Development Centre West Sweden (IDC), and Produktionslyftet. These organisations support manufacturing companies with their lean production implementation. The study was carried out in eight different SMEs that are or have been working with lean production, and consist of interviews with twenty-four employees in the companies, both managers and operators. The persons that were interviewed were asked open questions about leadership in the company, the improvement work and the employee participation in that, and were also asked questions about performance measurement and its communication in the company. Since the information was collected by interviews, the results from the empirical study are based on what answers the interviewees gave when they were asked. Therefore, it cannot be certain that the information is totally complete.

3. RESULTS FROM THE LITERATURE REVIEW

3.1 CATEGORIES OF PERFORMANCE MEASUREMENT COMMUNICATION

When existing literature was mapped out, the content could be categorised into three different categories. The first category involves the containment of the information that is communicated: what performance measures to use, and specification of how the measures should be designed. This category of performance measurement communication covers the information that is communicated, and is named *performance measurement content*. The next category identified was related to the way the communication is done. This includes both if the communication is written or oral, by whom it is communicated, and the frequency of the communication of the performance measurement. This category is named *performance measurement communication process*. The last category concerns different best practice for performance measurement communication. It includes presumptions for performance measurement communication, guidelines for communication between different parts or levels in the company, and some general communication guidelines. The category is named *performance measurement communication guidelines*.

Since PMS is a huge research area, and not the focus of this paper, the performance measurement content was not explored in-depth, but a draft overview was made of the first category. The performance measurement communication process and the performance measurement communication guidelines were more thoroughly reviewed.
3.2 PERFORMANCE MEASUREMENT CONTENT

Concerning the performance measurement content, Neely et al. (1997) have made a thorough literature review. It is a summary of recommendations of performance measures, and concludes them into ten elements that seek to specify what a good performance measure constitutes. That is: 1) a clear title of the measure, 2) the rationale underlying the measure, 3) the business objectives to which the measures relates, 4) an appropriate target for each measure, 5) formula – the way to measure the performance, 6) the frequency with which performance should be recorded and reported, 7) the person to measure, 8) the source of the raw data, 9) the person who should act on the data, and finally 10) the management process that will be followed depending on if performance appear to be either acceptable or unacceptable. In addition to this review, several authors see the disadvantages with financial indicators. The reasons are that they are inadequate (Nudurupati et al., 2011), they give misleading signals (Kaplan and Norton, 1992) or that they are insufficient to gauge business performance (Kaplan and Norton, 1996). Van der Stede et al. (2006) even conclude that organisations with extensive performance measurement systems that included both subjective and objective non-financial measures achieve higher performance than others. Also Kennerley and Neely (2002) mean that having both financial and non-financial performance indicators is important for the PMS. Maskell (1991) summarizes the characteristics of key performance measures for world class manufacturing companies. He means that there should be different measures for different areas of the company. Bilalis et al. (2002) mean that the information should provide: a clear vision of the job, target method and restrictions, a measure, results (absolute and against target) and managerial support. Ukko et al. (2006) mean that the quality of the information is important, and has a strong influence on the success of the target communication. Later Ukko et al. (2007) specify that it is the exactness, reliability, intelligibility and usefulness of the measures that is important. Some authors discuss the management information system (MIS). Garengo et al. (2007) mean that performance measurement require a MIS to support collection, processing and delivery of performance data. Bourne et al. (2002) mean that the difficulty of implementing the performance measures is caused by inappropriate information from the MIS.

The linkage between different measures is another important part of the performance measurement content. According to Amaratunga and Baldry (2002) compensation, reward and recognition should be linked to performance measures. Ukko et al. (2009) state that two of the most important factors to succeed with operative level performance measurement are the linkage of performance measurement to reward, and the understanding of the linkage between the individual’s target and the organisations’ targets.

3.3 PERFORMANCE MEASUREMENT COMMUNICATION PROCESS

The second category of performance measurement communication is the performance measurement communication process. Ukko et al. (2007) make references to an article in Finnish by Åberg (1997), where the internal communication is divided into three groups. These groups are: face-to-face communication, written communication and electronic communication. According to Ukko et al. (2006) the best success in target communication is achieved if information is communicated face-to-face. This com-
munication can be supported by some system communication, but the authors mean that for SMEs electronic communication is just a waste of resources. They continue by saying that for SMEs face-to-face communication can be supported by hand-outs and noticeboards. Later Ukko et al. (2009) state that the interactive communication is one of the most important factors that influence the operative level performance measurement.

Gama and Cavenaghi (2009) point on the importance of visual management. They propose a communication model of the vision and strategic objectives of the organisation, facilitated by the visual management and provided by an A3 report. Parry and Turner (2006) look into the mode of communicating, and mean that visual management systems act as an extension to metrics, and must be kept simple. They also state that only information which adds value to the management of the process should be displayed, and teams using the board must not be tempted to display information just because it is to hand. A colourful physical visual control system should be developed where possible, and tidying up and moving the system to an electronic version should be avoided. Further, Parry and Turner (2006) mean that the core visual tool is value stream mapping, but also mention 5S, andon boards and standard work charts as visual tools. These should according to the authors be displayed with key measures, since visualisation is central to communication. Finally, concerning the mode of communication, Bilalis et al. (2002) make some guidelines for the visual management. They mean that the best visual aids include graphical presentation, pictures, posters, schematics, symbols, transparencies and colour coding, the last which can be enhanced with audio signals.

3.4 PERFORMANCE MEASUREMENT COMMUNICATION GUIDELINES

Several authors express the need of good communication in general terms, such as clear communication (Nordin et al., 2012), effective communication (Sprague and McNurlin, 1993, Ukko et al., 2006), more information (Robson and Tourish, 2005), consistent information (Karlsson and Ahlstrom, 1996) or understandable and accessible information (Ukko et al., 2006). Sometimes the reason for the specification is pointed out. For effective communication Ukko et al. (2006) means that the purpose is to increase the understanding and knowledge of the employees. Other authors focus on the communication between different parts or levels in the company. Robson and Tourish (2005) see the need of a better information flow from the bottom to the top of the organisational structure, and mean that the managers need time to communicate effectively with those further down in the organisation. Worley and Doolen (2006) mean that clear communication is required between shifts and along all value streams, while Amaratunga and Baldry (2002) conclude that the communication should be effective and open between employees and stakeholders. Concerning lean production implementation communication Puvanasvaran et al. (2009) mean that the communication process should be effective at all levels, to make everyone be aware of and understand the lean production concept and the process of implementation. Scherrer-Rathje et al. (2009) mean that lean production wins need to be communicated from the outset, and that communicating early lean production success throughout the entire organisation is important.
There are also some performance measurement communication guidelines concerning managers. Nudurupati et al. (2011) mean that managers need up-to-date performance figures to proactively act on controlling processes, to achieve performance targets. They also mean that it is necessary that senior management support the management information system during design, implementation and use. Finally, the authors mean that information must be communicated throughout the organisation to make it transparent to everyone.

4. RESULTS OF THE EMPIRICAL STUDY

4.1 PERFORMANCE MEASUREMENT CONTENT

In research, performance measures are divided into financial measures, such as sales, productivity and efficiency, and non-financial measures, such as quality, customer satisfaction and cycle-time (Nudurupati et al., 2011). All participating companies in the empirical study have financial measures, and all but one communicate them. All companies but two also have non-financial measures, although some of the companies have had some of the measures even before the lean production implementation. The non-financial measures had in some companies been extended by typical lean production measures, like 5S, lead time and number of improvement proposals. Most of the companies have an uncertainty of what measures they should communicate, or work with changing what measures to communicate on different levels. Two of the companies mean that they have too many measures, while two have chosen some financial measures that are only reported in the management group. In one company the management team has a base of measures, and the teams can choose the measures that are relevant for them. In two companies the measures have been changed from figures to the cost of the figures, for example for scrapping of products, to make it more understandable. A summary about the performance measures in each company are mapped in table 1.

<table>
<thead>
<tr>
<th>Company</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial measures</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Non-financial measures</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Too many measures</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some financial measures only communicated in the management group</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teams can choose relevant measures from base</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present target communication as cost</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Performance measurement content in participating companies

4.2 PERFORMANCE MEASUREMENT COMMUNICATION PROCESS

In the literature review the way of communicating, and the frequency of communicating performance measures are parts of the performance measurement communication process. Also in the empirical part, as seen in table two, there are results connect-
ed to the performance measurement communication process. Concerning the performance measurement communication process all but one of the companies have production boards, where meetings are held for production information and follow-up. All boards but one are in the production area, and the last company are about to move the board there. Three of the companies also have other written information to the employees either on a TV screen, via Intranet or by an information paper. Five of eight companies have a daily follow-up, often consisting of short-term follow-up, actions on deviations, and other near-time information. In four of the companies weekly production meetings are held, while one company have a meeting every second week. Five of the companies also have monthly meetings in bigger groups, which are in the mode of one-way information. In almost all of the meetings it is specified who should attend, and what should be discussed. One company doesn’t have any structured meeting, but give the employees information orally and sporadic. This company started with monthly meetings, but after some months the meetings lapsed.

<table>
<thead>
<tr>
<th>Company</th>
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<th>C</th>
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<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production boards</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Production boards in the production area</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Other written information</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Daily production meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Weekly/every other week production meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Monthly information meetings</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

*Table 2. Performance measurement communication process in participating companies*

4.3 PERFORMANCE MEASUREMENT COMMUNICATION GUIDELINES

The theoretical part of performance measurement communication guidelines consist of presumptions for communication, and some guidelines. The empirical part, seen in table three, consists of the companies’ experience of the change in performance measurement communication. After implementing lean production, all companies mean that they improved their way of communicating performance measurement, and in all companies but one the improvements still maintain. Three of the companies mean that they now have improved the structure of the performance measurements, such as standardised the measures or have been more conscious of what measures they choose. Three other companies mean that they have improved their way of communicating, such as having structured or standardised their meetings. The structure of the follow-up has been improved in three of the companies. Two companies mean that the results now are followed-up with analysis and actions, while another company mean that the follow-up have been more simplified and understandable.
<table>
<thead>
<tr>
<th>Company</th>
<th>A</th>
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<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintained change in performance measurement communication</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Improved performance measurement structure</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improved communication structure</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Improved follow-up structure</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Performance measurement communication guidelines in participating companies

5. DISCUSSION AND CONCLUSION

Performance measurement communication for SMEs was categorised into three parts: performance measurement content, performance measurement communication process and performance measurement communication guidelines. This is comparable to a categorisation of a management information system, done by Nudurupati et al. (2011). They divide the system into three parts: to decide the indicators, to implement the measures and to exploit the information by the people. Also PMS can according to Neely et al. (2000) be divided into different parts: to design, to implement, to use and finally to maintain the PMS. Looking into product development, Frishammar and Ylinenpää (2007) mean that the capability of managing information consist of three components: acquiring, sharing and using information. The empirical part in this paper is categorised in the same way as the theory, showing improvements in different categories of performance measurement communication. This categorisation could help SMEs improve performance measurement communication, by getting concrete guidelines in each category, which also fits together as an entity.

The review also shows that there are some frameworks, guidelines and conclusions on specific topics in each area, but there is a lack of knowledge in the three parts of performance measurement communication together. The interviews indicate that almost all of the companies have improved different parts of their performance measurement communication. The way performance measurement communication has improved differs, but the measures, or the way of communicating performance measurement and results, has been more structured. Most of the companies have an uncertainty of how many or what measures to use, and there is no common way of choosing measures.

In one company the improvement worked stopped, and the improvement deteriorated. This company hasn`t maintained any improvement in their performance measurement communication, despite taking part of an improvement program. In this case the management didn`t prioritise the improvement work, but got stuck in the day-to-day business. This gives an indication that no matter what improvement program, the management have to be engaged in the improvement work to make and maintain improvements in performance measurement communication.

It can be concluded, that although all existing research in performance measurement and communication, there is no operational guideline of how to communicate performance measurement, and there is no common way of communicating performance measurement in SMEs. A performance measurement communication guideline might...
therefore be useful supporting lean production in SMEs, why it is an area for further research.

6. ACKNOWLEDGEMENT
The author would like to acknowledge VINNOVA for funding the research project PEXiSME. We are also grateful to all participating companies in the project for their cooperation and willingness to share information and experience.
7. REFERENCES


VISUAL COMMUNICATION OF PERFORMANCE MEASURES SUPPORTING CONTINUOUS IMPROVEMENT – CHALLENGES AND OPPORTUNITIES FOR MANUFACTURING SMES

Carina Larsson, University of Skövde and Kristina Säfsten, University of Jönköping

ABSTRACT

This paper provides a holistic view of visual communication of performance measures supporting continuous improvement in manufacturing SMEs. This is done by a theoretical part with a literature review, and an empirical part with case studies, including both the managers’ and the operators’ perspectives, and by focusing on manufacturing SMEs. The paper identifies five challenges and one opportunity in visual communication that SMEs perceive when using visual communication of performance measures, supporting continuous improvement.
1. INTRODUCTION

Visual management, performance measurement and communication are three well researched and mature research areas (Lindlöf, 2014, Neely et al., 1995, Mortensen, 2008). Unlike most previous studies this paper focuses visual communication of performance measurement supporting continuous improvement in manufacturing SMEs. A performance measure could for example be quality measured as number of reworks at the department compared to production, also having continuous improvement activities in the department focusing on quality. Communication is seen as a critical success factor for continuous improvement (Jayaraman et al., 2012, Kumar et al., 2009), and visually supported communication improves performance of production management by increased information quality (Maltz, 2000). Visual management also simplifies communication and fosters continuous improvement (Tezel et al., 2009).

Visual management have been researched on different levels. On operational level, Bilalis et al. (2002), set recommendations for improving the workplace visually, and Jaca et al. (2013) identifies visual management elements for improving the workplace. On strategic level Bititci et al. (2015) have developed a model showing that a visual management system have impact on communication, performance measurement, and continuous improvement, and Parry and Turner (2006) give a set of guidelines for implementing visual management tools. Many of these visual management models lack the view of the operators (i.e. Parry and Turner (2006)), which is identified as a gap in existing research (Bititci et al., 2015). Visual communication of performance measures is the focus of this paper, including both the managers’ and the operators’ perspective and filling the identified gap.

A literature review in the area shows that communication of performance measurement in small and medium-sized enterprises (SMEs) has not been paid much attention, although SMEs play a significant role in for example the European economy (European Comission, 2015). SMEs have specific characteristics and might need to adapt managerial practices to their specific characteristics (Cagliano et al., 2001). Specific characteristics, like poor managerial skills, entrepreneurial orientation and limited resources (Ates et al., 2013), might affect SMEs’ visual communication of performance measures. Very little research of performance measurement supporting improvement initiatives for SMEs have been carried out (Anand and Kodali, 2008), and increased knowledge in performance measurement communication for SMEs is needed (Larsson et al., 2014). This paper aims at contributing with experiences from the current practice in manufacturing SMEs, and to SMEs specific challenges and opportunities concerning visual communication of performance measures supporting continuous improvement.

The purpose of this paper is to provide a holistic view of visual communication of performance measures supporting continuous improvement in manufacturing SMEs. This is done by including both the managers’ and the operators’ perspectives, and by focusing on manufacturing SMEs. The paper specifically address: 1) how visual communication is used in the production area, 2) strengths with visual communication that could be used as opportunities in succeeding with visual communication of performance measures supporting continuous improvement in manufacturing SMEs, and 3) weaknesses with visual communication that could be seen as challenges in succeeding with visual communication of performance measures supporting continuous improvement in manufacturing SMEs. The paper seeks to answer the question: What
challenges and opportunities do manufacturing SMEs perceive when using visual communication of performance measures supporting continuous improvement?

2. THEORETICAL BACKGROUND

Visual communication is an expression of visibility, intended for a group and not just for an individual (Greif, 1991). This paper was based on this definition, treating all attempts to make communication visible as visual communication. Visual communication is close connected to visualization, which is defined as the graphic representation of data, information and knowledge (Eppler and Platts, 2009, p.43). In theory the terms visual communication, visual management, visual representation, and visualization are used, why the term used in the paper referred to will be kept in the theoretical background. Visualization has been used for communication between people way back (Lindlöf, 2014), and plays an important role in problem solving and knowledge transfer (Nonaka, 2010, Rieber, 1995). Visual communication can also be seen as close connected to encoding and decoding of communication (figure 1). This communication model is based on a model by Berlo (1960).

![Figure 1. Communication model based on Berlo (1960).](image)

Visual communication of performance measures could for example show production outcome per working hour, presented as a graph showing target and development the past year. Visualization is identified as important in improving management communication and decision making (Eppler and Bresciani, 2013). Visual management in manufacturing act as an extension to metrics, and predict probable outcome if no actions are taken (Parry and Turner, 2006). It supports communication and standardization, and should be used as an integral management system to guide the company in its journey of continuous improvement (Jaca et al., 2013). Jaca et al. (2013) also mean that the impact and effectiveness of visual management is underestimated. Bititci et al. (2015) look into SMEs, and shows that visual management support performance measurement, improve communication, and support continuous improvement for SMEs. Eppler and Platts (2009) identifies five strengths of visualization, it; 1) facilitates information compression, 2) enables new perspectives of thinking, 3) simplifies recall of information, 4) can integrate different perspectives and simplifies mutual understanding, mutual coordination and alignment, and 5) can engage, inspire, motivate and convince. Visual management is of high importance, and visual tools facilitates performance measurement and communication (Jaca et al., 2013, Parry and Turner, 2006). This paper focuses on how to use these strengths as opportunities to succeed with visual communication of performance measures, supporting continuous improvement.

Also pitfalls and things to avoid in visual communication is covered in theory, in this paper specified as weaknesses of visual communication, looked into as challenges needed to overcome in order to succeed with visual communication of performance measures. Wainer (1984) set up a list of things to avoid in order to succeed with visualization, summarizing that the most important is to examine the data to know what to
say, and then visualize that with a minimum of adornment, i.e. focus on simplicity. In manufacturing companies a common set-up for visual communication of performance measures is a whiteboard filled with diagrams and tables. Setting up whiteboards is also seen as a critical success factor for the implementation of lean six sigma (Jayaraman et al., 2012). The challenge of a whiteboard design is squeezing a lot of useful and often disparate information into a small amount of space while preserving clarity, telling people what's happening and helping the immediately recognize what needs their attention (Few, 2006). Unlike the dashboard in a car or an aircraft, which is professionally designed, dashboards in manufacturing companies are often less consciously developed. Few (2006) means that well-designed dashboard information is; 1) Exceptionally well organized, 2) Condensed, 3) Specific to, and customized for the dashboard's audience and objectives, and 4) Displayed using concise media that communicate the data and its message in the clearest and most direct way possible. Few (2006) specifies goals in the visual design process, meaning that unnecessary pixels need to be eliminated. This could be graphics inserted as decoration, 3d-graphs without any purpose of the third dimension, color variation without any specific purpose, delineation of sections by colors or lines not needed, or unnecessary grid lines. Further, Few (2006) means that pixels that are necessary but not the main message need to be muted.

The analysis of weaknesses in visual communication for SMEs is well covered by a recent, thorough literature review of visualization pitfalls by Bresciani and Eppler (2015). The review is divided into cognitive, emotional and social pitfalls, but also according to if the cause of the visualization problem is the encoding or the decoding (table 1), based on a model by for example Bürgi and Roos (2003).

<table>
<thead>
<tr>
<th>Table 1 - Visualization pitfalls (Bresciani and Eppler, 2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Encoding:</strong></td>
</tr>
<tr>
<td><strong>Cognitive pitfalls:</strong></td>
</tr>
<tr>
<td>Visualization might be ambiguous, misleading, or implicit. It might use unusual symbols or formats, or use symbols inconsistent. It might use inadequate templates, not have a clear logic, or be so polished that criticism is prevented. Visualization might distract from the main goal, hide important insights, or leave too much room for interpretation regarding purpose or main message, constraining the users’ thought in one direction, or lead to incorrect conclusions. Illustrations might be improper, depict elements more complex than necessary, leave out essential elements for simplification, or be cluttery. It might also take disproportional much time to do.</td>
</tr>
</tbody>
</table>
| **Emotional pitfalls:** | Previous experience of the visualization might influence willingness to use it, and some visualization might get more atten-
| Images might cause harm, be uninteresting or boring, have a suboptimal, non-aesthetic form, or be confusing or unap- |
pealing due to inadequate use of colors or combination of colors.

Social pitfalls:

A visualization might signal the wrong kind of required activity, result in unequal possibilities to contribute, or lead to participants being less outspoken about certain issues. It might also make a viewpoint or idea too fixed, guide a conversation in a certain direction, or lead to unequal participation.

Visualization might affect the behavior of the user, and hide individual differences. Visualization symbols or colors might be misinterpreted due to cultural issues, visualization might be differently interpreted due to different organization levels, or the broader context might be lost. A visual board might take attention away from body language and gestures, and group discussions based on visualization might require more time than verbal discussions.

To identify specific weaknesses and strengths of visual communication of performance measures in SMEs, SME characteristics need to be identified. An SME is a company that have less than 250 employees, and a turnover of less than or equal to 50 million Euro or a balance sheet total of less than or equal to 43 million Euro (European Commission, 2005). SMEs also have some specific characteristics than other companies, shown in table 2.
**Table 2 - SME characteristics**  
*(Wong and Aspinwall, 2004, Zach et al., 2014, Ates et al., 2013)*

<table>
<thead>
<tr>
<th>Area</th>
<th>SME characteristic</th>
</tr>
</thead>
</table>
| Ownership & management| Owned by entrepreneur, multi-tasked owner-manager  
Centralized, short-term, intuitive decision making by few decision makers  
Directive and paternal management style, command and control culture  
Top management highly visible at shop-floor  
Poor managerial skills                                           |
| Structure             | Simple, flat structure with few layers of management and hierarchy  
Flexible structure and information flows  
Division of activities limited and unclear, low degree of specialization                                   |
| Culture & behaviour   | Unified, organic and fluid culture with low departmental mindset  
Operations and behaviour of employees influenced by managers  
Results, short-term operation focus                                                                               |
| Systems, processes & procedures | Simple planning, evaluating, reporting and information systems  
Flexible and adaptable processes  
Informal, unclear rules and procedures and low degree of standardization and formalization  
Limited knowledge of and limited management attention to information system  
Packaged information system applications subordinated to the accounting function                                             |
| Human resources       | Modest know how with tacit knowledge and few experts, limited resources, ad hoc and small scale training and employee development  
Close, informal working relationship  
Low incidence of unionization  
Low resistance to change  
Modest financial resources                                                                                         |
3. METHOD

The paper was based on a theoretical and an empirical part. The theoretical part was a literature review in visual communication of performance measures. In the search for visual communication, search term used were *visualization*, *visual management*, *visual communication* and *visual information*. The review covered both weaknesses and strengths. In the search the term *strength* was complemented with the terms *opportunity*, *enabler* and *advantage*, and the term *weakness* was complemented with the terms *challenge*, *problem*, *pitfall* and *hinder*. SME characteristics were also identified in literature.

The empirical part of the paper started with an initial case study in four manufacturing SMEs, focusing on weaknesses and strengths in visual communication. The case study was based on the research strategy by Yin (2014), and consisted of interviews and of observations of existing written formal communication of performance measures in all four companies, ensuring construct validity. The interviews were made with managers, middle managers, white collar workers and operators, giving a holistic view. The same questions were used in all interviews, and the same things were studied in all companies, ensuring external validity. The analysis of the visual communication material followed the review by Bresciani and Eppler (2015), identifying weaknesses and strengths by looking into cognitive, emotional and social pitfalls as presented in table 1. A case study protocol and multiple sources were used, i.e. both interviews and analysis of documentation, ensuring reliability and construct validity. Finally, in the data analysis, internal validity was ensured through pattern matching between theory and empirics. Citations were translated to English.

In the initial case study, company D was identified to have well developed performance measures that was communicated throughout the company, and used visual communication to communicate performance measures. This was identified as good prerequisites for studying visual communication deeper, why company D was chosen for the deeper case study. In the deeper case study, both interview questions and observations were based on the visual communication review by Bresciani and Eppler (2015), ensuring the external validity in this single-case study (Yin, 2014). Also in this case study, interviews were made with managers, middle-managers, white-collar workers and operators. Reliability, construct validity and internal validity was ensured in the same way as for the initial case study. The analysis of both the interviews and of the visual communication material followed the review by Bresciani and Eppler (2015), identifying weaknesses and strengths by looking into cognitive, emotional and social pitfalls in encoding and decoding visualization, as presented in table 1.

In both case studies, it was analyzed to what extent visual communication was used in the companies, and the connection between visual communication and continuous improvement. This analysis was based on identified strengths of visual communication, and the connection between visual communication, performance measures and continuous improvement (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009).
4. EMPIRICAL FINDINGS AND ANALYSIS

Company A was a privately owned, medium-sized manufacturer, producing high volumes of few products, and with a high level of automation. The company had approximately 250 employees. Performance measures were visually communicated in two ways; on-line on screens in the production area and on computers in offices, and through whiteboards in the production area. The on-line communication of performance measures was presented as written sentences telling the outcome, where the figures were highlighted with ten different colors. Production results were presented as percentage remaining of the day, divided into different parts of the production, colored every other row white and grey. Production lines not producing for the moment were red, and one line is yellow (not explained why and the employees interviewed not knowing why). In the computer on-line presentation it was possible to go further into the numbers and get more information. A middle-manager meant that the on-line visual communication of performance measures was not used among operators and middle-managers, and that it didn’t add anything, and an operator meant that the on-line communication of performance measures actually didn’t say anything. Identified weaknesses in the on-line visual communication according to Bresciani and Eppler (2015) was not having a clear logic, and the coloring being cluttery, and essential elements, i.e. targets, was left out.

On the whiteboards in the production area in company A, production results were presented. Five tables and four graphs were presented on one A4-paper. Tables were presenting production results per shift and per day, and some of the tables were also presented as graphs. One manager thought that the communication worked well, another manager meant that not everyone needs to know everything, and yet another manager saw a need of communicating targets in the visual communication of performance measures, which wasn’t done today. Identified weaknesses according to Bresciani and Eppler (2015), was being over-complex and cluttery, showing both tables and graphs on the same performance measures, and giving much information on the same page. The visualization was also leaving out essential elements, i.e. not visualizing targets in the graphs and tables on the whiteboards. Based on the strengths of visual communication (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009), two weaknesses were identified; visual communication was not used in all parts of the company, and continuous improvement was not communicated visually.

Company B was a company-group owned, small-sized manufacturer producing one piece at a time in a low-automated production, and with products often adapted for the customer. The company had around 25 employees. Performance measures were visually communicated in one way; visual communication supporting oral communication of performance measures, also placed on a whiteboard in the lunch room. The visual communication was presented with figures and graphs. A manager meant that the communication “should not be too complicated”, and white-collars and operators meant that it was simple to understand the monthly presentations. Style, colors and language varied between the graphs. A manager meant about the visual communication that “I would like it a bit stricter and more formalized, actually”. Three of the company targets were followed up with graphs. On the whiteboard there was a list of the company’s financial targets, presenting some topics that also were presented in the graphs, and some other topics. Besides the financial targets, there was a list of improvement activities. Identified weaknesses in company B, according to Bresciani and Eppler (2015), was not including essential elements, i.e. specification of axis, and not specifying if the target should be above or below the target line. Another identified
weakness (Bresciani and Eppler, 2015) was that the visualization might guide the conversation in a specific direction, only visualizing one of the company targets. Based on the strengths of visual communication (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009), two weaknesses were identified; visual communication was not used in all parts of the company, and continuous improvement was not communicated visually.

Company C was a privately owned, medium-sized manufacturer with both machining and assembly and a huge number of similar products made of few materials. The company had around 100 employees. Performance measures were visually communicated one way, a visual communication placed on an information board at the entrance of the production area. It was a follow-up of discarded products presented as a graph. One operator saw the need of discarded products in relation to production which wasn’t presented, while another didn’t see any need of written communication at all. Managers were focused on improving performance measures, and did not have any opinion of visual communication of performance measures. Identified visual communication weaknesses in company C, according to Bresciani and Eppler (2015), was not including all essential elements in visualization, i.e. the target, and that the visualization might guide the conversation in a specific direction, only visualizing one of the company’s targets. Based on the strengths of visual communication (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009), two weaknesses were identified; visual communication was not used in all parts of the company, and continuous improvement was not communicated visually.

Company D was a company-group owned, medium-sized manufacturer with line production with few base products and many different options, including both manufacturing and assembly. The company had around 250 employees, and performance measures were visually communicated in three ways; whiteboards for daily visual communication, whiteboards for monthly visual communication, and a visual communication supporting monthly oral communication of performance measures. All performance measures were communicated visually. There was a connection between continuous improvement targets and other targets, and the managers and middle-managers meant that they wanted to connect them even more in order to drive continuous improvement better. The visual communication in the company was divided into company level, department level, and working group level, and new employees got an education in the performance measures and how to understand them. This company was chosen for a deeper study of the visual communication of performance measures.

The whiteboards for daily visual communication in company D was a visual presentation of each target per day, where green meant that the target is reached, red meant that the target is not reached, and if the color was red a comment was added. One manager meant that “we are explicit when we communicate, at least on our whiteboards”. Employees were well aware of this visual communication, meant that it was easy to understand, and that it was simplified but not too simple. The quality of the visualization were consciously thought of when doing the encoding, and resources had been put into visualizing the performance measures with a logical grouping and simplicity. The templates and grouping of the visual communication on whiteboards were the same for all performance measures. Several strengths were identified in this visual communication (Bresciani and Eppler, 2015), such as avoiding over-complex and cluttery visualization, including all essential elements in visualization, use symbols consistent, and have a clear logic.
The whiteboards for monthly visual communication of performance measures in company D included more information than the daily boards. They consisted of graphs showing the trends over the year, including the target. The same template was used for all graphs, but some graphs used a smiley to show on what side of the target you should be, some graphs used an arrow to show it, and in some graphs it was not shown. Operators meant that they were not used to read these visual communication, and did not see the need of it. Middle managers and managers appreciated the monthly follow-up, and meant that it showed trends, and initiated actions if results were going down, being a complement to the daily visual communication. One weakness was identified in this visual communication (Bresciani and Eppler, 2015), not using symbols consistent.

The last visual communication in company D was visual communication supporting oral company communication of performance measures. A manager told that “continuity is important”, and that they used the same agenda and almost the same tables and graphs at every monthly oral communication meeting. The template for the presentation had a colored line, and the company name in three places on each page. In the presentation, a table and a graph concerning the same topic was shown on the same page, and the manager presenting was telling where to look to draw conclusions. Targets were shown in some of the tables and graphs, and the colors red, green and yellow were used in tables (unexplained). Operators meant that they did not understand the pictures themselves, but needed an explanation of what to look at and what conclusions to draw. One operator meant that the understandability came from the manager sending the information and not from the visual communication, while another operator meant that “I actually have very hard to understand this”. Among managers, middle-managers and white-collar workers the opinions were scattered. One meant that the visualization was good, while another meant that this visual communication was tremendously too complex, and that it should be much simpler visualized. Yet another meant that the visual communication was understandable, but that it probably was too complex for the operators. Smileys and colored thumbs turned up or down was used to visualize on what side of the target line you should be. Middle-managers, white-collar workers and operators meant that the symbols increased the understandability. This visual communication also included pictures for visualizing recent happenings or improvements.

Weaknesses identified according to Bresciani and Eppler (2015), was over-complex and cluttery visualization (template and use of colors), not all essential elements included (targets and specifying axis in graphs), and inconsistent use of symbols (smileys and thumbs). Based on the strengths of visual communication (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009), two strengths were identified; use of visual communication in all parts of the company, and continuous improvement communicated visually. Identified weaknesses and strengths identified per company were summarized in table 3, and identified weaknesses and strengths identified per visual communication in each company were summarized in table 4.
Table 3 – Identified weaknesses and strengths in visual communication of performance measures based on (Bititci et al., 2015, Jaca et al., 2013, Eppler and Platts, 2009)

<table>
<thead>
<tr>
<th>Company:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use visual communication in all parts of the company</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Communicate continuous improvement visually</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

( (empty)- not identified, yes- identified strength, no- identified weakness )

Table 4 – Identified weaknesses and strengths in visual communication of performance measures based on (Bresciani and Eppler, 2015)

<table>
<thead>
<tr>
<th>Company and visual communication:</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-line screens</td>
<td>No</td>
<td>No</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Whiteboards</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Supporting oral communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information board</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboards for daily follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whiteboards for monthly follow-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual communication supporting oral company communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoid over-complex and cluttery visualization</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Include all essential elements in visualization</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Use symbols consistent</td>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Have a clear logic</td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not guide a conversation in specific direction</td>
<td>No</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

( (empty)- not identified, no - identified weakness, yes - identified strength )
5. DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Though theory shows a connection between visual communication of performance measures and driving continuous improvement, together with significant strengths using visual communication (Jaca et al., 2013, Eppler and Platts, 2009), the empirical findings indicated that many SMEs do not use visual communication in all parts of the company, and that they do not communicate continuous improvement visually. The empirical findings also indicated that including all essential elements, such as targets, explanation of what side of the target line to be, or explanation of axis in graphs is a common weakness in SMEs, present in all four case study companies. Other identified weaknesses, present in at least two of four case study companies, were; over-complex and cluttery visualization, and guiding a conversation in a specific direction. A visual communication without any identified weakness was the whiteboards for daily follow-up in company D. This indicated that daily, visual communication could be a strength for SMEs. On the other hand, and although the use of visual communication in all parts of company D, the visual communication of company information had three identified weaknesses, indicating that visual company communication might be a weakness in SMEs. These identified weaknesses could be seen as challenges, needed to overcome in order to succeed with visual communication. The identified strength could be seen as an opportunity for SMEs to succeed with visual communication.

Challenges and opportunities identified were compared to SME characteristics (table 3 and 4). A typical SME characteristic concerning ownership and management is that SMEs have poor managerial skills. This might affect negative the use of visual communication in all parts of the company, and to communicate continuous improvement visually. Another SME characteristic in ownership and management is directive and paternal management style, which might have a negative effect on guiding a conversation in specific direction. On the other side, SME management often are highly visible at shop-floor, which might support the daily, visual communication, often done at departmental level. Concerning structure, SMEs often have a simple, flat, flexible structure with few layers, and flexible information flows. This might support the daily, visual communication. Typical culture and behavior for SMEs is, among other things, a short-term operational focus. This might discourage the use of visual communication in all parts of the company, and the visual communication of continuous improvement. On the other hand, it might strengthen daily, visual communication, having the operational focus. Concerning systems, processes and procedures, SMEs often have low degree of standardization, which might discourage the use of visual communication in all parts of the company. Finally, concerning human resources, SMEs often have limited resources, possibly discouraging all identified weaknesses in visual communication, but also the strength. Summarizing table 4, it can be concluded that all identified weaknesses and strength in visual communication of performance measures are connected to specific characteristics of SMEs.
Table 4 - SME characteristics affecting weaknesses and strengths in visual communication of performance measures

<table>
<thead>
<tr>
<th></th>
<th>Ownership &amp; management</th>
<th>Structure</th>
<th>Culture &amp; behavior</th>
<th>Systems, processes and procedures</th>
<th>Human resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use visual communication in all parts of the company</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Communicate continuous improvement visually</td>
<td>-</td>
<td>-</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Avoid over-complex and clutter visualization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Have a clear logic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Not guide a conversation in specific direction</td>
<td></td>
<td>-</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Daily, visual communication</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

((empty) No effect, + Positive effect, - Negative effect)

5.2 CONCLUSIONS

This paper identifies five challenges and one opportunity for manufacturing SMEs using visual communication of performance measures. Perceived challenges are to: 1) use visual communication in all parts of the company, 2) communicate continuous improvement visually, 3) avoid over-complexity and cluttery visualization, 4) have a clear logic, and 5) not guide a conversation in specific direction. The only identified opportunity in visual communication of performance measures in manufacturing SMEs is communicate daily, visual communication. Being aware of these challenges and opportunities might strengthen manufacturing SMEs in visual communication of performance measures, supporting continuous improvement.

6. LIMITATIONS AND FURTHER RESEARCH

The empirical results are based on case studies in four manufacturing SMEs in Sweden. A possibility for future research is to broaden the view to include other cultural contexts, larger companies or other types of companies and organizations. The paper contributes to increased knowledge in visual communication of performance measures for SMEs, which could help SMEs improve their performance measurement communication, supporting continuous improvement. The originality of this study is the focus on visual communication of performance measures in manufacturing SMEs with a holistic perspective, including both managers’ and operators’ perspective.
7. ACKNOWLEDGEMENTS

The authors like to thank the KK environment INFINIT at the University of Skövde for providing funding for this project. They also would like to thank participating companies for their cooperation and openness to the researchers.

8. REFERENCES


COMMUNICATING CONTINUOUS IMPROVEMENT IN MANUFACTURING COMPANIES: DIVERGENCIES BETWEEN CURRENT PRACTICE AND THEORY

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University of Skövde, Sweden

ABSTRACT
Succeeding with continuous improvement is important for manufacturing companies to increase the competitive edge. In order to succeed with continuous improvement, literature shows that communication of improvement indicators need to be integrated with communication of control indicators. This paper identifies divergencies between current practice and theory in the communication of CI, which can be a reason for why manufacturing companies fail in their CI implementation. An integration of control indicators and improvement indicators could improve continuous improvement results, increasing business performance.
INTRODUCTION

Manufacturing companies all over the world experience increased competition, and continuous improvement (CI) is commonly used to increase the competitive edge, by, e.g., improving productivity, ensuring quality and increasing delivery reliability (Hyland et al., 2007). CI can be seen as a translation of the Japanese word kaizen, indicating a process of continuous incremental improvement of the standard way of working (Chen et al., 2001). Important activities to succeed with CI in manufacturing companies are: 1) to define the performance measures; 2) to clarify the relationship between the different types of performance measures; 3) to define improvement targets and align them with the company targets; and 4) to communicate the performance measures (Bititci and Nudurupati, 2002; Jørgensen et al., 2004; Kumar et al., 2009). Clarifying improvement targets and aligning them with company targets is important in order to increase the employees’ understanding when implementing improvement initiatives (Jayaraman and Teo, 2010; Kumar et al., 2013). Communication of targets and results is important to keep up the interest for CI (Gonzalez Aleu and Van Aken, 2016; Jayaraman and Teo, 2010; Kumar et al., 2009), while not aligning improvement targets with company targets jeopardizes the success of CI, opening for frequent changes of targets when leadership is changed in the company (Näslund, 2013). The communication of performance measures should, hence, support the alignment of improvement targets with company targets (Jayaraman et al., 2012; Näslund, 2013).

The importance of and systems for defining performance measures are well researched and have been known for a long time, see for example Kaplan and Norton (1996), Cross and Lynch (1988), and Neely and Adams (2001). Bititci and Nudurupati (2002) identify two different types of performance measures; control indicators and improvement indicators. Control indicators are needed to keep control of the process, while improvement indicators are needed to measure continuous improvement (CI) (Bititci and Nudurupati, 2002). The term performance measures is in this paper used as an umbrella term for both types of indicators. Understanding the relationship between control indicators and improvement indicators, and developing a loop control system, is important in order to effectively utilise the performance measures for CI in manufacturing companies (Kang et al., 2016).

Despite all research-based guidelines on how to define performance measures, to set targets, to align them and, which is the main concern of this paper, to communicate them, many manufacturing companies fail in their CI work (Bhasin, 2012; McLean and Antony, 2014). This paper seeks to identify divergencies between current practice and theory concerning communication of CI in manufacturing companies, to propose a model and recommendations for how to communicate CI in manufacturing companies. Effective communication of CI can improve employees understanding of targets and strategy, and enhance performance (Jaca et al., 2013; Ukko et al., 2007).
THEORETICAL FRAMEWORK

Performance measures can be defined as metrics quantifying the efficiency and effectiveness of actions (p. 81, Neely et al., 1995). Effective performance measures enable the organisation to assess whether targets are achieved and also facilitate improvements (Lebas, 1995). A great deal of research have focused on the shift from traditional performance measures, i.e. only financial measures, to multidimensional performance measures such as both financial and non-financial measures (e.g., Kaplan and Norton, 1996; Lynch and Cross, 1992; Neely and Adams, 2001). The balanced scorecard by Kaplan and Norton (1996) is said to be a powerful tool connecting performance measures and strategy. The use of multi-dimensional performance measures makes performance more effective, but by 2011 only one third of the organizations used multi-dimensional performance measures (Tung et al., 2011). Tung et al. (2011), among others, mean that organizations need to increase the use of other perspectives in the Balanced Scorecard (Kaplan and Norton, 1992) than the financial perspective.

Performance measures are critical for CI, and measuring performance enables and directs CI (Kang et al., 2016). When researchers and companies started adding non-financial performance measures to existing financial performance measures, CI indicators such as process cost reduction, quality and process cycle time were included among the performance measures (Chenhall and Langfield-Smith, 2007). Non-financial performance measures have also been linked to CI such as e.g. related to Just-in-time and Total Quality Management (Young and Selto, 1991). Performance measures are not independent, and identifying dependencies between them can be useful when utilizing them for CI (Kang et al., 2016). Kang et al. (2016) investigates such dependencies concerning quality, productivity and maintenance. They conclude that further investigation is needed on this topic.

Already Globerson (1985) stated that performance measures should be communicated in a loop in order to act on divergencies between targets and outcome, and Neely et al. (1997) proposed a framework with follow-up of results based on this loop. This loop of communicating performance measures should focus on and stimulate CI (Kaplan and Norton, 1992; Lynch and Cross, 1992; Medori and Steeple, 2000). Existing theory is summarized in a model (Figure 1), describing how communication of CI needs to be performed. Improvement indicators and control indicators are integrated in the same loop. This model may assist manufacturing companies in integrating CI into daily performance, to focus on CI on a daily basis and to succeed with CI.
This paper is based on a theoretical and an empirical study in the form of a case study. The theoretical study is a traditional literature review (Jesson et al., 2011). The review searched for one or two of the terms “CI”, “lean”, “improvement” and “performance measure”, adding the term “manufacturing” and in some searches the term “communication”. The main data sources were Scopus and WorldCat Beta, and results were limited to the subject areas of “engineering”, “decision science”, and “business, management and accounting” in order to exclude papers outside the performance measurement area. The searches were refined using a snowball approach according to the method of Rumsey (2008), which meant working backwards, following citations in the identified articles, and forward, where the articles had been cited. Based on the literature review, a model for communication of CI was developed (Figure 1). The model serves as a frame for contrasting the findings of the case study.

The purpose of the case study was to identify divergencies between current practice and theory concerning communication of CI in manufacturing companies. It did so by answering two questions: 1) How is communication of CI performed?; and 2) How are CI targets connected to daily performance targets?. The second question was included in order to compare how communication was actually performed to the approach suggested in the literature.

The study was performed at a Swedish manufacturing SME, the Vara plant of Volvo Penta. It was conducted by following the suggestions and procedures proposed by Yin (2014), including the data collection techniques observation, interviews and a survey.

Figure 1. Theoretical model for communication of CI
The observation of information boards focused on existing communication about CI efforts, of control indicators, of company targets, and tried to identify connections between improvement indicators, control indicators and company targets. Interviews were done with two managers, two middle managers and three operators in order to get an overview of current practice. Interviewees were chosen by one of the managers. The interviews consisted of two open-ended questions, each supported by three sub-questions. The questions concerned the employees’ perception of improvement indicators and control indicators, the communication of them, and the employees’ opinion about them. After the interviews, a survey was done in one department in order to deepen the study. A company manager chose the department because it was deemed a suitable target for an improvement effort in case suggestions for improvements were discovered. The survey was done with all 22 operators at the chosen department, working the day of the survey. The questions were based on the literature review. In the analysis, results from the case study were compared to theory, identifying divergencies between current practice in the company and theory. Some opportunities to improve communication of CI in the company were identified in the analysis. The company stated an ambition to implement a selection of the identified opportunities for improvement in the department subjected to the survey, and later on all over the company. The implementation process will be part of future research.

**EMPIRICAL RESULTS**

Studying communication boards at the Vara plant, one information board for control indicators and one information board for improvements at each department were identified. A middle manager told that they focused at one information board at a time. This indicated that improvement indicators and control indicators were followed up and communicated in separate loops. The company communicated a CI target of number of improvements per employee and year, followed up monthly. This CI target was chosen in order to put focus on CI and get CI activities started. The company also followed up on the cost saving resulting from CI, although this was not frequently communicated. The connection between CI and control indicators was identified to be weak. There was a company CI target, the same target as on department level. No connections between other company targets and CI could be identified.

When asking about the connection between CI and control indicators in the interviews, answers from managers were univocal. CI improved performance, but the connection was unclear and the control indicator results could not be clearly traced back to CI. The main contribution from CI had, according to a middle-manager, been on quality improvements. Both managers and middle-managers meant that the connection between CI and control indicators was weak, and needed to be strengthened. The main reason for not integrating the measures was, according to the plant manager, to make it simple to work with and follow up CI.

In the survey with the operators two questions were asked; 1) According to your perception, are the improvement targets connected to the control targets on company level? and 2) According to your perception, are the improvement targets connected to control targets on department level?. Responses were graded from 1 to 6, 1 being “No, not at all” and 6 being “Yes, clearly”. Of the 22 potential respondents, 20 answered the questions. The resulting mean value concerning the connection between improvement targets and control targets were 2.9 at company level, and 3.7 at depart
ment level. The conclusion is that the operators do see some, but no clear connections between improvement targets and control targets. The result is presented in Table 1.

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Connection on company level</th>
<th>Connection on department level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-No, not at all</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>6-Yes, clearly</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

*Table 1. Survey result concerning the connection between improvement targets and control targets at the Vara plant*

**DISCUSSION**

Literature concludes that the communication of improvement indicators needs to be integrated with the communication of control indicators. The empirical results, however, indicates that this integration was not implemented in the case study company. Based on the empirical results, existing communication of improvement indicators and control indicators can be illustrated as in Figure 2. This figure illustrates the two loops of communication in current practice, one for control indicators and one for improvement indicators.
This study indicates that there is a divergence between literature and practice concerning how CI is communicated in manufacturing companies. Theory recommends communication of improvement indicators and of control indicators to be integrated, while this empirical study indicates that communication of CI and of daily performance are not integrated.

CONCLUSION

Succeeding with continuous improvement is important for manufacturing companies to gain or sustain the competitive edge in a highly globalized world. In order to succeed with continuous improvement, literature shows that communication of improvement indicators need to be integrated with communication of control indicators (Figure 1). This case study, performed at a manufacturing company in Sweden, indicates that communication of improvement indicators and of control indicators are not integrated, but is performed without clear connections (Figure 2). This divergence can be a reason for why many manufacturing companies fail in their CI implementation. The indication from this case study needs to be tested further in order to either strengthen or disprove it. In addition, it may also be interesting to note that all communication of performance measures was conducted through communication techniques that were analogue and not digital. Hence, it would also be interesting to study if and how IT digital technology could facilitate communication and potentially alleviate the impact of problems.

ACKNOWLEDGEMENTS

The authors are grateful to the KK environment INFINIT at University of Skövde, Sweden, for providing funding for this project. They also want to thank Volvo Penta, Vara plant, for their cooperation and willingness to share information and experience.
REFERENCES


HOW TO VISUALIZE PERFORMANCE MEASURES IN A MANUFACTURING SME
Carina Larsson, University of Skövde

ABSTRACT
PURPOSE
This paper identifies strengths and weaknesses in the communication of performance measures and proposes guidelines for the visualization of performance measures supporting continuous improvement (CI) in manufacturing small and medium-sized enterprises (SMEs). The goal is to help manufacturing SMEs improve their communication of performance measures, thereby improving performance, and strengthening the company.

DESIGN/METHODOLOGY
This paper draws on both theoretical and empirical research. It begins with a literature review of theoretical guidelines for the visualization of performance measures. This theoretical information is then supplemented with a case study and a survey, both carried out at the Vara plant, a manufacturing SME with well-developed communication of performance measures. The case study involved all organizational levels in the company and focused on identifying strengths and weaknesses in visual communication of performance measures supporting CI. The information acquired from the literature survey and the case study was then used as the basis for a survey of the employees in one department as regards their perception, understanding, and opinion of visual communication of performance measures. The analysis of the results led to the development of guidelines and a substantive proposal improving visualization of performance measures in this specific company, and in manufacturing SMEs in general.

FINDINGS
A model for the visualization of performance measures supporting CI in the company was carried out. The guidelines proposed for all such visualizations are as follows: keep the visualization as simple as possible without compromising understanding; use symbols and colors consistently; use simple words; and do not include too much information in the visualization. The study also shows that it is important to support a written visualization with an oral presentation to explain the results.
INTRODUCTION

Small and medium-sized enterprises (SMEs) are important contributors to national growth and to the economy of the European Union (European Commission, 2015). They all face increasing pressure to improve their performance and their ability to cope with global competition. Many of them rely on performance measurement for daily production control; and use continuous improvement (CI) to increase their performance. Research indicates that this is the correct approach (Cocca and Alberti, 2010; Garengo and Biazzo, 2012; Hilton and Sohal, 2012). It has also been shown that communication is critical to success when using performance measurement and CI (Jayaraman et al., 2012; Kumar et al., 2009), as employees need to understand the company’s strategy and targets (Kaplan and Norton, 2001; Ukko et al., 2007).

SMEs are, however, less likely than larger companies to implement a performance measurement system effectively, in part because of deficits in the communication process (Taylor and Taylor, 2013). Yet little research has been done on the communication process in manufacturing SMEs (Larsson and Säfsten, 2016).

Visualization of performance measures is an important part of the communication process (Parry and Turner, 2006). Its benefits have been well researched (e.g., Lindlöf, 2014; Eppler and Bresciani, 2013). Visualization not only improves internal communication, it also improves performance, enhances the quality of information, and promotes an understanding of the connections between operational targets, overall targets and strategy (Bititci et al., 2015; Eppler and Platts, 2009; Maltz, 2000; Tezel et al., 2009). Visualization also supports the development of a CI culture. It should thus be part of an integral management system to guide the company into CI (Bititci et al., 2015; Jaca et al., 2013).

The literature is teemed with guidelines concerning communication in general (e.g., Mitchell et al., 2009; Nonaka, 1994), and guidelines regarding visualization (e.g., Andrews et al., 2011; Elmqvist and Fekete, 2010). Daily visual management is considered an important tool in implementing and running improvements (Kurdve et al., 2016).

Unlike most previous studies this paper focuses on visualization of performance measures supporting CI in manufacturing SMEs. Drawing on a case study and a survey within a manufacturing SME, this paper identifies strengths and weaknesses in the communication of performance measures and proposes a model for visualizing performance measures supporting CI in manufacturing SMEs.

In sum, this paper endeavours to answer the question: How can performance measures be visualized in manufacturing SMEs, supporting CI? A model for visualization of performance measures can help manufacturing SMEs improve their communication of performance measures supporting CI. This, in turn, can help increase performance and strengthen the company.
THEORETICAL BACKGROUND
CHARACTERISTICS OF AN SME

An SME is a company with fewer than 250 employees and a turnover less than or equal to 50 million Euros, or a balance sheet total of less than or equal to 43 million euros (European Commission, 2005). Some typical characteristics that distinguish such companies from larger companies are summarized in Table 1. These characteristics need to be taken into consideration, when visualizing performance measures in a way that fits the culture of SMEs.
<table>
<thead>
<tr>
<th>Area</th>
<th>SME characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership &amp; management</td>
<td>Owned by entrepreneurial, multi-tasked owner-manager</td>
</tr>
<tr>
<td></td>
<td>Centralized, short-term, intuitive decision-making by a few decision makers</td>
</tr>
<tr>
<td></td>
<td>Directive and paternal management style, command and control culture</td>
</tr>
<tr>
<td></td>
<td>Top management highly visible on shop floor</td>
</tr>
<tr>
<td></td>
<td>Poor managerial skills</td>
</tr>
<tr>
<td>Structure</td>
<td>Simple, flat structure with few layers of management and hierarchy</td>
</tr>
<tr>
<td></td>
<td>Flexible structure and information flows</td>
</tr>
<tr>
<td></td>
<td>Division of activities limited and unclear, low degree of specialization</td>
</tr>
<tr>
<td>Culture &amp; behavior</td>
<td>Unified, organic and fluid culture with low departmental mind-set</td>
</tr>
<tr>
<td></td>
<td>Operations and behavior of employees influenced by managers</td>
</tr>
<tr>
<td></td>
<td>Results, short-term operation focus</td>
</tr>
<tr>
<td>Systems, processes &amp; procedures</td>
<td>Simple planning, evaluating, reporting, and information systems</td>
</tr>
<tr>
<td></td>
<td>Flexible and adaptable processes</td>
</tr>
<tr>
<td></td>
<td>Informal, unclear rules and procedures and a low degree of standardization and formalization</td>
</tr>
<tr>
<td></td>
<td>Limited knowledge of and limited management attention to information system</td>
</tr>
<tr>
<td></td>
<td>Packaged information system applications subordinated to the accounting function</td>
</tr>
<tr>
<td>Human resources</td>
<td>Modest know how with tacit knowledge and few experts, limited resources, ad hoc and small scale training and employee development</td>
</tr>
<tr>
<td></td>
<td>Close, informal working relationship</td>
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<td></td>
<td>Low incidence of unionization</td>
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<td></td>
<td>Low resistance to change</td>
</tr>
<tr>
<td></td>
<td>Modest financial resources</td>
</tr>
</tbody>
</table>

*Table 1. Typical SME characteristics (Ates et al., 2013; Wong and Chan, 2014; Zach et al., 2014)*
**VISUALIZATION**

In this paper visualization is defined as a visible expression, intended to be shown to a group and not just an individual (Greif, 1991). For example, visualization can be used to present production output as a measure of daily performance, or graphs of the past year’s output can be used to show increasing productivity as a result of CI. Such a visualization might show the target, whether output is above or below the target, and what the trend of the output is.

Visualization has been used for communication for a long time (Lindlöf, 2014). Properly used, it can support problem-solving as well as knowledge transfer (Nonaka, 1994; Rieber, 1995). In communication models, such as those of Berlo (1960), visualization can be an important part of both encoding and decoding messages (Figure 1).

**Figure 1. Communication model based on Berlo (1960)**

Visualization supports CI since it can be used as an integral management system to guide the company on its journey to CI (Jaca et al., 2013). Through the use of visual tools and techniques, the companies can create a powerful and effective guidance system for production and improvement (Jaca et al., 2013; Parry and Turner, 2006). Guidelines for visualizing performance measures in order to support CI are summarized in Table 2:

| Performance measures should be visualized in all parts of the company |
| CI should be communicated visually |

**Table 2. Guidelines for visualization of performance measures supporting CI (Al-Kassab et al., 2013; Jaca et al., 2013; Parry and Turner, 2006)**

Although visualization is a powerful tool supporting CI, performance measures need to be visualized in the right way. Bresciani and Eppler (2015) recently undertook a thorough literature review of pitfalls in visualization, which they divided into cognitive, emotional and social pitfalls. While the social and emotional pitfalls are beyond the scope of this paper, the cognitive pitfalls were used to derive guidelines on how to visualize performance measures. These guidelines focused on what to visualize, the format of a visualization, and its presentation (Table 3).
**What to visualize:**
- Be aware that visualization generally depicts information less precisely than numbers and Tables
- Be aware that a visualization cannot be used in as many ways as more specific presentations
- Be aware that complex relationships may be difficult to understand when presented visually
- Be aware of visual conventions (e.g., not everyone reads from left to right, and that some visualization might cause harm)
- Only use visualization if the time to create the visualization is proportional to the output from the visualization
- Group related information together (proximity principle)
- Ensure an appropriate fit between the task and the visualization

**Visualization format:**
- Visualize as simply as possible
- Use a clear overall logic, or an accompanying text
- Use explicit visualizations
- Use colors consistently
- Use colors that all people (including the color blind) can distinguish
- Do not use cluttered or disturbing patterns (e.g., striped or flickering patterns)
- Use a format that is understandable to the target audience
- Use a format that fits the information
- Present only one item per visualization; do not distract from the main goal
- Present data graphically in the same way (i.e. retain the same height, width, and aspect ratio)
- Use simple, understandable, common visual rules and symbols to make the visualization easy to interpret, or signal that their function has changed
- Use symbols consistently, with the same symbols being used to convey the same kind of information
- Point out changes in pictures

**Visualization presentation:**
- Include all essential elements in the visualization, avoid the possibility of distortion
- Leave out non-essential elements that can make the information cluttered
- Make the presentation interesting for the target audience
- Make clear that the presentation is open for discussion and improvement

*Table 3. Guidelines for visualizing performance measures, based on Bresciani and Eppler (2015)*
METHOD

This research began with a review of the literature on visualizing performance measures. A search was conducted using the terms visualization, visual management, visual communication, or visual information, used in conjunction with either performance measurement, performance management, or performance measures. To further limit the number of papers, the terms manufacturing or production were included, and the subject area was limited to physical science and social science & humanities. An additional literature search was conducted for SME characteristics in order to identify typical SME characteristics.

The empirical part of the research involved a case study and a survey conducted within a manufacturing SME. The company was chosen on the basis of an earlier study of communication of performance measures, conducted in four manufacturing SMEs (Larsson and Säfsten, 2016). In the earlier study, this company was identified as having well developed performance measures communicated throughout the company. This was one of the prerequisites for an in-depth study of performance visualization.

In the case study, both the interview questions and observations were based on the visual communication review by Bresciani and Eppler (2015), so ensuring external validity in this single-case study (Yin, 2014). Interviews were conducted with managers, middle-managers, white-collar workers, and operators. The analysis of both the interviews and of the observations followed the methods of Bresciani and Eppler (2015), identifying weaknesses and strengths in visualizing performance measures. The extent of performance visualization used in the company was analyzed, as well as the connection between visualization of performance measures and continuous improvement. This analysis was based on theoretical connections between visualization of performance measures and CI (Table 2), and identified theoretical guidelines for the visualization of performance measures (Table 3).

On the basis of the strengths and weaknesses identified in the case study (Table 4), a survey was carried out in one department of the company. This department was chosen by the management based on the number of employees in that department, and its physical location, which meant that many employees would walk past it. There were three parts to the survey:

- Four scaled questions concerning the employees’ perception of different ways of presenting performance measures, each followed by an open-ended question about how to make presentations of performance measures understandable.
- Two open-ended questions testing the employees’ understanding of existing visualization of performance measures by asking them to describe a specific, current visualization of performance measures.
- Six scaled questions followed by one open-ended question about how employees thought performance measures should be visualized.

In order to ensure the questions in the survey would be understood, they were first tested on two operators in the department, one newly employed and one who had been there for a long time. After this test, some sentences were clarified before other employees in the department were approached. All employees in the department who were at work on the day the survey was conducted filled in the survey anonymously, and the survey was then analyzed by the author.
The result from the survey was compared to theoretical recommendations related to visualizing performance measures (Table 3) and analyzed. The result was also compared to typical SME characteristics (Table 1) and discussed. On the basis of this analysis and discussion, guidelines and a substantive proposal were made on ways to improve visualization in this company, as well as in manufacturing SMEs in general.

**EMPIRICAL FINDINGS**

The company chosen for the study was the Vara plant of Volvo Penta, a medium-sized manufacturer with about 210 employees involved in line production of diesel engines for boats. The company produces a few base products with many different options, and the production plant performs both manufacturing and assembly. Although the Vara plant is owned by a company group (AB Volvo), it functions as an independent unit. The structure, culture and behaviour, and human resources of this plant show many characteristics that are typical of an SME (Table 1). The plant has a simple, flat structure with few layers of management and hierarchy. This can be seen as an advantage, for the close contact between the managers and the operators, enables discussion and feedback. The plant also has a unified, organic and fluid culture and departmental mind-set.

Performance measures are visually communicated in three ways: whiteboards for daily visual communication, whiteboards for monthly visual communication, and a monthly visual PowerPoint communication on a screen, with supporting oral communication of performance measures. Almost all performance measures for both production output and CI are communicated visually with a view to improving production. The visual communication in the company is divided by company level, department level, and working group level. New employees are educated in the performance measures and how to understand them.

**CASE STUDY FINDINGS**

The whiteboards for daily visual communication in the company were visual presentations of the target for each day (Figure 2). Green numbers indicated that the target had been reached, and red numbers indicated that it had not been reached. One manager said that “we are explicit when we communicate, at least on our whiteboards”, explaining that the daily and monthly visualization was good. Employees were well aware of this visual communication, saying that it was easy to understand, and that it was simplified but not too simple. According to the production manager the quality of the visualization was consciously kept in mind when doing the encoding, using the same template at all departments.
The whiteboards for monthly visual communication of performance measures at the Vara plant (Figure 3) included more information than the daily boards. They consisted of graphs showing the target, and sometimes trends over the year. The same template was used for all graphs. However, some graphs used a smiley to show on which side of the target you should be, some graphs used an arrow to communicate the same information, and on some graphs it was not shown. Operators said that they were not used to reading these visual communications, and did not see the need to do so. Middle managers and managers appreciated the monthly follow-up as supplement to the daily visual communication, and believed that it showed trends. They initiated actions if results were going the wrong way. The templates and grouping of the visual communication on whiteboards were the same for all performance measures, communicating the different measures (safety, quality, delivery, cost, environment, personnel) in the same order at all locations as illustrated in Figure 3. Based on the guidelines in Table 3, several strengths were identified in the monthly visual communication, such as visualizing as simply as possible, using a clear logic, and including all essential elements in the visualization. One weakness that was identified was the failure to use symbols consistently (e.g. smileys or arrows).
The third form of visual communication at the company was visual PowerPoint communication on a screen, supporting monthly oral communication of performance measures (Figure 4 and Figure 5). A manager said that “continuity is important”, and so they used the same agenda and almost the same tables and graphs at every monthly communication meeting. The template for the presentation used bars with the company name in two to three places on each page. In the presentation, a table and a graph concerning the same topic were shown on the same page, and the presenting manager explained where to look to draw conclusions. Targets were shown in some of the tables and graphs, and the colors red, green and yellow were sometimes used in tables without explanation.

Operators said that they did not understand the figures themselves, but needed an explanation of what to look at and what conclusions to draw. One operator said that the understandability came from the manager presenting the information and not from the visual communication, while another said that “I actually struggle to understand this”. Among managers, middle-managers and white-collar workers opinions were divided. One thought that the visualization was good, while another said that it was much too complex and that it should be visualized more simply. Yet another stated that the visual communication was understandable, but that it probably was too complex for the operators. Smileys and colored thumbs pointing up or down were used to visualize which side of the target line you should be on. Middle-managers, white-collar workers and operators thought that the symbols increased understandability. This visual communication also included pictures for visualizing recent happenings or improvements. The weaknesses identified (based on Table 3) were over-complex presentations with cluttered visualization (template and use of colors), not including all essential elements (targets and specifying the axis in graphs), and inconsistent use of symbols (smileys and thumbs).
Figure 4. Example of visual PowerPoint communication on a screen, supporting monthly oral communication of performance measures at the Vara plant.
The first part of the survey concerned visual communication in general. It asked about perceptions of the current visualizations and the oral and/or written presentations of performance measures. The general opinion among the employees were that the visual presentations were understandable and easier to follow than only oral presentations. However, they indicated that joint oral and written presentations would improve understanding (Figure 6). The same point was made in response to the open-ended questions, where the most common answer was that all performance measures (both important performance measures and performance measures they want us to understand) should be presented both orally and in written form. Concerning the understanding of performance measures, the most common answer was that the presentation should be simple, well explained, and not include too much information. However, many employees also said that they did not know how to make the visualizations of performance measures easy to understand.
Understanding of the performance measures was tested in the second part of the survey. Operators were shown two monthly visualizations of performance measures (Figure 7), and asked to describe the information they understood from the diagram. They were asked to describe the topic, the target, whether the target had been met or not, and what the different colors meant. The result can be seen in Figure 8, showing that the target and the target achievement were well understood, while the topic was not as well understood. In addition, the mean value of the results from last year and of the current year (red/yellow color and orange color, wrongly labeled accumulated) was understood by only a few operators.

**Figure 6. Employees’ opinion of the understanding of performance measures, the Vara plant**

**Figure 7. Example of monthly visualization of performance measures at the Vara plant, delivery precision (a) and missed deliveries (b)**
The third part of the survey concerned how visualization tools could improve understanding of presentations of performance measures. The result in Figure 9 indicate that no one visualization tool is much better than another. However, the fact that the mean value is above 3.5 might indicate that some visualization tools make it a little easier to understand visualization of performance measures.

Figure 8. Understanding of current visualized performance measures at the Vara plant

Figure 9. Employees’ opinion about how visualization tools could improve understanding of performance measures presentations at the Vara plant
### ANALYSIS AND DISCUSSION

Comparing the findings of case study and the theoretical guidelines for visual communication (Table 2), we identified two strengths in the overall use of visualization in the company: visualization to communicate performance measures at the Vara plant. These were that visualization was used in all parts of the company and that CI was communicated visually. Similarly, comparing the findings of case study and the theoretical guidelines for visual communication supporting CI (Table 3), we identified five strengths and/or weaknesses in existing communication of performance measures at the plant.

Four strengths were identified in the use made of whiteboards for daily follow-up: visualizing as simply as possible, using a clear logic, using symbols consistently, and including all essential elements in the visualization. One weakness was identified in the use of whiteboards for monthly follow-up: symbols were not used consistently. When it came to the use of visualization of performance measures to support oral presentations, four weaknesses were identified: the visualization was not as simple as possible; colors were not used consistently; symbols were not used consistently; and all essential elements were not included. The weaknesses and strengths for each visual communication channel are summarized in Table 4.

<table>
<thead>
<tr>
<th>Whiteboards for daily follow-up</th>
<th>Whiteboards for monthly follow-up</th>
<th>Visual communication supporting oral company communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visualizes as simply as possible</td>
<td>S</td>
<td>W</td>
</tr>
<tr>
<td>Uses a clear logic</td>
<td>S</td>
<td></td>
</tr>
<tr>
<td>Uses colors consistent</td>
<td></td>
<td>W</td>
</tr>
<tr>
<td>Uses symbols consistent</td>
<td>S</td>
<td>W W</td>
</tr>
<tr>
<td>Includes all essential elements in visualization</td>
<td>S</td>
<td>W</td>
</tr>
<tr>
<td>Performance measures visualized in all parts of the company</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>CI communicated visually</td>
<td></td>
<td>S</td>
</tr>
</tbody>
</table>

(Empty - not identified, W - identified weakness, S - identified strength)

*Table 4 – Identified weaknesses and strengths in visual communication of performance measures at the Vara plant, based on Bresciani and Eppler (2015)*
The Vara plant is quite small, employees walk past whiteboards for many different departments, which probably increases the need for standardization. Many operators have been working at the plant for a long time. For example, the mean length of service in the department where the survey was done was fourteen years. The plant also exhibits SME characteristics such as tacit knowledge, few experts, and close, informal working relationships. These factors probably increase the need for simple visualizations with clear logic and consistent use of symbols and colors.

Drawing on theoretical guidelines for visualizing performance measures supporting CI (Tables 2 and 3), the results from the survey were summarized in the form of practical recommendations for improving visualization of performance measures at the Vara plant:

- Support the visual presentation of performance measures with an oral presentation every time it is updated. The presentation should be substantial, as simple as possible, and short.
- Explain all written elements well, but keep them as simple as possible by avoiding too much information.
- State the topic using simple words that are understood by everyone.
- If mean value results are included, they need to be explained.
- Chose a few visualization tools, for example happy and sad smileys, and use them consistently.

An example of how performance measures could be visualized is shown in Figure 10. In this example, the heading uses simple words to state the topic, and also defines the y-axis. The mean value from the previous year has been removed in order to simplify the visual, the current mean value is clearly defined, and smileys explain the target line.

![Figure 10: Example of simplified visualization of missed deliveries at the Vara plant](image-url)
CONCLUSION
Manufacturing SMEs can use visualization to strengthen their communication of performance measures, and support CI. At the studied company there was a need to simplify the visualizations without compromising the understanding. Possible simplification measures included using symbols and colors consistently, using simple words, and not including too much information. A generalized proposal for how to visualize performance measures is shown in Figure 11 (in contrast to Figure 10, which dealt with one specific example).

![Substantial, simplified, clear description of the topic](image)

*Figure 11. Proposed visualization of performance measures*

It was found that it is also important to support visualizations with oral presentations, explaining the results. The approach to simplifying the visualization of performance measures recommended for this plant might also be helpful to other manufacturing SMEs interested in improving their communication of performance measures, increasing their performance, and strengthening the company.

LIMITATIONS AND FURTHER RESEARCH
These guidelines and the proposal for visualization of performance measures are based on research at one specific manufacturing SME. The model needs to be implemented and evaluated in the company, as well as in other manufacturing SMEs. The model might also be adapted to companies other than manufacturing SMEs.

ACKNOWLEDGMENTS
The author would like to thank the KK environment INFINIT at the University of Skövde for providing funding for this project. She would also like to thank the Vara plant, for their cooperation and openness to the researcher.
REFERENCES


COMMUNICATING PERFORMANCE MEASURES: CURRENT PRACTICE IN MANUFACTURING SMES

Carina Larsson and Anna Syberfeldt, University of Skövde
INTRODUCTION

Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of an action (Amaratunga and Baldry, 2002) or as determining what to measure, how to measure it and how to report the results (Srimai et al., 2011). Over the years, performance measurement has developed into performance management, i.e. how to use performance measures to manage organizational performance (Amaratunga and Baldry, 2002; Bititci et al., 2011; Srimai et al., 2011). Performance measurement provides a basis for improving organizational performance (Amaratunga and Baldry, 2002).

The communication of performance measures is important in order to improve our understanding of strategy, and is a key to implementing successful performance measurement (Kaplan and Norton, 2001; Ukko et al., 2007b). Communication is defined as “the exchange of meanings between individuals through a common system of symbols” (Encyclopedia Britannica, 2014), and internal communication has long been seen as critical to company success (Redding, 1979). Communicating understandable and accessible performance measures is vital in order to align employees with organizational strategy (Kaplan and Norton, 2001).

The communication of performance measures is also important in order to improve the performance of small and medium-sized enterprises (SMEs) (Ukko et al., 2007a). SMEs are important contributors to national growth and to the European Union’s economy as a whole (European Commission, 2015; Supyuenyong et al., 2009), and a main purpose of effective communication in SMEs is to improve employee understanding of business goals (Ukko et al., 2007a). The managerial characteristics of SMEs differ from those of larger companies (Wong and Aspinwall, 2004), and SMEs must be flexible in reacting to market changes despite their relative lack of resources and managerial expertise (Hudson, 2001). Performance measurement systems are considered a means to improve performance (Cocca and Alberti, 2010), but SMEs are less likely than larger companies to implement effective performance measurement systems (Taylor and Taylor, 2013), and the literature has significantly neglected performance measurement and management in SMEs (Taticchi et al., 2010). A key barrier facing SMEs in the internal communication process is developing performance measures, following up results, making decisions based on performance information, and providing feedback to the organization (Ates et al., 2013).

This paper examines current practice of communicating performance measures in manufacturing SMEs. The paper explores three elements of the communication of performance measures in manufacturing SMEs: the specific performance measures communicated, how performance measures are communicated, and the physical context in which performance measures are communicated. The paper endeavours to answer the following question: What is the current practice of communicating performance measures in manufacturing SMEs? Improved knowledge could help fill the knowledge gap regarding the communication of performance measures, supporting performance measurement in manufacturing SMEs and improving performance.
THEORETICAL FRAMEWORK

The theoretical framework defines SMEs and their typical characteristics, explores performance measures, the communication channels of performance measures, the physical communication context, and proposes a two-way communication model.

SME CHARACTERISTICS

| Ownership & management | Owned by entrepreneur, multi-tasking owner-manager  
| Centralized, short-term, intuitive decision making by few decision-makers  
| Directive and paternalistic management style, command and control culture  
| Top management highly visible on the shop-floor  
| Poor managerial skills  
| Structure | Simple, flat structure with few layers of management and hierarchy  
| Flexible structure and information flows  
| Division of responsibilities is limited and unclear; low degree of specialization  
| Culture & behavior | Unified, organic, and fluid culture working across department boundaries  
| Operations and employee behavior influenced by managers  
| Result-oriented, short-term operational focus  
| Systems, processes & procedures | Simple planning, evaluating, reporting and information systems  
| Flexible and adaptable processes  
| Informal, unclear rules and procedures and low degree of standardization and formalization  
| Limited knowledge of and management attention to information systems  
| Packaged information system applications subordinated to the accounting function  
| Human resources | Modest know-how with tacit knowledge and few experts, limited resources, ad hoc and small-scale training and employee development  
| Close, informal working relationships  
| Low incidence of unionization  
| Low resistance to change  
| Modest financial resources  

Table 1. Typical SME characteristics. (Ates et al., 2013; Wong and Aspinwall, 2004; Zach et al., 2014)

Several typical characteristics distinguish SMEs from bigger companies. The European Union defines SMEs as having fewer than 250 employees and a turnover of less than or equal to EUR 50 million or a total balance sheet of less than or equal to EUR 43 million (European Commission, 2005). SMEs typically have certain characteristics
(Huin, 2004), such as short-term priorities, internal operational focus, lack of external orientation, tacit knowledge, desire for flexibility, poor managerial skills, entrepreneurial orientation, command and control culture, and limited resources (Ates et al., 2013). Zach et al. (2014) identify typical SME characteristics that could affect system implementation, concluding that ownership and limited resources were two of the most influential. Wong and Aspinwall (2004) summarize typical SME characteristics in six areas, five of which concern internal characteristics: ownership and management; structure; culture and behavior; systems, processes, and procedures; and human resources. These five areas are used to organize the typical SME characteristics summarized in Table 1.

PERFORMANCE MEASURES

Performance measurement is relevant in many academic disciplines, for example operations management, strategic management, management accounting and organizational behavior (Srimai et al., 2011). Extensive operations management research examines performance measures and performance measurement systems (Folan and Browne, 2005; Neely, 2005). Performance measures research can be divided into three areas: design of performance measures, implementation of performance measures, and use of performance measures (Bourne et al., 2000). The present paper covers the design, implementation, and use phases in the communication of performance measures and includes the communication of strategy, targets, results and the performance measures themselves. Performance measures have evolved from measurement to management, from static to dynamic, and from a shareholder value to a stakeholder focus (Srimai et al., 2011), commonly gathered in performance measurement systems. One of the best-known performance measurement systems is the balanced scorecard (Kaplan and Norton, 1992). It divides performance measures into four perspectives, i.e. financial, customer, internal, and learning and growth, all of which must be balanced (Kaplan and Norton, 1992). Research demonstrates that companies using both financial performance measures (e.g. earnings or return on assets) and non-financial performance measures (e.g. product quality or employee satisfaction) attain better performance (Lingle and Schiemann, 1996). In addition companies with both objective non-financial performance measures (e.g. product quality) and subjective non-financial performance measures (e.g. employee satisfaction) also attain better performance (Van der Stede et al., 2006). Performance measures in SMEs often emphasize financial factors (Hynes, 1998).

In considering the design of performance measures, the need for alignment between strategy, targets, and the performance measures themselves has been demonstrated by several researchers (e.g. Bourne et al., 2000; Garengo and Biazzo, 2012; Hudson et al., 2010; Kaplan and Norton, 1992). SMEs have a good understanding of financial performance measures, but these measures often lack a strategic alignment (Hudson et al., 1999). In communicating targets it is important to grasp the linkage between employee and the company targets, because this linkage fosters a better understanding of employee targets, thus improving performance (Ukko et al., 2009). Managers must communicate to employees what performance measures are the most important and clarify the alignment between performance measures and stakeholder value (Neely et al., 2002). Performance measures must have specified purposes and be relevant (Bititci and Nudurupati, 2002; Neely et al., 1997); they also must have clear titles, clear definitions and appropriate targets (Lohman et al., 2004; Neely et al., 1997).
Performance measures must be visual and easily understood and used (Bititci and Nudurupati, 2002), as SMEs in particular need performance measures that are easily understandable and obviously useful (Ukko et al., 2007a). The accuracy and reliability of performance measures are also important (Bititci and Nudurupati, 2002). SMEs need reliable, dynamic and flexible performance measures (Hudson et al., 2001; Ukko et al., 2007a).

COMMUNICATION CHANNELS

The communication of performance measures can be divided according to the communication channel used (Biron et al., 2011), for example, oral versus written communication (Tenhiälä and Salvador, 2014). Oral communication channels are also called rich communication channels (Byrne and LeMay, 2006) and include face-to-face information meetings. Oral communication builds relationships and confidence, enables early identification of conflicts, discusses and clarifies ambiguities, and satisfies common human needs for communication, safety, acknowledgement, and power, thereby promoting performance efficiency (Raisiene, 2012). Oral communication is the richest medium and is preferred by employees, as it allows nonverbal communication and immediate feedback, reflecting manager willingness to listen to employees (Byrne and LeMay, 2006; Men, 2014). Oral two-way communication between blue-collar employees and middle-managers also enables improved operational performance (Anh and Matsui, 2011). Oral communication has drawbacks, however: it is impermanent (Hertzum and Pejtersen, 2000), and requires the simultaneous presence of senders and receivers.

Besides oral communication channels there are written communication channels (e.g. written information on bulletin boards or video monitors), also called lean communication channels (Byrne and LeMay, 2006). Byrne and LeMay (2006) claim that employees prefer written communication channels for company information, and Daft et al. (1987) claim that managers also prefer written communication channels for unambiguous communication that must not be misunderstood. Written communication has drawbacks, however: giving an incomplete account of the context surrounding the issues treated (Hertzum and Pejtersen, 2000). Focusing on SMEs, Ukko et al. (2006) state that all internal communication channels positively affect performance, that oral communication is the best type of communication for performance measurement, and that oral communication can be supported by written communication (Ukko et al., 2007a). High-performing managers have the skills to choose the most appropriate communication channel depending on the richness of the message (Daft et al., 1987).

The communication of performance measures can be one-way or two-ways, and can be vertical or horizontal in the organization. The one-way communication of performance measures can be top-down or bottom-up vertically oriented (Malina and Selto, 2001), for example, from managers to employees concerning strategy or targets. One-way top-down strategy communication helps improve performance (Bourne et al., 2013; Rapert et al., 2002), and it is proposed that senior or top managers specifically become involved in such communication to improve performance management (Ferguson et al., 2013; Psychogios, 2012). Such vertical, one-way, top-down communication of performance measures gives employees access to information about targets, how well they are addressed, and how employees can help achieve them (Biron et al., 2011). One-way communication from managers to employees might also negatively affect the organization as it is passive, and could cause unproductive conflicts or ten-
sions (Malina and Selto, 2001). The communication of results from employees to managers can be seen as vertical, one-way bottom-up communication (Bititci and Nurdurupati, 2002). Engagement improves if the communication of performance measures runs both ways (Abdel-Maksoud et al., 2005), so two-way communication is important and should be used as often as possible (Ukko et al., 2007b). Two-way communication includes discussions or other interactive discourse between managers and employees (Ukko et al., 2007b), and employee participation in decision making facilitates performance because increased participation increases work motivation (Ukko et al., 2008). The importance of participation in decision making concerns mainly individual or team-level decisions, but also concerns company-wide decisions (Ukko et al., 2008). Vertical two-way communication can be seen as part of an evaluation and target-setting process improving performance measures (Biron et al., 2011), for example, the important activity of investigating existing performance measures and their usefulness (Bourne et al., 2000; Wouters and Sportel, 2005).

PHYSICAL COMMUNICATION CONTEXT
The physical context of the communication might also affect the communication of performance measures: for example, communication might occur in the office area where managers and other white-collar employees have their offices, on the shop-floor where blue-collar employees work, or in a common area where both white-collar employees and blue-collar employees spend time. Communication on the shop-floor is important, leading to quick decisions based on facts (Formánek and Maxan, 2015). In addition, shop-floor involvement has proven to be important for performance management, and companies with considerable shop-floor communication execute management practices more effectively than do companies with little such communication (Abdel-Maksoud et al., 2005; Zeng et al., 2013). Shop-floor communication also advances the company’s quality performance (Zeng et al., 2013). Communication on the shop-floor is also an important basis of “Industry 4.0”, a strategic initiative to create a “smart factory” where machines and people are connected and communicate with each other via the Internet (Fraunhofer, 2016).

TWO-WAY COMMUNICATION MODEL
Ever since Aristotle divided communication into the speaker, subject, and person addressed (Keyser, 1922), various communication models have been developed. Shannon et al. (1950) developed a mathematical communication model, identifying source, transmitter, signal, and recipient, a model that has been further developed by several other researchers. One example is the “SMCR” communication model of Berlo (1960), which includes the elements source, message, channel, and receiver (Figure 1). Berlo (1960) also added the encoding and decoding of the message as distinct communication processes not included in Shannon et al.’s (1950) previous communication model.

![Figure 1. Berlo’s (1960) communication model](image-url)
Berlo’s (1960) model is a general communication model not specifying the organizational direction in which the communication goes, i.e. whether it goes from managers to employees or from employees to managers. To adapt this general communication model to communication of performance measures in manufacturing SMEs, a two-way model based on theory is proposed in Figure 2. This model includes three communication channels with different performance measures:

- Strategy and targets communicated one-way top-down from managers to employees (Bourne et al., 2013; Rapert et al., 2002), complemented by questions and discussions communicated bottom-up, making the communication two-ways (Ukko et al., 2007b)
- Results communicated from employees to managers one-way bottom-up (Bititci and Nudurupati, 2002), complemented by discussions, making the communication two-ways (Ukko et al., 2007b)

### TWO-WAY COMMUNICATION FOR THE IMPROVEMENT OF PERFORMANCE MEASURES.

This model uses four elements suggested by Berlo (1960), i.e. source, receiver, message, and channel. Source and receiver are included in the model but not further explored in the study, while message and channel are explored. In addition to these elements, the physical communication context is added to the proposed model, visualized as the surroundings in which performance measures are communicated. The proposed two-way communication model might be used for further exploration of performance measurement communication.

![Figure 2. Proposed two-way communication model](image-url)
METHOD

This section describes the method used in the literature review, empirical study, and analysis of results. The research was carried out deductively (Spens and Kovács, 2006), exploring theory and current practice based on the two-way communication model proposed in figure 2.

LITERATURE REVIEW

The theoretical part of this paper started with a systematic literature review and continued with a traditional literature review (Jesson et al., 2011) exploring the communication of performance measures in general and in manufacturing SMEs in particular. The main data sources were Scopus, Google Scholar and WorldCat Beta. The review searched for the term “performance measurement” or “performance management”, “communication” or “information”, and “production” or “manufacturing” combined with the term “SME”. The searches were limited to peer-reviewed articles published since 2000 and the results were snowballed according to the method of Rumsey (2008). This entailed working both backwards, following citations in the identified articles, and forwards, following where the identified articles had been cited. Complementing these searches were general searches based on the search terms, but not limited in time. Typical SME characteristics were also searched for in existing theory to provide context for the results.

EMPIRICAL STUDY

The empirical study was conducted as a multiple case study following the structure advocated by Yin (2014) and based on the two-way communication model proposed in Figure 2. The participating companies were manufacturing SMEs selected from a group of companies that were or had been participating in a lean implementation program. This selection criterion was chosen because these companies were assumed to be likely to measure performance. Four case companies were chosen for the study, all manufacturing companies situated in the countryside or in small cities in Sweden, giving the companies similar geographic contexts. Two of the companies were privately owned while the other two were parts of bigger corporate groups. All companies had fewer than 250 employees and was in this study regarded as SMEs although turnover and profit was not known for all companies. The unit of analysis was the communication of performance measures, and the study was limited to formal communications. The case study used two data collection techniques: interviews and observations (Yin, 2014). Interviews were conducted with employees on all levels: managers, middle-managers, and blue-collar employees. The observations consisted of studying written communication concerning performance measures, including bulletin boards, video monitors, and written presentations.

Interview and observation guides were developed, covering the main aspects of the communication model proposed in Figure 2 (i.e. performance measures, communication channels, and physical communication context). The following three elements were addressed in both the observations and the interview guide:

Performance measures communicated: the object was to identify whether the performance measures were financial, objective non-financial, and/or subjective non-financial. We also identified whether strategy, targets, and/or results were communicated, whether strategy, targets, and performance measures were aligned, and the
purpose and relevance of the performance measures. Looking into how the performance measures were presented, the focus was whether the performance measures had clear titles, clear definitions, and appropriate targets, and whether the performance measures were visual as well as easy to understand and use.

Communication channels: the focus was on how the performance measures were communicated (i.e. orally or in writing), by whom they were communicated, and whether the communication was one-way or two-ways. If the communication was two-ways its purpose was to be explored, i.e. whether it concerned improving performance measures.

Physical communication context: this part consisted of looking into the physical context in which the communication of performance measures took place, dividing the physical context into office area, shop-floor, and common area.

The interview guide included one question not included in the observation guide. This question concerned the interviewees’ opinion of the current practice of communicating performance measures and the interviewees’ vision for communicating performance measures. This question addressed the performance measures communicated, the communication channels, and the physical communication context. The observations were conducted by the main author. The interviews consisted of six main open-ended questions, each supplemented with two to nine sub-questions. The employees were interviewed one at a time at company premises, by one or two participants in the research group. Interviews were conducted in Swedish and transcribed verbatim. For the purpose of this paper relevant passages were translated by the main author. The empirical results were summarized according to the proposed two-way communication model with the three identified elements (i.e. performance measures, communication channels, and physical communication context).

**ANALYSIS**

Current practices in the companies were compared with existing theory, identifying divergences between them. These divergences were related to typical SME characteristics, exploring whether SME characteristics might influence current practice in communicating performance measures in manufacturing SMEs.

**EMPIRICAL FINDINGS**

This section compiles the empirical findings from each of the four case companies, and summarized. For confidentiality reasons, fictitious company names are used in this paper, i.e. Home, Agriculture, Boat, and Car.

**HOME**

At the time of the study, Home was a privately owned, medium-sized manufacturer with approximately 240 employees. The company produced high volumes of a few products made of wooden material, and the level of automation was high.

The performance measures communicated in Home were financial and objective non-financial, and did not include subjective non-financial performance measures. Neither strategy nor targets were communicated. The results communicated were: products packed, received orders, stock of orders, product inventories, number of products invoiced, invoice value, and invoice status concerning completion time of continuous
improvement (CI) actions. The purpose and relevance of the performance measures were unclear, and some but not all performance measures were specified with clear titles and clear definitions. The performance measures lacked appropriate targets. Some results were compared with historical numbers, while other results were not compared with anything. Performance measures were presented in an unstructured, non-standardized way, using various colors without explaining their significance, and were not visually oriented or easy to understand. Managers held divergent views concerning the need for targets. One manager formulated his own targets due to the lack of company targets, while another manager said that what is “..most important is that key persons know, and they do.” Middle-managers saw a need for targets on an operational level. Blue-collar employees saw no specific needs for targets. Both managers and middle-managers saw a need for increased follow-up on the operational level. One manager stated that “the speed is so high so that we forget to follow-up.”

Home had oral one-way communication channels by which managers and middle-managers communicated results weekly, monthly, and quarterly. These oral channels were not supported by any specific written communication channels. There were two written communication channels, bulletin boards and video monitors. The bulletin boards were updated weekly, and the video monitors were updated in real time. The company had no two-way communication for improving performance measures. Both middle-managers and blue-collar employees appreciated the existing oral communication channels, and saw a need for more oral communication from managers. Middle-managers also saw a need for more and better written communication channels in order to deepen their understanding of existing problems and future improvement opportunities.

The physical communication context of the oral communication of performance measures was the office area and the shop-floor. The office area was near the shop-floor and blue-collar employees passed it every day, which is why the difference in physical context was perceived to be small. The bulletin boards were placed on the shop-floor, where they were paid little attention by employees. The video monitors, installed on the shop-floor and the offices, were used by managers but less frequently by middle-managers and blue-collar employees.

AGRICULTURE

At the time of the study, Agriculture was a small-sized manufacturer with around 25 employees, owned by a company group. The company had a one-piece production in which many products were customized. The level of automation was low, and product customization and preparation before start of production were crucial. The company had eight performance measures, seven financial and one subjective non-financial. Agriculture had an explicit strategy to be the long-term partner of its customers, though this was not aligned with any target, as well as a strategy to grow, which was aligned with a turnover target. Turnover was the most emphasized target, well known on all levels and communicated monthly. Other targets, not known by all employees and communicated once or twice a year, were: profit, inventory, warranty cost, delivery reliability, customer satisfaction, and purchase cost relative to turnover. The company’s action list of improvements to make during the year also served as a target, and was communicated approximately twice a year. The performance measures were chosen according to their purpose. Some performance measures communicated in Agriculture had clear titles, clear definitions, and appropriate targets, while others did
not. Some presentations of performance measures were visual and easy to understand, while others were not. Employees were aware of the turnover target, but the timeframe for achieving this target and the exact number to achieve were not always known. Knowledge of the other targets was not well disseminated in the company. Managers and other white-collar employees saw the importance of communicating targets to make everyone aware of what was happening and to ensure that everyone was working towards the same targets. One manager acknowledged that “we should probably be better at saying what we really want”. Blue-collar employees saw no need for improved targets.

Results were communicated one-way by managers orally supported by written communication of some performance measures. There was also a bulletin board where written communication of performance measures was mixed with other written information, not known by many of the employees. There was no two-way communication for the improvement of performance measures in the company. No opinions concerning the communication channels were expressed in the interviews.

Agriculture had almost no boundaries between the shop-floor and the office area. Blue-collar employees visited managers and other white-collar employees in their offices, and managers and other white-collar employees visited the shop-floor frequently. The bulletin board for written information was placed in the lunch room, which was a common area.

**BOAT**

At the time of the study, Boat was a medium-sized manufacturer with about 240 employees. The company had a production line turning out a few basic products with many options using both automated and manual work. Boat was owned by a corporate group, and was steered by many centrally determined guidelines. There were many performance measures in Boat, including financial as well as objective and subjective non-financial measures. Strategy was communicated by the managers once a year, and all performance measures were aligned with the strategy, had clear purposes and were relevant. Boat communicated performance measures concerning seven areas: safety, quality, delivery, cost, environment, personnel, and CI. All targets were set on the company level, broken down to the operational level, and known by employees. All performance measures had clear titles, clear definitions, and appropriate targets. The presentation of the performance measures was visual: the operational performance measures were easy to understand, while the overall performance measures were more complex and harder to understand. Two-way communication was used for the improvement of performance measures. Managers claimed that performance measures were chosen strategically, and one manager stated that the performance measures “covers the basic conditions of production quality very well”. One middle-manager claimed that the CI target needed to be better connected to the other targets, while blue-collar employees claimed that the CI target should emphasize how various factors affected performance instead of simply measuring the number of improvements.

Several oral communication channels were used on different levels in Boat. Strategy, targets and results were communicated by managers and middle-managers, and all oral communication was supported by written communication. The communication channels in Boat were structured and strategically chosen, and oral and written communication channels were developed simultaneously. Managers, middle-managers,
white-collar employees and blue-collar employees saw no need for more communication of performance measures.

All oral communication of performance measures with blue-collar employees was done on the shop-floor, and the bulletin boards were situated on the shop-floor. Managers and middle-managers visited the shop-floor regularly for meetings, which were often held near the bulletin boards or in a meeting room near the shop-floor.

CAR
At the time of the study, Car was a medium-sized manufacturer with about 80 employees. The company was privately owned and managed by its owners. The production consisted of machining and assembling a huge number of similar products. Its strategy, which was to be a leader in its line of business, was communicated orally once or twice a year. The company emphasized one financial performance measure, turnover growth, and one subjective non-financial performance measure, customer satisfaction. There was some alignment between strategy and results, but the performance measures were not consistently aligned with the strategy. The presentation of the performance measures was not visual and the measures lacked clear titles, clear definitions, and appropriate targets. The performance measures were visualized, but in a very simplified form that was difficult to understand.

The company did not communicate any targets. Overall company results were communicated orally once or twice a year, often in terms of turnover and profits compared with historical figures. Operational results in terms of delivery delays and product discards were communicated orally each week, and product discards were also communicated in written form. The written communication concerning product discards were posted on a bulletin board near the punch clock. There was no two-way communication for the improvement of performance measures. Neither targets nor results were well-known by the employees. Employees on all levels saw a need for performance measures that were easy to understand, in terms of both targets and results. Blue-collar employees paid little attention to the written communication, and believed that the communication was unstructured.

The weekly oral communication in Car was held near the punch clock, a less noisy part of the shop-floor. Managers often visited the shop-floor, while blue-collar employees visited the office area mainly for meetings.

SUMMARY OF EMPIRICAL FINDINGS
All four companies communicated financial performance measures. Agriculture and Boat communicated financial targets and results, while Home and Car communicated only financial results. Boat communicated both objective and subjective non-financial performance measures, while Home communicated objective non-financial performance measures, Agriculture communicated one subjective non-financial performance measure, and Car communicated no non-financial performance measure (Table 2).
Financial performance measures were communicated. Non-financial objective performance measures were communicated. Non-financial subjective performance measures were communicated.

<table>
<thead>
<tr>
<th>Company</th>
<th>Financial performance measures were communicated</th>
<th>Non-financial objective performance measures were communicated</th>
<th>Non-financial subjective performance measures were communicated</th>
</tr>
</thead>
<tbody>
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<td>Home</td>
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<tr>
<td>Agriculture</td>
<td>√</td>
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<tr>
<td>Boat</td>
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<tr>
<td>Car</td>
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</tbody>
</table>

Table 2. Financial and non-financial performance measures communicated

Two of the four case study companies (i.e. Agriculture and Car) communicated strategy but not targets, while Boat communicated strategy and targets, which were aligned. All companies communicated results. In Agriculture and Car the managers saw a need to improve the communication of targets, while the managers in Home had divergent opinions on this matter. The empirical findings indicate that manufacturing SMEs communicate performance measures, but that these measures are mainly financial. In addition, the findings indicate that manufacturing SMEs do not communicate a clear alignment between strategy and targets. The communication of strategy, targets, and results is summarized in Table 3.

<table>
<thead>
<tr>
<th>Company</th>
<th>Strategy was communicated</th>
<th>Targets were communicated</th>
<th>Results were communicated</th>
<th>There was an alignment between strategy and targets</th>
</tr>
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<tbody>
<tr>
<td>Home</td>
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</table>

Table 3. Communication of strategy, targets, and results

Current practice for presenting performance measures were highly divergent concerning purpose, title, definition, visual presentation, and understandability of the measures. The empirical findings indicated that many performance measures lacked clear titles, clear definitions, and appropriate targets, and moreover was not visually presented or easily understood.

The second communication element was the communication channels, illustrated in Figure 2. Current practices of top-down communication from managers to employees and of two-way communication for improving of performance measures were summarized. Due to a lack of applicable current practices in the case study companies, one-way bottom-up communication was not summarized. All companies had oral one-way, top-down communication of performance measures. In two companies, i.e. Home and Agriculture, there were no connections between the one-way oral communication channels and the written communication channels, and in those companies the writ-
ten communication channels were used by managers but less frequently by other employees. Agriculture had almost no written communication channels. Boat had designed oral and written communication channels for performance measures simultaneously, and its employees frequently used both these channels. Boat also had two-way communication to improve performance measures, while the other companies, i.e. Home, Agriculture and Car, had no two-way communication for improving performance measures. The empirical findings indicate that two-way communication for improving performance measures is rare in manufacturing SMEs. They also indicate that in current practice many manufacturing SMEs have oral and written communication channels for communicating performance measures that are not aligned with each other.

The third element was the physical communication context. In Home, oral and written communication of performance measures was executed both on the shop-floor and in the office area, and managers were highly visible on the shop-floor. In Agriculture oral and written communication of performance measures was executed in the common lunch room. Managers in Agriculture often visited the shop-floor, and blue-collar employees often visited the office area. In Boat, most oral and written communication was executed on the shop-floor or in an office area next to the shop-floor; managers often visited the shop-floor and blue-collar employees sometimes visited the office area. Both oral and written communication of performance measures in Car was executed on the shop-floor. The empirical study found almost no boundaries between the office area and the shop-floor in the case study companies, and that managers and others white-collar employees frequently visited the shop-floor.

**ANALYSIS AND DISCUSSION**

As basis for the study a two-way communication model was proposed (Figure 2), exploring three identified communication elements: performance measures, communication channels, and physical context of the communication. Based on the model, the three communication elements were explored empirically. The empirical results were related to theory and discussed.

The first communication element explored was the performance measures. Previous studies have established that financial as well as objective and subjective non-financial performance measures improves performance (Lingle and Schiemann, 1996; Van der Stede et al., 2006). The empirical findings indicate that manufacturing SMEs mainly use financial performance measures. This indicates a divergence between current practice and theory in the use of both objective and subjective non-financial performance measures in manufacturing SMEs. Based on the previously established need for alignment between performance measures and strategy (Bourne et al., 2000), the present study identifies a divergence between current practice and theory concerning clear alignment between targets and strategy in manufacturing SMEs. Previous studies have established that performance measures must have a purpose, relevance, a clear title and definition, and an appropriate target as well as being conveyed visually and easy to understand (Bititci and Nudurupati, 2002; Lohman et al., 2004; Neely et al., 1997; Ukko et al., 2007a). The present empirical study found that many performance measures lacked these characteristics, indicating a divergence between current practice and theory concerning the presentation of performance measures.
The second communication element explored was the communication channels. Previous studies have established that oral communication is preferred by employees but lacks permanence (Hertzum and Pejtersen, 2000; Men, 2014), and that written communication is recommended for conveying company information (Byrne and LeMay, 2006). The present empirical findings indicate that manufacturing SMEs frequently use oral communication channels frequently, but that they lack written communication channels aligned with the oral channels. Theory indicates a need for this alignment (Ukko et al., 2007a), so further exploration of the matter is warranted. Theory also indicates a need for two-way communication for improving performance measures (Biron et al., 2011; Bourne et al., 2000; Wouters and Sportel, 2005; Ukko et al., 2007b). The present empirical findings indicate that manufacturing SMEs do not use two-way, vertical communication channels. This indicates a divergence between current practice and theory in using two-way, vertical communication channels between managers and employees for improving performance measures in manufacturing SMEs.

The third communication element explored was the physical communication context. According to previous studies, shop-floor communication improves performance and makes management practice more effective (Zeng et al., 2013). The present empirical finding indicate that manufacturing SMEs engage in considerable communication of performance measures on the shop-floor and have vague boundaries between the shop-floor and office areas. This marks an alignment between current practice and theory.

Typical SME characteristics such as poor managerial skills, result-oriented and short-term operational focus, and limited resources might influence the divergences in how performance measures are communicated in manufacturing SMEs. Concerning the physical communication context the empirical alignment between current practice and theory is possibly attributable to typical SME ownership, management, and structural characteristics. However, it should be noted that the communication of performance measures in Boat deviates from that in the other case study companies. Boat was owned by a corporate group and was steered by many centrally determined guidelines. The present study suggests that an SME steered by centrally determined guidelines might not fit ordinary SME specifications concerning the performance measurement area.

**CONCLUSIONS**

This paper endeavours to answer the question: *What is the current practice in communicating performance measures in manufacturing SMEs?* Answering this could help fill a knowledge gap regarding the communication of performance measures. Improved communication of performance measures is a key factor for the successful implementation of performance measurement (Kaplan and Norton, 2001; Ukko et al., 2007a), which in turn is an important factor for improved performance (Davis and Albright, 2004). From the theoretical part of the study a two-way communication model was proposed (Figure 2), exploring three communication elements: performance measures, communication channels, and the physical communication context. The proposed two-way communication model might be used for further exploration of performance measurement communication.

In this study, three divergences concerning the performance measures communicated were identified: the use of both objective and subjective non-financial performance
measures; having a clear alignment between targets and strategy; and the presentation of performance measures. Concerning the communication channels, the study indicated a divergence in the use of two-way, vertical communication channels between managers and employees for improving performance measures. Further, also concerning the communication channels, the study identified a need of further exploration. This need concerned the alignment between written and oral communication channels. In addition, one accordance between current practice and theory was identified in the study, concerning the physical communication context.

Typical SME characteristics might influence the identified divergences and the identified consistency between current practice and theory in communicating performance measures in manufacturing SMEs. However, the present study suggests that an SME steered by centrally determined guidelines might not fit ordinary SME specifications concerning the performance measurement area.

**LIMITATIONS AND FUTURE RESEARCH**
The empirical part of this paper is made in manufacturing SMEs in Sweden. The generalisability of the findings to other contexts is an intriguing question for further research.
REFERENCES


PERFORMANCE MEASUREMENT FOLLOW-UP SUPPORTING CONTINUOUS IMPROVEMENTS IN MANUFACTURING COMPANIES - A SYSTEMATIC REVIEW

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Kristina Säfsten, Jönköping University
Anna Syberfeldt, University of Skövde

ABSTRACT
Performance measurement has been paid a lot of attention. This paper provides a systematic review of existing research in performance measurement follow-up, which so far has been less treated. The paper suggests a categorization of the follow-up phase into the performance measurement system, input to and output from the system, and operational activities. It is concluded that there is a lack of research concerning the operational activities in the follow-up phase. It is also concluded that most of the research concerning follow-up of performance measurement does not support continuous improvement explicitly, but concerns performance measurement follow-up in general.
INTRODUCTION

In the increasing world-wide competition many manufacturing companies focus on continuous improvements to enhance process performance and thereby increase profitability (Bond, 1999). Continuous improvement (CI) is an umbrella concept for various efforts to improve processes. The efforts may be of either incremental or breakthrough character, and the name of the specific effort may vary. Frequently used efforts are for example lean production, kaizen or six sigma. Implementation of various CI efforts is challenging (Behrouzi and Wong, 2011, Denton and Hodgson, 1997), and many manufacturing companies fail in their implementation of different improvement initiatives (Nordin et al., 2012). However, some factors have been identified as supporting CI implementation, and one of them is performance measurement (Bakås et al., 2011, Hilton and Sohal, 2012). In much of the research the area of the performance measurement is general or undefined (Bourne et al., 2013, Digalwar and Sangwan, Neely et al., 1997). However, there are some research which focus on the follow-up of performance measurement related explicitly to continuous improvements (Anand and Kodali, 2010). Research in performance measurement often focus on what measures to use (Gomes et al., 2004, Kennerley and Neely, 2002) and the measurement system itself (Kaplan and Norton, 1996, Neely et al., 2005, Nudurupati et al., 2011). Despite the huge amount of research literature on performance measurement, an overview of existing knowledge in performance measurement follow-up is missing.

Performance measurement can be described as a process (Bititci and Nudurupati, 2002, Kuwaiti, 2004), where Bititci and Nudurupati (2002) use Deming’s PDCA process and add the performance measurement implications. Despite the huge amount of research literature on performance measurement, an overview of existing knowledge in performance measurement follow-up is missing. This paper systematically reviews relevant journals in order to identify and categorize existing knowledge and gaps concerning performance measurement follow-up supporting continuous improvement in manufacturing companies. The paper seeks to answer the question: What is the existing knowledge in performance measurement follow-up?

METHOD

In order to cover the area thoroughly, a systematic literature review was made (Jesson et al., 2011), divided into six phases (table 1). The first phase was a scoping review and a review plan, and the second phase a comprehensive search for relevant articles. In the third phase a quality assessment was done in order to exclude articles outside the area, followed by the fourth phase extraction exploring the identified articles. Finally, in the fifth phase, the data was synthesised and in the sixth phase the report was written up.

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
<th>Phase 5</th>
<th>Phase 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Scoping review</td>
<td>Comprehensi...</td>
<td>Quality assessment</td>
<td>Data ex...</td>
<td>Synthesis</td>
<td>Write up</td>
</tr>
<tr>
<td>b. Review plan</td>
<td></td>
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</tbody>
</table>

Table 1 – Key phases in systematic review (Jesson et al., 2011, p.108)
PHASE 1A: SCOPING REVIEW

The purpose with the scoping review was to find relevant journals in performance measurement. This was done by a search in Scopus database complemented with a search for reviews of performance measurement, which recommends journals. During the search in Scopus database, the first search term used was “performance measurement”. This was used in combination with the term “manufacturing” in order to catch articles and reviews concerning performance measurement in manufacturing. The words were searched for in all fields of the papers. The data range was limited to papers published from 2000, and the subject areas “life science” and “health science” were excluded. The journal search ended up in 7058 papers, whereof 6452 articles and 606 reviews. These papers were analysed according to source (figure 1).

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Accounting, organisation and society</td>
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<tr>
<td>Benchmarking</td>
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<td></td>
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<tr>
<td>Business Process Management Journal</td>
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<tr>
<td>European Journal of Operations and Research</td>
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<tr>
<td>Expert Systems and Applications</td>
<td>*</td>
<td></td>
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</tr>
<tr>
<td>Harvard Business Review</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Management and Data Systems</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>International Journal of Logistics Systems and Management</td>
<td>*</td>
<td></td>
<td></td>
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<tr>
<td>International Journal of Operations and Production Management</td>
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<td>*</td>
<td>*</td>
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<tr>
<td>International Journal of Production Economics</td>
<td>*</td>
<td></td>
<td>*</td>
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<tr>
<td>International Journal of Production Research</td>
<td>*</td>
<td></td>
<td>*</td>
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<tr>
<td>International Journal of Productivity &amp; Performance Management</td>
<td>*</td>
<td>*</td>
<td></td>
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<tr>
<td>Journal of Operations management</td>
<td>*</td>
<td></td>
<td></td>
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<tr>
<td>Management Accounting</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management Accounting Research</td>
<td>*</td>
<td></td>
<td></td>
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<tr>
<td>Management Science Journal</td>
<td>*</td>
<td></td>
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<tr>
<td>Measuring Business Excellence</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations Research</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production planning and control</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategic Management Journal</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Quality Management and Business Excellence</td>
<td>*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 - Source analysis of first step literature search

A search for reviews was made in the result from the journal search in Scopus, looking for summaries of relevant journals in the performance measurement area. The journal search ended up in two up-to-date reviews. Choong (2013) presents a list of the top-ten journals concerning publications related to performance measurement systems (PMSs), and
Taticchi et al. (2010) makes a citation analysis in performance measurement and management, listing the top five most cited journals in the area. The results from the two searches were summarized in table 2. Journals identified in more than one of the three lists of journals were assumed to be of some relevance for the area and were chosen for the comprehensive search.

Table 2 – Identification of relevant journals in performance measurement

The identified journals were:
International Journal of Operations and Production Management (IJOPM)
International Journal of Production Economics (IJPE)
International Journal of Production Research (IJPR)
International Journal of Productivity & Performance Management (IJPPM)

PHASE 1B: REVIEW PLAN

The review plan was made in order to identify relevant search words and specify inclusion and exclusion criteria for an optimal search during phase 2. With the starting point with the purpose of the paper, to identify and categorize existing knowledge concerning performance measurement follow-up supporting continuous improvement in manufacturing companies the terms were identified. The term “performance measurement” was seen as central, was complemented only with “performance measure” and “performance measures” and was searched for in all parts of the papers. Follow-up was complemented with “performance evaluation”, “performance valuation”, “performance assessment” and performance communication” and was also searched for in all parts of the papers. The term “manufacturing” was complemented with “production” in order to include all papers in the
area, although it also could include papers with the term “lean production”, sometimes used outside the manufacturing area. In order to strictly delimit to manufacturing these terms were only searched for in the abstracts of the papers. After the specification of search terms inclusion and exclusion criteria was set. The search was limited to articles and reviews, and to papers published from 2000 and newer in order to get up-to-date articles.

**PHASE 2: COMPREHENSIVE SEARCH**

The comprehensive search was done in the 4 journals identified during phase 1. The search resulted in 840 papers from the 4 journals, as seen in table 3, based on the identified search words, and with the identified exclusion and inclusion criteria.

<table>
<thead>
<tr>
<th>Journal</th>
<th>IJOPM</th>
<th>IJPE</th>
<th>IJPR</th>
<th>IJPPM</th>
<th>Tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified number of articles</td>
<td>118</td>
<td>128</td>
<td>548</td>
<td>46</td>
<td>840</td>
</tr>
</tbody>
</table>

**PHASE 3: QUALITY ASSESSMENT**

After the comprehensive search a manual delimitation for quality assessment was done, excluding papers that were outside the specification but had not been excluded in the system delimitation. Manual delimitation was required to exclude papers that included terms such as performance measurement, manufacturing or follow-up without exploring it. The manual delimitation was done in three rounds; first by reading the title of the paper, then by reading the abstract and finally by reading the whole paper. The result of the manual delimitation is summarized in table 4.

<table>
<thead>
<tr>
<th>Journal</th>
<th>IJOPM</th>
<th>IJPE</th>
<th>IJPR</th>
<th>IJPPM</th>
<th>Tot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of papers from system search</td>
<td>118</td>
<td>128</td>
<td>548</td>
<td>46</td>
<td>840</td>
</tr>
<tr>
<td>Manual delimitation by title:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not performance measurement</td>
<td>-23</td>
<td>-30</td>
<td>-340</td>
<td>-4</td>
<td>-397</td>
</tr>
<tr>
<td>Not follow-up</td>
<td>-10</td>
<td>-43</td>
<td>-87</td>
<td>-4</td>
<td>-144</td>
</tr>
<tr>
<td>Not manufacturing</td>
<td>-25</td>
<td>-11</td>
<td>-7</td>
<td>-9</td>
<td>-52</td>
</tr>
<tr>
<td>Remaining number of papers</td>
<td>60</td>
<td>44</td>
<td>114</td>
<td>29</td>
<td>247</td>
</tr>
<tr>
<td>Manual delimitation by abstract:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not performance measurement</td>
<td>-1</td>
<td>-1</td>
<td>-9</td>
<td></td>
<td>-11</td>
</tr>
<tr>
<td>Not follow-up</td>
<td>-33</td>
<td>-28</td>
<td>-70</td>
<td>-14</td>
<td>-145</td>
</tr>
<tr>
<td>Not manufacturing</td>
<td>-1</td>
<td>-1</td>
<td>-2</td>
<td>-5</td>
<td>-9</td>
</tr>
<tr>
<td>Remaining number of papers</td>
<td>25</td>
<td>14</td>
<td>33</td>
<td>10</td>
<td>82</td>
</tr>
<tr>
<td>Manual delimitation by whole paper:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not performance measurement</td>
<td>-2</td>
<td></td>
<td></td>
<td></td>
<td>-2</td>
</tr>
<tr>
<td>Not follow-up</td>
<td>-16</td>
<td>-8</td>
<td>-13</td>
<td>-3</td>
<td>-40</td>
</tr>
<tr>
<td>Not manufacturing</td>
<td>-1</td>
<td>-3</td>
<td></td>
<td>-1</td>
<td>-5</td>
</tr>
<tr>
<td>Remaining number of papers</td>
<td>7</td>
<td>5</td>
<td>17</td>
<td>6</td>
<td>35</td>
</tr>
</tbody>
</table>
If not obvious that the paper should be excluded, it was passed to the next round and a more thorough analysis. For example, if an abstract states that the paper explores the implementation of performance measurement the paper is passed to whole paper delimitation round, since follow-up could be a part of the implementation process. After the manual delimitation 35 papers remained, which were reviewed and analysed.

**PHASE 4-6: DATA EXTRACTION, SYNTHESIS AND WRITE UP**

After data extraction, the content of the identified papers was scrutinised based on the questions raised in this paper. Initially, the papers were categorized according to the four different phases of the performance measurement process (Bititci and Nudurupati, 2002). Thereafter, the papers were sorted according to their focus: focus on the performance measurement system, focus on the input to or output from the performance measurement system, or focus on the operational activities between measurement, see figure 3. Finally, the papers were sorted according to the intention of the performance measurement follow-up. Here a distinction was made between whether the purpose of the follow-up was to control or improve the performance.

**FINDINGS**

**PERFORMANCE MEASUREMENT PROCESS CATEGORIZATION**

The performance measurement process can be applied to the PDCA (Plan-Do-Check-Act) process (Bititci and Nudurupati, 2002), see figure 2. The PDCA phases are described as; Plan – Design or redesign business processes for improvement, define performance indicators and model the relationship between these indicators, Do – Implement the plan, identify the data sources for performance indicators and measure them, Check – Analyse the data, conduct root cause analysis and communicate the results to decision makers, and Act – Identify the key areas that need improvement, decide the changes needed to improvement. The follow-up part of the process can then be applied to the Check phase where the follow-up is done.

![Figure 2 – Performance measurement process after Bititci and Nudurupati (2002)](image)

When the analysis was done (table 6) the analysis showed that there were 11 papers focusing on the Plan phase of the PDCA process. These papers were focusing on what measures to follow-up instead of focusing on the follow-up process, and were therefore excluded.
from further categorization. The analysis also showed that 9 papers were focusing on the Check phase and 16 papers were focusing on the overall PDCA process.

PERFORMANCE MEASUREMENT SYSTEM SORTING

The papers were then sorted according to their relation to the performance measurement system (PMS). A well-known perspective is the one of Kaplan and Norton (1992), putting the financial perspective, the customer perspective, the internal business perspective and the innovation and learning perspective, creating the balanced scorecard. Neely et al. (2005) make a categorization of the framework levels; the individual measures, the performance measurement system as an entity, and the relationship between the performance measurement system and the environment within which it operates. The result from this systematic review indicated different relations to the PMS, see figure 3.

Figure 3 – relation to performance measurement system

Looking into all of the papers, 14 of the 25 papers were focusing on the PMS, whereof 5 papers from the Check phase and 9 papers from the PDCA process focus. One paper was focusing on the input to the PMS, coming from the Check phase, and 7 papers were focusing on the output from the PMS, whereof 3 from the Check phase and 4 from the PDCA process (table 5).

Table 5 – Papers categorized in system relation categories
PERFORMANCE MEASUREMENT FOLLOW-UP INTENTION

The final step was identifying whether the papers connected to performance measurement follow-up in CI, or if it was focusing on performance measurement follow-up in general. In 7 of the 25 papers there was a focus on CI, and in the rest the reason for the follow-up was not specified.

Table 6 – Paper analysis and categorization

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
<th>Journal</th>
<th>Process category</th>
<th>Intention</th>
<th>System sorting</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Decision–Information-Synchronisation perspective on the performance of FMS</td>
<td>Chan et al. (2011)</td>
<td>IJPR</td>
<td>C</td>
<td>general</td>
<td>PMS</td>
</tr>
<tr>
<td>A method to align a manufacturing execution system with Lean objectives</td>
<td>Cottyn et al. (2011)</td>
<td>IJPR</td>
<td>PDCA</td>
<td>CI</td>
<td>Output</td>
</tr>
<tr>
<td>A methodology for monitoring system performance</td>
<td>Talluri and Sarkis (2002)</td>
<td>IJPR</td>
<td>C</td>
<td>general</td>
<td>PMS</td>
</tr>
<tr>
<td>A new approach to environmental-performance evaluation</td>
<td>Nakashima et al. (2006)</td>
<td>IJPR</td>
<td>PDCA</td>
<td>CI</td>
<td>PMS</td>
</tr>
<tr>
<td>A new decision support system for performance measurement using combined fuzzy TOPSIS/DEA approach</td>
<td>Zeydan and Çolpan (2009)</td>
<td>IJPR</td>
<td>C</td>
<td>general</td>
<td>PMS</td>
</tr>
<tr>
<td>An analytical technique to model and assess sustainable development index in manufacturing enterprises</td>
<td>Garbie (2014)</td>
<td>IJPR</td>
<td>C</td>
<td>general</td>
<td>Output</td>
</tr>
<tr>
<td>An integrated approach to explain the manufacturing function’s contribution to business performance</td>
<td>Gonzalez-Benito and Lannelongue (2014)</td>
<td>IJOPM</td>
<td>PDCA</td>
<td>general</td>
<td>Op. action</td>
</tr>
<tr>
<td>Common database for cost-effective improvement of maintenance performance</td>
<td>Kans and Ingwald (2008)</td>
<td>IJPE</td>
<td>PDCA</td>
<td>CI</td>
<td>PMS</td>
</tr>
<tr>
<td>Historical analysis of performance measurement and management in operations management</td>
<td>Radnor and Barnes (2007)</td>
<td>IJPPM</td>
<td>PDCA</td>
<td>general</td>
<td>Op. action</td>
</tr>
<tr>
<td>HY-CHANGE: a hybrid methodology for continuous performance improvement of manufacturing processes</td>
<td>Dassisti (2009)</td>
<td>IJPR</td>
<td>PDCA</td>
<td>CI</td>
<td>Output</td>
</tr>
<tr>
<td>Study Title</td>
<td>Authors</td>
<td>Journal</td>
<td>Methodology</td>
<td>Type</td>
<td>Outcome</td>
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<td>---------------------------------------------------------------------------</td>
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<tr>
<td>Impact of visual performance management systems on the</td>
<td>Bititci et al. (2015)</td>
<td>IJPR</td>
<td>PDCA</td>
<td>CI</td>
<td>Output</td>
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<tr>
<td>performance practices of organisations</td>
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<td>Integrated analysis of quality and production logistics performance in</td>
<td>Colledani and Tolio (2010)</td>
<td>IJPR</td>
<td>PDCA</td>
<td>general</td>
<td>PMS</td>
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<td>manufacturing lines</td>
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<td>and New Zealand evidence</td>
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<tr>
<td>Kaizen events and organizational performance: a field study</td>
<td>Doolen et al. (2008)</td>
<td>IJPPM</td>
<td>PDCA</td>
<td>CI</td>
<td>Op. action</td>
</tr>
<tr>
<td>Manufacturing change</td>
<td>Duberley et al. (2000)</td>
<td>IJOPM</td>
<td>C</td>
<td>general</td>
<td>Input</td>
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<tr>
<td>Analytic Network Process (ANP) approach</td>
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<tr>
<td>MIS-user interface design for job shop manufacturing environment</td>
<td>Mandal and Baliga (2000)</td>
<td>IJOPM</td>
<td>C</td>
<td>general</td>
<td>Output</td>
</tr>
<tr>
<td>Performance evaluation and capacity planning in a metallurgical job-shop</td>
<td>Negri da Silva and Morabito (2009)</td>
<td>IJPR</td>
<td>C</td>
<td>general</td>
<td>Output</td>
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<tr>
<td>system using open queueing network models</td>
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<tr>
<td>Performance evaluation of production systems monitored by statistical</td>
<td>Colledani and Tolio (2009)</td>
<td>IJPE</td>
<td>PDCA</td>
<td>general</td>
<td>PMS</td>
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<tr>
<td>process control and off-line inspections</td>
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<td>case of microelectronic communication company</td>
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<tr>
<td>Quantitative models for performance measurement systems—alternate</td>
<td>Sarkis (2003)</td>
<td>IJPE</td>
<td>PDCA</td>
<td>general</td>
<td>PMS</td>
</tr>
<tr>
<td>considerations</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Strategy management through quantitative modelling of performance measurement systems
Bititci et al. (2001) IJPE PDCA general PMS

Tailoring performance evaluation to specific industrial contexts – application to sustainable mass customisation enterprises
Medini et al. (2014) IJPR PDCA CI PMS

Value of maturity models in performance measurement
Bititci et al. (2014) IJPR C general PMS

VR-PMS: a new approach for performance measurement and management of industrial systems
Vernadat et al. (2013) IJPR PDCA general PMS

**DISCUSSION AND CONCLUSION**

This result shows that in the huge amount of performance measurement research few papers concerning the follow-up phase of the performance measurement process are found in this systematic review. When further investigating the papers in the follow-up phase it can be seen that the performance measurement system itself is the most examined part, followed by the output from the system. Comparing with Choong (2013) it can also be seen that he treats input and output as an information system, communicating with the performance measurement system, but which is not further examined. The result shows that the numbers of papers focusing on performance measurement follow-up are relatively few, and it can be seen that there is a lack of research concerning recommendations for the follow-up phase. This conclusion supports the conclusions of Taticchi et al. (2010), who states that future research should for larger companies address the translation of process information into effective tasks. It can also be concluded that most of the research concerning follow-up of performance measurement does not explicitly address CI, but concerns performance measurement follow-up in general. This result might support the opinion of Bititci and Nudurupati (2002) stating that performance measurement is a CI tool.

The systematic review confirms that there is a lot of research in performance measurement systems (Neely et al., 2005). However, using a systematic review in order to find research in performance measurement follow-up was found to be very challenging. This might depend on the wide range of terms used for follow-up, and that follow-up of performance measures also is treated in e.g. performance management and general management. Based on the systematic review it can be concluded that there is a lack of operational level work with performance measurement follow-up. Although both performance measurement and CI are well researched areas, research focusing on performance measurement follow-up supporting CI for manufacturing companies is rarer examined. This paper contributes by summarizing and analysing existing research, based on a systematic review. The outcome identifies area for further research, which can strengthen manufacturing companies to succeed with continuous improvements, increasing efficiency and strengthen competitiveness.
REFERENCES


Digalwar, A. K. & Sangwan, K. S. An overview of existing performance measurement frameworks in the context of world class manufacturing performance measurement.


Carina Larsson reviewed her M.Sc. in Mechanical Engineering from University of Luleå in 1993. Since 2011 she has been working as a lecturer at University of Skövde.

In this thesis Carina explores the communication of performance measures. The aim is to support CI by improving the communication of performance measures, and to this end, this thesis identifies the main challenges in the communication of performance measures supporting CI. The research scope is manufacturing companies in general, and manufacturing companies with SME characteristics in particular.