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Improving operational performance by influencing shopfloor behavior via performance management practices

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ABSTRACT

It is generally believed that companies applying performance management practices outperform those that do not measure and manage their performance. Studies examining the link between performance management and performance improvement implicitly assume that performance management affects behavior of individuals in an organization, which then facilitates the achievement of organizational goals. This study takes a step towards understanding this implicit assumption. We investigate how performance management practices relate to improvement in performance by influencing behavior of individuals. We focus on operational performance management, i.e. the definition and use of performance measures on the shopfloor in production and distribution. We use a survey among 102 companies to identify the relations between performance management practices, shopfloor behavior and improvement in performance. We identified three independent clusters of operator behavior that positively correlate with performance improvement: "Understanding", "Motivation" and "Focus on Improvement". We show that 17 out of the 20 performance management practices found in literature have a significant and positive relation with one or more clusters of operator behavior. We furthermore found that there is a positive correlation between the number of performance management practices applied and performance improvement, suggesting that it is not only which practices are applied but also how many. Recommendations emerging from this study enable managers to identify which behavioral changes are desired to improve performance and to select those performance management practices that positively influence the desired behavior.

1. The challenge of managing performance

The strategic aspects of performance management have received a significant amount of attention in literature (de Waal et al., 2009; Ittner et al., 2003b; Wouters and Wilderom, 2008). However, an operational perspective to performance management is necessary in order to uncover why and how performance management practices impact performance improvement. A key research challenge is "...to cover the roles and impact of metrics in operating systems" (Melnyk et al., 2004, p. 210). We therefore aim at gaining insight – at the shopfloor level – in performance management practices. In line with Grütter et al. (2002, p. 642) the term "shopfloor" refers to operators who do most of their work in direct production or distribution. The term excludes strategic management and others at higher organizational levels. We focus our research on operational performance management, which refers to the definition, implementation and use of performance measures on the level of day-to-day operations executed by shopfloor operators in factories and warehouses.

In this article we posit that performance improvements are largely the result of the execution of certain behaviors at the shopfloor and that these behaviors are in turn influenced by specific performance management practices. Assumptions in performance management research often involve broad leaps in logic from useful performance management practices to enhanced organizational performance; moreover, there is no compelling evidence to suggest that these links exist (Chenhall, 2003). Studies examining the link between performance management and performance improvement implicitly assume that performance management affects behavior of individuals in an organization, which then facilitates the achievement of organizational goals (Hall, 2008). Our research is therefore focused on the following questions:

- Which operator behaviors at the shopfloor lead to improvements in performance?
- Which performance management practices influence operator behavior at the shopfloor and how?

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Fig. 1. Research model.

Our research model is depicted in Fig. 1.

In the next section, we review literature on behavioral effects of performance management. Thereafter we review literature on performance management practices. Then we describe our survey design and the results of the survey. We discuss our results and end with conclusions, recommendations and suggestions for future research.

2. Behavioral effects of performance management

Performance measurement continues to present challenges to operations managers (Melnyk et al., 2004). Research suggests that these challenges may rather be attributed to implementation problems than to a lack of benefits from the measurement per se (Ittner, 2008). One could argue that the success of measuring and managing operational performance is in stimulating desired behavior on the shopfloor (Barnes and Radnor, 2008). It is therefore essential that behavioral effects of performance management are well understood for a successful design and implementation of performance management (Luckett and Eggleton, 1991). Similar to de Waal (2004) we use behavioral effects twofold: for conduct of shopfloor employees that can be observed ("observable conduct") and for conditions that allow these employees to display performance related conduct. One such key condition is the degree to which employees understand shopfloor performance ("shopfloor understanding"). Research has shown that managing performance can have a particularly great effect when appropriate and easily understandable performance information is provided to individuals (Dumond, 1994; Forza and Salvador, 2000). Table 1 provides an overview of the behavioral effects discussed in this section.

Below, we first review the aspects related to shopfloor understanding and subsequently the aspects related to observable conduct.

Many authors agree that performance metrics need to provide a balanced overview (Bourne, 2005; de Waal, 2006; Johnston et al., 2002). If design is not done carefully, a maze of metrics may be the result, entailing in a culture of tough competition (Kald and Nilsson, 2000). Performance metrics may interact (Bourne et al., 2005) and potentially be conflicting, negatively impacting results. Operator understanding is facilitated by frequent review of metrics. Johnston et al. (2002) found that a more frequent review of performance ensured the focus was on action and not on reporting per se. As a result, information on performance is more up to date, which facilitates decision-making.

This leads us to identifying four aspects of shopfloor understanding (see Table 1), based on which we have defined the following hypothesis:

H1a: Shopfloor understanding aspects U1 to U4 positively relate to performance improvement.

The second aspect we discuss relates to observable conduct. Feedback about performance to operators can have motivational impact (Luckett and Eggleton, 1991). Motivated people are crucial to deliver high performance (Bourne et al., 2005). Motivation of operators is an area that has been extensively studied by organizational psychologists but virtually unexplored in relation to the managerial domain (Van Herpen et al., 2005). The study of Van Herpen et al. (2005) showed that the level of transparency that may result from a performance management system positively correlates with motivation of personnel. Obtaining operator buy-in and acceptance are furthermore critical to performance management success (de Waal and Counet, 2009). Bourne et al. (2005) describe an example where operators were paid through a productivity bonus scheme that rewarded high levels of output. This could result in for example delaying selected shipments on purpose and giving priority to easy work in order to drive operator productivity but not necessarily profit. If well designed, individual rewards are aligned with overall performance metrics. If reward structures are not in line with overall targets the impact of an otherwise well-designed framework of performance metrics may be limited (Otley, 1999). Performance management not only leads to motivation of shopfloor employees. The other side of the coin is that operators may argue that such performance measures are perceived as "a big stick", resulting in opposition that may negatively impact shopfloor behavior (Bourne et al., 2002).

Data may sometimes be misrepresented on purpose to improve performance scores or hide anomalies. Such manipulation is often seen as unavoidable fact of organizational life (Demski, 1998). Performance measures should be designed such that possibilities to manipulate results are minimized (Gunasekaran et al., 2004). Kerssens-van Drongelen and Fisscher (2003) argue that in any performance evaluation the evaluator and the ones evaluated balance between morality and self-interest: the employees evaluated may for example decide to hide information out of self-interest.

Research among successful organizations indicates that results are better if performance management is focused on supporting improvement rather than just for monitoring and control (Johnston et al., 2002). It has furthermore been found that individuals who collaborate more take decisions that generate higher performance levels (Dumond, 1994). Typically, collaboration in target setting among employees has a positive impact on performance (Shields et al., 2000). Performance management is expected to result in an increased focus on improvement actions among employees (Bourne, 2005; Ukko et al., 2007) and may therefore foster proactive behavior to solving upcoming issues (Johnston et al., 2002). Performance improvement results are also impacted by aspects that are not directly linked to performance management, such as team characteristics or environment (Bourne et al., 2005; Grütter et al., 2002). Nonetheless, a collaborative attitude may foster thinking across functional boundaries and organizations; this is generally expected to lead to improved performance (Johnston et al., 2002).

We used the literature overview above to identify ten aspects of observable conduct on the shopfloor (see Table 1). Stated formally, we expect the following hypothesis:

H1b: Aspects of observable conduct C1 to C10 positively relate to performance improvement.

3. Performance management practices

3.1. Performance management in phases

Literature on performance management is dominated by the question "what to measure". In general, analysis of data should be considered an explicit step as data collection and analysis are a key task in monitoring performance (Gunasekaran and Kobu, 2007). We use four phases of performance management that are comparable to the phases identified by Santos et al. (2008). The first phase entails the "definition" of a performance management system, which deals with selecting and defining metrics. The second phase discusses the "implementation" of the system. The third phase is "data collection and reporting" as information and information systems are more and more receiving a pivotal role in performance management. Phase four is focused at the "management" of performance, such as improvement or communication. Below, we will discuss literature on performance management practices for each of these phases. Table 2 summarizes this literature.

Table 1
Behavioral effects of operational performance management.

ID	Effect	Based on
U1	Performance indicators provide a balanced and complete view of shopfloor performance	Bourne (2005) de Waal (2006) Johnston et al. (2002) Kald and Nilsson (2000)
U2	There is a healthy conflict between the targets of different departments	Bourne et al. (2005)
U3	Mostly, the required management information for further analysis of bottlenecks is directly available	Johnston et al. (2002)
U4	Management has an up-to-date view of operational bottlenecks through the performance indicators	Johnston et al. (2002)
C1	Operators are motivated to realize targets on the performance indicators	Bourne et al. (2005) Luckett and Eggleton (1991) Van Herpen et al. (2005)
C2	Operators accept the performance indicators	de Waal and Counet (2009) Otley (1999)
C3	There is no or limited opposition against the implementation of performance indicators	Bourne et al. (2002)
C4	Operators never consciously manipulate performance data	Demski (1998) Gunasekaran et al. (2004) Kerssens-van Drongelen and Fisscher (2003)
C5	Operators actively discuss performance indicators among each other, either in a neutral or critical manner	Johnston et al. (2002)
C6	Operators show collaborative behavior	Johnston et al. (2002) Dumond (1994) Shields et al. (2000)
C7	Operators show a strong focus on improvement in their behavior	Bourne (2005) Johnston et al. (2002) Ukko et al. (2007)
C8	Operators show pro-active behavior	Johnston et al. (2002)
C9	Operators are still motivated to do work which is not rewarded via performance indicators	Bourne et al. (2005) Grütter et al. (2002)
C10	Operators are focused on improving performance of the complete process across departments instead of just their own department	Johnston et al. (2002)

U1 to U4 identify conditions related to understanding; C1 to C10 relate to observable conduct.

3.2. Defining a performance management system

In literature, the selection and definition of measures has received ample attention (Bourne et al., 2000). Throughout recent years, several extensive overviews have been published that provide good coverage of categories of performance metrics and frameworks to capture these metrics (Beamon, 1999; Chan et al., 2006; Franco-Santos et al., 2007; Gunasekaran et al., 2001; Gunasekaran et al., 2004; Gunasekaran and Kobu, 2007; Neely, 2005; Shepherd and Günter, 2006).

It is generally acknowledged that structuring metrics according to a framework is advisable (Ahn, 2001; Bourne et al., 2002; Ittner et al., 2003b; Johnston et al., 2002). The use of a standard framework such as the SCOR model, the Balanced Scorecard or the EFQM model ensures a link between strategy and operations. Research shows that metrics that provide such a link, visible in e.g. a linkage between strategic intentions and actual execution, add value (Bendoly et al., 2007; Bourne et al., 2005; Braam and Nijssen, 2004; Kuwaiti and Kay, 2000). A key struggle in performance metrics definition is to develop the right indicators (Bourne et al., 2002). Ideally, the metrics should cover three key aspects of performance: effectiveness, efficiency and flexibility (Hardjono and Bakker, 2006). Once performance metrics have been defined, targets need to be set. These targets should preferably be set jointly with all relevant departments involved (Holmberg, 2000; Kennerley and Neely, 2002). Very often, these targets are the result of a negotiation process, though negotiating goals is an approach that is not preferred (Schneiderman, 1999). Guidelines for target setting, such as externally derived targets or goals derived from strategy, are necessary (Ahn, 2001).

Based on the above literature overview we have identified five definition practices that are expected to relate to behavioral effects on the shopfloor (D1 to D5 in Table 2). Stated more formally, we expect the following hypothesis:

H2a: Performance management system definition practices D1 to D5 positively relate to behavioral effects on the shopfloor.

3.3. Implementing a performance management system

Implementation of performance management deals with putting the performance management system and procedures in place (Bourne et al., 2000). The decision to implement a performance management system can be based on different arguments. There may be business reasons such as customer needs (or other stakeholder needs). The impulse to implement performance management can also be driven by the need to comply with rules and regulations, e.g. based on an audit (Bourne et al., 2003).

The implementation of a performance management system should preferably be done as part of a companywide project (Bourne et al., 2005; Bourne, 2005; Nudurupati and Bititci, 2005) and with specific goals. It is key to involve personnel in such a project as this can facilitate the change process. Kuwaiti and Kay (2000) found that empowerment – or the extent to which employees perceive themselves as having the authority to take decisions – is positively correlated with performance measurement implementation. They argued that performance feedback is one of the main factors influencing empowerment. Hence a performance management system is essential to self-empowered teams. Not involving personnel in the development of performance management systems may lead to resistance to change

Table 2
Practices in operational performance management.

ID	Practice	Based on
D1	Define performance indicators according to a standard model, e.g. Balanced Scorecard, EFQM, SCOR or a corporate standard model rather than a custom-made model	Ahn (2001) Bourne et al. (2002) Ittner et al. (2003b)
D2	Derive operational performance indicators from strategic and tactical company objectives	Bendoly et al. (2007) Bourne et al. (2005) Braam and Nijssen (2004) Kuwaiti and Kay (2000)
D3	Cover all three aspects – efficiency, effectiveness and flexibility – in the performance indicators	Hardjono and Bakker (2006)
D4	Define operational performance indicators jointly with all departments involved, rather than by each department separately	Holmberg (2000) Kennerley and Neely (2002)
D5	Use objective criteria for defining standards and targets, either external (customer requirements, benchmarks or market standards) or internal (time studies or historical data), rather than estimates by management or operators	Schneiderman (1999) Ahn (2001)
I1	Initiate a performance management initiative to improve business performance, i.e. cutting costs or improving customer service, rather than non-business reasons such as complying with legislation or assessing/rewarding operators	Bourne et al. (2003)
I2	Make team leaders and/or operators part of the implementation team	Kuwaiti and Kay (2000) Franco-Santos and Bourne (2005)
I3	Implement performance indicators as part of a companywide project	Bourne (2005) Bourne et al. (2005) Nudurupati and Bititci (2005)
I4	Involve an external expert in performance measurement or organizational change in the implementation	Ahn (2001) Bourne et al. (2002) Bourne et al. (2003)
I5	Pay explicit attention to cultural change and/or operator training in the new way of working during implementation	de Waal and Counet (2009) Bourne et al. (2002)
R1	Have independent staff responsible for gathering input data and computing and reporting performance indicators	Kuwaiti (2004)
R2	Use a predefined computational model in MS Excel/MS Access/business intelligence system for collecting and calculating performance metrics rather than manual or ad hoc computations or standard reports from business systems	Bourne et al. (2005)
R3	Make performance indicators as well as the underlying details electronically available	Bourne et al. (2002) Gunasekaran and Kobu (2007) Nudurupati and Bititci (2005)
R4	Report performance indicators of individuals (either publicly or confidentially) rather than not reporting this performance	Johnston et al. (2002)
R5	Report performance indicators to operators at least daily	Bourne et al. (2005) de Waal and Counet (2009) Kennerley and Neely (2002)
M1	Define operator goals in terms of individual or team performance rather than departmental or company performance	Dumond (1994)
M2	Use a standard methodology for continuous improvement that ties actions to measures (e.g. Deming cycle)	Neely (1999), Schneiderman (1999)
M3	Apply a leadership style that focuses on task and relation equally	Johnston et al. (2002)
M4	Create a direct relation between performance and (financial) rewards or salary raise of operators	Ahn (2001) Franco-Santos and Bourne (2005) Kennerley and Neely (2002) Ukko et al. (2007)
M5	Discuss achieved performance indicators between departments in a structural manner	Bourne et al. (2002) Cousins et al. (2008) Gunasekaran and Kobu (2007)

D1 to D5 relate to "Definition"; I1 to I5 relate to "Implementation"; R1 to R5 relate to "Data Collection and Reporting"; M1 to M5 relate to "Management".

(Franco-Santos and Bourne, 2005). Such resistance may lead to lack of motivation of personnel to induce improvements. This may be detrimental as performance management is regarded as a key driver for continuous improvement (Nudurupati and Bititci, 2005).

Once the decision has been taken to develop a performance management system, a project team needs to be set up. This may be consultant-led where the majority of the work is done by external people or facilitator-led where a person is used to guide organizational change and the majority of work is done by company operators (Bourne et al., 2003). Literature shows a preference for external support in a performance management development initiative (Ahn, 2001; Bourne et al., 2002) although it is not described what this should entail. Nonetheless, one of the reasons why projects fail is that the facilitator left and the project waned as a result (Bourne et al., 2002).

The change process and its cultural characteristics require explicit attention. Paying attention to the change process as well as to the perceived benefits are key reasons for people to embark on and continue with implementation of performance management (de Waal and Counet, 2009). If it is not worth pursuing for employees or the project has an instable foundation in the company, projects may easily fail (Bourne et al., 2002; de Waal and Counet, 2009).

Based on the above literature overview we have identified five implementation practices that are expected to relate to behavioral

effects on the shopfloor (I1 to I5 in Table 2). Stated in a more formal manner, we expect the following hypothesis:

H2b: Performance management system implementation practices I1 to I5 positively relate to behavioral effects on the shopfloor.

3.4. Collecting and reporting performance data

Who should be responsible for performance management in the hierarchy of an organization is not clear. Kuwaiti (2004) argues that a post responsible for the performance management process is necessary for successful performance management activities. He argues that particularly the technical performance management functions should be performed within the performance management organization although the data collection is best suited in the day-to-day activities. Data should preferably be collected and reported electronically to save effort and time and to provide consistency (Bourne et al., 2002; Gunasekaran and Kobu, 2007; Nudurupati and Bititci, 2005). Ease of data access in such systems is key (Bourne, 2005) as well as use of standard data analysis tools (Bourne et al., 2005). The performance data in these systems should be made available to operators at least at an individual level and used for reviewing performance (Johnston et al., 2002); making performance data available to operators should take place frequently (Bourne et al., 2005; de Waal and Counet, 2009; Kennerley and Neely, 2002).

Based on the above literature overview we have identified five data collection and reporting practices that are expected to relate to behavioral effects on the shopfloor (R1 to R5 in Table 2). Stated as a formal hypothesis we expect the following:

H2c: Performance data collection and reporting practices R1 to R5 positively relate to behavioral effects on the shopfloor.

3.5. Managing performance

Once data have been collected and presented, performance should be managed in order to enable improvement. Dumond (1994) showed that a performance measurement system is important in guiding an individual's performance and hence to define goals at the level of the individual. Performance management and performance targets should preferably be improvement oriented and this requires a performance improvement method (Schneiderman, 1999). Before any organization can determine what to improve, it needs to identify where and why current performance falls short (Neely, 1999). This is in fact the basic premise of the Deming (plan-do-check-act) cycle. Such a method ensures a structured diagnosis of issues, such as root-cause analysis, and is preferably based on a scientific methodology.

Management of performance should be non-threatening and action oriented (Johnston et al., 2002). To avoid resistance, performance management should not only be focused on tasks but also on the relation with operators. Performance results can potentially be connected to an incentive system (Ahn, 2001). Some argue that connecting performance to an incentive system is beneficial (Franco-Santos and Bourne, 2005; Kennerley and Neely, 2002; Ukko et al., 2007) though others (Ittner et al., 2003a) disagree. Whether communication between departments on performance is necessary depends on the situation. Bourne et al. (2002) identified that people may be reluctant to share performance results because of the questions that may arise. Gunasekaran and Kobu (2007) argue that frequent meetings and transparent communication are helpful to overcome barriers that may arise. Cousins et al. (2008) show that discussing performance measures has a positive effect on performance not only within a company but also between suppliers and customers.

Based on the above literature overview we have identified five management practices that are expected to relate to behavioral effects on the shopfloor (M1 to M5 in Table 2). We expect the following hypothesis:

H2d: Performance management practices M1 to M5 positively relate to behavioral effects on the shopfloor.

4. Research design and data analysis

4.1. Research design, sample selection and analysis approach

In order to obtain broad-based information on the relation between performance management practices and behavioral effects and between behavioral effects and performance improvement we applied a mailed survey methodology. This methodology allows for empirical verification of theoretical relationships in larger samples from actual business (Wacker, 1998). Together with a team of industry experts we developed a questionnaire that captured the practices used in performance management, behavioral effects at the shopfloor and performance improvement. Development of questionnaire items based on both academic and practical perspectives helps to develop good scales and keep questionnaire revisions to a minimum (Hensley, 1999). The team consisted of seven members holding senior supply chain or operations positions in companies or being active as senior industry consultants. Every team member had extensive experience with designing, implementing and using performance management.

The questionnaire developed by the team contained 20 multiple-choice items representing the 20 practices listed in Table 2, 14 multiple choice items representing the 14 behavioral effects on the shopfloor (Table 1) and 3 multiple choice items for performance improvement. We used a multiple-choice structure because we wanted to be able to address specific practices and behavioral effects. The unit of analysis is a shopfloor in production or distribution. We used literature and the expertise of the team to develop questionnaire items representing practices as well as behavioral effects. For each questionnaire item we identified preferred and non-preferred practices or behavioral effects. Performance improvement has been assessed on three aspects: productivity of the workforce, number of errors made at the shopfloor and inventory turns. We measured performance improvement similar to Shah and Ward (2003), who measured the effect of lean by asking for a percentage of increase or decrease over time of 6 performance variables. For each of the three performance improvement variables, respondents could choose between four buckets of improvement in performance, ranging from a decrease in performance to more than 5% performance increase since the respondents started with performance management. We controlled for experience in performance management, which we measured by the number of years that passed since beginning with performance management.

The empirical research took place end of 2006. Similar to Evans (2004) the sample selection could not be completely random as the objective was to observe practices of companies that already have performance management in place. The mailing list has been assembled using the membership database of the Dutch council of Logistics Management (VLM), an organization similar to CSCMP in the USA. We have selected companies representing relatively fast evolving sectors as these sectors are generally considered to be leading in supply chain management (Fine, 1998): food, retail, high-tech, pharmaceuticals, logistics services and automotive. Using the VLM membership database, we were able to quickly identify the desired informants in each company. We targeted medium and large companies with at least 50 employees in the Netherlands. All companies have been contacted beforehand to ensure that the contact information was still valid and that the company had experience with performance management. The questionnaire has been sent to 350 international companies based in the Netherlands.

Table 3
Sample characteristics.

Characteristic	Subdivision	% of total
Industry sector	Retail	25
	Food	24
	High-tech	16
	Logistics services	9
	Pharmacy	8
	Automotive	6
	Other	14
Number of employees	<100	5
	101–1,000	22
	1,000–25,000	38
	>25,000	25
	Unknown	10
Turnover	EUR 0–5 mln	1
	EUR 5–25 mln	4
	EUR 25–250 mln	17
	EUR 250–1,000 mln	23
	EUR 1 bln+	42
	Unknown	14
Respondent function	Board/upper management	61
	Operations unit manager	14
	Operations staff	14
	Operations team leader	2
	Unknown	9

Table 4
Observed changes in operational performance (% of total number of respondents; $N = 102$).

Item	% of total
Productivity has decreased	0
Productivity has stayed the same	28
Productivity has increased by 5% or less	36
Productivity has increased by more than 5%	35
The number of errors has increased	0
The number of errors has stayed the same	27
The number of errors has decreased by 5% or less	48
The number of errors has decreased by more than 5%	25
Inventory turns have decreased	2
Inventory turns have stayed the same	62
Inventory turns have increased by 5% or less	18
Inventory turns have increased by more than 5%	19

Table 5
Correlation coefficients (Spearman's Rho) of operational performance improvement items ($N = 102$).

	Item	1	2	3
1	Productivity increase	1.000		
2	Error reduction	0.379**	1.000	
3	Inventory turns increase	0.174	0.285**	1.000

** Correlation is significant at the 0.01 level (2-tailed).

Although the companies targeted were international, staff will predominantly be Dutch, limiting our ability to identify cultural influences on our findings.

We used one informant per responding company for both dependent and independent variables. We tried to overcome issues of same source bias by following the advise of Huber and Power (1985) to focus on people who are knowledgeable. Table 3 contains an overview of the profile of the respondents. The majority of the respondents to the survey were upper or middle management who were likely to have a good overview of performance management because of their involvement in performance reviews and planning processes. We did not have sufficient information to track non-response and compare non-respondents to respondents. Instead, we made a comparison between companies responding in the initial round of mailing and in the second wave. The later wave of surveys may be considered similar to non-respondents. This is a method used more often in Operations Management surveys (Li et al., 2005) Using the χ^2-statistic we found that there was no significant difference between the two groups in terms of number of employees or turnover.

4.2. Data analysis

In total, 104 questionnaires have been returned, of which two had to be discarded because of insufficient data, yielding 102 usable questionnaires (29% response rate). This figure is comparable to other Operations Management surveys (Frohlich, 2002). None of the Cronbach's alphas were less than 0.931 if any item was deleted, which is above the lower limit of 0.7. Table 3 provides an overview of the responses by sector and by company size. The responses are fairly evenly divided over the sectors, although two sectors make up nearly half of the responses (logistics service providers and retailers). The majority of the companies are relatively large (1000 employees or more).

First, we analyzed the experienced performance improvement as a result of performance management using descriptive statistics. Table 4 shows that the majority the respondents perceived an increase in productivity (71%) and quality (73%) as a result of the implementation and use of performance management. A large portion experience improvements of more than 5%. None of the respondents observed a decrease in productivity or quality. Furthermore, 37% of the respondents observed an increase in inventory turns.

We first analyzed correlations between the three performance improvement items (productivity, quality and inventory turns) in Table 5. Because of the significant correlations between the items, we decided to cluster the performance improvement items into a single composite index.

Next we used a Mann–Whitney U test to compute the significance of the relation between each of the 14 behavioral effects and the composite performance improvement index. We followed a method comparable to Ross and Droge (2002, p. 24). For each behavioral effect we split the 102 survey responses in those representing preferred aspects (sample $n1$) and those representing non-preferred aspects (sample $n2$). Next, for each behavioral effect the responses were rank ordered, but now across all three performance improvement items (thus, $102 \times 3 = 306$ were ordered). We then calculated the Mann–Whitney U test statistic for each behavioral effect as if it were based on a sample with 306 responses to identify the differences between sample $n1$ and $n2$. Table 6 shows the relation between the 14 aspects on the one hand

Table 6
Relation between behavioral effects (U1–U4 and C1–C10) and the composite performance improvement index (X) using a Mann–Whitney U-test ($N = 102$).

	U1	U2	U3	U4	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
X	1.000**	0.604	0.980*	1.000**	1.000**	0.999**	0.710	0.430	1.000**	0.926	1.000**	1.000**	0.551	0.992**
% Use	36%	44%	44%	49%	44%	54%	93%	58%	79%	56%	72%	66%	75%	22%

U1 to U4 identify conditions related to understanding; C1 to C10 relate to aspects of observable conduct.
* Significant at $\alpha = 0.05$ using a Mann Whitney U-test.
** Significant at $\alpha = 0.01$ using a Mann Whitney U-test.

Table 7
Identification of clusters of behavioral effects: correlation coefficients (Spearman's Rho) of aspects of understanding and of observable conduct ($N = 102$).

	U1	U3	U4	C1	C2	C5	C7	C8	C10
U1	1.000								
U3	0.430**	1.000							
U4	0.392**	0.580**	1.000						
C1	0.373**	0.300**	0.254*	1.000					
C2	0.557**	0.285**	0.286**	0.233*	1.000				
C5	0.315**	0.451**	0.185	0.201*	0.320**	1.000			
C7	0.063	0.100	0.174	0.222*	0.013	0.077	1.000		
C8	0.312**	0.430**	0.281**	0.337**	0.241*	0.319**	0.367**	1.000	
C10	0.042	0.246*	0.241*	0.232*	0.046	0.202*	0.297**	0.330**	1.000

U1 to U4 identify conditions related to understanding; C1 to C10 relate to aspects of observable conduct.
U1/U3/U4 are combined in the cluster "Understanding"; C1/C2/C5 are combined in the cluster "Motivation"; C7/C8/C10 are combined in the cluster "Focus on Improvement"; the three clusters are shaded grey.
* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

and the composite performance improvement index (denoted by X) on the other. This table shows that 9 out of 14 behavioral effects have a significant relation with the composite performance index X.

We subsequently developed a table of correlations between these 9 behavioral effects (Table 7) and manually grouped them into logical clusters of significant behavioral effects. Since data had been recorded on an ordinal scale, it was not possible to calculate clusters statistically so we had to revert to a manual procedure. We elicited three behavioral effect clusters (see Table 8). The first behavioral effect cluster we labeled "Understanding", representing the fact that operators get a better understanding about their performance as well as the performance of their department; secondly, we identified the cluster "Motivation", which represents the fact that operators become more motivated to achieve their performance targets. The last cluster was "Focus on Improvement", which relates to the attention paid by operators to optimizing and improving performance.

Next, we analyzed which of the 20 performance management practices positively relate to the three clusters of behavioral effects. Table 9 summarizes which practices and behavioral effect clusters are significantly related. Although used by a large percentage of the respondents (93%), we had to omit practice I1 ("Initiate a performance management initiative to improve business performance") from the analysis. The Mann–Whitney U test statistic was calculated using a normal approximation, which requires that there be at least 10 responses for both samples $n1$ and $n2$ (Mann and Whitney, 1947). Due to the small number of respondents not using the practice (only 7 respondents) we were not able to evaluate practice I1.

Table 8
Description of clusters of behavioral effects.

Cluster	Description
Cluster "Understanding"	Operators and their direct managers have a balanced, up to date and complete view of shopfloor performance and can directly analyze bottlenecks using data
Cluster "Motivation"	Operators intend to realize the performance indicators and accept the targets set; they actively discuss performance, and particularly tackle each other over performance issues
Cluster "Focus on Improvement"	Operators show pro-active behavior that is directed towards improvement within but also across the boundaries of their department

5. Discussion

5.1. Shopfloor understanding and observable conduct

Hypothesis H1a states that the four aspects U1 to U4 that relate to operator understanding positively relate to performance improvement. Three out of the four aspects of understanding positively correlate with performance improvement. We did not find a significant relation between the presence of a healthy conflict in performance goals between departments (U2) and performance improvement. Whether the presence of a healthy conflict in goals has an influence on performance improvement likely depends on other mediating aspects. Research has shown that conflicting goals between individuals may lead to different performance effects dependent on circumstances such as effort required to perform a task (Locke et al., 1994). This may also translate to the level of departmental goals. Earlier research showed that the key is not to *experience* such goal conflict: situations where e.g. personal values (a love for activity A) conflict with demands of the reward system of the organization (only activity B gets you promotion) should be avoided (Locke et al., 1994).

With regard to hypothesis H1b (the aspects of observable conduct B1 to B10 positively relate to performance improvement), we found that 6 out of the 10 aspects of observable conduct positively relate to performance improvement. We discuss the four aspects of behavioral conduct for which we did not find support. The first aspect for which we found no support concerned the "level of opposition against implementation" (B3). Our data suggest that how companies deal with the level of resistance is more important for performance improvement than the existence of resistance per se. Interestingly, we found a positive relation between the level of opposition against implementation and the attention paid to change management (I5). This suggests that those organizations that had to cope with opposition focused more on change management and operator training than those that did not experience opposition. Because of this attention to change management, these organizations may have been able to overcome the opposition. Although many managers fear opposition it may not be such a big obstacle when adequately coped with through change management and operator training.

Secondly, the observable conduct "operators manipulate performance data" (B4) is not related to performance improvement. Several authors have analyzed situations of dealing with manipulation of accounting data (Arya and Glover, 2008; Demski, 1998) and argue there is a wide variety of conclusions dependent on the content of the information manipulated. Goetzmann et al. (2007) describe manipulation of performance measures in reporting stock market performance and conclude that manipulation-proof mea-

Table 9
Significance of practices in operational performance management.

ID	Practice	U	M	I	% Preferred practice use
D1	Define performance indicators according to a standard model, e.g. Balanced Scorecard, EFQM, SCOR or a corporate standard model rather than a custom-made model	0.992**	0.711	0.925	52%
D2	Derive operational performance indicators from strategic and tactical company objectives	1.000**	0.999**	0.985*	47%
D3	Cover all three aspects – efficiency, effectiveness and flexibility – in the performance indicators	0.996**	0.702	0.163	15%
D4	Define operational performance indicators jointly with all departments involved, rather than by each department separately	0.961**	0.681	0.995**	50%
D5	Use objective criteria for defining standards and targets, either external (customer requirements, benchmarks or market standards) or internal (time studies or historical data), rather than estimates by management or operators	1.000**	0.824	0.972*	70%
I1	Initiate a performance management initiative to improve business performance, i.e. cutting costs or improving customer service, rather than non-business reasons such as complying with legislation or assessing/rewarding operators	n/a	n/a	n/a	93%[1]
I2	Make team leaders and/or operators part of the implementation team	0.994**	0.998**	0.990**	37%
I3	Implement performance indicators as part of a companywide project	0.972*	0.841	0.301	41%
I4	Involve an external expert in performance measurement or organizational change in the implementation	0.952*	0.424	0.008	16%
I5	Pay explicit attention to cultural change and/or operator training in the new way of working during implementation	1.000**	0.998**	0.906	63%
R1	Have independent staff responsible for gathering input data and computing and reporting performance indicators	0.504	0.256	0.288	32%[2]
R2	Use a predefined computational model in MS Excel/MS Access/business intelligence system for collecting and calculating performance metrics rather than manual or ad hoc computations or standard reports from business systems	1.000**	0.963*	0.931	55%
R3	Make performance indicators as well as the underlying details electronically available	1.000**	0.845	0.874	60%
R4	Report performance indicators of individuals (either publicly or confidentially) rather than not reporting this performance	0.919	0.933	0.958*	50%
R5	Report performance indicators to operators at least daily	1.000**	0.999**	0.957*	23%
M1	Define operator goals in terms of individual or team performance rather than departmental or company performance	1.000**	0.998**	0.996**	62%
M2	Use a standard methodology for continuous improvement that ties actions to measures (e.g. Deming cycle)	0.476	0.843	1.000**	28%
M3	Apply a leadership style that focuses on task and relation equally	0.998**	0.860	0.966*	62%
M4	Create a direct relation between performance and (financial) rewards or salary raise of operators	0.698	0.689	0.422	33%[2]
M5	Discuss achieved performance indicators between departments in a structural manner	1.000**	1.000**	1.000**	62%

U = behavioral effect cluster 'Understanding'; M = behavioral effect cluster 'Motivation'; I = behavioral effect cluster "Focus on Improvement".
[1] Does not meet testing criteria for normal approximation (sample $n1$ = sample $n2 > 10$); n/a = not applicable.
[2] Not a preferred practice (no statistically significant relations with the behavioral effect clusters).
* Significant at $\alpha = 0.05$ using a Mann Whitney U-test.
** Significant at $\alpha = 0,.01$ using a Mann Whitney U-test.

sures exist but are more difficult to define. This indicates that it depends on the measure whether manipulation can take place or not. This may be the reason why we do not find a significant relation.

Third, we did not find a significant relation between a "shift towards more collaborative behavior" (B6) and performance improvement. The questionnaire item related to this observable conduct contained three possible answers: "no change in behavior", "more collaborative behavior", and "more competitive behavior". Our data do show that companies that observed "no change in behavior" reported significantly lower performance improvement results than the other two groups. However, we did not see a significant difference in performance improvement between companies experiencing "more collaborative behavior" vs. companies experiencing "more competitive behavior". Hence we cannot confirm that more collaborative conduct relates to higher performance levels. This conclusion may be related to the fact that collaboration is dependent on many different circumstances (De Leeuw and Fransoo, 2009) that have not been part of the scope of this research.

Last, we did not find a significant relation between the "motivation to do unrewarded work" (B9) and performance improvement. Interestingly, we do see a significant correlation between B9 and the behavioral effect cluster "Understanding". People who are motivated to do work that is not rewarded in performance metrics typically seem to understand the contribution of those activities better. We furthermore observed a significant negative relation between doing unrewarded work and the preferred practice to derive performance metrics from strategic and tactical goals. This effect is known among for example university professors. University faculty often suffer from conflicts in demands for research productivity and demands for teaching (Locke et al., 1994). Locke et al. (1994) showed that teaching performance was negatively related to research goals and strategy. As a result, less rewarded work (teaching) is not done well if work that is derived from goals and strategy (research) receives priority. Furthermore, it is a well-known effect in goal-setting theory that goal importance moderates performance improvement (Locke and Latham, 2002): if people commit to goals (research output) they are more inclined to reach those goals in particular – and neglect other goals.

5.2. Performance management practices

Using the 9 significant behavioral effects identified above we developed three clusters of behavioral effects ("Understanding", "Motivation", and "Focus on Improvement"; see Table 8). Our study shows that out of the 19 practices that met the analysis requirements 17 have a significant positive relation with the three behavioral effect clusters. The preferred practices and their relations with the behavioral effect clusters are summarized in Table 9.

Hypotheses H2a to H2d deal with the extent to which performance management practices are related to the behavioral effect clusters. We find support for hypothesis H2a ("practices D1 to D5 in definition of performance metrics positively relate to behavioral effects on the shopfloor"). All definition practices were positively related to one or more of the behavioral effect clusters. We also find equal support for hypothesis H2b ("practices I1 to I5 in implementation of performance metrics positively relate to behavioral effects on the shopfloor"): all four qualified implementation practices were positively related to behavioral effect clusters. The significance of all practices in Definition and Implementation confirms the importance of both defining and implementing performance indicators well. Without good definition and implementation of performance metrics it is difficult to improve performance.

We furthermore find support for hypothesis H2c ("practices R1 to R5 in reporting performance metrics positively relate to behavioral effects on the shopfloor"). Four out of five performance management practices have a positive relation with one or more behavioral effect clusters. There is no relation between the practice "Have independent staff for gathering input data and computing and reporting performance indicators" (R1) and any behavioral effect cluster. This contradicts the findings of Kuwaiti (2004). This may relate to the fact that the Kuwaiti study investigated opinions on the need for having an independent person manage the performance management process. Although opinions may show that it is desirable to have an independent organizational unit manage the performance management process, actual performance management practice suggests that there is little advantage in doing so.

Last, we find equal support for hypothesis H2d ("practices M1 to M5 in managing performance metrics positively relate to behavioral effects on the shopfloor"). Four out of five practices are significantly related to at least one of the behavioral effect clusters. Furthermore, we find that all four significant performance management practices in this category relate to the behavioral effect cluster "Focus on Improvement". The practice "Create a direct relation between performance and (financial) rewards or salary raise of operators" (M4) is not significantly related to any behavioral effect cluster. Although many organizational theorists have argued to make pay dependent on performance one should be careful and precise with shaping this relation (Austin and Gittell, 2007). If reward systems pay little attention to intrinsic motivation of people but rather to achieving organizational objectives, performance outcomes may not be as desired. Performance related rewards might also lead to hiding information to subvert the management system. Our findings extend the findings of Pennings (1993) to the shopfloor. Pennings found that Dutch executives are less receptive to performance based pay: executive pay was found to be culturally conditioned and that may well be the same with the performance based rewards on the shopfloor. The impact of national culture on the design of performance management has been noted to be relevant in managing performance (Chenhall, 2003). However, we have only focused on companies located in the Netherlands, and were therefore not able to incorporate this aspect in our study. Furthermore, there are important contingency factors that we did not account for, such as the interaction between difficulty to reach the goal and the incentive type exploited (Locke and Latham, 2002).

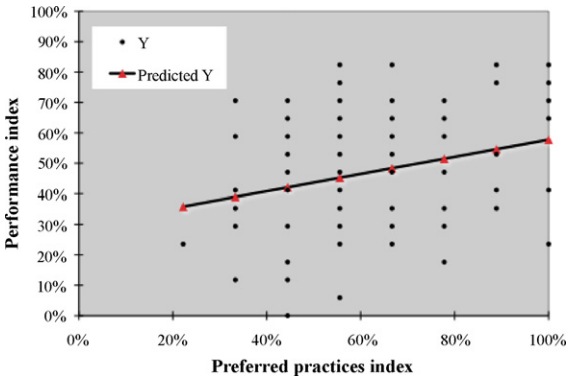

Fig. 2. Scatter plot and regression line: preferred practice index vs. performance index.

5.3. The more the better?

In their research on manufacturing practices collected in the renowned Global Manufacturing Research Group (GMRG) study, Corbett and Whybark (2001) found that many studies have shown a significant positive relation between the number and intensity of practices that a firm has in place and the performance levels achieved. The larger the number and intensity of good manufacturing practices in use – irrespective of which practices – the higher the performance levels are. We used our data to investigate if similar effects occur with operational performance management practices and found that this is indeed the case. We followed an approach that is largely similar to Corbett and Whybark (2001). For each of the respondents, we established two indices: a preferred practice index and a performance index. For the practice index of a respondent we identified how many of the significant preferred practices identified above are present. This score was compared to the maximum possible score of 17 (there are 17 significant practices in our research). The percentage of the maximum score was used as the practice index. To calculate the performance index we first rated the scales from 0 points for the lowest improvement to 3 points for the highest improvement. The combined performance score was the sum of the individual scores, which we then divided by the maximum score of 9 (3 performance improvement items with a maximum score of 3 each). This resulted in indices that theoretically could range from 0% to 100%. The resulting plot of the performance index vs. the preferred practice index is shown in Fig. 2. Despite the scatter, there is a general tendency for firms with a larger number of good performance management practices to have a higher performance index. A simple linear regression analysis, depicted in Table 10 and inserted in Fig. 2 confirms this. Our analysis shows a significant correlation between the number of performance practices implemented and the performance index. Based on this we can conclude that there is a positive relation between the number of significant practices in use and the combined performance index. The variation explained by this regression is close to the variation reported in the study of Corbett and Whybark (2001).

In our study we controlled for the number of years of experience in performance management. We analyzed whether certain significant performance management practices occurred more with companies that have a longer lasting experience in performance management. Using a Mann–Whitney *U* test we found that only one

Table 10
Regression analysis on number of preferred practices (independent: number of preferred practices; dependent: combined performance improvement index; $N = 102$).

*R*2	Significance	Coefficient	Intercept
0.074	<0.006	29.6	0.28

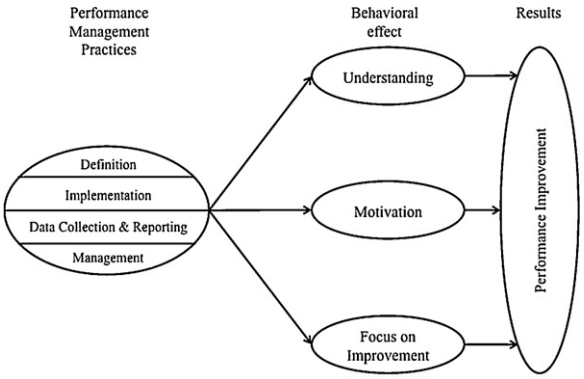

Fig. 3. Conceptual model.

of the 17 significant performance management practices (practice M5: "Discuss achieved performance indicators between departments in a structural manner") occurred significantly more often with companies that have a longer lasting history in performance management. We furthermore investigated to what extent the number of years of experience in performance management moderates the relation between the number of preferred practices in use and performance improvement. Regression analysis showed that a model that includes both experience and the number of best practices in use explains more variation in performance improvement than a model that only incorporates the number of preferred practices in use. We then included the interaction effect between years of experience and the number of preferred practices in use in the model. We did not find an increase in the variation explained. One can therefore argue that although experience in performance management may influence performance improvement, the moderating effect on the relation between performance management practices, behavioral effects and performance improvement is not significant. Therefore we do not expect that experience in performance management moderate our research results significantly.

6. Conclusions, recommendations and future research

In this article we have attempted to close a gap in performance management research by providing insights into the effects of performance management practices via shopfloor behavior on operational performance improvement. Based on our empirical research we identified three clusters of operational behavioral effects that act as mediators between preferred practices and performance improvement. The first cluster is "Understanding", which relates to operators understanding shopfloor performance; the second is "Motivation" which relates to the acceptance of performance measures by operators and motivation to realize performance and active discussion of performance; the third cluster is "Focus on Improvement" which relates to using performance management to improve within and across organizational departments. We have investigated the relation between performance management practices and each of these behavioral effects. This resulted in an overview of relevant practices, as depicted in Table 9. This table shows that 15 out of 17 significant practices relate to the cluster Understanding. This underlines the broad effects of performance management practices on Understanding. It is also a further confirmation of Dumond (1994) and Forza and Salvador (2000) who argued that managing performance can have a particularly great effect when appropriate and easily understandable performance information is provided to individuals. A better understanding of performance information enables operators to take better decisions, which will positively affect performance improvement.

Our study results suggest that performance management practices influence the three behavioral effect clusters ("Understanding", "Motivation" and "Focus on Improvement"), which in turn are positively related to performance improvement. These results enable us to better understand how performance practices influence performance improvement through behavior. Fig. 3 shows these relations in a conceptual model.

Our study results can support managers in identifying preferred performance management practices. Both managers starting with performance management and those who already have experience may use our study results to select appropriate performance management practices. Based on the manager's observation which aspect of shopfloor Understanding, Motivation or Focus on Improvement requires attention, the manager may select performance management practices that influence that specific behavior on the shopfloor. For example, if operator motivation is an issue, our results show managers which practices stimulate motivation among shopfloor operators. One should bear in mind, however, that our research findings also suggest that 'more is better', implying that it is more important to implement several practices than to perform one practice very well. Focusing on getting performance practices implemented may therefore be more important than trying to select exactly those practices that have most impact.

Our research is limited by the fact that we focus on a diversity of industries; a focus on one or a limited number of industries enables the relation of performance management practices to industry characteristics. Furthermore, our approach does not enable us to establish a ranking of importance in practices. Longitudinal case studies of performance measurement implementation projects may be able to support such research. We furthermore only discuss organizations that have embarked upon performance management and have been successful in implementing and using it. Research shows that success in performance management is not a given and that many attempts fail (de Waal and Counet, 2009). Our research did not cover practices that may cause failure in performance management. A detailed analysis of such failures may be a topic of future research. Another limitation is same source bias. We use the same person for identifying information about dependent as well as independent variables. Although we have focused on knowledgeable persons to obtain information, future studies need to focus on obtaining data on dependent and independent variables from different respondents in the same company. Last, we only focused on Dutch companies. Hence, we were not able to incorporate the impact of cultural differences. In our research, for example, the impact of culture is visible in the lack of a significant relation between performance-based pay and performance improvement in our research. We therefore suggest that future research be focused on different nationalities so that cultural impacts can be incorporated. This could be done through an analysis of the effects of a set performance management practices in different countries for a number of international companies and through a comparison of the effects of these practices across countries. Future research may furthermore focus on quantifying differences of performance management practices in terms of impact on performance improvement through the use of causal modeling. Certain practices may have more impact on performance improvement than others. Furthermore, causal modeling may help in determining if there is a preferred order in which to introduce performance management practices. This may be related to how certain performance management practices impact the decision-making behavior of operators on the shopfloor, which is an aspect we have not covered in our research.

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