

Performance measurement systems in logistics organizations:

Design, usage, and impact on organizational capabilities and competitiveness

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1 Introduction

1.1 Problem exposition

Performance measurement systems (PMS), over the last three decades, have become a key element of management control systems (MCS) (Henri, 2006b; Malmi and Brown, 2008). With their origin in the accounting discipline, MCS traditionally focused on formal mechanisms to monitor financial results and provide feedback as part of a cybernetic philosophy (Hofstede, 1978). In further developing this role to “present managers with financial and non-financial measures covering different perspectives which, in combination, provide a way of translating strategy into a coherent set of performance measures” (Chenhall, 2005), PMS has received considerable attention, with a large number of conceptual contributions across disciplines. In addition to well-established frameworks such as Lynch and Cross’ (1991) performance pyramid or Kaplan and Norton’s (1992) balanced scorecard, researchers have provided an impressive amount of conceptual contributions and recommendations for PMS design (Neely, 2005). Moreover, the role of PMS in creating competitive advantage has been investigated both in the accounting literature (e.g. Ittner et al., 2003; Simons, 1990) and in operations management (e.g. Ghalayini et al., 1997; Evans, 2004). Still, Melnyk et al. (2004), by stating that “performance measurement continues to present a challenge to operations managers as well as researchers of operations management” (p. 210), reflect a broad consensus in the PMS research community that further empirical research is required for both academics and practitioners to understand the contribution of PMS to organizational competitiveness (Gunasekaran and Kobu, 2007).

The logistics discipline, in seeking to employ PMS to control processes and support decision-making (Fawcett et al., 1997), has taken PMS beyond the definition of a “set of metrics used to quantify both the efficiency and effectiveness of actions” (Neely et al., 1995, p. 81). Context-specific frameworks have provided insights into PMS design for logistics and the selection of logistics performance metrics (e.g. Caplice and Sheffi, 1995; Griffis et al., 2004). Moreover, with the growing importance of supply chain management in the last decade (Kouvelis et al., 2006), researchers have called for logistics performance measurement to go beyond the boundaries of individual organizations (e.g. Gunasekaran et al., 2004; Rafele, 2004). In this regard, Keebler and Plank (2009), in their empirical study of U.S. logistics organizations with data collected from 1998 to 2000, found that “logistics measurement at a supply chain level is limited at best” (p. 786).

Overall, compared to the large body of conceptual insights, the share of empirical PMS research in the logistics and supply chain management literature is rather low (Akyuz and Erkan, 2010; Gunasekaran and Kobu, 2007). Besides a small number of benchmark investiga-

tions on logistics performance measurement practice in the U.S. (Fawcett and Cooper, 1998; Keebler and Manrodt, 2000; Keebler and Plank, 2009), only few exploratory studies have been conducted so far. Some notable exceptions are the quantitative studies by Fawcett et al. (1997) and van Donselaar et al. (1998) as well as case study research by van Hoek (2001), Schmitz and Platts (2004), and Wouters (2009).

Yet, with highly demanding customers and increasing competitive pressures (Manuj and Mentzer, 2008), logistics practitioners and researchers require further empirical insights into the role that PMS can play in increasing the competitiveness of logistics organizations, i.e. organizations that are primarily involved with logistics activities. Looking at today's logistics requirements—including transportation, warehousing, inventory management, order fulfillment, and distribution (Mentzer et al., 2004)—the ongoing outsourcing trend in logistics (Deepen et al., 2008; Langley et al. 2006) has resulted in a dynamic co-existence of internal logistics departments of manufacturing and trading companies and logistics service providers (LSPs) as providers of third party logistics (Selviaridis and Spring, 2007). Internal logistics departments of manufacturing and trading companies, on the one hand, represent one of many functions that contribute to their company's value creation within a larger organizational context. In manufacturing companies, the overall organizational setup may comprise several, largely independent logistics organizations like inbound/supply logistics and out-bound/distribution logistics. During recent years, many logistics departments in manufacturing and trading companies have paved their way from mere support functions to more strategic functions (McGinnis and Kohn, 2002). LSPs, on the other hand, are "pure players" with logistics being their core competence (Busse and Wallenburg, 2011; Lai, 2004). Although an LSP organization will obviously comprise non-logistical support functions like marketing, sales, accounting, and human resources, logistics services represent their clear business focus.

Yet, while LSPs and internal logistics departments of manufacturing and trading companies are characterized by the immanent differences outlined above, managers in both types of logistics organizations, in designing and using their PMS, will ultimately aim at enhancing the competitiveness of their logistics activities and hence share the same basic objectives in performance measurement practice. Although Morgan's (2004) statement that "survival may be the difference between a good PMS and a mediocre PMS" (p. 534) is pointedly formulated, logistics managers in both types of logistics organizations need to bring their PMS to a level of sophistication which their organization will actually benefit from. Confronted with a growing body of conceptual PMS knowledge on advanced PMS design but a lack of empirical

evidence on the truly relevant aspects of PMS, they need guidance regarding the generally applicable design attributes that need to be incorporated into their PMS, regardless of their specific organizational context. This leads to the first research question of this dissertation:

RQ1: Based on prior PMS literature, which design attributes can be identified that distinguish advanced from less advanced PMS in logistics?

Moreover, while PMS information seeks to fulfill the “needs of managers who must convert firm resources into customer value more efficiently and effectively” (Fawcett et al., 1997), the actual contribution of PMS to the competitiveness of logistics organizations, due to a lack of empirical research, remains somewhat vague. Besides conceptual propositions that “good performance measures and metrics will facilitate a more open and transparent communication between people leading to a co-operative supported work and hence improved organizational performance” (Gunasekaran and Kobu, 2007, p. 2820), only Fawcett et al. (1997) and Rodrigues et al. (2004) have provided first empirical evidence of the positive relationship between performance measurement and operational success in logistics. Yet, given the “paucity of empirical research into the performance impact of measurement frameworks” (Neely, 2005, p. 1267), it remains mostly unclear how PMS can support logistics organizations in addressing the challenges that go along with rapidly changing markets (Gundlach et al., 2006) and the increasing complexity of supply chain processes (Fawcett and Magnan, 2002) in order to ensure high levels of organizational performance.

In this regard, the accounting literature has provided important empirical findings regarding PMS effectiveness, yet not fully clarifying the exact nature of the relationship between advanced forms of PMS and organizational competitiveness. In extending prior studies (e.g. Chenhall, 2005; Simons, 1990), Henri (2006b) proposed that “PMS use may not contribute directly to performance, but instead contribute indirectly through capabilities” (p. 538). Building on these findings and following resource-based theory where capabilities permit the deployment of resources (Amit and Schoemaker, 1993), logistics researchers and practitioners require evidence that a superior PMS as a valuable resource translates into enhanced organizational capabilities and—by using these capabilities to master the challenges that logistics organizations are facing—competitiveness. This leads to the second research question of this dissertation:

RQ2: To what extent can a superior PMS help logistics organizations to foster pivotal organizational capabilities and thereby ultimately logistics performance?

One specific challenge that has been widely recognized as a new, major challenge for logistics organizations in recent years, particularly since the economic and financial crisis, is demand and supply market turbulence (Braunscheidel and Suresh, 2009). Accordingly, supply chain risk management (SCRM) has become a dominant research stream in what Christopher and Holweg (2011) have called the “era of turbulence”. Logistics organizations, in seeking to ensure a comprehensive risk management while making the monitoring of market turbulence an integral part of existing management control processes, need to account for corresponding risk metrics in designing their performance measurement systems. Yet, the potential role of PMS in supporting logistics organizations to cope with market turbulence has received little attention within the SCRM domain, and “performance measurement in the new supply era is still an open area of research” (Akyuz and Erkan, 2010, p. 5137). Overall, research regarding the role of management control systems in SCRM is particularly scant, though Christopher and Holweg (2011) have stated that supply chain turbulence “marks a major departure from current thinking and will require revisiting the management accounting procedures that are used to evaluate different supply chain decisions” (p. 63). So far, the few propositions that supply chain risk metrics should be accounted for in PMS design (Rasid et al., 2012; Ritchie and Brindley, 2007) represent initial ideas and are merely of conceptual nature. Within the PMS literature, the use of risk metrics to capture the risks related to higher levels of market turbulence—i.e. PMS design for turbulence—can neither be considered an established design attribute nor has its relevance been verified empirically.

Regarding the organizational antecedents for the use of risk metrics within a PMS, the accounting literature suggests that upper management’s focus of PMS use may represent a factor that influences PMS design and the selection of performance measures (Henri, 2006a). Here, following established concepts, two distinct types of PMS use that are characterized by different managerial mindsets are an (interactive) attention-focusing use and a (diagnostic) score-keeping use (Simon et al., 1954; Simons, 1990). In short, an attention-focusing PMS use—in aiming at stimulating organizational awareness (Henri, 2006a)—may have different implications for the use of risk metrics in PMS design than a score-keeping PMS that primarily seeks to monitor results against expectations (Vandenbosch, 1999). Therefore, and given the lack of research in this domain, it is important to understand the role of upper manager’s mindset in driving or impeding PMS design for turbulence.

Overall, both the PMS and the SCRM literature would benefit from an investigation of the role that PMS can play in supporting logistics organizations in dealing with market turbulence. This leads to the third research question of this dissertation:

RQ3: How can logistics organizations use PMS to cope with increasing levels of market turbulence and what is the role of upper management's control focus in this context?

Despite the importance of performance measurement for logistics organizations and the challenges in the new supply chain era outlined above (Gunasekaran and Kobu, 2007), little attempt has been made to empirically investigate how logistics organizations actually design their PMS in practice and whether they follow researchers' conceptual recommendations. In the U.S., Fawcett and Cooper (1998), Keebler and Manrodt (2000), and Keebler and Plank (2009)—using the same data set as the Keebler and Manrodt (2000) study—investigated the state of performance measurement, the use of specific performance metrics, and specific PMS-related outcomes in logistics organizations. In Germany, Weber and Blum (2001) provided insights into the status quo and effectiveness of logistics control, albeit taking a broader perspective on management control practice rather than the specific PMS context.

These prior studies only partly focused on PMS as an entity and the implementation of scholarly recommended design attributes in practice. Therefore, in addition to the cause-and-effect relationships outlined in the first three research questions, both logistics researchers and practitioners need to gain a comprehensive understanding of the actual status quo of PMS design and effectiveness in current logistics practice. Researchers, on the one hand, need to validate existing PMS knowledge in order to develop an understanding for the robustness of conceptual findings in practice and to define further research avenues based on the current state of practice. Logistics managers, on the other hand, in seeking to understand where their organization stands and how it needs to proceed, require a benchmark of the actual state of PMS in logistics practice. This leads to the fourth research question of this dissertation:

RQ4: What is the actual state of PMS in logistics practice?

Given the call for more empirically grounded PMS research in logistics and supply chain management (Gunasekaran and Kobu, 2007; Akyuz and Erkan, 2010), the aim of this dissertation, in answering the above outlined research questions, is to close theoretical gaps while gaining valuable insights for logistics managers of both manufacturing companies and LSPs. In this regard, the academia has debated the supposed conflict between the methodological rigor of research and the relevance of results for both theory and practice. Mentzer (2008), in contributing to the debate, asked: "How can research be good if it is not relevant to the discipline under study?" (p. 72) while at the same time clearing up the misconception that rigor and relevance may be contradictory. In line with his assessment, this dissertation's relevance—without compromising on methodologically rigorous analyses—was ensured via

discussions with both logistics practitioners and researchers before, during, and after data collection. For this purpose, a group of ten academics and practitioners were first involved in discussing and challenging the practical relevance of questions during the development of the online survey. Next, as informants had to be knowledgeable in the research domain and familiar with the PMS of their respective logistics organization, a key informant approach was applied (Daugherty et al., 2009). A newsletter mailing of the German Logistics Association (*Bundesvereinigung Logistik, BVL*) was used to announce the survey and ask logistics managers involved in the PMS domain for participation. A link to a registration form was included in the newsletter mailing. The same link was sent to 3297 potential respondents from a commercial database, yielding a total of 349 registrations of prospective survey participants from both mailings. Along with 714 logistics managers from a database collected at the authors' university that were pre-screened to determine if they met the criteria for our study, they received a link to the online survey.

Overall, 431 usable data sets—251 from internal logistics departments of manufacturing companies and 180 from LSPs—were collected and will be described in more detail in the following chapters. Several discussion forums were used to refine research priorities and to calibrate research results. After data collection, first results were presented and discussed at an international conference of the German Logistics Association and at the *LM2011* conference. The discussions were then further detailed in two workshops with logistics practitioners organized by the University of St. Gallen and WHU – Otto Beisheim School of Management, respectively. This way, the relevance of results for logistics and supply chain managers was further validated.

1.2 Outline of the dissertation

In total, this dissertation consists of five main chapters. After the introduction, detailed investigations of the outlined research questions on PMS in logistics organizations are conducted in three chapters based on quantitative empirical analyses, followed by a chapter of concluding remarks.

Chapter 2 addresses research questions 1 and 2. It builds on a cross-disciplinary literature review of PMS frameworks and conceptual contributions to identify the key design attributes that constitute an excellent PMS in logistics organizations. In conceptualizing PMS excellence as the degree to which these attributes are simultaneously incorporated into a PMS, it uses structural equation modelling to show how PMS that follow these recommendations

provide value to logistics organizations. Using a resource-based perspective, the positive impact of PMS excellence on customer orientation and cross-functional integration as two pivotal capabilities in logistics organizations and ultimately on logistics performance are hypothesized and tested. In so doing, this chapter particularly contributes to the limited empirical research regarding the effectiveness of scholarly recommended PMS design attributes.

Chapter 3 addresses research question 3 by examining the role of PMS in enabling logistics organizations to cope with market turbulence as a major source of supply chain risk. Using structural equation modelling, it outlines how PMS design for turbulence can help logistics organizations to build organizational resilience—the ability to cope with turbulence—and thus drive distribution service performance. Regarding the antecedents to PMS design for turbulence, the chapter builds on the accounting literature to investigate upper management’s role in driving or impeding the use of supply chain risk metrics.

Chapter 4 is primarily descriptive in nature and complements the dissertation by investigating the current state of PMS in logistics practice, thus addressing research question 4 while building on the concepts of advanced PMS design introduced in chapters 2 and 3. Using cluster analysis, different PMS design patterns and sophistication levels in logistics organizations are identified and outlined along their main characteristics. Moreover, tests of difference and regression analysis are used to relate these patterns to specific context factors and competitive outcomes and to examine key differences and dependencies. In so doing, this chapter recapitulates and enhances prior works like Fawcett and Cooper (1998) and Keebler and Plank (2009).

The dissertation concludes with Chapter 5 which summarizes the overarching insights and contributions as well as future research possibilities.

2 Performance measurement systems in logistics: Impact on capabilities and performance¹

¹ This chapter is based upon the eponymous unpublished manuscript co-authored with Carl Marcus Wallenburg.

2.1 Introduction

Rapidly changing markets (Gundlach et al., 2006) and the increasing complexity of today's supply chains (Malik et al., 2011) impose tremendous challenges on logistics organizations. They need to increasingly orient themselves toward the customers they are serving (Gunasekaran et al., 2004) and improve operational efficiency by aligning internal efforts across functions (Rodrigues et al., 2004). In dealing with such challenges, the role of performance measurement systems (PMS) has been widely discussed (Gunasekaran and Kobu, 2007; Mentzer and Firman, 1994). As traditional forms of PMS have been criticized for failing to adequately address managers' actual information needs (Fawcett et al., 1997), more advanced PMS frameworks have emerged in accounting, operations, and logistics to support decision-making and enhance performance (Griffis et al., 2004; Kaplan and Norton, 1992; Neely et al., 1995).

In practice, however, it remains unclear what constitutes a truly good PMS. Although many frameworks for advanced PMS discuss similar design attributes, no consensus regarding the truly relevant aspects of PMS has been reached, and few attempts have been made to consolidate the existing body of knowledge across disciplines. Moreover, although recent survey-based studies in management accounting and in operations management have provided first insights regarding the impact of advanced PMS on organizational performance (Chenhall, 2005; Evans, 2004; Ittner et al., 2003), empirical evidence on the positive effects of such advanced PMS in logistics operations is scant. Only Fawcett et al. (1997) and Rodrigues et al. (2004) have investigated the relationship between performance measurement and operational success in logistics, albeit focusing on a limited and context-specific scope of PMS design attributes. For managers of logistics operations who are facing cost-benefit tradeoffs when considering investments into PMS, the actual value proposition of advanced PMS as a lever to enhance logistics performance remains difficult to grasp. They need to gain insight into the extent to which advanced PMS can help them address the challenges of responding more effectively to customer needs and to align logistics operations across internal functions.

Corresponding to the above research gaps, the first objective of this research is to provide a consolidated view of the design attributes that distinguish superior from inferior PMS in logistics. To do so, the present study first conducts an extensive literature review across different disciplines to identify PMS excellence as the degree to which these specific design attributes are incorporated into a PMS. As a valuable resource, an excellent PMS can help logistics organizations to address the above outlined challenges by enabling increased customer orientation and cross-functional integration as two pivotal capabilities in logistics

operations. Thus, in empirically applying the conceptualization of PMS excellence along a resource-based perspective, our second objective is to outline that PMS excellence fosters these two capabilities in logistics organizations, and ultimately enhances logistics performance. For this purpose, a new second-order construct to measure PMS excellence in logistics operations is developed from the literature review.

The remainder of this paper is organized accordingly. Building on the conceptualization of PMS excellence, we present the hypotheses of our research framework. After describing our empirical methodology and the hypotheses test results derived from a study of 429 logistics organizations, we discuss implications and identify avenues for future research.

2.2 Research framework

2.2.1 Conceptualizing PMS excellence

Performance measurement systems (PMS) refer to “the set of metrics used to quantify both the efficiency and effectiveness of actions” (Neely et al., 1995, p. 81). Yet, different authors have focused on very different focal aspects in their attempt to provide guidance to the design of PMS. Therefore, the PMS literature does not convey a clear picture of the design attributes that constitute an excellent PMS that comprehensively supports an organization in dealing with its strategic and operational challenges. To address this shortcoming, we follow the call of Ittner et al. (2003, p. 739) that “future studies can also extend our analyses by examining a broader set of performance measurement system attributes” and provide a comprehensive conceptualization of the attributes that constitute an excellent PMS in general and an excellent logistics PMS in particular. To do so, we have conducted an extensive literature review on the recommended design attributes of advanced PMS in the accounting, operations, and logistics literature, thereby adopting an approach Auzair and Langfield-Smith (2005) used for establishing a comprehensive characterization of management control systems.

Across disciplines, a significant body of literature has examined PMS, with contributions ranging from broad conceptual PMS frameworks, such as the performance pyramid (Lynch and Cross, 1991) or the balanced scorecard (Kaplan and Norton, 1992) in management accounting to context-specific frameworks, such as the performance prism system in operations management (Neely and Adams, 2000) or function-specific frameworks for supply chain related performance measurement (Gunasekaran et al., 2004) or the selection of measures in

logistics (Griffis et al., 2004; Griffis et al., 2007). Although articles have focused on different aspects of PMS design and different levels of detail, the identified frameworks often share several underlying and recurring design attributes to distinguish less sophisticated from more advanced forms of PMS. An example is the broad consensus across disciplines that both financial and non-financial measures should be incorporated into a PMS to keep managers from ignoring relevant performance dimensions (Chenhall, 2005; Neely, 1999). In conceptualizing advanced PMS for empirical research, some authors have examined the use of specific performance measures along the dimensions of the balanced scorecard (e.g. Henri, 2006b; Tung et al., 2011) or context-specific measurement dimensions (e.g. Evans, 2004; Fawcett et al., 1997). Others have limited their inquiries to a single or a few attributes of advanced PMS design (e.g. Ittner et al., 2003; Rodrigues et al., 2004). Together, while providing important empirical insights into the impact of specific aspects of PMS design, they have not developed an exhaustive conceptualization of the design attributes that constitute an excellent PMS. Recent PMS literature reviews in logistics (Akyuz and Erkan, 2010; Gunasekaran and Kobu, 2007), on the other hand, have focused on outlining prior studies and their content rather than synthesizing the observable design attributes of an excellent PMS.

Through a detailed analysis of PMS design attributes recurrently suggested across disciplines, we have identified the distinct categories shown in Table 2-1, which need to be incorporated into an excellent PMS for logistics operations. Building on this synthesis of prior knowledge, we define PMS excellence as the degree to which an organization combines the following six interconnected dimensions into its PMS: *measurement diversity*, *strategic-operational linkage*, *external linkage*, *information timeliness*, *information aggregation*, and *system adaptability*.

Measurement diversity refers to the degree to which a PMS uses a broad set of measures along all relevant performance dimensions of an organization (Amir et al., 2010; Ittner et al., 2003). It encompasses the use of multiple, complementary types of measures (Brignall and Ballantine, 1996; Malina and Selto, 2004) such as financial and non-financial, strategic and operational, as well as lagging (ex post) and leading (ex ante) measures (Evans, 2004; Malmi and Brown, 2008). Though some authors have limited measurement diversity to the dimensions of the balanced scorecard in their research (e.g. Henri, 2006; Tung et al., 2011), the PMS literature, on a generic level, discusses this factor as the comprehensiveness of a PMS with respect to the measurement information needs in a specific organizational context (Eccles and Pyburn, 1992; Griffis et al., 2007).

Dimensions of PMS excellence	Sources from cross-disciplinary literature review
<i>Measurement Diversity</i>	Amir et al. (2010); Brignall and Ballantine (1996); Chenhall (2005); Eccles (1991); Evans (2004); Griffis et al. (2007); Henri (2006a); Ittner et al. (2003); Kaplan and Norton (1997); Malina and Selto (2004); Malmi and Brown (2008); Neely et al. (1995); Rodrigues et al. (2004); Tung et al. (2011)
<i>Strategic-Operational Linkage</i>	Caplice and Sheffi (1995); Bourne et al. (2000); Chenhall (2005); Dixon et al. (1990); van Donselaar et al. (1998); Fawcett et al. (1997); Ferreira and Otley (2009); Griffis et al. (2004); Ittner et al. (2003); Kaplan and Norton (1997); Maskell (1989); Otley (1999); Petersen et al. (2009); Pun and White (2005); Simons (2000); Wisner and Fawcett (1991)
<i>External Linkage</i>	Akyuz and Erkan (2010); Chenhall (2005); Evans (2004); Fawcett et al. (1997); Gunasekaran et al. (2004); van Hoek (1998); Keebler and Plank (2009); Lai et al. (2002); Malina and Selto (2004); Morgan (2004); Neely (2005); Schmitz and Platts (2004); Simatupang and Sridharan (2004)
<i>Information Timeliness</i>	Amir et al. (2010); Fawcett et al. (1997); Ferreira and Otley (2009); Ghalayini et al. (1997); Griffis et al. (2004); Gunasekaran and Kobu (2007); Ittner et al. (2003); Maskell (1989); Neely et al. (1995); Selviaridis and Spring (2007)
<i>Information Aggregation</i>	Amigoni (1978); Bond (1999); Brignall and Ballantine (1996); Caplice and Sheffi (1994); Ferreira and Otley (2009); Ittner et al. (2003); Lee et al. (2002); Morgan (2004); Pun and White (2005); Weber and Schäffer (1998)
<i>System Adaptability</i>	Brignall and Ballantine (1996); Ghalayini et al. (1997); Griffis et al. (2007); Gunasekaran and Kobu (2007); Kennerley and Neely (2003); Maskell (1989); Malina and Selto (2004); McGinnis and Kohn (2002); Morgan (2004); Neely (2005); Waggoner et al. (1999)

Table 2-1: Dimensions of PMS excellence

Strategic-operational linkage refers to the extent to which a PMS translates an organization's strategic goals into a consistent set of performance measures on all organizational levels (Caplice and Sheffi, 1995; Chenhall, 2005). If established successfully, the strategic and operational levels of a PMS will be integrated through causal links between operational value drivers and strategic objectives (Kaplan and Norton, 1992; Petersen et al., 2009). Having consistent operational and strategic performance measures in place will not only enhance PMS satisfaction in an organization (Sandt et al., 2001) but will make these performance measures a useful basis for management incentive schemes and personal goals (Evans, 2004; Otley, 1999). Thus, in supporting an organization's strategy implementation, the strategic-operational linkage of a PMS adds significant value to managerial decision-making.

External linkage refers to the degree to which an organization's PMS accounts for external supply chain elements and their interrelation with its own business performance (Gun-

asekaran and Kobu, 2007; Schmitz and Platts, 2004) to support coordination with supply chain partners (Akyuz and Erkan, 2010). Yet, it does not necessarily imply the integration of systems between supply chain partners. In contrast to the traditional performance measurement focus within the boundaries of an organization (Short and Venkatraman, 1992; Lai et al., 2002), it is important—particularly for logistics managers—to understand how their organization’s performance depends on other members of their supply chain, including customers, suppliers, and alliance partners (Normann and Ramírez, 1993; Chenhall, 2005). Thus, whereas accounting for measures that extend across supply chain relationships is discussed in PMS research across disciplines, external linkage stands out as particularly relevant for logistics operations (van Hoek, 1998; Neely, 2005).

Information timeliness refers to the degree to which performance measurement information is readily available for decision-makers (Brignall and Ballantine, 1996; Ittner et al., 2003). While periodic result measures will be consulted infrequently (Griffis et al., 2007), managers must be able to monitor day-to-day operations to reduce the time lag between measuring performance and applying the results for corrective action (Gunasekaran and Kobu, 2007). Identifying operational priorities in a timely way, therefore, is of particular relevance in operations management and logistics (Fawcett et al., 1997; Neely et al., 1995).

Information aggregation refers to the degree to which a PMS focuses performance information on the most relevant measures (Ittner et al., 2003; Ferreira and Otley, 2009). In addressing the abundance of modern information systems and the time restrictions managers face in making decisions, information aggregation encompasses prior recommendations in PMS research such as using selective measures (Amigoni, 1978; Weber and Schäffer, 1998) and using less detailed, simpler measures at higher levels of the managerial hierarchy (Brignall and Ballantine, 1996).

System adaptability refers to the degree to which a PMS can be adjusted to specific requirements or new findings. Competitive organizations are adapting constantly to their environment (McGinnis and Kohn, 2002); therefore, they need to select and use new or different measures dynamically in order to reflect current conditions (Malina and Selto, 2004; Kennerley and Neely, 2003; Waggoner et al., 1999). Correspondingly, a PMS must be designed to be adaptable in the same way, as “firms and managers must be able to identify and select new or different measures consistent with evolving organizational priorities” (Griffis et al., 2007, p. 35).

A PMS will provide value to a logistics organization particularly when its design reflects a combination of all six dimensions. For example, measurement diversity by itself is not beneficial when it results in excessive reporting and information overload (Schick et al., 1990), thus not putting managers in a good position to monitor operations and make decisions efficiently and effectively. Here, the PMS literature provides clear evidence that each dimension of PMS excellence, to unfold its value, should not be improved alone but needs to be combined with one or several other dimensions. Kaplan and Norton (1992) stress the simultaneous importance of a multidimensional approach to performance measurement (measurement diversity) and the interlinkage between strategic goals and operational value drivers (strategic operational linkage). Similarly, Brignall and Ballantine (1996)—besides stressing non-financial measures—also suggest less detailed, more aggregated, and simpler PMS information on higher hierarchical levels (information aggregation) as well as the importance to change a PMS when necessary as “the PM system is not cast in stone” (p. 15) (system adaptability). In focusing on the PMS literature within the field of logistics and supply chain management, Gunasekaran and Kobu (2007) also outline the simultaneous importance of PMS linkages to supply chain partners (external linkage) and the timely availability of performance measures (information timeliness) in PMS design. Thus, in bringing the many different, but partly overlapping PMS design frameworks together, it can be concluded that the six dimensions are complementary and mutually reinforcing in enhancing PMS value. Building on this insight, the present study conceptualizes the combined existence of these six dimensions as PMS excellence.

2.2.2 Conceptual model and hypotheses

According to the resource-based view (RBV) of the firm, resources are assets, processes, information, knowledge, or firm attributes that enable managers to develop and implement strategies to improve efficiency and effectiveness, ultimately leading to sustainable competitive advantage (Barney 1991). From this perspective—and given the fact that many logistics organizations are struggling to implement a PMS that adequately addresses their managers’ information needs (Fawcett et al., 1997; Keebler and Plank, 2009)—PMS excellence as a superior reporting and control structure constitutes an organizational capital resource (Tomer, 1987) that can lead to enhanced organizational competitiveness. Amit and Schoemaker (1993) extended the RBV by suggesting that competitive advantage and superior performance result from leveraging resources and assembling, integrating, and deploying such resources to build organizational capabilities. Given the ongoing challenges of logistics

organizations to respond effectively to customer needs (McGinnis and Kohn, 2002) and to align internal efforts across departments (van Hoek and Mitchell, 2006), this research focuses on customer orientation (Selviaridis and Spring, 2007) and cross-functional integration (Zacharia and Mentzer, 2004) as two pivotal capabilities in logistics operations. Following Amit and Schoemaker’s (1993) perspective, we investigate the impact that PMS excellence as a valuable resource has on logistics performance via customer orientation and cross-functional integration as two capabilities that leverage this resource. As we analyze the impact of PMS excellence as a source of competitive advantage in different organizational contexts, logistics performance refers to the overall competitiveness of an organization regarding the efficiency and effectiveness of its logistics activities (Mentzer and Konrad, 1991; Mentzer et al., 2004).

In addition to the mediated impact of PMS, prior research in other disciplines has investigated direct relationships between PMS and performance (e.g. Said et al., 2003; Evans, 2004; Chenhall, 2005). Although the exact mechanisms between the use of PMS and performance remains ambiguous (Henri, 2006b), resource-based theory—in looking at competitive advantage as an outcome of one or more valuable resources—supports such a direct relationship. Therefore, we will also consider the direct impact of PMS excellence on logistics performance in the research model as displayed in Figure 2-1.

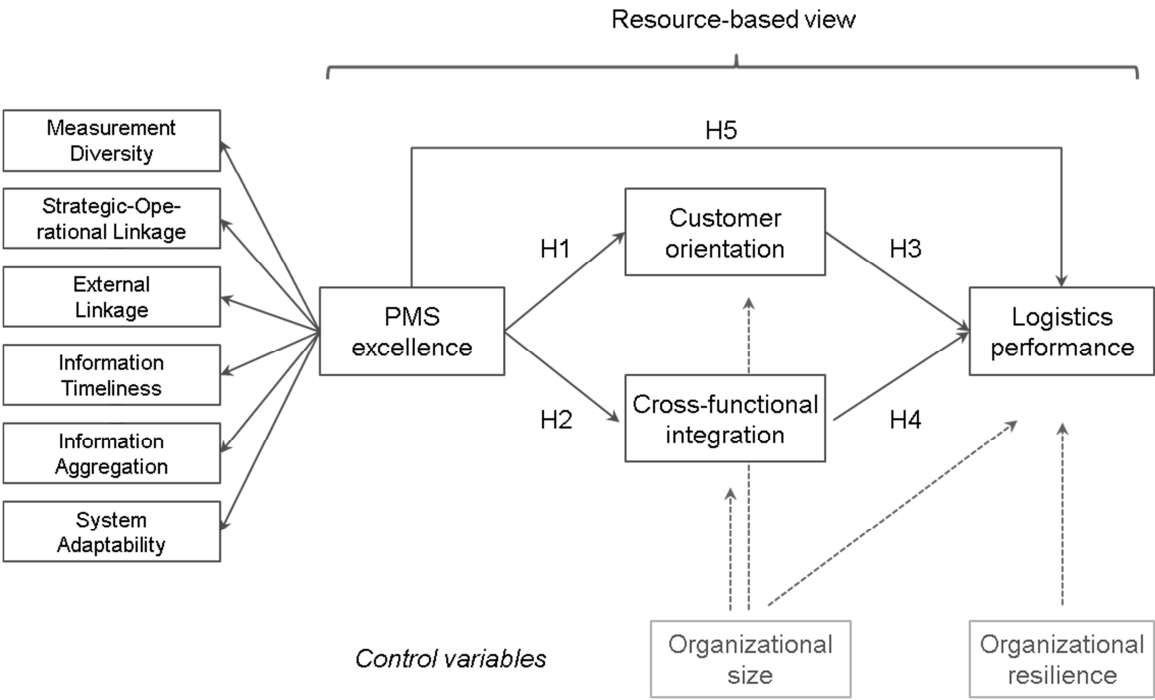


Figure 2-1: Conceptual research model

Impact of PMS excellence organizational capabilities

With an increasing awareness of the benefits of leveraging logistics to increase customer value (Fugate et al., 2010), customer orientation has become an essential capability in logistics operations (Zhao et al., 2001). Rather than a generic strategy, it represents a capability that may—depending on the preferences of the specific company’s customers—involve both cost and service aspects. In seeking to attain this capability, logistics organizations must understand their performance with respect to existing and future customer expectations (Gunasekaran and Kobu, 2007). Performance measurement systems represent an important formal mechanism to support such an understanding (Gunasekaran and Kobu, 2007). Having an excellent logistics PMS in place will do more than translate customer satisfaction as a strategic goal into operational value drivers such as on-time pickup and delivery, lead times, or consistency of service. By providing such operational measures in a timely and aggregated manner while adapting them to evolving customer priorities, PMS excellence will also put logistics managers in a position to continuously focus organizational attention and efforts on activities that add distinct value. By linking internal activities to those of customers through performance measures, it can help to improve service levels or to even identify sources of increased functionality or additional services. In summary, and following our RBV perspective, we argue that PMS excellence as a valuable resource will enhance the ability of logistics organizations to meet existing and to anticipate upcoming customer needs. We thus posit our first hypothesis:

H1: PMS excellence has a positive effect on customer orientation in logistics organizations.

A second capability that leverages PMS excellence as a valuable resource is cross-functional integration which generally refers to bringing different departments together for interaction and collaboration (Daugherty et al., 2009; Zacharia and Mentzer, 2004). In the context of logistics organizations, it reflects the ability to align logistics operations across departments (Bowersox et al., 2002) and thereby improve decision-making efficiency and effectiveness.

The contribution of PMS excellence to cross-functional integration can be explained by the common ground that a PMS provides to an organization’s different departments. If operational priorities in managing day-to-day activities differ between departments, focusing managers’ and employees’ attention on the same issues across departments is not a simple effort. To support interaction and shared priorities, it is essential that employees recognize the

value of working together (Daugherty et al., 2009), not only within their function, but also across the departments of an organization. As “a lack of measurement or systems that put functions in competition with each other certainly harm integration efforts” (Pagell, 2004, p. 476), excelling in performance measurement represents an important basis in this context for several reasons. First, using a diverse set of financial and non-financial measures along all relevant performance dimensions, while providing transparency on dependencies between internal performance and external partners, will ensure that the priorities of each function are represented adequately. Second, having high-level strategic measures linked to the operational level will provide transparency regarding different departments’ contributions to the organization’s goals. Finally, such operational driver measures will be readily available across departments, tailored to the time constraints of day-to-day operations, and ready to be adjusted to cross-functional priorities.

Overall, PMS excellence will not only contribute significantly to conveying the same priorities to different departments, but also encourage information-sharing and joint work teams in managing logistics operations. Combined with first empirical insights on the positive effects of advanced measurement systems on integrated internal operations provided by Rodrigues et al. (2004), we argue:

H2: PMS excellence has a positive effect on cross-functional integration in logistics organizations.

Impact of organizational capabilities on logistics performance

Capabilities are the organizational routines by which firms deploy valuable resources, which can significantly contribute to superior performance (Day, 1994; Barney et al., 2011). In leveraging the resource of PMS excellence, both customer orientation and cross-functional integration are corresponding capabilities that can create competitive advantage and enhanced performance in logistics operations.

Responding to customer expectations has long been regarded a key driver of performance in logistics (Defee et al., 2010). Extant logistics and supply chain literature has focused mainly on service performance as a dimension of logistics performance rather than customer orientation as an organizational antecedent (Shang and Marlow, 2005). Nevertheless, a small number of studies have provided insights regarding the positive contributions that customer-focused logistics capabilities have on firm performance (Innis and La Londe, 1994; Zhao et al., 2001) as well as on supply chain performance (Jeong and Hong, 2007).

In general, an organization with a strong customer focus will be adept at reacting to formal and informal feedback (Baker and Sinkula, 1999) and will work continuously on meeting or exceeding customer expectations (Bowersox et al., 1999). Given the direct customer interaction in logistics operations, key dimensions of customer value such as delivery reliability, quality of service, and flexibility (Fawcett et al., 1997) are closely linked to the organization's overall performance. This becomes particularly evident when looking at the most-used operational performance measures such as on-time delivery, order fill rates, lead times, or complaint rates (Lai, 2004; Keebler and Plank, 2009). In seeking to improve customer value along these measures, logistics organizations will, at the same time, improve their overall competitiveness regarding the efficiency and effectiveness of logistics processes.

Along with prior suggestions on customer responsiveness as a source of competitive advantage in logistics (Daugherty et al., 1992), we therefore propose:

H3: Customer orientation in logistics organizations has a positive effect on logistics performance.

A significant body of research has found the integration of different departments within an organization to be an essential enabler of performance (e.g. Chen et al., 2007; Droege et al., 2004; Ruekert and Walker, 1987). Given the strong process-focus in logistics operations, cross-functional exchange, information sharing, and teamwork among the departments involved in logistics operations are of crucial importance (Mentzer 2004; Rodrigues et al., 2004). Indeed, prior studies have suggested and confirmed that logistics organizations that achieve cross-functional integration enjoy improved performance (Kahn and Mentzer, 1996; Ellinger et al., 2000). Besides reduced duplication and redundancy (Stank et al., 2001), cross-functional integration can lead to improved on-time delivery, lead time reductions, and reduced inventory (Gustin et al., 1995).

As logistics processes always involve more than one functional area (Kahn and Mentzer 1996), the primary reasons for the performance impact of cross-functional integration are quite straightforward. Managers and employees from different functions who build cross-functional teams (Daugherty et al., 2009) facilitate superior performance in managing processes and ensure that efforts and resources are coordinated (Chen et al., 2007). With the relevant areas working together rather than remaining in functional silos, their assets, know-how, and information are mutually supportive and build a more efficient and effective logistics organization. Ultimately, such an integrated organization will yield higher levels of logistics performance:

H4: Cross-functional integration in logistics operations has a positive effect on logistics performance.

Direct impact of PMS excellence on logistics performance

Besides the mediated impact of PMS excellence on logistics performance via organizational capabilities, prior empirical studies have suggested, and partly confirmed, direct relationships between PMS and performance (Davis and Albright, 2004; Evans, 2004; Fawcett et al., 1997), thereby leaving an open debate about the exact nature of the relationship between PMS and performance.

In management accounting, Henri (2006b) analyzed this issue and concluded that “since a large proportion of the relationships between PMS use and performance is expected to come indirectly through capabilities, the direct effects are expected to be relatively small” (p. 539). Also, in investigating both mediated and direct links between PMS and firm-level performance, Chenhall (2005) confirmed both links but found stronger support for the mediated effects.

Based on these findings in accounting and the complex interaction of various processes within logistics organizations, it is reasonable to assume that most of the value of PMS excellence will be mediated through organizational capabilities. At the same time, following resource-based logic from a theoretical standpoint—where resources have a direct potential for sustainable competitive advantage and rent-generation (Barney, 1991; Grant, 1991)—it can be argued that PMS excellence as a valuable resource can also have a direct impact on performance. Furthermore, from a managerial standpoint in logistics operations, having the right information at the right time to make decisions enhances organizational competitiveness (Gunasekaran and Kobu, 2007). Building on the findings of prior research, PMS excellence represents a source of information that—in addition to its primary impact through organizational capabilities—will translate directly into enhanced logistics performance. In further investigating the impact of PMS in logistics operations, while contributing to the above-noted debate in other disciplines, we therefore propose:

H5: PMS excellence has a positive direct effect on logistics performance that is smaller than the mediated effect via organizational capabilities.

2.3 Methodology and scale development

2.3.1 Sample design and characteristics

To test our research model, a large-scale survey among logistics organizations of manufacturing, trading, and logistics companies in Germany was conducted to collect primary data. As informants had to be knowledgeable and familiar with the PMS of their respective logistics organization, a key informant approach was applied (Mitchell, 1994). Potential respondents were gathered from three databases of 4,011 logistics and supply chain managers who received an email announcement of the survey. To ensure that informants were knowledgeable in our field of research, the announcement asked experts involved in the PMS domain of their respective logistics organization for registration via an online form. Subsequently, after a four week registration period, an email that included a link to the online survey was sent to a total of 1,063 registered candidates. The survey was active between July and September 2011, and three reminder emails were used to improve the response rate. A set of 431 responses was considered usable due to the low percentage of missing values. Based on the initial sample of 1,063 registered managers, this corresponds to a very good response rate of 40.5% (Wagner and Kemmerling, 2010). Two outliers were removed based on Mahalanobis distance (Byrne, 2001). Respondent demographics are summarized in Table 2-2.

Industry	Percent	Job title of respondents	Percent
Automotive	12%	Top level executive / director	55%
Machinery and equipment	11%	Senior manager	27%
High-tech and electronics	5%	Manager	12%
Chemicals and pharmaceuticals	7%	Non-executive	6%
Consumer goods	11%	Number of logistics employees	
Logistics services	42%	Less than 100	51%
Other industries	12%	100 to 999	34%
		1,000 or more	15%

Table 2-2: Respondent demographics

In our survey, we pointed out that a Performance Measurement System (PMS) refers to any structured set of performance measures used to quantify the efficiency and effectiveness of operations in the respondents’ respective logistics organization, not necessarily a sophisticated information system.

As both independent and dependent variables were collected from the same respondents, we applied several methods to minimize the potential for common method bias. In addition to separating items of independent and dependent variables through survey questions that were unrelated to our model while also assuring anonymity to survey participants, we applied the marker variable technique to detect potential common method bias (Lindell and Whitney, 2001; Podsakoff et al., 2003). As a measure that should theoretically not be related to any of the focal constructs in the model, a three-item marker for perceived external risk was used as part of the survey to test for statistical dependence that may be caused by common method bias. Using the lowest correlation of the marker variable's items to the items used to measure the constructs of our research model (0.0005 with $p > 0.991$) as the upper bound for potential common method variance, we found no indication for the presence of common method bias.

Non-response bias was examined in two ways. First, no significant differences ($p < 0.05$) were found when comparing all scale items via independent sample *t*-tests between the first and last third of responses (Armstrong and Overton, 1977). Second, 30 randomly selected non-respondents were convinced to complete a short version of the survey that included six items from our model (Lambert and Harrington, 1990). Again, no significant differences ($p < 0.05$) were found compared to the responses of the original participants. Thus, non-response bias is not expected to influence the results of this study.

2.3.2 Measurement scales

All construct measures used for the survey relied upon multi-item 7-point Likert scales. During questionnaire design, all items were discussed with a group of ten academics and logistics practitioners. Three further practitioners were involved to examine specific questions and to validate the final survey. Following suggestions by Brislin (1976), the questionnaire was first developed in English, then translated into German, and finally back-translated into English to improve the translation accuracy for our target group of German speaking logistics managers. The back-translated version was checked against the original version.

Development of second-order PMS excellence construct

Armstrong and Shimizu (2007) pointed out that the operationalization of resource constructs in empirically testing the RBV represents an important challenge. They stated that RBV researchers should “theoretically identify what the observable consequences of unobservable resources are likely to be” and that “since it is unlikely to find one proxy that reflects

unobservable resources, researchers should use multiple variables to collectively represent latent constructs” (p. 968). To provide a comprehensive scale that is applicable universally to any logistics organization and to address Armstrong and Shimizu’s (2007) suggestions, the present study operationalizes PMS excellence as a second-order construct that combines the extent to which the six dimensions of PMS excellence can be observed in a specific organization. As presented in the research framework in more detail, these include measurement diversity, strategic-operational linkage, supply-chain linkage, information timeliness, information aggregation, and system adaptability. An initial list of items for each first-order construct was compiled based on the study’s PMS literature review. To verify the validity of the first-order constructs and eliminate ambiguous items, an item sorting approach developed by Moore and Benbasat (1991) was adapted following prior applications in instrument development (e.g. Lee et al., 2002; Li et al., 2005). While a description of the detailed sorting procedure is beyond the scope of the present paper, the basic construct validation rationale was as follows. In a first step, comprehensiveness and categorization of the sub-constructs and underlying items were discussed and adapted with three logistics practitioners. Next, to further verify the scale, two groups of five logistics researchers each were formed to categorize defined items. While the six underlying sub-constructs described above were not known to the first group, their objective was to build item categories and provide proposed construct definitions for each category. For the second group, the underlying constructs were named, and each member sorted items into constructs, while also providing convergence grades for each item to indicate the quality of fit. Based on the results, which indicated a high fit of proposed items and constructs, a small number of ambiguous items were modified or eliminated.

Further constructs

To measure customer orientation, we used Narver and Slater’s (1990) well-established scale. Two indicators for customer satisfaction were merged to reduce overlap that may have confused respondents. One item (“We pay close attention to after-sales service”) was dropped because it did not universally fit the context of all logistics organizations.

Cross-functional integration was measured using the scale items developed by Zacharia and Mentzer (2004) and Daugherty et al. (2009). When we discussed the survey with logistics practitioners, one item (“The orientation of our organization has shifted from managing functions to managing processes”) was deemed confusing for measuring cross-functional integration and therefore omitted.

The scale developed by Fugate et al. (2010) was used to measure logistics performance. As the study used data from manufacturing, trading, and service companies, this scale was chosen due to its applicability to different logistics contexts.

Further, we included the size of the logistics organization, i.e. the number of employees in logistics operations, as control variable, as organizational size can be a source of variance that may influence research results (Wagner and Bode, 2006). To prevent any omitted variable bias, organizational resilience, due to its potential impact on logistics performance, was added as a second control variable.²

2.3.3 Model and scale analysis

Confirmatory factor analysis (CFA) was conducted in AMOS to check unidimensionality and convergent validity, internal consistency of constructs, discriminant validity, and second-order construct validity. Following Brown (2006), one second-order model was used with grouped first-order dimensions of our newly developed PMS excellence scale. Based on low loadings or high correlated errors, SOL4, EL2, EL4, and SA3 were removed from the new second-order scale to improve the model fit without affecting the coverage of their respective first-order constructs (Hair et al., 2006). Good fit indices of the CFA model ($\chi^2/df = 1.656$; CFI = 0.967; GFI = 0.903; TLI = 0.964; RMSEA = 0.039) confirm unidimensionality (Hair et al., 2006).

<i>Please rate the extent to which the following items describe the Performance Measurement System of your logistics organization:</i>		Mean	SD	Stand. Weight	t-value
Measurement Diversity (Cronbach's alpha = 0.85; AVE = 0.71; CR = 0.88) Our Performance Measurement System ...					
MD1	... is not limited to one dimension (e.g. financials only), but measures performance along multiple complementary dimensions.	4.89	1.74	0.79	18.88
MD2	... ensures that all relevant performance dimensions are accounted for.	4.79	1.61	0.87	21.32
MD3	... provides a diverse set of measures (e.g. financial/non-financial, internal/external, lagging (ex-post)/leading (ex-ante) measures).	4.46	1.67	0.86	Fixed
Strategic-Operational Linkage (Cronbach's alpha = 0.82; AVE = 0.60; CR = 0.82) Our Performance Measurement System ...					
SOL1	... provides causal links between operational value drivers (input measures) and strategic result measures (output measures).	4.06	1.73	0.70	14.80
SOL2	... links all business activities with the achievement of goals and objectives of the organization as a whole.	4.48	1.67	0.85	16.03
SOL3	... provides consistent and mutually reinforcing links between current operating performance and long-term strategies.	3.96	1.56	0.77	Fixed
SOL4	... shows how activities of one business unit affect other units and the organization as a whole.*				

² A detailed investigation of organizational resilience is provided in chapter 3.

External Linkage (Cronbach's alpha = 0.88; AVE = 0.57; CR = 0.84) Our Performance Measurement System ...					
EL1	...provides measures that link internal activities to those of our supply chain partners (customers, suppliers, alliance partners).	3.83	1.79	0.78	13.28
EL2	... links our business performance to customers and suppliers.*				
EL3	... enhances transparency on performance linkages between different participants in the supply chain.	3.76	1.70	0.81	13.60
EL4	... integrates external measures like customer service or supplier performance.*				
EL5	... includes measures that were jointly defined with our supply chain partners (customers, suppliers, and alliance partners).	3.34	1.77	0.68	Fixed
EL6	... supports coordination with our supply chain partners.	3.22	1.72	0.74	17.03
Information Timeliness (Cronbach's alpha = 0.84; AVE = 0.73; CR = 0.89) Our Performance Measurement System ...					
IT1	... ensures more frequent measurement for continuously needed operational measures than for periodic result measures.	5.36	1.70	0.79	19.29
IT2	... has performance measurement information readily available when needed.	5.26	1.52	0.92	23.23
IT3	... helps to reduce the time lag between measuring performance and applying results for corrective action.	4.83	1.63	0.84	Fixed
Information Aggregation (Cronbach's alpha = 0.80; AVE = 0.57; CR = 0.80) Our Performance Measurement System ...					
IA1	... focuses on relevant performance information based on selective measures.	5.40	1.39	0.82	13.71
IA2	... provides less detailed, more focused performance information as one rises in the managerial hierarchy.	5.11	1.71	0.76	13.08
IA3	... does not generate as many performance measures as possible but prioritizes the most relevant measures.	5.31	1.51	0.67	Fixed
IA4	... has the right level of detail / accuracy for different PMS user groups.*				
System Adaptability (Cronbach's alpha = 0.93; AVE = 0.84; CR = 0.94) Our Performance Measurement System ...					
SA1	... can be easily adjusted to new findings or additional requirements.	4.66	1.65	0.94	27.16
SA2	... responds dynamically to changed requirements or circumstances.	4.63	1.64	0.96	28.04
SA3	... ensures adaptability of performance measures to specifics of different organizational units (e.g. BUs/departments).*				
SA4	... is not an off-the-shelf solution but easily adjustable to our specific business requirements.	4.57	1.69	0.84	Fixed
Items were measured with 7-point Likert scale ranging from 1 = I strongly disagree to 7 = I strongly agree (* items eliminated in scale-refinement after large-scale analysis)					

Table 2-3: Second-order PMS excellence construct

As shown for the new PMS excellence scale in Table 2-3 and the dependent scales in Appendix 1-1, all dimensions exhibit good convergent validity with the lowest *t*-value at 13.08 (IA2) and a minimum standardized regression path of 0.67 (IA3).

In addition to Cronbach's alpha, internal consistency of constructs was assessed via composite reliability (CR) and average variance extracted (AVE). All constructs exceeded the recommended minimum value of 0.6 for CR (Bagozzi and Yi, 1988) and 0.5 for AVE (Fornell and Larcker, 1981), supporting the reliability of the constructs and their measurement

items. For discriminant validity, AVE and squared correlation were compared for all constructs following the Fornell-Larcker (1981) criterion, which all constructs met (Table 2-4).

Scale	AVE	Squared Correlations			
		(1)	(2)	(3)	(4)
(1) PMS excellence	0.59	--			
(2) Customer orientation	0.54	0.31	--		
(3) Cross-functional integration	0.65	0.24	0.22	--	
(4) Logistics performance	0.79	0.10	0.19	0.11	--

Table 2-4: Test for discriminant validity

2.3.4 Validation of second-order construct

To validate the second-order PMS excellence construct, we followed Cao and Zhang (2011) by examining the target (T) coefficient between the first-order model and the second-order model (where $T = \text{first-order } \chi^2 / \text{second-order } \chi^2$). As the fit indices for higher-order models can never be better than the corresponding first-order model (Segars and Grover, 1998), a T coefficient of 0.80 to 1.00 indicates the existence of a second-order construct (Marsh and Hocevar, 1985). The calculated target coefficient of 91.0% is shown in Table 2-5 and strongly supports the more accurate representation of our second-order model structure over the corresponding first-order model.

Model	χ^2 (df)	Normed χ^2	CFI	TLI	RMSEA	T coefficient
First-order	612.58 (368)	1.665	0.971	0.965	0.039	91.0%
Second-order	673.28 (392)	1.718	0.966	0.963	0.041	

Table 2-5: Fit indices for first and second order model

2.4 Hypothesis test results

The structural model (including the control variables) was tested using AMOS and shows adequate fit with $\chi^2/\text{df} = 1.95$; CFI = 0.95; TLI = 0.94; RMSEA = 0.047. Results are displayed in Figure 2-2.

Hypotheses 1 and 2 posit that PMS excellence improves the two capabilities of customer orientation (H1) and cross-functional integration (H2). Our model's results provide strong support for both hypotheses, with significant and substantial standardized path coefficients of +0.591 ($p < 0.001$) and +0.512 ($p < 0.001$), respectively. Thus, the proposed role of PMS

excellence as an enabler of these two pivotal capabilities in logistics organizations is clearly underscored.

Hypotheses 3 and 4, which postulate a positive effect of both capabilities on logistics performance, receive support as well. With a standardized regression weight of +0.264 ($p < 0.001$), the effect of customer orientation on logistics performance is stronger than that of cross-functional integration (+0.138, $p = 0.019$). While the positive effects of cross-functional integration confirm previous research suggesting that overcoming functional boundaries is a key success factor in logistics operations, the high impact of customer orientation emphasizes its particular importance for logistics organizations.

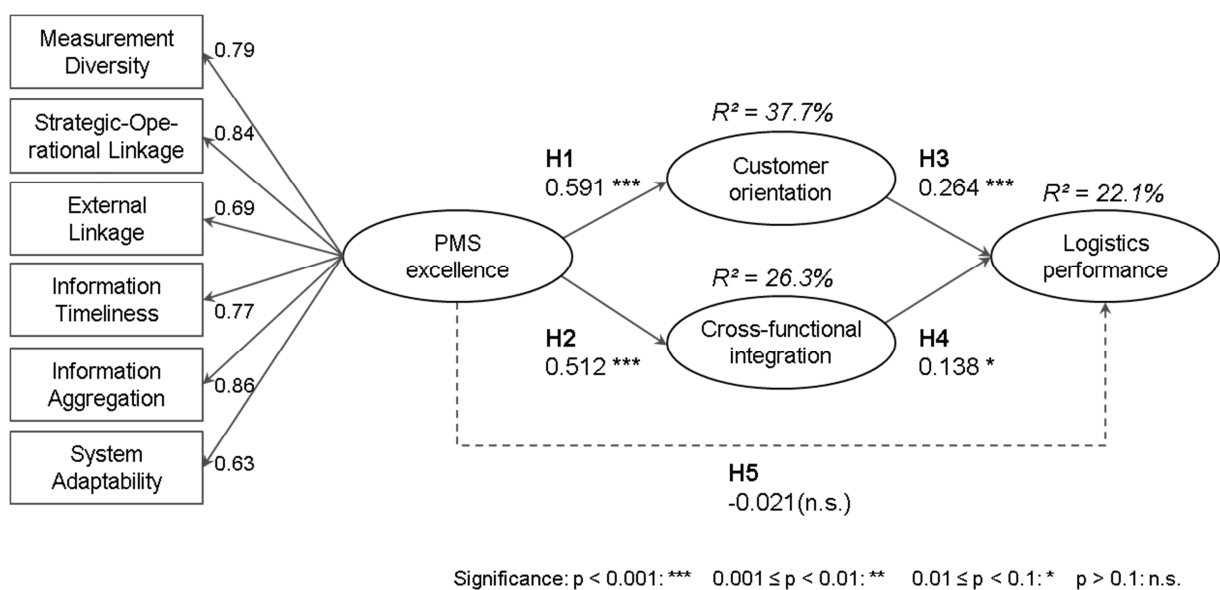


Figure 2-2: Results of structural equation model

The direct effect of PMS excellence on logistics performance is not only smaller than the mediated effect but—other than stated in Hypothesis 5—virtually non-existent and insignificant; thus, we do not find support for H5. To assess the explanatory power of our research model, squared multiple correlations (R^2) were examined for all endogenous latent variables. The results indicate that 37.7% of customer orientation’s total variance and 26.3% of cross-functional integration’s total variance are explained by PMS excellence in logistics organizations. Furthermore, 22.1% of variance in logistics performance is explained. An overview of hypothesis test results, including coefficients and p -values for the model with and without controls, are shown in Appendix 2-2.

2.5 Discussion and implications

While the role of performance measurement to support managerial decision-making in logistics has been extensively discussed in prior conceptual research (e.g. Griffis et al., 2007; Caplice and Sheffi, 1995), empirical evidence on PMS impact in logistics was scant. The present study confirms the relevance of PMS as a potential source of competitive advantage in logistics organizations and provides a holistic conceptualization of PMS excellence while validating its mediated impact via customer orientation and cross-functional integration as two pivotal organizational capabilities.

2.5.1 Theoretical implications

Building on our newly derived conceptualization of PMS excellence in logistics organizations and the second-order construct developed for our study, our empirical results show that the six interconnected and mutually reinforcing dimensions of PMS excellence—measurement diversity, strategic-operational linkage, external linkage, information timeliness, information aggregation, and system adaptability—combine to significantly enable organizational capabilities and logistics performance. While PMS excellence builds on design attributes that are recommended across disciplines, there are obviously other elements to consider from PMS frameworks that are not related to design, e.g. criteria for the selection of specific measures in a particular organizational context (Ghalayini et al., 1997; Griffis et al., 2004). Still, in summarizing the key criteria of advanced PMS design, PMS excellence represents a common denominator for the large body of conceptual PMS knowledge in the literature. Given the small share of PMS research in logistics and supply chain management that is empirical (Gunasekaran and Kobu, 2007), it is an important finding that the criteria provided by different conceptual PMS frameworks are actually found to provide significant value to logistics organizations. By integrating the complementary dimensions of PMS excellence into a second-order construct, we also followed the call of Armstrong and Shimizu (2007) to better operationalize resource constructs for empirical RBV research and to use multiple variables to collectively measure such constructs.

PMS excellence shows to be a strong driver of organizational customer orientation and explains 37.7% of its variance. While there is little doubt that customer orientation represents a key capability in logistics, our findings suggest that logistics organizations that excel in PMS will be in a better position to use performance information to actually fulfill customer

requirements by focusing organizational attention and efforts on activities that add customer value.

Next, PMS excellence was shown to be a substantial facilitator of cross-functional integration, thus addressing logistics organizations' ongoing challenge to continuously improve internal alignment for enhanced operational efficiency. In providing a broad set of performance measures that convey the same priorities to different departments, while being readily available across the organization and adapted to managerial information needs and time constraints, PMS excellence significantly supports interaction and collaboration among different departments. Prior research has confirmed the relevance of cross-functional relationships in logistics (Daugherty et al., 2009; van Hoek, Ellinger, and Johnson, 2008); therefore, having 26.3% of variance in cross-functional integration explained by PMS excellence is an important finding.

Together, customer orientation and cross-functional integration fully mediate the impact of PMS excellence as a valuable resource and explain 22.1% of overall logistics performance. Here, while the positive effects of cross-functional integration confirm previous research suggesting that overcoming functional boundaries is a key success factor in logistics operations, the even higher impact of customer orientation emphasizes its particular importance for logistics organizations.

In following the original RBV definition (Barney, 1991), our research framework also proposed a direct relationship between PMS excellence as a valuable resource and logistics performance as a result of competitive advantage. However, unlike hypothesized, the direct impact was not only found to be smaller than the mediated impact, but turns out to be irrelevant. As prior empirical research by Fawcett et al. (1997) found a positive relationship between performance measurement information and operational success in logistics using correlation analysis, the present study's results refine these findings by confirming that the impact of PMS excellence is fully mediated through organizational capabilities. We thereby also support previous suggestions from accounting research that the performance impact of PMS is mediated through organizational capabilities (Chenhall, 2005; Henri, 2006b).

2.5.2 Managerial implications

The present study's findings offer important implications for managers involved in the performance measurement practice of their respective logistics organization. In general, the results strongly underscore the value of an excellent PMS. More specifically, our research provides conceptual guidance on the criteria that managers need to simultaneously account for

when designing their organization's PMS. Think of an approach that, for example, builds on the idea of the balanced scorecard (BSC), but is enhanced by further aspects. While a BSC represents a formalized example of a PMS that already incorporates different dimensions of performance measures (measurement diversity) and links the strategic and operational level (strategic operational linkage), further important criteria of advanced PMS design should be added as emphasized in our work. Regardless of whether a PMS consists of a simple set of measures that are linked within a spreadsheet or a sophisticated information system, the outlined design criteria can be equally incorporated. Logistics managers seeking to further exploit PMS potential will need to assess and critically challenge the observable characteristics of PMS design and implementation within their organization. To reach beyond a coherent and diverse set of measures that translates logistics strategy to the operational level (Kaplan and Norton, 1997), they need to not only review the status of their PMS along all six dimensions of PMS excellence, but to develop an understanding of the factors that enable PMS within their organization.

Moreover, the supported relationships of our RBV framework can guide managers in exploiting PMS excellence for logistics performance by fostering customer orientation and cross-functional integration as two key capabilities in logistics operations. The substantial share of an organizations' customer orientation variance explained by PMS excellence reveals a significant managerial lever to meet the continuous challenge of delivering real customer value. Furthermore, the supported relationship between PMS excellence, cross-functional integration, and overall logistics performance strongly confirms prior conceptual suggestions by Gunasekaran and Kobu (2007) that "good performance measures and metrics will facilitate a more open and transparent communication between people leading to a co-operative supported work and hence improved organizational performance" (p. 2820). Hence, while there are many organizational factors contributing to cross-functional integration (Pagell, 2004), logistics managers on all hierarchical levels should also seek to exploit the opportunities arising from a better PMS to tie their organization together and to focus on the most urgent priorities across all functional departments.

2.6 Limitations and future research

Some limitations of our study need to be recognized, which, at the same time, offer promising avenues to further advance our understanding of PMS in logistics. First, in applying resource-based theory to analyze the impact of PMS excellence as a source of

competitive advantage, the present research focused on the combined and mutually reinforcing existence of PMS design characteristics within a rather generic organizational context. In using data from manufacturing and trading companies in various industries, as well as service companies with different focus areas, we had to measure dependent variables with rather general items that are equally applicable to different logistics contexts. To understand PMS in more detail, future research should also investigate the importance of PMS design in more specific logistics contexts, for example, its role for distribution service performance in a specific industry or a specific type of logistics organization. In so doing, it will be important for researchers to view context-related performance items, ideally operational data, to better understand the exact relationships. Furthermore, case study research may be particularly relevant in this context to provide empirical evidence in addition to large-scale analysis.

Second, in explaining how managers can transform PMS excellence to create value, we focused the present research on customer-orientation and cross-functional integration as two pivotal capabilities that address ongoing challenges in logistics operations. Given that “the RBV requires further elaboration to explain the link between the management of resources and the creation of value” (Sirmon et al., 2007, p. 273), future research could examine other relevant capabilities. For example, given the challenge of increasing volatility and supply chain disruptions, understanding the potential contribution of PMS to supply chain risk management and organizational resilience would benefit academics and practitioners alike.

Third, we have focused our RBV perspective on the impact of PMS excellence as a valuable resource in logistics organizations without investigating the antecedents of PMS excellence. It would be interesting, therefore, to understand the specific enablers and barriers to PMS excellence based on first findings by Keebler and Plank (2009) and to better understand the factors that influence PMS value for an organization, where Tung et al. (2011) have provided first interesting insights.

3 Using performance measurement systems in logistics organizations in the era of turbulence³

³ This chapter is based upon the eponymous unpublished manuscript co-authored with Carl Marcus Wallenburg and Andreas Wieland.

3.1 Introduction

During recent years, an increasing level of turbulence has fundamentally challenged the assumption of stability in traditional supply chain management practice (Christopher and Holweg, 2011; Malik et al., 2011) and, in the aftermath of the economic and financial crisis since 2008, demand and supply market turbulence has increasingly been accepted to be a major source of supply chain risk (Blome and Schoenherr, 2011; Braunscheidel and Suresh, 2009). Indeed, in seeking new approaches to cope with market turbulence and disruptions of material flow, risk management has become a major field of supply chain management research (Sodhi et al., 2012). Consistent with the definition of supply chain risk management (SCRM) as “the implementation of strategies to manage both everyday and exceptional risks along the supply chain based on continuous risk assessment with the objective of reducing vulnerability and ensuring continuity” (Wieland and Wallenburg, 2012), most authors have focused on risk identification, risk assessment, as well as mitigation and contingency strategies to control risk (e.g. Ponomarov and Holcomb, 2009; Sodhi et al., 2012).

Yet, despite a broad consensus that the risk management process—besides identifying, assessing, and implementing strategies to control risk—also requires a constant monitoring of risk to sense new important factors and update the initial assessment (Hallikas et al., 2004), this vital part of a comprehensive SCRM process has not received the same level of attention. In supply chain management practice, however, the objective of ensuring high and consistent levels of distribution service performance (Ellinger et al., 2000) in a turbulent market environment will largely depend on such a constant monitoring to prevent the occurrence of an event or to enable fast reactions. Correspondingly, Christopher and Holweg (2011) have proposed that higher levels of turbulence “will require revisiting the management accounting procedures that are used to evaluate different supply chain decisions” (p. 64). To make the monitoring of market turbulence an integral part of existing management control processes, it is of pivotal importance to account for corresponding metrics in designing an organization's performance measurement system (PMS) (Rasid et al., 2012; Ritchie and Brindley, 2007). However, recent empirical research shows that by far not all logistics organizations actually have adapted PMS design to the changing supply chain environment (Weber et al., 2012).

In this context, the primary objective of our research is to demonstrate (1) *that* adapting PMS design to market turbulence is vitally important and (2) *why* it is important for achieving higher levels of distribution service performance. It has been argued that the resource-based view (RBV) suggests that supply chain management has the characteristics to be a source of temporary or even sustained competitive advantage for a firm (Barney, 2012; Lavie, 2006).

Following this view, we argue that the integration of supply chain risk metrics in an organization's PMS helps to build organizational resilience—the ability to adjust and maintain functions under challenging conditions (Ponomarov and Holcomb, 2009)—and thus enhances distribution service performance.

Building on Henri's (2006a) concept of upper management control impact on PMS design, our secondary objective is to demonstrate that PMS design for turbulence is contingent upon an organization's upper management focus of PMS use. Here, an (interactive) attention-focusing use and a (diagnostic) score-keeping use represent two distinct types of PMS use that are characterized by different managerial mindsets (Simon et al., 1954; Vandenbosch, 1999). While an attention-focusing PMS use seeks to increase organizational awareness of critical success factors and uncertainties (Henri, 2006a), a score-keeping use focuses on comparing outcomes to expectations (Vandenbosch, 1999). Therefore, organizations where the upper management strongly uses PMS for attention-focusing will design their PMS in a way that allows identifying new risk developments (i.e. the monitoring of market turbulence). In contrast, organizations where the upper management focuses on a score-keeping use of PMS will tend to discourage forward looking activities like the monitoring of market turbulence.

To meet the outlined objectives, the rest of this article is organized as follows: First, we provide a brief overview on the current state of SCRM research and present the concepts covered in our study. After outlining the theoretical framework of the research model and its underlying hypotheses, we describe the results derived from our study of 431 logistics organizations. Finally, theoretical and managerial implications of the findings are discussed and avenues of future research are proposed.

3.2 Conceptual framework and hypotheses

Corresponding to the proclamation of the “era of turbulence” (Christopher and Holweg, 2011) and to the statement that “modern supply chains seem to be more vulnerable than ever” (Wagner and Bode, 2006, p. 307), many researchers have expressed a broad consensus that new approaches are required in supply chain management to cope with increasing levels of market turbulence (e.g. Jüttner et al., 2003; Sheffi and Rice, 2005; Tang, 2006). Meanwhile, SCRM, as a “hot topic” with considerable attention from academia has been widely discussed both in supply chain management research and in managerial practice (Kouvelis et al., 2006; Malik et al., 2011; Sodhi et al., 2012). Besides ample conceptual work on new approaches to supply chain strategies and design (e.g. Jüttner, 2005; Manuj and Mentzer, 2008; Ponomarov

and Holcomb, 2009), the positive effects of SCRM on supply chain resilience and ultimately supply chain performance have also been empirically shown (e.g. Wagner and Bode, 2008; Wieland and Wallenburg, 2012).

3.2.1 An organizational perspective on SCRM

As part of a comprehensive SCRM approach, monitoring market turbulence on an organizational level involves “the imperative to devise and develop appropriate performance measures and metrics to evaluate, educate and direct the operational and strategic decisions” (Ritchie and Brindley, 2007, p. 304). Before outlining the hypotheses of our conceptual model, we will give a brief overview of the primary constructs of this study.

PMS design for turbulence refers to the degree to which an organization’s PMS accounts for risk metrics to monitor the potential impact of market turbulence. Such metrics, in seeking to reveal the increasing risks in the supply chain context and the need for new responses to manage these risks, will help front-line managers to make decisions with the right information at the right time (Gunasekaran and Kobu, 2007).

Organizational resilience is the ability of an organization to cope with turbulence. Following Ponomarov and Holcomb (2009, p. 128) in summarizing works of Weick et al. (1999), Bunderson and Sutcliffe (2002), and Edmondson (1999), it can also be defined as “the capacity to adjust and maintain desirable functions under challenging or straining conditions”. While recent research has mainly focused on the concept of supply chain resilience from a cross-company perspective (e.g. Christopher and Holweg, 2011), this study focuses on the resilience of individual logistics organizations, i.e. both internal logistics departments of manufacturing and trading companies and logistics service providers.

Distribution service performance refers to the overall fulfillment of customer expectations in logistics operations (Ellinger et al., 2000; Springinkle and Wallenburg, 2012). Within the cost-to-service tradeoff in logistics (Stank et al., 2001), it focuses on the quality of service that is key to creating customer satisfaction (Mentzer et al., 2012; Rhea and Shrock, 1987). This research looks at distribution service performance as the key outcome of a logistics organization that affects the performance of other supply chain members, and ultimately overall supply chain performance (Cooper et al., 1997; Mentzer et al., 2001).

3.2.2 Upper management's role in PMS design for turbulence

In his seminal work, Henri (2006a) outlined that upper manager's—i.e. executive managers, not lower level operational managers (Carpenter et al., 2004)—usage focus of PMS represents a contingent factor for PMS design as well as the selection of performance metrics. In this domain, the accounting-related literature has provided various classifications of managerial PMS use, including differentiations between score carding, problem solving, and attention directing (Simon et al., 1954), between an instrumental, conceptual and symbolic use (Menon and Varadarajan, 1992) as well as a diagnostic and interactive use (Simons, 1990). Vandenbosch (1999), in extending Simon et al.'s (1954) framework, differentiated between a score keeping, problem solving, attention focusing, and legitimizing use of PMS.

Building on these different classifications from an SCRM perspective, the two distinct types of PMS usage focus which represent the opposing ends on a continuum between using PMS for either empowering or controlling an organization are an (interactive) attention-focusing and a (diagnostic) score-keeping use (Henri, 2006a; Vandenbosch, 1999). In that sense, these two types are the two most polar forms of PMS use and—as we will argue in the hypotheses of our conceptual model—constitute contingent factors for the use of supply chain risk metrics in an organization.

Attention-focusing refers to an interactive PMS use that fosters organizational dialogue (Simons, 1990), where the guiding question is “What problems should we look into?” (Henri, 2006a; Simon et al., 1954). For upper managers preferring an attention-focusing use of performance metrics, PMS will serve as “ammunition machine” (Burchell et al., 1980, p.15) to proactively direct employees' attention on critical success factors and uncertainties (Henri, 2006a). Within the classification provided by Menon and Varadarajan (1992), it represents a conceptual use that fosters the awareness and understanding of specific situations (Schäffer and Steiners, 2003).

Score-keeping, in contrast, represents a diagnostic PMS use (Simons, 1990) for reporting and surveillance (Feldman and March, 1981), where the guiding question is “How am I doing?” (Simon et al., 1954). It focuses on a reactive cybernetic logic that compares operating results to prior expectations and provides feedback for potential future corrections (Hofstede, 1978). Hence, for upper managers focusing on a score-keeping use of PMS, performance metrics will serve as a routine control measure to follow-up with predefined goals (Henri, 2006a; Vandenbosch, 1999).

3.2.3 Development of hypotheses

Figure 3-1 presents the conceptual model of this research. To investigate SCRM in logistics organizations, we build on two theoretical domains. The outcome part of the model reflects the causal relationships to be proposed between PMS design for turbulence, resilience as an organizational capability, and enhanced levels of distribution service performance. Following Calantone et al. (2003) and Trkman and McCormack (2009) in that an organization’s ability to sense and adapt to changes in its environment represents a sustainable competitive advantage, we use a resource-based perspective to argue that logistics organizations using appropriate metrics for risk monitoring will be more resilient and in a better position to cope with market turbulence which is the basis to enhance their overall distribution service performance.

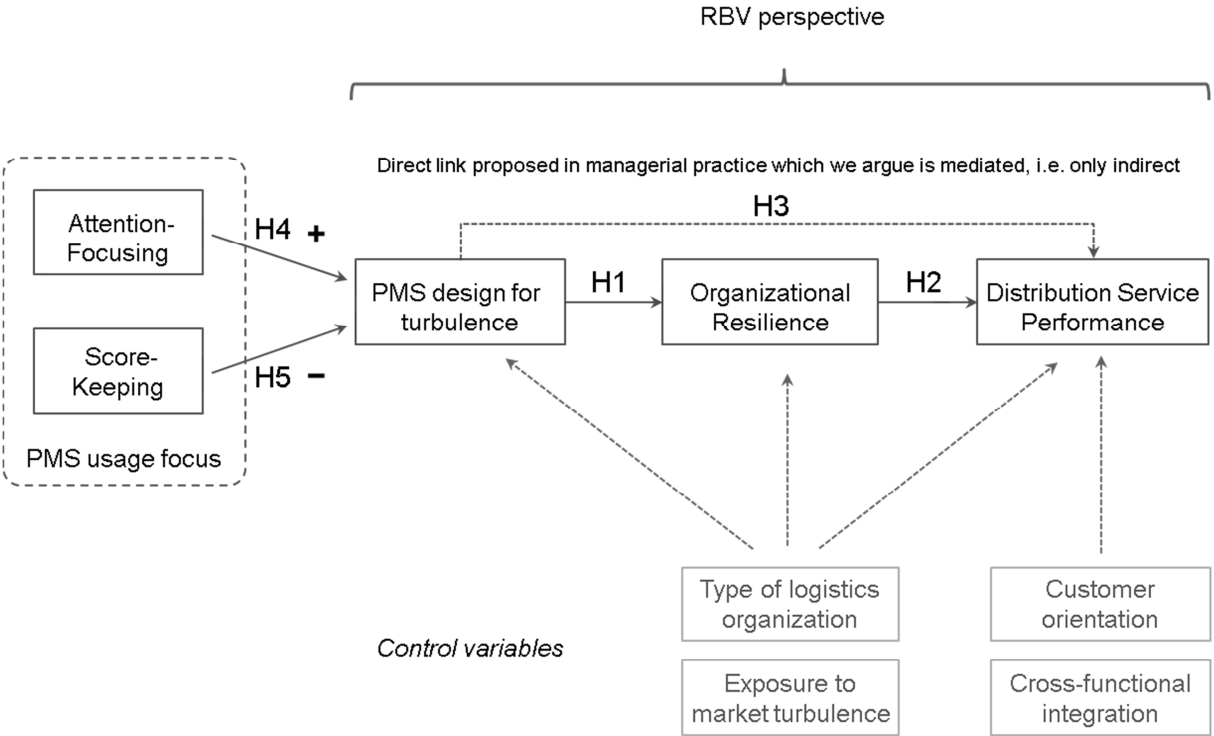


Figure 3-1: Conceptual research model

In the antecedent part of the model, we investigate how the focus of upper management’s PMS usage either acts as a driver or as an impediment of PMS design for turbulence. Building on Henri’s (2006a) concept of upper management control impact on PMS design, we argue that an upper management seeking to use PMS primarily for attention-focusing will be more inclined to draw upon supply chain risk metrics than an upper management primarily pursuing a score-keeping use.

Outcome: Linking PMS design for turbulence, organizational resilience, and performance

In seeking ways to manage higher levels of market turbulence, logistics organizations need to monitor supply chain risks through appropriate performance metrics (Rasid et al., 2012). Such forward-looking risk metrics, in providing an organization with early warning signals, represent an intangible resource which—though being among the strategically most important resources (Itami, 1987)—are often disregarded in management information systems (Grant, 1991). Following Amit and Schoemaker's (1993) extension of the RBV where organizational capabilities forge the link between valuable resources and competitive advantage, we argue that organizational resilience as the ability of an organization to cope with challenging conditions translates the value of PMS design for turbulence into enhanced distribution service performance.

In order to manage supply chain risk in daily operations, front-line logistics managers—in following up with the initial identification and assessment of risk sources—need to constantly keep track of potential impacts. Though it remains a challenge to assess the probability of supply chain risks and their impact (Wagner and Bode, 2008), PMS design for turbulence will be an important foundation for such a constant monitoring of risk. Risk metrics will inform operational decision-makers as well as workers about the current state of identified risk sources and thus sharpen organizational awareness. Regarding the coordination of SCRM across departments, front-line managers from different departments will better collaborate when sharing one overall risk monitoring process, similarly to other processes of internal relational behavior (Wong et al., 2012). This way, PMS design for turbulence will allow an organization to either anticipate and prevent the occurrence of future change (proactive lever) or to make current change visible and enable fast reactions (reactive lever). These two levers are the components of resilience (Wieland and Wallenburg, 2012). Looking at the proactive lever, the monitoring of risk will increase resilience by helping an organization to prepare for an external risk, to assess its impact and probability, and to take timely precautions without increasing the level of control perceived among employees that might decrease organizational flexibility (Ignatiadis and Nandhakumar, 2006). In case of an unexpected supply chain event, the reactive risk monitoring lever consists in a quick detection that allows for speedy corrective actions to recover and stabilize operations (Sheffi and Rice, 2005; Wieland and Wallenburg, 2012) and, in that way, increases resilience. Overall, supply chain risk metrics will put a logistics organization in a position to cope with market turbulence and thus minimize their vulnerability.

We therefore argue that PMS design for turbulence, by providing a constant monitoring of external risk and facilitating SCRM coordination across departments enhances an organization's resilience in coping with market turbulence. Based on this reasoning, we hypothesize:

H1: PMS design for turbulence has a positive impact on organizational resilience.

Grant (1991), in line with Amit and Schoemaker (1993), proposed that “while resources are the source of an organization's capabilities, capabilities are the main source of its competitive advantage” (p. 119). In leveraging the monitoring of turbulence, organizational resilience represents such a capability. A number of conceptual contributions have highlighted the importance of organizational resilience as a distinct source of competitive advantage (Coutu, 2002; Hamel and Välikangas, 2003; Sheffi and Rice, 2005). McCann et al. (2009) provided first empirical insights into the importance of resilience for competitiveness and profitability in turbulent environments, albeit not focusing on the supply chain context. In line with Weick et al.'s (1999) statement that “resilience is not only about bouncing back from errors, it is also about coping with surprises in the moment” (p. 46), Wieland and Wallenburg (2012) have empirically confirmed the importance of both the proactive and reactive dimensions of resilience from an overall supply chain perspective. Given these findings, we argue that organizations that are prepared to cope with market turbulence will be in a better position to fulfill customer expectations regarding consistently high levels of distribution service performance by mitigating potential negative consequences of turbulence outlined in prior SCRM research (e.g. Wagner and Bode, 2008). First and foremost, keeping processes stable or recovering quickly while adapting processes to changed circumstances will be a critical factor for continued delivery reliability. Moreover, in an unstable environment, a resilient organization will better perform in responding to short-term customer requests. For example, it will be prepared to adapt its own delivery quantities to shortages caused by the bullwhip effect or upstream capacity constraints (Lee and Billington, 1993; Sheffi and Rice, 2005) while taking quick action to resolve these shortages. In summary, and adding to the findings outlined above, we propose:

H2: Organizational resilience has a positive impact on distribution service performance.

Supply chain risk management has gained significant levels of attention as a “hot topic” in managerial practice, but actual SCRM processes are still in their infancy and often too simple to actually mitigate risk (e.g. Jüttner, 2005). Although it seems obvious that managing market turbulence goes beyond measuring it, Sheffi and Rice (2005) have stated that many

logistics organizations “use formal processes to gather risk metrics for presentations to their boards of directors” which “can go only a limited way toward reducing vulnerability” (p. 48). Following this line of thought, we argue that the mere use of risk metrics to monitor market turbulence does not deliver performance improvements by itself. As previously outlined, PMS design for turbulence will help an organization to follow up with the initial identification and assessment of risk sources and to keep track of potential effects ahead of their occurrence. However, leveraging risk monitoring information for increased levels of distribution service performance forms part of an organizational learning process. Manuj and Mentzer (2008) emphasize the role of organizational learning in SCRM in “promoting an ongoing stream of dialogue and inquiry, analyzing mistakes, seeking feedback, communicating, and questioning” (p. 148). Thus, with a learning orientation as an organizational antecedent to SCRM (Braunscheidel and Suresh, 2009), making use of supply chain risk metrics for superior performance comes through the increasing ability to cope with turbulence (i.e. organizational resilience). Similarly, Ponomarov and Holcomb (2009) suggest that readiness, efficient response, and recovery constitute the core elements of supply chain resilience as a learning process towards sustainable competitive advantage.

Building on this reasoning, we argue that an enhanced competitive position in terms of higher levels of distribution service performance can only be achieved by continuously translating the monitoring of supply chain risk into an organization’s resilience in terms of precautions or fast reactions. Therefore, we propose:

H3: The positive impact of PMS design for turbulence on distribution service performance is mediated by organizational resilience.

Linking the focus of PMS use and PMS design for turbulence

Henri (2006a), in conceptualizing the impact of upper management’s control focus on PMS design and the diversity of performance metrics, found that upper managers—depending on their primary type of PMS use—will not need the same variety of financial and non-financial measures to support their objectives. In using PMS for attention-focusing, upper managers seek to foster organizational dialogue and the awareness of critical issues. Hence, the mindset of upper-level managers who prefer an attention-focusing use is targeted towards empowering rather than controlling their organization (Vandenbosch, 1999). By selecting performance measures that—besides tracking progress towards predefined goals—can send signals throughout the organization, they will generally give an important role to non-financial measures that are more actionable than financial measures (Ittner and Larcker,

1998), including leading measures that aim at predicting what will happen (Evans, 2004). Henri (2006a) found that a key objective of an attention-focusing PMS use is to direct employees' attention on critical uncertainties and that it strongly supports the use of such non-financial measures. Vandebosch's (1999) results underline upper-level managers' awareness that PMS information can affect what their organization focuses on. In the context of higher levels of market turbulence, upper-level managers with an attention-focusing mindset will take a broader view and will be more inclined to recognize the role of supply chain risks and the importance of risk metrics as part of a comprehensive SCRM process. Besides fostering the initial identification and assessment of supply chain risk, they will seek to ensure a constant risk monitoring process. Thus, in designing the PMS of their organization, they will proactively foster the integration of supply chain risk metrics. Therefore, we propose:

H4: The degree to which upper management uses PMS for attention-focusing has a positive influence on PMS design for turbulence.

A score-keeping use of PMS focuses on comparing results with predefined expectations in order to fulfill managers' and stakeholders' information requirements (Atkinson et al., 1997). In evaluating different types of PMS use, Vandebosch (1999) found a score-keeping use to be negatively related to organizational competitiveness, albeit recognizing its *raison d'être* in the simplicity of being "one of the easiest management information and control systems to develop" (p. 88). Hofstede (1978) states that "standards are often set by higher line management, intervening is the task of lower line management, while the actual process to be controlled is carried out by operating personnel" (p. 452). Hence, the mindset of upper-level managers who prefer a score-keeping use is targeted towards controlling rather than empowering their organization. In seeking to establish a standardized reporting routine with a cybernetic control of results, their PMS will be dominated by lagging (outcome) measures at the expense of leading (predictive) measures (Evans, 2004). Moreover, given upper-level managers' preference for performance measures that are simple and easy to use (Gunasekaran and Kobu, 2007), such a focus on outcomes usually results in a clear dominance of financial measures and a negligence of non-financial measures (Henri, 2006a). Consequently, it can be assumed that upper-level managers with a score-keeping mindset—even when made aware of the importance of SCRM in a supply chain context with increasing levels of market turbulence—will not be inclined to foster PMS design for turbulence. As part of their reporting to stakeholders, they may provide an initial identification and assessment of supply chain risk, or even define risk mitigation and contingency strategies upfront to control risk. They will,

however, be less inclined to recognize front-line managers' need for a constant proactive monitoring of risk through the integration of supply chain risk measures in their organization's PMS.

Thus, even in a supply chain context that is characterized by an increasing level of market turbulence, an upper management preference for a score-keeping PMS use will be an impediment to the design of PMS for supply chain risk. If used at all, risk metrics will play a subordinate role. Therefore, we propose:

H5: The degree to which upper management uses PMS for score-keeping has a negative influence on PMS design for turbulence.

3.3 Methodology

3.3.1 Sample design and characteristics

As basis for hypotheses testing, an online survey was conducted to collect primary data from logistics organizations of manufacturing and trading companies as well as logistics service providers in Germany. Following Phillips (1981) in that informants are most reliable when they participate in relevant decision-making processes, our target informants had to be knowledgeable with their organization's logistics PMS, the process of supply chain risk management, and their organization's distribution service performance. In line with our research objective, 4,011 potential respondents were gathered from three databases of managers involved in logistics and supply chain management. They received an email that announced the survey and asked experts involved in the PMS domain of their respective logistics organization for registration via an online form, thus yielding an initial sample of 1,063 registered candidates. Only they received a link to the online survey. To ensure a common understanding, it was pointed out that a performance measurement system (PMS) refers to any structured set of performance measures used to quantify the efficiency and effectiveness of operations in the respondents' respective logistics organization, not necessarily a technologically sophisticated management information system. Given the single informant approach of the study, anonymity was assured to participants and items of independent and dependent variables were separated through survey questions that were unrelated to our model to minimize the potential for common method bias (Podsakoff et al., 2003).

The survey was active between July and September 2011 and three reminder emails were used to improve the response rate. After eliminating nine data sets because of missing

data, a set of 431 responses was used for our analysis, which corresponds to a very good response rate of 40,5% (Wagner and Kemmerling, 2010). Within these data sets, a remainder of less than 1% missing item values was estimated using the expectation maximization algorithm (Dempster et al., 1977). A demographic summary of the companies and respondents is shown in Table 3-1.

Industry	Percent	Job title of respondents	Percent
Automotive	12%	Top level executive / director	55%
Machinery and equipment	11%	Senior manager	27%
High-tech and electronics	5%	Manager	12%
Chemicals and pharmaceuticals	7%	Non-executive	6%
Consumer goods	11%	Number of logistics employees	
Logistics services	42%	Less than 100	51%
Other industries	12%	100 to 999	34%
		1,000 or more	15%

Table 3-1: Respondent demographics

Besides focusing the initial sample on logistics and supply chain managers, respondent positions were analyzed to assess the validity of our data (Phillips, 1981). With an average tenure of more than 14 years and 82% of participants in senior positions, the answers reflect a high level of competency in our field of research.

Due to our single-informant approach, common method bias may be a problem (Podsakoff et al., 2003) and was assessed using Harman's single-factor test of common method bias (Harman, 1967; Paulraj et al., 2012). An unrotated factor analysis of all measurement items reveals 4 factors with Eigenvalues above 1 that explain 68.2% in total variance, where the first factor accounts for 33.0% of variance. As the test assumes that, if common method bias is present, either (a) a single factor will emerge from the factor analysis or (b) one factor will account for the majority of the covariance among the measures (Podsakoff et al., 2003), common method bias does not appear to be a problem.

To test for late-response bias, the means of all items were compared between the first and last third of responses via *t*-test analysis (Armstrong and Overton, 1977). Results showed no significant differences ($p < 0.05$) for any of the items and therefore no indication for a late-response bias. Moreover, in following Lambert and Harrington (1990) and Mentzer and Flint (1997), a test for non-response bias was conducted. 30 non-respondents were convinced to complete an abbreviated version of the survey online, including eight item questions related to

the constructs of our model. Again, an independent sample *t*-test that compared answers between the full respondent version and the short non-respondent version showed no significant differences ($p < 0.05$). Therefore, it can be assumed that non-response bias does not influence the results of this research.

3.3.2 Measurement scales

All construct measures used for the survey relied upon multi-item Likert-type scales (see Appendix 3-1 for all measurement scales and items). A review of the existing logistics, supply chain management, and accounting literature provided items for the measurement scales. As the survey was sent to German logistics and supply chain managers, it was first developed in English, then translated into German, and finally back-translated into English to ensure validity as recommended by Brislin (1976). Items were discussed with a group of ten academics and logistics practitioners during development of the survey to validate readability. As a result of the discussion, a few items were adapted to better fit our research context. Three further practitioners were involved for specific questions and final validation of the survey.

Both PMS use for attention-focusing and PMS use for score-keeping were measured with the scales of Vandebosch (1999). For attention-focusing, one item (“vocabulary in the organization”) was deemed confusing and therefore omitted. Instead, an item of Henri’s (2006a) scale (AF4) was added to ensure scale validity and comprehensiveness.

Given the lack of empirical research on the monitoring of market turbulence in the supply chain context, no suitable instrument to measure PMS design for turbulence could be identified. Therefore, items were generated based on a review of extant SCRM and PMS literature (Christopher and Holweg, 2011; Ritchie and Brindley, 2007; Trkman and McCormack, 2009) and discussed with the group of ten researchers and practitioners involved in the development of the survey. First, statements were formulated to reflect a PMS that accounts for the monitoring of market turbulence in the supply chain environment. Next, a discussion of the statements ensured that the items were applicable to the context of any logistics organization. Small adaptations were made during the translation process to enhance understandability for the target group of German-speaking logistics managers.

To measure organizational resilience, statements from conceptual SCRM research (Ponomarov and Holcomb, 2009; Tang, 2006; Weick et al., 1999) were used to define items. Unlike broader conceptual SCRM research, these statements specifically referred to the concept of resilience. After adapting the items to fit the context of our research, they were subsequently discussed and further refined.

Distribution service performance was measured using the established scale of Ellinger et al. (2000) where one item (“notifying customers in advance”) was replaced with an item from the scale’s adaptation by Stank et al. (2001) (DSP5) to better reflect the overall fulfillment of customer expectations in logistics operations.

Cronbach’s alpha was used to assess the reliability of the measurement scales and surpassed the lower bound of 0.7 (Nunally, 1978) for all constructs. Moreover, all composite reliabilities (CR) were 0.83 or higher and all average variances extracted (AVE) were 0.55 or higher. With that, the values well exceeded the recommended 0.7 (Bagozzi and Yi, 1988) and 0.5 (Fornell and Larcker, 1981), respectively. The assumed construct dimensionality and convergent validity was supported by an exploratory factor analysis (EFA) as shown in the Appendix 3-2 and a subsequent confirmatory factor analysis (CFA) which indicates good model fit ($\chi^2/df = 1.76$; CFI = 0.98; TLI = 0.97; RMSEA = 0.042) (Garver and Mentzer, 1999). Further, a high significance of loadings for the scales measurement items is confirmed by a lowest standardized regression path of 0.65 (AF4) and a lowest *t*-value of 13.63 (DSP2) (Gerbing and Anderson, 1988; Koufteros, 1999) as shown in Appendix 3-1.

To test discriminant validity between the constructs, a series of chi-square tests was conducted for one pair of constructs at a time by constraining the estimated correlation to 1.0 (Anderson and Gerbing, 1988; Garver and Mentzer, 1999). Significantly lower χ^2 values for the unconstrained models confirm discriminant validity for each pair of constructs ($p < 0.05$).

3.3.3 Controls

A logistics organization’s actual exposure to market turbulence may influence the proposed relationships. To capture such a potential influence, we controlled for the exposure to market turbulence. We operationalized this control variable along three items based on the SCRM literature (Braunscheidel and Suresh, 2009; Trkman and McCormack, 2009) (see Appendix 3-3). Also, as the sample included both internal logistics departments of manufacturing and trading companies (58%) and logistics service providers (42%), we included a binary control variable for the type of logistics organization to capture any influences that the different organizational setups may have on the proposed relationships. Further, customer orientation and cross-functional integration were added as control variables to prevent any omitted variable bias.⁴

⁴ A detailed investigation of customer orientation and cross-functional integration is provided in chapter 2.

3.4 Results

To test the hypotheses, the structural model (including the controls) was calculated using AMOS. As shown in Figure 3-2, the results indicate adequate fit ($\chi^2/df = 2.49$; CFI = 0.91; TLI = 0.90; RMSEA = 0.059) (e.g., Homburg and Baumgartner, 1995). In the right part of the model, the hypothesized positive impact of PMS design for turbulence on organizational resilience (H1) receives clear support with a standardized path coefficient of +0.30 and high significance ($p < 0.001$). Moreover, organizational resilience shows a strong positive and highly significant (+0.27; $p < 0.001$) effect on distribution service performance, also supporting hypothesis 2.

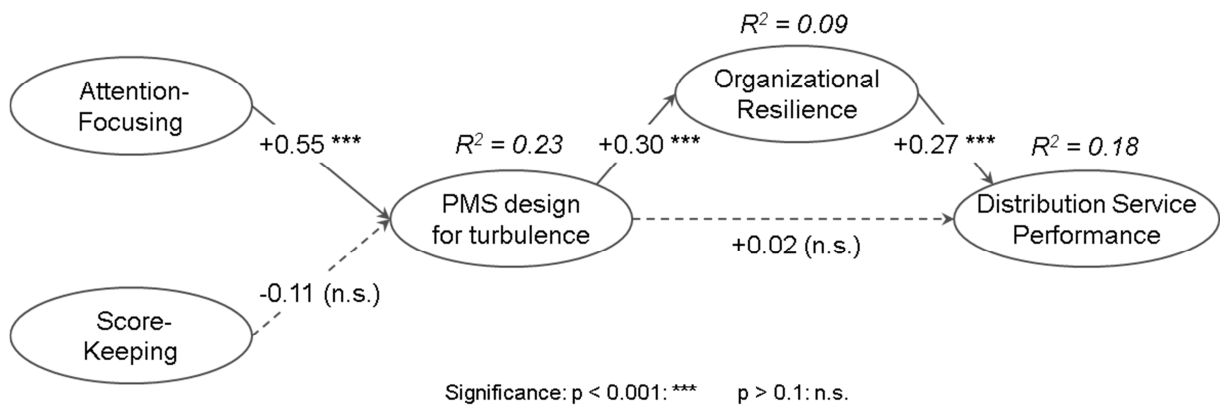


Figure 3-2: Results of structural equation model

As the direct path from PMS design for turbulence to distribution service performance has a very low and non-significant standardized coefficient (+0.02; $p > 0.50$), hypothesis 3—in proposing that the positive effect of PMS design for turbulence on distribution service performance is mediated by organizational resilience—receives support as well. Full mediation was demonstrated following the test proposed by Bagozzi and Dholakia (2006). The model with a direct path from PMS design for turbulence to distribution service performance was compared to a model without the direct path. The difference in chi-square values between the two models serves as a test for the significance of the added path. This difference is 0.43, with one degree of freedom, which is not significant ($p > 0.50$). Hence, the direct path is insignificant and the 18% of variance in distribution service performance explained by the model are fully mediated by organizational resilience.

Regarding the effect of upper management's PMS usage focus on PMS design for turbulence examined in the left part of the model, the positive hypothesized impact of attention-

focusing (H4) is strongly confirmed with a high standardized coefficient and significance (+0.55; $p < 0.001$). The hypothesized negative impact of a score-keeping use on PMS design for turbulence (H5) finds only very weak support (-0.11; $p = 0.26$). An overview of hypothesis test results, including coefficients and p -values for the model with and without controls, can be found in Appendix 3-5.

3.5 Discussion and implications

3.5.1 Theoretical implications

Looking at the established conceptual framework of SCRM as a process of identifying, assessing, controlling, and monitoring supply chain risk (Hallikas et al., 2004; Norrman and Jansson, 2004; Wieland and Wallenburg, 2012), prior research focused primarily on the initial identification and assessment of risk as well as on mitigation and contingency strategies to control risk. In arguing that a constant monitoring of supply chain risk to sense new developments is of pivotal importance in SCRM, the aim of this research was to show the value of supply chain risk metrics in an organization's PMS and to outline the mechanism underlying their impact on distribution service performance. These metrics were focused on market turbulence which, in recent years, turned out to be a major source of supply chain risk. Besides adding to the existing research that, for the most part, looks at SCRM as an isolated organizational process, one of the study's contributions lies in bringing together SCRM and an established element of management control, namely PMS. As Christopher and Holweg (2011), in light of higher levels of market turbulence, have proposed to revisit management accounting procedures from a supply chain management perspective, PMS design for turbulence underlines the value of integrating the monitoring of market turbulence into PMS as an established system of management control. In investigating this value, we related PMS design for turbulence to organizational resilience as a key capability and confirmed the positive impact on distribution service performance as a key customer-related outcome in logistics operations. The actual exposure to market turbulence which we used as a control variable does neither significantly impact PMS design for turbulence or organizational resilience, nor the proposed relationships. Even in a moderation analysis that divides the sample into two sub-samples of logistics organizations with a high and low exposure to market turbulence, the proposed relationships between PMS design for turbulence, organizational resilience, and distribution service performance remain significant for both groups. This

finding shows that even logistics organizations with a relatively low exposure, in the era of turbulence, are still sufficiently affected to benefit from the confirmed relationships and the positive impact on distribution service performance. Similarly, a moderation analysis between the two basic types of logistics organizations in our sample—shippers' internal logistics departments on the one hand ($n = 251$) and logistics service providers ($n = 180$) on the other hand—shows no significant path differences in a chi-square test ($p < 0.05$), thus confirming the robustness of results and their generalizability to different organizational contexts in logistics operations.

In line with the RBV perspective taken in this research where organizational capabilities forge the link between valuable resources and competitive advantage (Amit and Schoemaker, 1993), the impact of PMS design for turbulence as an intangible resource is fully mediated by organizational resilience which substantially explains distribution service performance ($R^2 = 18\%$). Here, having no evidence for a direct performance impact of PMS design for turbulence is an important finding as it shows that risk monitoring by itself cannot unfold its benefits unless translated into organizational resilience. Our results show that companies must take an effort in leveraging the information provided by supply chain risk metrics to prepare for market turbulence by building organizational resilience.

In seeking to understand why, in current logistics practice, some organizations make use of supply chain risk metrics while others do not (Weber et al., 2012), we built on Henri's (2006a) concept of upper management control impact on PMS design. The results shed light on upper management's role in driving or impeding PMS design for turbulence. Our findings—where an attention-focusing PMS use explains a substantial share of PMS design for turbulence—confirm that upper-level managers better realize the need for supply chain risk metrics when using PMS for attention-focusing rather than for score-keeping. These findings, while validating the expected effect of an attention-focusing PMS use in the SCRM context, are in line with the strong positive implications on organizational competitiveness found by Vandebosch (1999) and on the diversity of performance measures found by Henri (2006a).

In contrast, we could not find sufficient proof for our hypothesis that a score-keeping PMS use, in representing a mindset that primarily seeks to control an organization, negatively influences PMS design for turbulence. The proposed negative effect turns out to be insignificant. Still, the difference between the impact of an attention-focusing PMS use and a score-keeping use is highly significant. Moreover, as our data confirm prior findings that the different types of PMS use are not mutually exclusive but co-exist in managerial practice

(Ansari and Euske, 1987), PMS design for turbulence will mainly depend on the positive impact of upper management PMS use for attention-focusing.

3.5.2 Managerial implications

The results of our study offer several insightful implications for logistics managers. Given the need to manage supply chains in the context of higher levels of market turbulence, we provide clear support that the integration of supply chain risk metrics in the PMS of an organization can be a source of competitive advantage. Even for organizations with a relatively low exposure to market turbulence, the proposed relationships of our RBV perspective (resource → capability → performance) are confirmed. Accordingly, logistics managers need to be aware that—even if they consider their organization to be less affected by market turbulence than others—PMS design for turbulence can still be an enabler of distribution service performance. However, the results confirm that risk monitoring through an organization's PMS promises higher levels of performance only if logistics organizations manage to translate their risk awareness into resilient operations. Moreover, we have demonstrated that upper-level managers' mindset plays an essential role in accounting for turbulence in PMS design to support front-line managers and employees in daily operations. Hence, upper-level managers can draw conclusions in two principal fields.

First, they need to critically review the readiness of their PMS for the monitoring of market turbulence. If supply chain risk metrics are not being used in their organization, they may want to reconsider PMS design, including their own role in selecting and prioritizing the mix of measures. As a possible explanation for the lack of supply chain risk metrics consists in a strong focus on score-keeping, accounting for new supply chain management requirements in PMS design requires a broader perspective of the risks associated with higher levels of market turbulence. Although upper management's mindset and hence the focus of control in an organization will not change overnight, moving towards an attention-focusing PMS use will gradually prepare an organization for supply chain risk. Here, it will be of pivotal importance to involve front-line managers and employees with a sound understanding of risk monitoring needs in daily operations. Only upper-level managers who, for the sake of simplicity, take a conscious decision to focus on a score-keeping PMS use (Vandenbosch, 1999) may continue to pass on the integration of supply chain risk metrics.

Second, as the mere use and reporting of risk metrics does not imply higher levels of performance by itself but through organizational resilience only, a learning process is required to truly leverage the benefits arising from risk monitoring. From a managerial perspective,

this is an important finding which, at first glance, contradicts the often cited phrase “what gets measured gets done” (e.g. Otley, 1999). At second glance, it confirms that SCRM cannot follow the cybernetic control logic often used for financial controlling where goals are set in advance and compared to actual results (Hofstede, 1978). As supply chain risk represents an external factor, it is mostly impossible or inappropriate to monitor results against predefined goals. Tracking the potential impact of market turbulence, for example, cannot follow a cybernetic logic. However, upper-level and front-line managers can jointly ensure that the information provided by supply chain risk metrics actually translates into the capability to better cope with supply chain risk.

3.6 Limitations and future research

Besides the discussed findings of this study, a few issues need to be pointed out that also offer promising avenues for further research.

First, data were solely collected in Germany which may limit the generalization of findings (Wagner and Bode, 2006). Second, in seeking to bring together SCRM with PMS as an established management control system, we had to measure PMS design for turbulence with rather general items to fit the different organizational contexts of participating companies and, due to its importance, we concentrated on market turbulence rather than other supply chain risk sources. Moreover, no “hard facts” were drawn upon to measure distribution service performance, though the high share of participating key informants provides reliable results. In further investigating the role of PMS for risk management, it would be interesting to explore more specific supply chain setups, including the identification of particular risk metrics being used in managerial practice. Here, we would strongly encourage case study research that would not only contribute to SCRM research, but at the same time allow “revisiting the management accounting procedures that are used to evaluate different supply chain decisions” as proposed by Christopher and Holweg (2011). A multiple case study of different companies involved in a supply chain may yield interesting insights into the relationship between PMS design for turbulence, organizational resilience, and overall supply chain resilience.

Moreover, in seeking to understand the drivers and impediments underlying PMS design for turbulence, our study focused on two opposing types of PMS use as a contingent variable for PMS design. Other organizational factors may also play an important role in this context. Besides investigating a broader scope of organizational culture for the role of

management control systems in SCRM, examining other determinants of PMS design such as strategic priorities (Henri, 2006a) would provide valuable contributions to the supply chain management and accounting literature.

4 The state of performance measurement systems in logistics practice: Patterns and outcomes⁵

⁵ This chapter is based upon the eponymous paper co-authored with Carl Marcus Wallenburg and presented at the *NOFOMA* conference 2013.

4.1 Introduction

In logistics and supply chain management (SCM) practice, increasing competitive pressures have made cost and service advantages a key part of many companies' corporate strategies (McGinnis and Kohn, 2002; Lai, 2004). To manage operations in line with these strategic objectives, decision-makers require adequate performance measurement systems (PMS) with financial and non-financial metrics to fulfill their information needs (Fawcett et al., 1997). As PMS has become an established element of managerial control in practice, various conceptual frameworks for advanced PMS design have emerged, also within the field of logistics (Gunasekaran and Kobu, 2007). Yet, little attempt has been made to empirically show how logistics organizations design their PMS and whether they actually follow the scholarly recommendations. Only Fawcett and Cooper (1998) and Keebler and Plank (2009) provided first insights into the state of logistics performance measurement in U.S. companies. And even though our study shows that logistics managers attribute a high importance to their organization's PMS, the assessment of Melnyk et al. (2004, p. 210) that “performance measurement continues to present a challenge to operations managers as well as researchers of operations management” is still true today.

The objective of our research is to comprehensively describe the current state of PMS in logistics practice—both in internal logistics departments of manufacturing and trading companies (shippers) and at logistics service providers (LSPs)—and to provide an understanding for the associated context factors and outcomes of advanced logistics performance measurement. To do so, we empirically identify typical design patterns along seven design dimensions. These dimensions that distinguish a more advanced from a less advanced PMS (e.g. timeliness of information) were extracted from the literature and serve as the basis for the clustering of logistics organizations.

In order to provide guidance for both logistics managers and researchers, we build on and substantially expand prior PMS research in several ways. First, we identify distinct sophistication levels of PMS that can be observed in practice. Second, we investigate the propositions of Fawcett and Cooper (1998) and Keebler and Plank (2009) that higher levels of PMS sophistication relate to a higher coverage of key performance measures. Third, this research is the first to address potential differences in logistics performance measurement practice between shippers, where logistics operations are embedded into a larger organizational context, and LSPs, which are "pure players" with logistics being their core competence (Lai, 2004). Fourth, given the growing degree of turbulence within supply chain and in their external environment (Blome and Schoenherr, 2011) and the broad consensus that “perfor-

mance measurement in the new supply era is still an open area of research” (Akyuz and Erkan, 2010, p. 5137), we investigate whether logistics organizations account for this development by enhanced PMS. Finally, Morgan (2004) points out that even company failure may result from the difference between a good PMS and a mediocre PMS. Therefore, this research investigates the link between PMS design and competition-related outcomes.

4.2 Research framework

4.2.1 Attributes of advanced PMS design

PMS, for more than two decades, have received considerable attention across disciplines. In seeking to provide guidance for the design of PMS which address the deficits that short-term, purely profit-driven performance measurement have (Bond, 1999; Hofstede, 1978), researchers’ contributions have ranged from broad conceptual frameworks for advanced PMS like the balanced scorecard (Kaplan and Norton, 1992) to context-specific frameworks in operations management and logistics (e.g. Neely and Adams, 2000; Griffis et al., 2007; Gunasekaran et al., 2004).

Empirical research on the actual state of PMS in logistics practice has, despite the large body of conceptual insights, mainly focused on examining the use of specific performance measures. Here, Fawcett and Cooper (1998) and Keebler and Plank (2009) provided valuable insights into the use of key measures. Yet, to fully grasp an PMS as an entity, it is also important to examine the underlying attributes of PMS design (Neely et al., 1995; Tangen, 2004), which further distinguish more from less advanced PMS in logistics organizations.

Within the large body of conceptual research in the accounting, operations, as well as logistics and SCM literature, different frameworks for advanced PMS design focus on different key aspects and different levels of detail. Yet, they share a number of underlying and recurring attributes suggested across disciplines, which we have identified through an extensive literature review. Four of the design attributes refer to content-related design of the PMS, we call this domain PMS scope, and three attributes refer to the user-oriented preparation and presentation of performance measurement information which we call PMS usability (see Table 4-1).

Regarding PMS scope, the prior literature widely outlines three attributes that advanced PMS should entail *measurement diversity*, *strategic-operational linkage*, and *external linkage*.

We complement these three attributes by a fourth of key importance for logistics organizations, *design for turbulence*.

PMS scope	Sources from cross-disciplinary literature review
<i>Measurement Diversity</i>	Amir et al. (2010); Brignall and Ballantine (1996); Chenhall (2005); Eccles (1991); Evans (2004); Henri (2006a); Ittner et al. (2003); Malina and Selto (2004); Malmi and Brown (2008); Neely et al. (1995); Rodrigues et al. (2004)
<i>Strategic-Operational Linkage</i>	Caplice and Sheffi (1995); Bourne et al., (2000); Chenhall (2005); Ferreira and Otley (2009); Ittner et al. (2003); Kaplan and Norton (1992); Otley (1999); Petersen et al. (2009); Pun and White (2005); Wisner and Fawcett (1991)
<i>External Linkage</i>	Akyuz and Erkan (2010); Chenhall (2005); Evans (2004); Gunasekaran and Kobu (2007); van Hoek (1998); Keebler and Plank (2009); Lai (2002); Malina and Selto (2004); Morgan (2004); Neely (2005); Simatupang and Sridharan (2004)
PMS usability	Sources from cross-disciplinary literature review
<i>Information Timeliness</i>	Amir et al. (2010); Fawcett et al. (1997); Ferreira and Otley (2009); Ghalayini et al. (1997); Griffis et al. (2004); Ittner et al. (2003); Neely et al. (1995); Selviaridis and Spring (2007)
<i>Information Aggregation</i>	Amigoni (1978); Bond (1999); Brignall and Ballantine (1996); Caplice and Sheffi (1994); Ferreira and Otley (2009); Ittner et al. (2003); Lee et al. (2002); Morgan (2004); Pun and White (2005)
<i>System Adaptability</i>	Brignall and Ballantine (1996); Ghalayini et al. (1997); Griffis et al. (2007); Kennerley and Neely (2003); Malina and Selto (2004); McGinnis and Kohn (2002); Morgan (2004); Neely (2005)

Table 4-1: Established attributes of advanced PMS design

Measurement diversity refers to the degree to which a PMS uses a broad set of complementary, financial and non-financial performance measures instead of few narrow-focused measures in order to keep managers from ignoring relevant aspects of performance (Malina and Selto, 2004; Ittner et al., 2003). *Strategic-operational linkage* refers to the degree to which a PMS links an organization's strategic goals with the organizational level through performance measures (Kaplan and Norton, 1992; Wisner and Fawcett, 1991). *External linkage* refers to the degree to which a PMS accounts for external elements (e.g. suppliers and customers) in the supply chain and their interrelation with the performance of the logistics organization (Gunasekaran and Kobu, 2007; Rodrigues et al., 2004). Without necessarily implying the integration of systems across organizations, it supports coordination within the supply chain (Akyuz and Erkan, 2010). Due to logistics' upstream and downstream interconnectedness within the supply chain, external linkage stands out as particularly relevant

attribute for logistics organizations (van Hoek, 1998). Moreover, as risks within the supply chain have become an increasing challenge in recent years, Christopher and Holweg (2011) posit that higher levels of turbulence and volatility “will require revisiting the management accounting procedures that are used to evaluate different supply chain decisions” (p. 64). Also, Ritchie and Brindley (2007) as well as Rasid et al. (2012) have proposed to account for the new challenges in performance measurement. Therefore, PMS *design for turbulence* has to be considered as a fourth attribute of advanced PMS in logistics organization. It captures the degree to which a PMS enables companies to understand and accounts for market turbulence by providing corresponding risk metrics.

PMS usability entails three attributes that characterize advanced PMS: *information timeliness*, *information aggregation*, and *system adaptability*. The first attribute, *information timeliness*, refers to the degree to which a PMS ensures that performance information is readily available and not provided with a substantial time-lag which allows managers to identify operational priorities and take corrective action where needed (Fawcett et al., 1997; Gunasekaran and Kobu, 2007). *Information aggregation* refers to the degree to which a PMS focuses performance information on the most relevant aspects accounting for managers’ information needs and time constraints (Ferreira and Otley, 2009) with less detailed and more aggregated performance measures at higher levels in the managerial hierarchy (Brignall and Ballantine, 1996). *System adaptability* refers to the degree to which the PMS itself can easily be adjusted to new requirements (Malina and Selto, 2004) as “managers must be able to (...) select new or different measures consistent with evolving organizational priorities” (Griffis et al., 2007, p. 35).

Together, the outlined seven attributes can be used to distinguish more advanced from less advanced of PMS design. Therefore, we use them to outline current performance measurement practices in logistics organizations.

4.2.2 Associated factors of PMS design

Providing a comprehensive picture about the state of performance measurement in logistics practice also requires an understanding of the organizational context and the factors that may be related to PMS design (Chenhall, 2003; Ferreira and Otley, 2009). Here, contingency-based research in the accounting literature has mainly proposed factors as the organization’s environment, technology, size, structure, and strategy (Chenhall, 2003; Henri, 2006a). This research, besides examining a broad range of context factors suggested in prior research,

provides a thorough insights into few specific factors that are of particular relevance in logistics PMS.

Coverage of key logistical performance measures

Prior empirical logistics research (e.g. Fawcett and Cooper, 1998; Keebler and Plank, 2009), has mainly used the coverage of key logistical performance measures as an indicator to judge how advanced a PMS is. They found greater levels of information availability regarding key logistical performance measures to be associated with higher levels of organizational competitiveness. As one may argue that the mere number of indicators is not what drives competitiveness, we want to view the relationship between different PMS design patterns and the corresponding coverage of key performance measures. With that we expand on Fawcett and Cooper (1998, p. 348), who state that “high performance logistics firms have greater access to measurement information”, where superior access can both be related to scope and usability. For comparability reasons we consolidated the performance measures used by Fawcett and Cooper (1998) and Keebler and Plank (2009) to a list of 25 measures that are both applicable and comparable in content for shippers’ internal logistics organizations and LSPs. In line with their classifications of performance measures and given the cost-to-service tradeoff in logistics (Stank et al., 2001), we covered both logistics efficiency (16 measures related to financials and productivity) and logistics effectiveness (9 measures related to process quality and customer service).

Shippers’ logistics organizations vs. LSPs

Given the immanent differences between shippers’ internal logistics departments and LSPs, it is reasonable to assume that PMS design patterns will differ between these two types of logistics organizations. For LSPs, logistics operations are at the core of their business (Busse and Wallenburg, 2011), thus representing the focus of their entire organization. For shippers, in contrast, their internal logistics organization represents one of several functional areas within a larger organizational context. As “pure players” LSPs have two advantages, from a core-competence perspective (Prahalad and Hamel, 1990) their logistics has far greater importance and will receive more management attention and resources, which facilitates better PMS. Second, their PMS is not embedded into a larger company context and, therefore, does not need to compromise with PMS designs directives catered for other business functions. Contrasting this, shippers often claim better managerial competences in logistics than many LSPs—supposedly the latter have not outgrown a pure hands-on mentality that focuses

on basic functions of transportation and storage. In order to shed more light on these issues we investigate possible differences in PMS design between the two groups.

Turbulence

In recent years, logistics organizations have been facing a growing degree of supply and demand market turbulence as major sources of supply chain risks (Blome and Schoenherr, 2011). As a consequence, Christopher and Holweg (2011) proposed that higher levels of turbulence “will require revisiting the management accounting procedures that are used to evaluate different supply chain decisions” (p. 64). Following this line of thought and other claims in the literature that logistics performance measurement needs to account for supply chain risk (e.g. Rasid et al., 2012; Ritchie and Brindley, 2007), it may be assumed that logistics organizations that are exposed to high environmental turbulence should reflect this especially in the supply chain related elements of PMS (i.e. in the attributes external linkage and design for turbulence).

While prior empirical research showed that performance measurement at the supply chain level is rather limited (Keebler and Plank, 2009), we provide a more detailed understanding, by examining the link between a logistics organization’s exposure to turbulence and PMS design patterns. This provides insights whether or not logistics organizations actually respond to the “era of turbulence” (Christopher and Holweg, 2011, p. 80) in performance measurement practice.

Outcomes

By addressing the information needs of managers “who must convert firm resources into customer value more efficiently and effectively” (Fawcett et al. 1997, p. 410), PMS ultimately serves as facilitator of performance. Accordingly, Gunasekaran and Kobu (2007), in their literature review on logistics performance measurement have stated that “the real challenge for managers of this new enterprise environment is to develop suitable performance measures and metrics to make right decisions that would contribute to an improved organizational competitiveness” (p. 2819). In logistics operations, organizational competitiveness is primarily reflected by increased levels of logistics efficiency (i.e. how well resources are utilized), and logistics effectiveness (i.e. how well goals are accomplished) (Mentzer and Konrad, 1991).

Yet, prior research has also discussed PMS satisfaction as a criterion of PMS success (e.g. Banker et al., 2001; Ittner et al., 2003). For logistics managers, PMS satisfaction, usefulness, and perceived cost-benefit efficiency may serve as a proxy for their PMS’ actual

contribution to competitiveness. Therefore, we include these three directly PMS-related aspects to complement logistics efficiency and effectiveness as the objective measures of logistics performance.

4.3 Methodology

4.3.1 Data collection

To provide a comprehensive picture on the state of PMS practice in German logistics organizations, an online survey was used to collect primary data from both shippers and LSPs. Following a key informant approach (Phillips, 1981), participants had to be knowledgeable with their firm’s logistics PMS and related organizational context. Therefore, an announcement of the survey was sent to potential respondents from three databases of logistics and supply chain managers—both at shippers’ internal logistics departments and at LSPs—that asked experts involved in the PMS domain of their respective logistics organization for an online registration. After a four-week registration period, an initial sample of 1,063 registered candidates received the link to our online survey, thus yielding a total of 431 complete and usable data sets (251 from shippers and 180 from LSPs, respectively). Respondent demographics are shown in Table 4-2.

Industry	Percent	Job title of respondents	Percent
Automotive	12%	Top level executive / director	55%
Machinery and equipment	11%	Senior manager	27%
High-tech and electronics	5%	Manager	12%
Chemicals and pharmaceuticals	7%	Non-executive	6%
Consumer goods	11%	Number of logistics employees	
Logistics services	42%	Less than 100	51%
Other industries	12%	100 to 999	34%
		1,000 or more	15%

Table 4-2: Respondent demographics

4.3.2 Measurement

Building on our extensive literature review of the established attributes of advanced PMS design and its associated factors, a group of ten logistics practitioners and researchers

were involved in the development of our survey instrument. To measure the attributes of PMS design, statements from the literature review (see Table 4-1) were used and validated using an item sorting approach developed by Moore and Benbasat (1991). The final scales are shown in Appendix 4-1. Logistics efficiency and effectiveness were measured using established items that are equally applicable to shippers and LSPs from Ellinger et al. (2000), Stank et al. (2001), and Fugate et al. (2010). Items for the measurement of subjective perceptions of PMS success (satisfaction, usefulness, and cost-benefit efficiency) as well as for a logistics organization's level of exposure to market turbulence were newly developed as no suitable instruments exist in the literature. Subsequently, three further logistics managers were involved to validate the final survey and to identify remaining ambiguities or wording issues. The scales can be found in Appendix 4-1.

Given the study's single informant approach, items of different variables were separated through other survey questions to minimize the risk of common-method bias. Moreover, using *t*-test analysis, neither an indication for late-response bias nor an indication for non-response bias was found following the rationale of Armstrong and Overton (1977) and Lambert and Harrington (1990).

4.3.3 Data analysis

As one major objective of this study is to identify distinct types of companies based on their PMS design we follow previous research (Gerdin, 2005; Gomes et al., 2006) and use cluster analysis along the seven design attributes to explore the PMS patterns observable in logistics practice. Cluster analysis allows exploring relations of similarity where each cluster is as homogeneous as possible with respect to the characteristics of interest and distinctively different from the other clusters (Lai, 2004; Gerdin, 2005). As a basis for the analysis, for each PMS design attribute (measurement diversity (MD), strategic-operational linkage (SOL), external linkage (EL), design for turbulence (DT), information timeliness (IT), information aggregation (IA), and system adaptability (SA)) a score was computed as the mean of the corresponding scale items. Given the objective of identifying distinct PMS types based on the design attributes, a categorical differentiation was required to clearly distinguish high from low implementation levels for each design attribute (Lai, 2004). Therefore, the means were translated into three rank-values with "0" for the lowest 25% of companies within that attribute, "1" for the intermediate 50%, and "2" for the highest 25% within the attribute. Hierarchical cluster analysis, using the squared Euclidean distance as agglomeration coefficient to maximize within-clusters homogeneity (Gerdin, 2005), suggests that a division into

five company clusters represents the best solution based on a large percentage change in the agglomeration coefficient between a five and a four cluster solution.

After having identified the five clusters, we used different uni- and multivariate statistical methods including ANOVA and regression analysis to analyze the relationships of the PMS design to the key domains outlined in the concept section (i.e. associated factors and outcomes of PMS design).

4.4 Empirical results

4.4.1 Patterns of PMS design

The key characteristics of each PMS type are summarized in Table 4-3 and will be described hereafter.

PMS type	Description	Implementation level of PMS design attributes							Noteworthy structural features ¹
		MD	SOL	EL	DT	IT	IA	SA	
	Average	4.7	4.2	3.5	3.7	5.1	5.1	4.6	
1. "All-round laggards" (n = 63; 15%)	Least advanced PMS with broad design deficits	2.6	2.4	1.8	1.9	3.5	3.6	3.5	Size ² : 70% small Industry: Machinery
2. "Usability laggards" (n = 49; 11%)	PMS with substantial usability deficits	4.2	3.4	3.2	3.4	3.5	4.0	3.1	Size ² : 41% mid-size Industry: Automotive
3. "Middlers" (n = 111; 26%)	Mediocre PMS with still considerable deficits	4.4	4.0	2.9	3.2	5.2	5.1	4.3	-
4. "Turbulence leaders" (n = 57; 13%)	Advanced PMS with strong external focus	5.6	4.6	4.4	5.1	5.1	5.2	5.0	Industry: High-tech
5. "All-round leaders" (n = 151; 35%)	Well-advanced PMS with no major design deficits	5.7	5.1	4.4	4.3	6.2	6.1	5.7	Industry: Consumer goods

¹ See Appendix 4-2 for details on structural characteristics

² Number of logistics employees in organization: Small (less than 100) = 51%; mid-size (100 up to 999) = 33%; large (1000 or more) = 16%

Table 4-3: PMS types with key characteristics

PMS Type I—"All-round laggards": A first group of logistics organizations (n = 63; 15%) shows substantial deficits along all seven design attributes. The attribute scores of this group lie well below the overall average and only at between 40 and 60 percent of the values of the most advanced group. Deficits can be observed across all attributes. Yet, they are most pronounced regarding PMS scope. Looking at the structural company data, companies with

less than 100 employees in logistics are overrepresented (70% of type I companies are small, compared to 40% of other companies in our study). Further, the machinery industry is overrepresented.

PMS Type II—“Usability laggards”: This cluster (n = 49; 11%) contains the logistics organizations that are similar to the all-round laggards in their deficiencies with respect to PMS usability (i.e. in terms of IT, IA, and SA). At the same time, they are substantially more advanced than the “all-round-laggards” along the attributes of PMS scope (MD, SOL, EL, and DT) and with that only slightly below the overall averages in the four PMS scope attributes. As the smallest cluster, this PMS design pattern appears to be rather uncommon in logistics practice. From a structural perspective, medium and large organizations are overrepresented just as the automotive industry.

PMS Type III—“Middlers”: Performance measurement practice of these logistics organizations (n = 111; 26%) are characterized by a middling position—not being good, but also not really bad across all seven attributes. Correspondingly, both PMS scope and usability are close to the overall sample mean.

PMS Type IV—“Turbulence leaders”: A rather small group of logistics organizations (n = 57; 13%), is at a middle level in terms of PMS usability, but is leading with respect to PMS scope. This group seems particularly well prepared for today’s supply chain requirements in performance measurement; not only are links to external partners (EL) well accounted for, but this PMS type is clearly most advanced in usage of risk measures related to market turbulence (DT). From a structural perspective, high-tech companies are strongly represented in this cluster.

PMS Type V—“All-round leaders”: The PMS of logistics organizations in this cluster (n = 151; 35%) is advanced along all design attributes. The cluster represents a rather large group of organizations that, albeit still leaving room for further progress in PMS design (especially in the supply chain related attributes EL and DT), have managed to implement a rather comprehensive performance measurement practice, both regarding PMS scope and usability.

Overall, there is still room for improvement for all PMS types and along all design attributes. While many logistics organizations have managed to reach sound levels especially in the areas of information timeliness and information aggregation, the average implementation level of external linkage and design for turbulence stand out as particularly lagging. Here, without necessarily integrating PMS across company boundaries, logistics organizations need

to further account for their interrelation with external partners in the supply chain that may have an impact on their own performance.

In comparing the PMS design patterns of all clusters, Figure 4-1 shows the relative implementation levels along all design attributes for all clusters (100% is the value of the all-round leaders on the respective attribute).

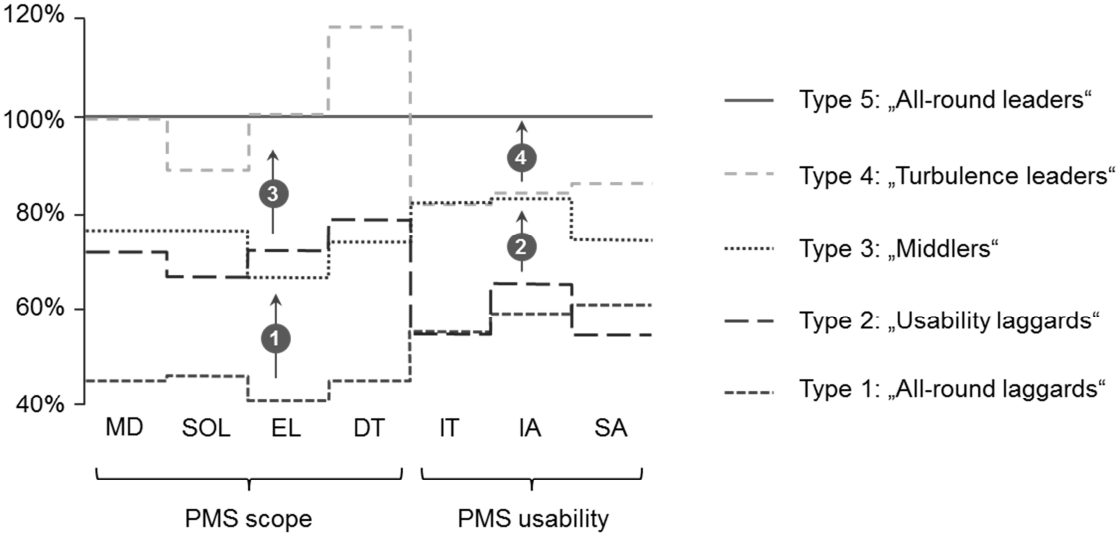


Figure 4-1: PMS types and development path

First of all, the patterns reveal the close connections within PMS scope and within PMS usability. Changes in the different attributes of PMS scope (MD, SOL, EL, and DT) go hand in hand with one another, i.e. a higher implementation level of measurement diversity, for the most part, comes with higher implementation levels of the other attributes of PMS scope. The same applies for the attributes of PMS usability. Second, one can observe a pattern that corresponds to a possible development path. Moving from the least advanced to the most advanced PMS type (from I to V), alternating improvements occur. Starting from an all-round low level (all-round laggards), the next level is characterized by improved PMS scope (indicated with (1) in Figure 1). Then from II to III PMS usability improves, before again PMS scope improves from III to IV. The last improvement is PMS usability, when moving from type IV to V.

Moreover, several structural factors were tested for (e.g., IT usage, educational level, and industry). Here, the only significant finding is that small organizations with less than 100 logistics employees are lagging behind in PMS scope and PMS usability whereas size has no significant impact when comparing mid-size and large organizations.

4.4.2 Coverage of key performance measures

Both Fawcett and Cooper (1998) and Keebler and Plank (2009), in empirically investigating the state of performance measurement in logistics practice, have focused on the coverage of key performance measures as a proxy for performance measurement comprehensiveness and hence PMS sophistication. Our study, while focusing on the design attributes of a system rather than specific performance measures to assess PMS sophistication, confirms their findings for the most part. While data were collected for 25 key performance measures related to the two principal areas of logistics effectiveness and efficiency. Table 4-4 shows an excerpt of four pivotal measures in each category (see Appendix 4-2 for full list). Looking at the results, it becomes evident that the coverage of key logistical performance measures steadily increases as PMS advances moving from Type I over Types II and III to Types IV and V.

Performance measures	Cluster I: All-round laggards	Cluster II: Usability laggards	Cluster III: Middlers	Cluster IV: Turbulence leaders	Cluster V: All-round leaders	Difference I to V (p-value)	Average I to V	Fawcett/ Cooper (1998)	Keebler/ Plank (2009)
Logistics effectiveness (average of all 9 measures)	41%	55%	56%	68%	66%		59%	72%	64%
On-time delivery	65%	69%	77%	95%	90%	25% (0.01)	81%	88%	79%
Order fill rate	49%	66%	68%	84%	82%	33% (0.01)	73%	85%	81%
Cycle time	30%	53%	57%	63%	63%	33% (0.01)	55%	83%	62%
Customer complaints	70%	80%	84%	89%	91%	11% (0.01)	84%	73%	76%
Logistics efficiency (average of all 16 measures)	36%	51%	51%	63%	66%		55%	75%	53%
Total logistics cost	52%	69%	71%	86%	89%	37% (0.01)	77%	94%	N/A
Freight cost	79%	82%	86%	93%	90%	11% (0.05)	87%	87% ¹	78% ¹
Equipment downtime	21%	35%	41%	67%	59%	38% (0.01)	47%	56%	46%
Labor utilization	32%	57%	64%	86%	81%	49% (0.01)	67%	N/A	36%

¹Calculated average value for inbound freight cost and outbound freight cost

Table 4-4: Coverage of key performance measures

Moreover, the increase in the coverage of key performance measures particularly corresponds with the “development path” of PMS design attributes that are related to improve-

ments in PMS scope rather than PMS usability. A substantial gap in key performance measures coverage is present between the all-round laggards and the two following clusters (usability laggards and middleers) and again for the two top clusters (all-round leaders and turbulence leaders). A comparison between the all-round laggards and both usability laggards and middleers shows that some shifts in key performance measure coverage are significant at the $p < 0.05$ level (e.g. order fill rate, cycle time, labor utilization) while others are not (e.g. on-time delivery, customer complaints, freight cost). Yet, all of these differences are equally significant (or non-significant) for both Type II and III.

The overall difference between the all-round laggards and both top clusters (all-round leaders and turbulence leaders) are highly significant ($p < 0.01$) for all performance measures except for one (freight costs; $p < 0.05$). Even between the middle two clusters and the top two clusters all differences are significant at $p < 0.05$ except for the availability of the measure customer complaints. In contrast, the differences within these two groups (i.e. between all-round leaders and turbulence leaders respectively between middleers and usability laggards) are not significant ($p > 0.05$) for any key performance measure.

In comparing the results to the studies conducted by Fawcett and Cooper (1998) as well as Keebler and Plank (2009) conducted with U.S. organizations and our results from Germany, we notice two things: First, Fawcett and Cooper (1998)—with very few exceptions—found a higher overall coverage of key performance measures. While it must be doubted that information availability, in general, was higher in the late 1990s, the difference may be caused by Fawcett and Cooper's focus on large corporations with a more detailed reporting of performance measurement information. Average availabilities found by Keebler and Plank (2009) are closer to the results of our study. Second, there has been no clearly discernible shift in key performance measure coverage from effectiveness to efficiency or vice versa.

While our study shows that the coverage of key performance measures actually is a proxy for how advanced the PMS is, it is important not to confound the importance of key performance measures with a need for a high number of performance measures. In line with the design attribute of information aggregation, it remains important to focus performance measurement on a limited number of selected measures (Bond, 1999; Tangen, 2004) rather than practicing excessive reporting that may result in information overload (Schick et al., 1990).

4.4.3 Shippers vs. LSPs

A comparison between internal logistics departments of manufacturing and trading companies (shippers) on the one hand and LSPs on the other hand does not reveal any major differences in PMS sophistication. As shown in Table 4-5, only the usability laggards and the turbulence leaders stand out as outliers regarding the sample's overall shares of 58% shippers and 42% LSPs. Within the usability laggards, LSPs are overrepresented (49%) and, thus, more often suffer from a lack of PMS usability in terms of well-prepared performance measurement information than shippers. One could have imagined the use of less sophisticated information technology as a possible explanation, but a one-item question asking respondents for the intensity of IT usage shows no significant difference between shippers and LSPs.

Type of logistics organization	Cluster I: All-round laggards	Cluster II: Usability laggards	Cluster III: Middlers	Cluster IV: Turbulence leaders	Cluster V: All-round leaders	Average
Shippers	57% (n=36)	51% (n=25)	57% (n=63)	67% (n=38)	59% (n=89)	58% (n=251)
LSPs	43% (n=27)	49% (n=24)	43% (n=48)	33% (n=19)	41% (n=62)	42% (n=180)

Table 4-5: Cluster shares – Shippers vs. LSPs

Moreover, shippers (67%) are clearly overrepresented among the turbulence leaders. This may be due to their higher awareness of supply chain complexity. While LSPs can focus on their customers as well as a small number of suppliers and horizontal cooperation partners (Schmoltzi and Wallenburg, 2011), shippers tend to operate directly in supply chain that today are more and more complex (Peck and Christopher, 2003; Sheffi and Rice, 2005).

Overall, LSPs appear less homogeneous with a wider spread in PMS sophistication across clusters which is confirmed by higher standard deviations along the PMS design attributes (mean standard deviation along all attributes is 1.54 for LSPs, 1.38 for shippers). Hence, LSPs as "pure players" with logistics as their core competence (Lai, 2004), as a whole, do not show the advantages in PMS design that one could have expected. Rather, the LSP industry exhibits both organizations with a very good PMS and organizations with a substantial need to catch up with those good practices. One explanation is that the logistics industry in general, and particularly in Germany, is very fragmented (Wagner and Kemmerling, 2010)

with a number of leading-edge companies on the one hand and a high share of small, to be further professionalized organizations on the other hand.

4.4.4 Market turbulence and PMS design

The literature claims that logistics organizations need to account for new and expanded PMS requirements in the “era of turbulence” (Christopher and Holweg, 2011, p. 80). This claim is understandable and consistent with contingency theory and the idea of fit between the organizational setup and the external context (Donaldson, 2001). Consequently, when the environment becomes less predictable, companies need to improve their PMS as part of their overall management control system.

Yet, our results indicate a very different picture in reality. A superior PMS does not appear to be the result of responding to a challenging context. In fact, all five PMS clusters exhibit almost the same level of supply and demand market turbulence and the slight differences are not significant ($p > 0.10$). Moreover, the two most opposing PMS clusters with regarding PMS design for turbulence, turbulence leaders and all-round laggards, are faced with the identical average level of turbulence (both 3.45) as shown in Table 4-6.

Market turbulence	Cluster I: All-round laggards	Cluster II: Usability laggards	Cluster III: Middlers	Cluster IV: Turbulence leaders	Cluster V: All-round leaders
Average	3.45	3.41	3.34	3.45	3.39
Ongoing fluctuations (e.g. raw material prices)	3.73	3.71	3.79	3.86	3.79
Fluctuations in customer demand	3.63	3.39	3.59	3.42	3.48
Fluctuations in upstream supply	3.00	3.12	2.63	3.07	2.91

Table 4-6: PMS clusters and market turbulence

Viewing only the two PMS attributes that are directly concerned with supply and demand markets and their turbulence (EL and DT), both are not affected by the level of market turbulence. In order to verify this, we also performed regression analyses and found the

regression coefficient of market turbulence on EL to be 0.04 ($p > 0.47$) and on DT 0.10 ($p > 0.11$).

Instead, the clusters with the best overall PMS (Type IV and V) also exhibit by far the best PMS design with respect to incorporating upstream and downstream aspects of the supply chain (captured via EL) and key indicators that provide insights into market turbulence (captured via DT). First, as shown in Table 4-7, it can be seen that their average values for EL and DT are much higher than those of the three other clusters. Second, the clear majority of companies that can be regarded as good practice in both dimensions (the top 25% in both dimensions) are in cluster IV or V. In contrast, if companies are clustered according to the market turbulence they are faced with, the differences are very small and not significant.

	Cluster I: All-round laggards (15%)	Cluster II: Usability laggards (11%)	Cluster III: Middlers (26%)	Cluster IV: Turbulence leaders (13%)	Cluster V: All-round leaders (35%)	Exposure to market turbulence	
						High (50%)	Low (50%)
External linkage	1.79	3.15	2.91	4.37	4.35	3.44	3.50
Share of Top 25% companies with respect to External Linkage	0%	2%	5%	33%	60%	52%	48%
Design for turbulence	1.92	3.37	3.17	5.05	4.28	3.68	3.62
Share of Top 25% companies with respect to Design for Turbulence	0%	5%	5%	42%	49%	50%	50%

Table 4-7: Supply chain related PMS design

Actually, the logistics organizations that have better prepared for higher levels of market turbulence are the ones that also excel in the other dimensions of PMS. Obviously, in current logistics practice, accounting for higher levels of market turbulence in PMS design is less a question of actual exposure to market turbulence, but rather of its overall proficiency in PMS and the awareness of new PMS requirements. While recognizing a changing supply chain environment and high exposure to turbulence is one thing, actually having the ability to do so is another thing altogether and continues to be a challenge for many organizations (Melnik et al., 2004; Ritchie and Brindley, 2007).

4.4.5 Outcomes

Regarding the outcomes of advanced PMS design, the literature has discussed two major rationales to assess PMS success: PMS satisfaction as a rather subjective criterion (Banker et al., 2001; Ittner et al., 2003) and PMS impact on performance as a more objective criterion (Chenhall, 2005; Evans, 2004; Fawcett et al., 1997). For both rationales, the results of our study provide detailed insights into the relationships between sophistication of PMS design and success in logistics practice.

PMS design and subjective perceptions of PMS success

To investigate the relationship between PMS design and subjective perceptions of PMS success, respondents were asked to assess both their overall satisfaction with their organization's PMS, PMS usefulness for the control of logistics operations, and PMS cost-benefit efficiency. For this part, only respondents who considered themselves familiar with the cost associated with the development and maintenance of their organization's logistics PMS (n = 332) were asked to assess cost-benefit efficiency.

Subjective perceptions of PMS success	Cluster I: All-round laggards	Cluster II: Usability laggards	Cluster III: Middlers	Cluster IV: Turbulence leaders	Cluster V: All-round leaders	Difference I to V (p-value)
PMS satisfaction	2.63	3.35	4.14	5.19	5.56	2.93 (0.01)
Usefulness for logistics control	3.06	3.57	4.45	5.49	5.98	2.92 (0.01)
Cost-benefit efficiency	3.69	3.86	4.71	5.23	5.88	1.92 (0.01)

Table 4-8: PMS design and subjective perceptions of PMS success

As shown in Table 4-8, the results clearly reflect a positive relationship between advanced PMS design and subjective perceptions of PMS success. The difference in both PMS usefulness and cost-benefit efficiency is highly significant ($p < 0.01$) between the two leading clusters (all-round leaders and turbulence leaders) and the three other clusters. And in seven out of eight cases (two dependent variables times four moves) is the difference significant at $p < 0.05$ when moving from one sophistication level to the next (e.g. moving from Type II to III). Particularly noteworthy is the clarity and the extent to which subjective perceptions of PMS success are linked to PMS sophistication. While this relationship had so far not been

empirically investigated related to logistics, the results are consistent with prior findings in the accounting literature (Ittner et al., 2003; Sandt et al., 2001).

PMS design and logistics performance

From a managerial perspective, the actual impact of PMS design on logistics performance is more important than subjective perceptions of PMS success. Here, following the cost-to-service trade-off in logistics (Stank et al., 2001) this study applies the established distinction between logistics efficiency and effectiveness (Mentzer and Konrad, 1991) as shown in Table 4-9.

The results clearly support a positive impact of advanced PMS design on logistics performance. Overall, logistics efficiency of both lagging clusters—while not differing between them—is significantly lower than that of the other three clusters (all-round leaders, turbulence leaders, and middlers) at $p < 0.01$, where the differences among the latter three are again highly significant ($p < 0.01$) both for the overall efficiency and for all of its sub-measures.

Logistics Performance	Cluster I: All-round laggards	Cluster II: Usability laggards	Cluster III: Middlers	Cluster IV: Turbulence leaders	Cluster V: All-round leaders	Difference I to V (<i>p</i> -value)
Logistics Efficiency: (3-item average)	3.97	4.07	4.26	4.50	4.66	0.69 (0.01)
Total logistics cost	3.86	3.96	4.18	4.23	4.58	0.72 (0.01)
Freight cost	4.05	4.02	4.23	4.56	4.78	0.73 (0.01)
Labor productivity in logistics	4.02	4.24	4.38	4.72	4.63	0.61 (0.01)
Logistics Effectiveness: (3-item average)	5.02	5.04	5.07	5.31	5.32	0.30 (0.05)
Delivery dates and quantities	5.08	4.96	5.03	5.25	5.31	0.23 (0.10)
Over/short/damaged deliveries	4.87	4.98	4.91	5.07	5.12	0.25 (0.05)
Adherence to customer specifications	5.10	5.18	5.28	5.61	5.45	0.35 (0.01)

Table 4-9: PMS design and logistics performance

The study also supports a link between logistics effectiveness and sophistication of PMS design. While the differences are not quite as distinct compared to logistics efficiency,

as the relationship between PMS design and logistics efficiency, the differences between the two lagging clusters and the all-round leaders are all significant at least at the $p < 0.10$ level. Overall, logistics effectiveness appears to benefit only from high sophistication levels of PMS design. Whereas Types I to III exhibit similar levels of logistics effectiveness, substantial PMS driven improvements can only be observed for logistics organizations with high implementation levels of both PMS scope and PMS usability.

4.5 Discussion and implications

This research, to the best of our knowledge, provides the first comprehensive picture on performance measurement practice in logistics organizations. Besides the focus on PMS as an entity that is defined by its design rather than the coverage of specific performance measures, several new aspects of performance measurement practice have been investigated. Overall, we find distinct differences in PMS sophistication between high performing and low performing logistics organizations along all attributes of advanced PMS design. While about one third of the logistics organizations show—without being perfect—sound implementations levels for both PMS scope and PMS usability, more than half should improve significantly. Although the results, due to the different regional focus, are only partly comparable to the insights provided by Fawcett and Cooper (1998), they confirm that organizations with more advanced PMS also show a distinctively better coverage of key logistical performance measures. Similar to Keebler and Plank's (2009) findings in U.S. logistics organizations, major deficits are found in supply chain related performance measurement. Here, and bearing in mind the broad consensus that increasing levels of turbulence represent one of the major challenges in current logistics and supply chain management practice (Blome and Schoenherr, 2011; Christopher and Holweg, 2011), it was important to find that logistics organizations with generally more advanced PMS appear to be substantially better prepared to cope with increased turbulence than their counterparts with broad PMS deficits.

From a managerial perspective, the results can serve as a benchmark and guidance for logistics organizations that are willing to potentially change the design of their PMS. Given the insight that higher levels of PMS sophistication are related to enhanced performance both regarding logistics efficiency and logistics effectiveness, managers need to raise questions regarding the design attributes of PMS scope and usability in order to identify and eliminate major deficits. What is the organization's current stage of development in PMS design? And: Which shortcomings must be addressed to ensure better implementation levels for all design

attributes? When answering these questions, managers should not only assess each design attribute individually, but view the simultaneous presence of the attributes related to PMS scope and PMS usability to gain a sound and comprehensive (self-)assessment. Only then will it be possible to decide whether an incremental or a fundamental redesign is required to advance the PMS to higher levels.

During the process of self-assessment, it will also be crucial not to confuse the importance of key performance measures with a rationale of “the more measurement, the better” that may result in excessive reporting and thus not fulfill logistics managers’ actual information needs (Schick et al., 1990). While being in line with Fawcett and Cooper’s proposition that “high performance logistics firms have greater access to measurement information” (p. 348), the results of our study primarily suggest that overall PMS sophistication—i.e. the design of a system according to attributes recommended across disciplines—are a strong basis for high levels of logistics performance.

From a theoretical perspective, the results provide two important insights. First, we find clear support for researchers’ prior conceptual PMS contributions and frameworks: higher levels of PMS sophistication are actually related to enhanced performance in terms of logistics efficiency and logistics effectiveness. Yet, in order to account for specific requirements, a fourth scope dimension (design for turbulence) should be considered in PMS design. Second, in contrast to what can be assumed based on contingency theory which posits a fit between the organizational setup and its environment, PMS design practice does not appear to follow the requirements induced by increasing levels of market turbulence—at least not short term. In fact, regarding market turbulence, PMS design is driven by an organization’s overall proficiency in PMS where leading organizations have the ability to account for external factors and lagging organizations do not.

4.6 Limitations and future research

In seeking to provide a comprehensive picture of the state of PMS in logistics practice, it was aimed to minimize any limitations. Yet, and partly due to its empirical-descriptive character, this research does have some limitations which, at the same time, offer interesting possibilities of future research. First, the results, due to the different regional focus, are only partly comparable to previous insights provided by Fawcett and Cooper (1998) and Keebler and Plank (2009). While recapitulating the coverage of key performance measures examined in these two U.S. studies provides an essential baseline, it would also be beneficial to

empirically investigate the selection of key performance measures in specific logistics organizations.

Moreover, as in any empirical-descriptive study, focal areas of research had to be prioritized. Therefore, besides the major focus on patterns of PMS design, both antecedents and outcomes were limited to specific aspects.

Regarding the antecedents to PMS design, the study focused on market turbulence as an external factor and an area of interest in current logistics and supply chain management research and practice (Blome and Schoenherr, 2011). Given the finding that there was no relationship between the actual exposure to market turbulence and the implementation level of PMS design for turbulence, further insights regarding other PMS antecedents would certainly be valuable to researchers and practitioners and require further research. Moreover, there are obviously further important antecedents to investigate, including other sources of external risk as well as internal organizational factors like the availability of resources or the skill set of employees (Keebler and Plank, 2009).

Regarding the outcomes of PMS design, the study focused on logistics efficiency and effectiveness as two major sources of competitiveness in logistics organizations. Yet, to actually derive clear cause-and-effect relationships and to understand *how* PMS is actually translated into organizational competitiveness, the findings provided in chapters 2 and 3 provide a more robust basis for the impact of PMS on organizational competitiveness and further research possibilities.

5 Concluding remarks

In view of a large body of conceptual PMS research across disciplines and the comparably limited number of empirical PMS studies in the logistics discipline (Gunasekaran and Kobu, 2007), this dissertation is dedicated to providing in-depth empirical insights on PMS design and PMS contribution to competitive outcomes in logistics organizations. For this purpose, it consolidates prescriptive frameworks to identify the key attributes of advanced PMS design while taking into account the growing importance of performance measurement in the supply chain context (Akyuz and Erkan, 2010). Building on this consolidation of scholarly recommended PMS design attributes, hypotheses on the effectiveness of advanced PMS design regarding competitive outcomes in logistics organizations and corresponding research models are derived from the literature and tested using the resource-based view as a theoretical foundation. Regarding the new requirements of logistics performance measurement in the era of turbulence, PMS design for turbulence is shown to be contingent upon upper management's control focus. Moreover, a comprehensive picture of the actual state of PMS practice in logistics organizations—both manufacturing companies' internal logistics departments and LSPs—is provided.

5.1 Main research findings and contributions

In addition to the detailed discussions of research findings as well as implications for theory and practice provided in each chapter of the dissertation, this section starts with a brief overview of the main findings while particularly seeking to summarize the most relevant insights and to draw overall conclusions.

Chapter 2, in answering the first and second research question, provides evidence that advanced PMS represents a valuable resource that acts as a substantial driver of customer orientation and cross-functional integration as two pivotal capabilities in logistics organizations which ultimately enhance logistics performance. By investigating PMS as an entity whose overall level of sophistication is defined by the combined existence of key design attributes derived from the literature, this dissertation goes significantly beyond previous research that followed the dimensions of the balanced scorecard (e.g. Henri, 2006b; Tung et al., 2011) or specific attributes of advanced PMS design (e.g. Rodrigues et al., 2004; Chenhall, 2005).

From a research perspective, the chapter confirms the scholarly recommended PMS design attributes of measurement diversity, strategic-operational linkage, external linkage, information timeliness, information aggregation, and system adaptability. As these attributes

are taken from an extensive literature review across disciplines and particularly logistics, the findings confirm the common denominator of multiple conceptual contributions on PMS design. Moreover, the hypothesized importance of the combined presence of these attributes is validated through the second-order PMS excellence construct, thus confirming that different attributes of advanced PMS design are complementary and mutually reinforcing. Particularly for logistics managers who are pursuing higher levels of PMS sophistication, it is an important finding that working on one specific design attribute, e.g. measurement diversity, may not yield the expected benefits in enhancing organizational capabilities and competitiveness unless other design attributes are implemented as well.

Chapter 3, by investigating the role of PMS in supply chain risk management, addresses previously un-researched aspects of PMS design and effectiveness in logistics organizations. Although a few authors have vaguely pointed to the potential role of control systems in supply chain risk management (e.g. Rasid et al., 2012), this dissertation first shows that accounting for higher levels of market turbulence through PMS design for turbulence actually fosters organizational resilience—the ability to cope with turbulence—and thus drives distribution service performance. Unlike the widely established PMS design attributes built upon in chapter 2, PMS design for turbulence adds a new design dimension that is shown to provide distinct value to logistics organizations. In a supply chain environment that is characterized by increasing levels of market turbulence (Christopher and Holweg, 2011), empirical evidence on the positive impact of supply chain risk metrics is a valuable insight both for the academia and for logistics practice.

The results also show that upper management's control focus in using PMS interactively (attention-focusing) or diagnostically (score-keeping) can act as a driver or impediment of PMS design for turbulence. In contrast to prior research that focused on openly expressed management support as an antecedent to the effectiveness of PMS (Keebler and Plank, 2009; Tung et al., 2011), we can see that upper managers' mindset—as a rather subtle driver or impediment that many decision-makers may not even be aware of—can have a substantial impact as well.

In complementing the fundamental investigation of PMS design and its effectiveness in logistics organizations (chapter 2) and the more specific role of PMS for the growing challenge of market turbulence in the supply chain environment (chapter 3), chapter 4 provides an overall picture of how PMS is actually implemented in logistics practice. It follows an empirical-descriptive approach and provides in-depth insights into the patterns of PMS design and the usage of key performance measures in logistics organizations, as well as

associated factors and competitive outcomes. Using cluster analysis along the key PMS design attributes identified in chapter 2 and 3, the results reveal five different PMS sophistication levels in logistics organizations. Moreover, the path of development along the different PMS sophistication levels shows close connections between the content-related PMS design attributes, i.e. PMS scope, and the attributes related to the user-oriented preparation and presentation of performance measurement information, i.e. PMS usability. To bring their organization's PMS to the next level, logistics managers need to not only improve a specific design attribute, but simultaneously advance all attributes of PMS scope or PMS usability, depending on where their PMS is particularly lagging behind.

Overall, besides substantial differences in PMS sophistication between leading and lagging logistics organizations, the supply chain related design attributes of external linkage and design for turbulence stand out as particularly lagging. Along with the fact that—in contrast to contingency-based logic—PMS design in logistics organizations is not adapted to the level of turbulence faced in the market, this is a disconcerting finding which shows that logistics managers need to particularly question whether their organization's PMS practice appropriately addresses supply chain related challenges. During a workshop discussion of results with logistics practitioners⁶, contrasting views like “External linkage is extremely important. I need full transparency at least down to my sub-suppliers” on the one hand and “Why care about external linkage? My suppliers know that I expect them to deliver as promised” on the other hand made it obvious that there is quite a disagreement regarding the actual need to measure performance beyond the boundaries of individual organizations. It should go without saying that performance measurement at the supply chain level requires “thinking outside the box” of one's own logistics organization. Yet, whether or not integrated PMS or jointly defined performance metrics are required to do so is another thing altogether. Therefore, this issue will be further addressed in the next section about future research possibilities.

Yet, supply chain related performance measurement is not the only area of investigation where PMS reality does not turn out exactly as expected. The comparison between the two basic types of logistics organizations—internal logistics departments of manufacturing companies and LSPs—shows only very small differences. Rather than translating their logistics “core competence” into substantial advantages regarding performance measurement practice, LSPs comprise a wide spread of organizations with both very sophisticated and still underdeveloped PMS. Although this is partly due to the fragmented structure of the logistics

⁶ See chapter 1 (workshop at international conference of the German logistics organization)

industry in Germany (Wagner and Kemmerling, 2010), LSPs, overall, do not fulfill the leadership role that one may expect from their business focus on logistics services.

Viewing all chapters together, some of the findings of this dissertation are of general nature and therefore equally valuable for researchers and practitioners. First, whereas the evidence that scholarly recommended PMS design attributes actually do provide value in logistics organizations is an important finding, understanding how they provide value is obviously more important. Here, we learn that the impact of PMS excellence, although one may expect a direct relationship between PMS excellence and competitive outcomes, is fully mediated by organizational capabilities. This is confirmed both for PMS excellence along the established attributes of advanced PMS design in chapter 2 (where PMS value is fully mediated by customer orientation and cross-functional integration) and for the specific investigation of PMS effectiveness regarding the growing challenge of market turbulence in chapter 3 (where PMS value is fully mediated by organizational resilience). In both cases, the direct relationships between PMS and enhanced levels of performance are virtually irrelevant.

For PMS research, on the one hand, this is a valuable clarification which supports that PMS has an indirect impact on organizational competitiveness only (Chenhall, 2005; Henri, 2006b). Other than the descriptive results in chapter 4 and suggestions from correlation analysis in prior studies (e.g. Fawcett et al., 1997) could make one believe, we learn that positive outcome effects are only achieved indirectly, mediated via organizational capabilities. This contribution is mostly owed to the dissertation's research design and its hypotheses-driven theoretical foundation. Here, the resource-based view—although being criticized for its “all-inclusiveness” (Priem and Butler, 2001) and its limited explanatory power (Hoopes et al., 2003; Sirmon et al., 2007)—serves as a useful theoretical foundation if combined with sound, literature-driven hypotheses.

For logistics managers, on the other hand, it is important to know that competitive outcomes can only be expected if PMS value is successfully translated into organizational capabilities. Hence, it is essential, but not sufficient, to ensure high implementation levels of the attributes of advanced PMS design. By clearly underscoring PMS impact through organizational capabilities, the dissertation provides an answer to Sirmon et al.'s (2007) claim that “unfortunately, there is minimal theory explaining ‘how’ managers/firms transform resources to create value. Therefore, the RBV requires further elaboration to explain the link between the management of resources and the creation of value.”

In reflecting the dissertation's overall findings regarding PMS design in logistics organizations as a central domain of investigation, it is essential to bring the different chapters

together. As outlined above, chapter 2 identifies PMS excellence as the combined existence of six mutually reinforcing key design attributes derived from the literature. Whereas these established design attributes have recurrently been recommended across PMS frameworks, chapter 3—in investigating the role of PMS in the era of turbulence—adds a new, more specific design attribute that was not previously researched. Yet, PMS design for turbulence, even though readdressed in chapter 4 for the purpose of a comprehensive and up-to-date description of the current state of PMS in logistics practice, stands on a somewhat different level than the established attributes of advanced PMS design. As many logistics organizations—albeit showing an advanced use of both financial and non-financial performance metrics—have not yet managed to prepare for the specific requirements of the era of turbulence (Weber et al. 2012), the dissertation investigated this specific aspect of PMS design in detail. That is to say, the use of risk metrics related to demand and supply turbulence, was treated as a stand-alone design attribute. Yet, in anticipating further developments of performance measurement practice in logistics organizations, PMS design for turbulence—in becoming an inherent part of PMS excellence—is to be captured via measurement diversity (regarding the use of supply chain risk metrics) and external linkage (regarding the demand and supply dependencies from partners in the supply chain). Therefore, in the long run, it will not be considered a stand-alone PMS design attribute.

In sum, the investigations in chapters 2 through 4 present a complete picture on PMS design and effectiveness in logistics organizations. Although PMS represent a much-examined field of research, the empirical findings on cause and effect relationships as well as the current state of practice shed light on previously under-investigated issues, thus providing profound insights for researchers and practitioners and a sound basis for future research.

5.2 Future research possibilities

In addition to the limitations and research avenues provided in each chapter, this final section seeks to present a broader picture of future research possibilities arising from the dissertation.

Regarding PMS design as the focal subject of examination, a common denominator of PMS frameworks was used to consolidate PMS knowledge regarding recommendable design attributes in logistics organizations. For this purpose and given the quantitative approach of the dissertation, the measurement items of content-related design attributes had to cover the

individual design attributes broadly enough to capture the implementation of the attribute in different organizational contexts. Regarding PMS usability, the attributes of information timeliness, information aggregation, and system adaptability, when it comes to the detailed requirements of specific organizations, will have different implications in different contexts. Similarly, measurement diversity, besides the general applicability of financial and non-financial measures, may present itself in different ways when it comes to the actual selection of performance metrics. Most importantly, both the supply chain related attributes of external linkage and design for turbulence and strategic-operational linkage require a context-specific implementation in practice. For instance, external linkage may range from an intra-organizational assessment and measurement of performance dependencies from other supply chain members to a full inter-organizational integration with jointly defined performance measurement. Here, different organizational contexts may require different approaches and logistics managers' understanding of the ideal state of external linkage and corresponding performance measurement requirements may vary significantly. Therefore, further empirical research is required to better understand the context-specific design and effectiveness of external linkage beyond prior researchers' conceptual contributions (e.g. van Hoek, 1998). Given the need for detailed investigations, qualitative case study research will most probably provide the best research approach for this purpose.

At the same time, the role of PMS in supply chain risk management, i.e. the implementation of PMS design for turbulence and the selection of supply chain risk measures in specific logistics organizations, is clearly in its infancy and should be further investigated. Overall, I agree with Akyuz and Erkan (2010) that "performance measurement in the new supply era is still an open area of research" (p. 5137). Here, the dissertation has laid the foundation to conduct in-depth case studies regarding supply chain related PMS design and its impact on organizational competitiveness.

Similarly, and judging from the above mentioned discussion with logistics practitioners, strategic-operational linkage appears to be highly relevant in logistics organizations and should therefore be further examined for the specific requirements of the logistics function. Yet, no detailed empirical insights have been provided on the attribute's actual implementation in logistics practice. For such case-specific and detailed investigations, researchers should distinguish between shippers and LSPs and take an organization's specific scope of logistics services into consideration. This way, detailed case studies can ensure a selection of different logistics organizations as "polar types" (Eisenhardt, 1989).

Another important area for further research consists in the antecedents to advanced PMS design. Here, while chapter 3 showed that PMS design for turbulence is contingent upon upper management's control focus, the results of chapter 4 did not support the idea of fit between higher levels of market turbulence and PMS design. For logistics managers who are willing to take their organization's PMS to the next level, it is not only important to be aware of the design attributes that should be implemented. They also require further insights regarding the drivers and inhibitors of PMS excellence within their organization. Although Keebler and Plank (2009) have provided first survey-based empirical insights in this regard, there is still plenty of work to be done to gain a comprehensive understanding of PMS antecedents. From a research perspective, further theory development may be required to fully explain the relationship between both internal and external factors and PMS design.

Overall, although PMS represents a well-established field of research, there are still plenty of opportunities to advance PMS knowledge, particularly through further empirical insights. Here, this dissertation can serve as a basis for detailed, context-specific studies on PMS design and effectiveness in logistics organizations.

6 References

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7 Appendix

Appendix 2-1

Scales and descriptive statistics

Constructs and Scale Items	Mean	SD	Stand. Weight	t-value
Customer Orientation (Narver and Slater 1990)				
Cronbach's alpha = 0.76; AVE = 0.54; CR = 0.78				
Please rate the extent to which the following items describe your logistics organization:				
CO1 We have a very good understanding of customer needs.	5.72	1.08	0.73	15.92
CO2 There is a high commitment to serving customers' needs.	5.62	1.17	0.73	15.80
CO4 We have very clear objectives regarding customer satisfaction.	5.40	1.50	0.74	16.20
Cross-functional Integration (Zacharia and Mentzer 2004; Daugherty et al. 2009)				
Cronbach's alpha = 0.88; AVE = 0.65; CR = 0.90				
Please rate the extent to which the following items describe your logistics organization:				
CFI1 Within our organization cross-functional work teams are extensively utilized for managing day-to-day operations.	4.57	1.69	0.73	17.08
CFI2 Within our organization, employees are encouraged to work together with colleagues from other functional areas.	5.05	1.54	0.87	21.90
CFI3 Managers in our organization are strongly encouraged to share information and provide input to other functional areas.	5.40	1.47	0.86	21.78
CFI4 Within our organization, employees from different functional areas are strongly encouraged to share resources.	4.98	1.53	0.84	20.95
CFI5 Managers across our organization work together in (informal) teams.	4.86	1.66	0.71	16.53
Logistics Performance (Fugate, Mentzer, and Stank 2010)				
Cronbach's alpha = 0.90; AVE = 0.79; CR = 0.92				
Please rate your logistics organization's performance on logistics activities in comparison to your competitors:				
LP1 Our overall logistics performance is well above industry average.	4.94	1.10	0.82	20.13
LP2 In general, our logistics performance is excellent.	4.88	1.20	0.94	24.85
LP3 We are outstanding at performing our logistics activities.	4.99	1.16	0.90	23.44

Items were measured with 7-point Likert scale ranging from 1 = *I strongly disagree* to 7 = *I strongly agree*
(for *Logistics Performance*: 1 = *much worse* to 7 = *much better*)

Appendix 2-2

Structural equation model without and with controls

Parameter	Model A: Structural equation model without controls		Model B: Structural equation model with controls	
	Estimate	<i>p</i> -value	Estimate	<i>p</i> -value
PMS excellence → Customer orientation (H1)	0.509	***	0.591	***
PMS excellence → Cross-functional integration (H2)	0.576	***	0.512	***
Customer orientation → Logistics performance (H3)	0.341	***	0.264	***
Cross-functional integration → Logistics performance (H4)	0.172	0.003	0.138	0.019
PMS excellence → Logistics performance (H5)	0.036	0.629	-0.021	0.787
Organizational size → Customer orientation (control)			-0.168	***
Organizational size → Cross-functional integration (control)			-0.029	0.523
Organizational size → Logistics performance (control)			0.136	0.004
Organizational resilience → Logistics performance (control)			0.337	***
R ² Customer orientation	0.332		0.377	
R ² Cross-functional integration	0.259		0.263	
R ² Logistics performance	0.202		0.221	

Note: *** *p*-value < 0.001; ** 0.001 < *p*-value < 0.01; * 0.01 < *p*-value < 0.1

Appendix 3-1

Measurement scales and items

Constructs and Scale Items	Mean	SD	Stand. Weight	t-value
Attention-Focusing (Vandenbosch, 1999)				
(Cronbach's alpha = 0.87; AVE = 0.63; CR = 0.87)				
Please rate the extent to which your upper management currently uses PMS to ...				
AF1 ... tie the organization together.	4.99	1.63	0.84	14.34
AF2 ... enable the organization to focus on our critical success factors.	4.92	1.53	0.83	14.26
AF3 ... provide a common view of the organization.	4.94	1.60	0.84	14.33
AF4 ... enable discussion in meetings of superiors, sub-ordinates and peers.	4.71	1.69	0.65	fixed
AF5 ... enable continual challenge and debate of underlying results, assumptions and action plans.*				
Score-Keeping (Vandenbosch, 1999)				
(Cronbach's alpha = 0.90; AVE = 0.71; CR = 0.91)				
Please rate the extent to which your upper management currently uses PMS to ...				
SK1 ... track progress towards goals.	5.69	1.35	0.86	22.21
SK2 ... review key performance indicators.	5.35	1.47	0.80	19.77
SK3 ... monitor results.	5.75	1.31	0.86	22.27
SK4 ... compare outcomes to expectations.	5.74	1.29	0.85	fixed
PMS Design for Turbulence (newly developed)				
(Cronbach's alpha = 0.84; AVE = 0.65; CR = 0.85)				
Please rate the extent to the following items describe the PMS of your logistics organization:				
PDT1 We use specific risk metrics to understand the impact of external turbulence on our business.	3.64	1.86	0.80	15.37
PDT2 We use early warning indicators to anticipate and plan for fluctuations.	3.81	1.76	0.87	15.84
PDT3 We measure market volatility in order to be able to react on time.	3.50	1.76	0.73	fixed
Organizational Resilience (newly developed)				
(Cronbach's alpha = 0.83; AVE = 0.63; CR = 0.83)				
Please rate the extent to the following items describe your logistics organization:				
OR1 Our logistics organization has a strong ability to cope with external risk or turbulence.	5.00	1.30	0.83	16.51
OR2 We are well prepared to sustain operations in a turbulent market environment and to recover quickly afterwards.	5.21	1.25	0.86	fixed
OR3 We have the capacity to adjust required functions under challenging or straining conditions.	5.24	1.19	0.69	14.42
Distribution Service Performance (Ellinger et al. 2000; Stank et al. 2001)				
(Cronbach's alpha = 0.86; AVE = 0.55; CR = 0.86)				
Please rate your logistics organization's performance in comparison to competitors:				
DSP1 The ability to meet quoted or anticipated delivery dates and quantities on a consistent basis.	5.16	1.08	0.76	14.10
DSP2 The ability to respond to the needs and wants of key customers.	5.40	1.11	0.69	13.63
DSP3 The ability to accommodate delivery times for specific customers.	5.22	1.13	0.67	14.50
DSP4 The adherence to customer specifications.	5.35	0.98	0.71	17.26
DSP5 The global judgment regarding the extent to which logistics performance matches customer expectations.	5.28	0.93	0.86	14.42
Items were measured with 7-point Likert scales ranging from 1 = <i>not at all</i> to 7 = <i>to a very great extent</i> (for Distribution Service Performance: 1 = <i>much worse</i> to 7 = <i>much better</i>) (* items eliminated in scale-refinement after large-scale analysis)				

Appendix 3-2

Exploratory Factor Analysis

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
AF1	0.756				
AF2	0.800				
AF3	0.837				
AF4	0.576				
SK1		0.669			
SK2		0.595			
SK3		0.928			
SK4		0.905			
PDT1			0.826		
PDT2			0.861		
PDT3			0.710		
OR1				0.808	
OR2				0.861	
OR3				0.698	
DSP1					0.746
DSP2					0.710
DSP3					0.681
DSP4					0.722
DSP5					0.841

Note: Only factor loadings above 0.30 are displayed

Appendix 3-3

Controls

Exposure to Market Turbulence (control variable)

Please rate the extent of fluctuations in your logistics organization's environment:	Mean	SD
MT1 Our environment is characterized by a high number of ongoing fluctuations (e.g. raw material prices).	3.78	1.03
MT2 Our customer demand is subject to very high fluctuations.	3.51	1.03
MT3 The supply of our (sub-)suppliers is subject to very high fluctuations.	2.90	1.00

Items were measured with a 5-point Likert scale ranging from 1 = *not at all* 5 = *to a very great extent*

Type of Logistics Organization (control variable)

Internal logistics department of manufacturing/trading company	n = 431 (58% of sample)
Logistics service provider	n = 251 (42% of sample)

Appendix 3-4

Correlation matrix for the measurement items

	AF1	AF2	AF3	AF4	SK1	SK2	SK3	SK4	PDT1	PDT2	PDT3	OR1	OR2	OR3	DSP1	DSP2	DSP3	DSP4	DSP5
AF1	1																		
AF2	0,692	1																	
AF3	0,709	0,705	1																
AF4	0,527	0,544	0,544	1															
SK1	0,617	0,601	0,612	0,438	1														
SK2	0,603	0,581	0,537	0,457	0,712	1													
SK3	0,559	0,511	0,526	0,418	0,719	0,674	1												
SK4	0,562	0,519	0,529	0,372	0,712	0,635	0,789	1											
PDT1	0,282	0,343	0,271	0,282	0,262	0,300	0,235	0,248	1										
PDT2	0,313	0,340	0,312	0,328	0,253	0,250	0,179	0,189	0,706	1									
PDT3	0,289	0,302	0,319	0,237	0,249	0,211	0,176	0,149	0,583	0,637	1								
OR1	0,214	0,210	0,262	0,235	0,253	0,186	0,224	0,194	0,191	0,186	0,196	1							
OR2	0,193	0,215	0,205	0,189	0,208	0,151	0,206	0,150	0,211	0,235	0,242	0,706	1						
OR3	0,168	0,169	0,158	0,123	0,126	0,120	0,128	0,074	0,061	0,133	0,042	0,566	0,593	1					
DSP1	0,083	0,086	0,110	0,103	0,079	0,107	0,080	0,063	0,074	0,034	0,089	0,258	0,234	0,233	1				
DSP2	0,082	0,085	0,115	0,114	0,088	0,122	0,134	0,153	0,083	0,084	0,076	0,231	0,205	0,229	0,483	1			
DSP3	0,118	0,138	0,116	0,107	0,083	0,102	0,056	0,094	0,128	0,097	0,121	0,225	0,247	0,211	0,520	0,562	1		
DSP4	0,180	0,157	0,165	0,122	0,121	0,175	0,151	0,140	0,121	0,115	0,131	0,187	0,198	0,181	0,523	0,492	0,485	1	
DSP5	0,136	0,160	0,179	0,138	0,100	0,129	0,108	0,094	0,092	0,088	0,079	0,263	0,257	0,291	0,679	0,586	0,526	0,625	1

Appendix 3-5

Structural equation model without and with controls

Parameter	Model A: Structural equation model without controls		Model B: Structural equation model with controls	
	Estimate	<i>p</i> -value	Estimate	<i>p</i> -value
PMS design for turbulence → Organizational resilience (H1)	0.298	***	0.298	***
Organizational resilience → DSP (H2)	0.368	***	0.265	***
PMS design for turbulence → DSP (H3)	0.044	0.427	0.023	0.676
Attention focusing → PMS design for turbulence (H4)	0.557	***	0.553	***
Score keeping → PMS design for turbulence (H5)	-0.110	0.250	-0.108	0.258
Market turbulence → PMS design for turbulence (control)			0.071	0.220
Market turbulence → Organizational resilience (control)			0.003	0.957
Market turbulence → DSP (control)			-0.093	0.117
Customer orientation → DSP (control)			0.258	***
Cross-functional integration → DSP (control)			0.025	0.625
R ² PMS design for turbulence	0.225		0.230	
R ² Organizational resilience	0.089		0.091	
R ² DSP	0.147		0.183	

Note: *** *p*-value < 0.001

Binary control (type of logistics organization) not included due to non-meaningful path coefficients

Appendix 4-1

Measurement scales

(all items were measured with 7-point scales ranging from 1 = I strongly disagree to 7 = I strongly agree)

a. PMS design attributes – PMS scope

Please rate the extent to which the following items describe the PMS of your logistics organization

Measurement Diversity: Our Performance Measurement System ...

MD1 ... is not limited to one dimension (e.g. financials only), but measures performance along multiple complementary dimensions.

MD2 ... ensures that all relevant performance dimensions are accounted for.

MD3 ... provides a diverse set of measures (e.g. financial/non-financial, internal/external, lagging /leading measures.)

Strategic-Operational Linkage: Our Performance Measurement System ...

SOL1 ... provides causal links between operational value drivers (input measures) and strategic results (output measures).

SOL2 ... links all business activities with the achievement of goals and objectives of the organization as a whole.

SOL3 ... provides consistent and mutually reinforcing links between current operating performance and long-term strategies.

External Linkage: Our Performance Measurement System ...

EL1 ...provides measures that link internal activities to those of our supply chain partners.

EL2 ... enhances transparency on performance linkages between different participants in the supply chain.

EL3 ... includes measures that were jointly defined with our supply chain partners (customers, suppliers, alliance partners).

Design for Turbulence: Our Performance Measurement System ...

DT1 ... uses specific risk metrics to understand the impact of external turbulence on our business.

DT2 ... uses early warning indicators to anticipate and plan for fluctuations.

DT3 ... measures market volatility to enable our organization to react on time.

b. PMS design attributes – PMS usability

Please rate the extent to which the following items describe the PMS of your logistics organization

Information Timeliness: Our Performance Measurement System ...

IT1 ... ensures more frequent measurement for continuously needed operational measures than for periodic result measures.

IT2 ... has performance measurement information readily available when needed.

IT3 ... helps to reduce the time lag between measuring performance and applying results for corrective action.

Information Aggregation: Our Performance Measurement System ...

IA1 ... focuses on relevant performance information based on selective measures.

IA2 ... provides less detailed, more focused performance information as one rises in the managerial hierarchy.

IA3 ... does not generate as many performance measures as possible but prioritizes the most relevant measures.

System Adaptability: Our Performance Measurement System ...

SA1 ... can be easily adjusted to new findings or additional requirements.

SA2 ... responds dynamically to changed requirements or circumstances.

SA3 ... is not an off-the-shelf solution but easily adjustable to our specific business requirements.

Subjective perceptions of PMS success

(all items were measured with 7-point scales ranging from 1 = I strongly disagree to 7 = I strongly agree)

Please provide your overall assessment of your logistics organization's PMS

PMS satisfaction

I am very much satisfied with our PMS.

PMS usefulness for logistics control

Our PMS is highly useful for the control of our logistics operations.

Cost-benefit efficiency: Our Performance Measurement System ...

CBE1 ... generates benefits that compensate the costs associated with its development and maintenance.

CBE2 ... shows a very adequate relationship between measurement effort and support for managerial decision-making.

CBE4 ... enhances organizational effectiveness to an extent that justifies its initial and ongoing expenditures.

CBE4 ... ensures a cost-effective gathering of performance information.

Logistics performance

(all items were measured with 7-point scales ranging from 1 = I strongly disagree to 7 = I strongly agree)

Logistics efficiency: Please rate your logistics organization's performance in comparison to competitors:

EFC1 Total logistics cost.

EFC2 Freight cost.

EFC3 Labor productivity in logistics operations.

Logistics effectiveness: Please rate your logistics organization's performance in comparison to competitors:

EFN1 The ability to meet quoted or anticipated delivery dates and quantities on a consistent basis.

EFN2 The share of over/short/damaged deliveries.

EFN3 The ability to respond to the needs and wants of key customers.

Appendix 4-2

Descriptive Statistics

Total list of key performance measures

Performance measure	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Average
Logistics effectiveness (overall average)	41%	55%	56%	68%	66%	59%
On-time delivery	65%	69%	77%	95%	90%	81%
Order fill rate	49%	66%	68%	84%	82%	73%
Cycle time	30%	53%	57%	63%	63%	55%
Customer complaints	70%	80%	84%	89%	91%	84%
Customer satisfaction	37%	61%	50%	81%	70%	61%
Returns allowances	41%	37%	51%	53%	60%	51%
Reaction time	8%	24%	26%	37%	34%	28%
Billing accuracy	10%	22%	20%	37%	33%	26%
Inventory differences	59%	69%	70%	74%	75%	71%
Logistics efficiency (overall average)	36%	51%	51%	63%	66%	55%
Total logistics cost	52%	69%	71%	86%	89%	77%
Freight cost ¹	79%	82%	86%	93%	90%	87%
Equipment downtime	21%	35%	41%	67%	59%	47%
Labor utilization	32%	57%	64%	86%	81%	67%
Warehousing cost	62%	71%	72%	77%	87%	77%
Overhead cost	56%	61%	64%	70%	78%	68%
Failure cost	16%	27%	27%	51%	43%	34%
Customer profitability	17%	43%	39%	53%	55%	44%
Inventory turnover	49%	63%	76%	77%	82%	73%
Orders per employee	27%	47%	40%	56%	58%	47%
Units per employee	25%	41%	38%	42%	54%	42%
Orders per time	33%	47%	42%	47%	61%	49%
Units per time	27%	43%	38%	47%	58%	45%
Turnover per hour	16%	35%	26%	33%	36%	30%
Space utilization	40%	55%	53%	63%	64%	57%
Equipment utilization	16%	37%	40%	54%	58%	44%

¹Calculated average value for inbound freight cost and outbound freight cost

Structural characteristics

Structural feature	Cluster I	Cluster II	Cluster III	Cluster IV	Cluster V	Average
Industry (shippers only)						
Automotive	13.9%	36.0%	15.9%	23.7%	19.1%	19.9%
Machinery and equipment	22.2%	4.0%	19.0%	15.8%	14.6%	15.9%
High-tech and electronics	11.1%	12.0%	9.5%	13.2%	4.5%	8.8%
Chemicals and pharmaceuticals	16.7%	16.0%	9.5%	10.5%	10.1%	11.6%
Consumer goods	8.3%	4.0%	17.5%	13.2%	30.3%	18.7%
Other industries	15.0%	10.0%	32.5%	17.5%	25.0%	19.9%
Organizational size (number of logistics employees in organization)						
Small (less than 100)	69.8%	40.8%	51.4%	57.9%	43.7%	51.0%
Mid-size (100 up to 999)	19.0%	40.8%	33.3%	28.1%	38.4%	33.2%
Large (1000 or more)	11.2%	18.4%	15.3%	14.0%	17.9%	15.8%