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Designing decision support systems for value-based management: A survey and an architecture

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ABSTRACT

Value-based Management (VBM) concepts are prevalent in theory and practice since shareholder value creation is commonly considered the paramount business goal. However, VBM mainly applies data-driven concepts to support decision-making, disregarding model-driven approaches. This paper develops a comprehensive approach to designing model-driven DSS for VBM. First, we derive a conceptual architecture for Integrated Business Planning (IBP) as the foundation for a model-driven approach to VBM. Second, we present a unified modeling approach for value-based performance and risk optimization that implements Value Added (xVA) performance metrics and applies robust optimization methods to mitigate risk impact.

1. Introduction and scope

Creating shareholder value is commonly considered the paramount business goal [120], and requires an integrated approach to performance [21] and risk management [98]. Value-based Management (VBM) provides a corresponding framework using value driver trees and risk-adjusted performance metrics as major concepts for performance and risk management [58]. Value driver trees drill down a top-level metric into operational levers for performance management [95] and risk implications are considered via risk-adjusted cost of capital [120]. However, there are two major drawbacks to this common approach from an OR perspective. First, value driver trees are explanatory frameworks and do not provide support on balancing conflicting value drivers. Second, the influence of uncertainty is covered indirectly via risk-adjusted parameters instead of managing risk impact based on scenario information. From a decision support perspective (see [90]), VBM mainly resorts to data-driven concepts, disregarding model-driven approaches.

Decision support models for VBM are receiving increasing attention in OR-related publications (e.g., [44,45,63,92]). These articles implement conceptual approaches [25,64,115] and build upon previous decision support models for integrated supply chain and financial management (e.g., [41,65,81,109]). They use prevalent value-based performance metrics to do this, such as discounted Free Cash Flow (FCF) and Economic Value Added (EVA), and apply robust optimization methods to deal with risk impact. A few conceptual papers discuss approaches to corporate planning and optimization advocating a comprehensive decision-oriented approach that integrates operations, financial, and risk considerations within the supply chain context [40,91,114]. However, a unified modeling approach for model-driven decision support in VBM has not yet been presented.

A comprehensive architecture for Integrated Business Planning (IBP) bridging the gap between Supply Chain Management (SCM) and Financial Management (FM) [103] constitutes the foundation for model-driven decision support in VBM. Conceptual architectures have been developed separately for SCM [34] and FM [4] summarizing a large body of literature on decision-oriented approaches in both domains [73,111]. Long-term capital budgeting/structuring and short-term working capital management constitute the two planning levels of FM [4]. SCM distinguishes three planning levels [34]: long-term strategic network planning, mid-term sales and operations planning, and short-term order fulfillment planning. Although modeling frameworks in SCM underline the relevance of financial aspects and risk implications [15,75], unified frameworks and approaches to IBP are mainly discussed outside the academic literature [10,103].

A diverse body of literature deals with Enterprise Resource Planning (ERP) [77,104], including discussions on future trends and research perspectives [55,72]. The scope of ERP expands beyond classical data and process integration to provide enhanced modeling and analytical capabilities for complex business problems [76,105]. Corresponding DSS for advanced business planning have emerged as stand-alone systems 'bolt on' ERP covering different functional aspects and methodological approaches [76,97]. Advanced Planning and Scheduling (APS) systems in SCM focus on material flows and pursue a model-driven approach using optimization methods [90,111]. In contrast, Business Planning and Simulation (BPS) systems in FM mainly cover financial

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flows and apply data-driven concepts [32,97]. Although the OR discipline could contribute substantially to the conceptual and methodological advancement of ERP [55], a comprehensive conceptual architecture for model-driven IBP has not yet been developed.

In summary, a large body of literature deals with concepts and decision support models in VBM and IBP. However, two main gaps in the literature can be determined. First, a comprehensive conceptual architecture for model-driven IBP deserves further research since corresponding approaches are confined to their respective domains. Second, various decision-oriented approaches to VBM exist, but a unified modeling approach has not yet been presented. This paper therefore develops a comprehensive approach to designing model-driven DSS for VBM. The remainder of the paper is structured as follows: a conceptual architecture for IBP following the hierarchical planning paradigm is derived in Section 2 from a literature survey. Section 3 develops a corresponding unified modeling approach for value-based performance and risk management using Value Added (xVA) performance concepts and robust optimization methods. We conclude the paper in Section 4 summarizing major research perspectives.

2. A conceptual architecture for Integrated Business Planning

2.1. Overview

In the following, we derive the Integrated Business Planning (IBP) matrix as a comprehensive conceptual architecture for model-driven DSS at the corporate level (see Fig. 1). The IBP matrix is structured along the two dimensions *time horizon* and *corporate perspective*, and follows the hierarchical planning paradigm [101]. The architecture distinguishes three different levels from long- to short-term [34], and provides an integrated perspective on profit, cash flow, and risk considerations [114]. The real-time execution level is positioned below the planning domains and covers the management of operations/financial transactions as well as risk monitoring [52,74,83].

The IBP matrix is predominantly targeted at companies in supply chain-oriented manufacturing industries, but can easily be adapted to retail and service industries. Definitions and detailed descriptions for the 8 domains, 14 subdomains, and 23 decision-relevant aspects of the IBP matrix are developed from a literature survey (see Table 1). In a hybrid top-down and bottom-up approach, we consolidate relevant conceptual and architectural frameworks for decision support in IBP, and investigate decision-oriented aspects from selective influential papers. Surveying the literature on decision-oriented approaches, we focus on mixed-integer linear programming models due to their prevalence in model-driven DSS for corporate planning [111].

Profit and cash flow perspective constitute the two pillars of corporate performance [58]. The profit perspective covers the physical dimension of business, and thus includes all (dis-)investment and operational decisions in SCM [34] as well as Supplier and Customer Relationship Management (SRM and CRM), Product Lifecycle Management (PLM), and Human Resource Management (HRM) [76]. Since the physical and financial dimensions are inextricably interlinked [103], the cash flow perspective covers decisions on capital budgeting and working capital management to finance decisions of the physical domains and to ensure fundamental liquidity [4]. A separate risk perspective [98,114] is introduced to complete the model-driven approach to integrated performance and risk management.

Two types of risk can be distinguished according to their severity [112]: *operational risks* result from the uncertainty of future events in the ordinary course of business, as opposed to *disruption risks* from natural or man-made disasters. Decision-oriented approaches can address both types of risk [45,60] and implement the four common risk management responses [116]: risk *avoidance* and *adoption* either completely eliminate or accept risks and thus correspond to configuration decisions at the long-term level. Coordination decisions at the mid- to short-term level result in risk *mitigation* or *transfer*, reducing or sharing risk impact [98].

A company creates value if earnings exceed total costs of invested capital [95]. Although a multitude of value-based performance metrics exists [95,120], model-driven approaches mainly focus on Value Added (xVA) concepts such as Economic Value Added (EVA) or metrics based on Free Cash Flow (FCF) such as Corporate Value (CV) or Shareholder Value (SV). Hahn and Kuhn [44] implement the EVA concept in mid-term corporate planning and compare the integrated value-based approach to a common approach where the physical and financial perspectives are optimized sequentially. The numerical analyses outline a substantial improvement potential in EVA of between 9% and 32%. Majumdar and Chattopadhyay [70] conduct a similar analysis for their integrated approach to investment and financial planning in power systems. They evaluate the incremental net worth of the firm and obtain an improvement potential of 22% for the integrated approach. Incremental net worth of the firm is comparable to Market Value Added (MVA) which is the multi-annual extension of the EVA concept [120]. Lainez et al. [62] investigate optimal supply

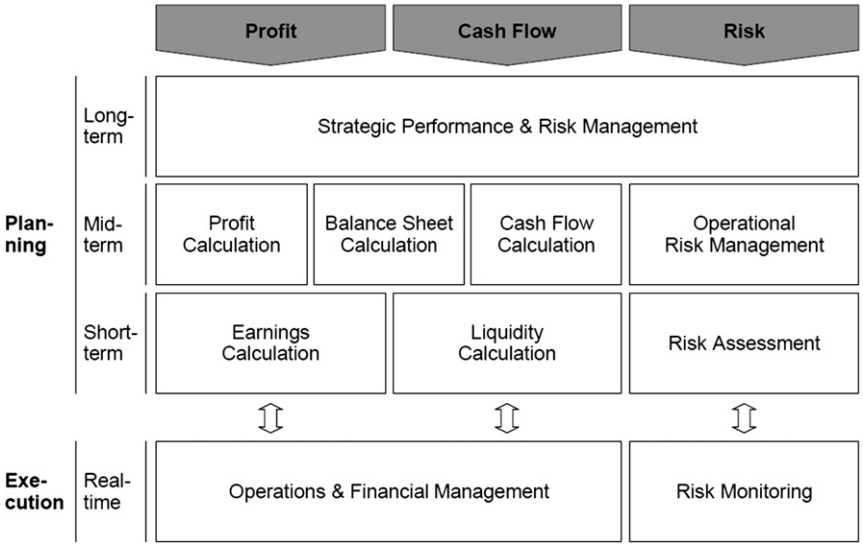

Fig. 1. The Integrated Business Planning (IBP) matrix.