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How to support plant managers in strategizing volume-oriented changeability in volatile and uncertain times – Deriving requirements for a practice-oriented approach

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Abstract. Volume-oriented Changeability (VoC) contributes to a production plant's profitability and competitiveness in the face of increasing demand volatility and uncertainty, which is characterized by more frequent and severely affecting extreme events. Strategizing VoC in practice entails overcoming obstacles due to dynamic and interdependent target conflicts. Currently, a dedicated and applicable approach is lacking. Based on identified obstacles, requirements are derived for providing plant's general managers conceptual and methodical support within strategizing VoC. The requirements constitute the result of this paper and should be taken into account by subsequent research on academically sound and practical relevant approaches for the defined purpose.

Keywords: Uncertainty; Volatility; Resilience; Volume-oriented Changeability; Strategizing; Demand-responsive Supply Chain.

1 Introduction

The environment of production plants is characterized by increasing demand volatility and uncertainty, which also comprises major disruptions due to extreme events, like grey or black swans [1, 2]. As the frequency and extent of those fluctuations and extreme events as well as the number of unknown risks in an uncertain world is increasing, it is hardly possible to use common forecasting methods anymore. Assumptions and derived decisions regarding configuring production resources of plants often turn out to be wrong. A multitude of scientific approaches and concepts have been developed, and these often focus on technical-related topics [3]. The concept of volume-oriented changeability (VoC) was introduced [4, 5] with the target of synchronizing capacities and costs with demand fluctuations. VoC can be regarded as a specific subset of the broad concept of changeability [4]. It should provide added value for plant managers or managers in charge as project managers to strategize and/or implement procedures to economically and competitively handle implications of demand volatility and uncertainty. The plant level including the interface towards corporate management is still being widely neglected in the research on responsiveness of organizations and organizational units towards volatility and uncertainty. Existing scientific approaches are either designed for the company level [6], supply chain level [7], manufacturing network

level [8], or on the factory level, which mainly focuses on topics with high relevance for operations and logistics closely related to the shop floor [3, 9, 10]. There is a lack of attention in literature to providing practically relevant and applicable approaches and tools that address important fields and occurring obstacles within strategizing VoC of production plants. These obstacles (summarized in chapter 2) were identified in recently conducted action research cases (in eight production plants in six countries over two years) regarding strategizing abilities of production plants in the face of demand volatility and uncertainty. They were evaluated by Rippel et al. [11]. Based on this findings and the same action research cases, this paper derives requirements for an approach for strategizing the ability of production plants to economically and competitively handle volatility and uncertainty. The purpose is to provide the key parameters for subsequent research on an academically sound and practice-oriented approach.

2 Revealing obstacles within strategizing VoC

Obstacles, classified as target-immanent or approach-immanent, were identified and evaluated by Rippel et. al [11] and summarized in the following:

Business cycle-continuous profitability (O1) considers the arising trade-off between stability of unit costs (advantageous: high share of variable costs) in decline phases and exploitation of fixed costs degression effects (advantageous: high share of fixed costs) in growth phases. **Multi-period competitiveness (O2)** addresses that risks are transferred to third parties in order to handle volatility and uncertainty, which comes at a price. The “risk premiums” might exist in a non-transparent form due to their indirect and long-term nature (e.g., innovativeness or attractiveness of the company as employer). **Multi-dimensional performance (O3)** reveals that the synchronization of costs and capacities with demand volumes has implications for other target dimensions of technical, social and financial natures. These implications can be supportive or obstructive to existing strategies and implied target dimensions. **Vigorous effectiveness (O4)** refers to the extent and speed as essential factors within VoC. Accordingly, the scope should not be limited to production functions but include support and administrative functions of the plant. Furthermore, plants lose time to actually interpret the changes of the business environment but then might decide and act too rigorously due to time pressure and accumulating manufacturing costs. **Practice-oriented applicability (O5)** indicates that many approaches lack applicability in practice due to their partly single-disciplinary nature, unfeasible requirements in terms of required data and effort due to the frequently enormous complexity. Besides, many assumptions and forecasts are required but might include fragile and erroneous input in face of uncertainty with unknown risks.

3 Deriving requirements for strategizing VoC in practice

Based on the identified obstacles, requirements for a practically relevant and effective approach for strategizing VoC are derived and incipient hypotheses of possible solutions are given in the following.

3.1 Purpose-oriented requirements

The category “purpose-oriented” comprises three requirements which details the purpose of the underlying target of VoC, which is synchronizing capacity and costs with demand fluctuation.

Solution concreteness. Approaches should explicitly address challenges, obstacles and solutions for handling volume fluctuations in production plants and contributing to a demand-responsive supply chain. Instead of generally covering various change drivers and dimensions, solutions specifically for volume fluctuations have to be defined. Thereby, plant managers should be guided by what necessarily and concretely needs to be considered in order to preventively implement measures and adapt structures, behavior and activities. For doing so, an approach should suggest relevant and important fields of action to be considered and possible enablers and levers. Solution concreteness mainly contributes to tackling the obstacles O4 and O5.

Financial explicitness. This requirement incorporates the relevance of financial considerations within managerial decision making. Beyond providing the technical possibilities to scale capacity in case of demand in-/decrease, approaches have to stress financial impacts both regarding additional costs for VoC potentials but also the target effectiveness, namely the degree of synchronization between capacities and production costs and resulting stability of unit costs and profit margins. Besides costs and capacity, the cash-flow of a production plant is endangered in the considered market environment. As fixed costs often comprise fixed cash outflows and investments into fixed structures imply amounts of bound capital, fluctuating cash inflows driven by demand volatility put severe pressure on the plant’s liquidity. An approach should clearly differentiate between and make transparent the above named types and significance of financial impacts (i.e., cash-flow effective and/or profit-&-loss effective), since the effect might vary [12]. An approach should reflect and define a project-specific understanding, priorities and expectations (of involved stakeholders) as well as ambition level regarding profitability and competitiveness related to cash-flow and/or profit-&-loss impacts. This should set clear guidance for the solution search within the strategizing project and finally assess the target achievement. In particular, financial explicitness addresses the obstacles O4 and O2.

Uncertainty-adequate. The approach to be developed should sufficiently incorporate the characteristics and constraints of uncertainty, which are considered in this paper as “the insufficiency or imperfection of knowledge or information critical to decision-making, concerning the past, present or future events, or conditions within and surrounding an organizational system” [13, p. 401]. Within this paper and the VoC concept, we assume that neither objective nor subjective probabilities are present, which makes rational decision-making nearly impossible [14]. This requirement sets the most challenging criteria since it is questioning common approaches to model and to evaluate benefits of changeability. Significant limitations exist in modeling the system, and these reduce the practical relevance in the end. The ensuing results might incorporate an illusion of accuracy and certainty [15]. According to Gigerenzer, “When we face a complex problem, we look for a complex solution. And when it doesn’t work, we seek an even more complex one. In an uncertain world, that’s a big error. Complex problems

do not always require complex solutions.” [15, pp. 14] Therefore, a robust approach should incorporate simple and heuristic elements where possible and reasonable. The requirement “uncertainty-adequate” would address obstacles O5, O2 and O1.

3.2 System boundary-dependent requirements

Within the system boundary-dependent requirements, the focus is to define which system elements, interfaces and interdependencies have to be investigated and where design possibility exists within the considered system “production plant” [14].

Strategic plant level. Taking account the underlying problem mentioned above, strategic management at the production plant is likely to be the hierarchical level in charge of responding effectively to volatile and uncertain demand volumes. This level is relevant since manufacturing costs are highly sensitive due to fixed cost components and main fixed costs are bound on this system level [16]. Main fixed costs of a production plant consist of assets and personnel costs, in particular in indirect plant functions. It is at the strategic plant level where structures, (i.e., people and assets) are determined and planned upon. Measures to synchronize costs and capacity with demand can be implemented by taking a holistic perspective and has probably the highest leverage potential since plant management is not limited to managing production functions but also several supportive functions. Therefore, an approach should holistically address the strategic plant level and define the system boundaries accordingly. The manufacturing network, supply chain and company level are considered as supersystem, whereas the factory level (in the narrower, production-related sense) and further downward levels are defined as subsystem. The specific needs and obstacles of a plant’s general managers to handle demand volatility and uncertainty should be addressed. In particular, their permitted and authorized scope for action should be appropriately taken into consideration since this scope might set significant limitations and restrictions to modifying and intervening in the plant and further cross-organizational processes, structures and patterns. Thus, this requirement mainly addresses obstacle O4 and additionally O3 and O5.

Interdisciplinary solution space. Basically, a multitude of approaches, measures and solutions for different partial problem aspects and occurring tasks within the broad concept of changeability exist [3, 10]. Since VoC-relevant measures were developed from a multitude of different disciplines (e.g., finance and sourcing, engineering and factory planning, supply chain management, human resource), an integrated toolkit is barely available for holistic, strategic management level. The intentions and priorities of the various disciplinary streams differ and are sometimes contradictive to each other [5]. For example, technical approaches to increase the changeability of production systems, which could be advantageous from an engineering perspective, might stand in contrast to measures proposed by asset management approaches. Therefore, a portfolio of solution options and alternatives from different disciplines should be comprehensively revealed and an overview of specific measures provided for practitioners in order to be able to compare dis-/advantages of measures and resulting target conflicts, to select plant-specific appropriate measures and to combine their impacts. Interdisciplinary solution space is beneficial in taking obstacles O3 and O4 into account.

3.3 Organization concept-oriented requirements

Based on the above mentioned system level, the organizational concept of the plant has to be considered according to management aspects and dimensions since system-dependent contradictions and restrictions originate here [4]. Partly, they can be influenced by the plant management in the short-, middle- or long-term.

Socio-technical management aspects. A socio-technical system is a hybrid form of a social system and a technical system and consists of interrelated elements of both system types [17]. Therefore, a production plant can be considered a socio-technical system since it consists of human beings and technical devices interacting with each other [18]. Socio-technical analysis of VoC means to consider not merely comprising human and technical system elements and their interactions but to extend the view beyond that and integrate in particular behavioral and activity-oriented aspects. In order to include this understanding, the system aspects “structure,” “behavior” and “activities” should be addressed in an integrated manner [19]. In regard to synchronizing capacities and costs with demand volumes, the following topics of these aspects can be considered as relevant: Structure consists of resources mainly in the form of personnel and assets as well as organizational structure and processes [20]. This structure is the object that is managed in relation to volatile and uncertain demand volumes. Here, preventive measures are to be applied in order to make the structure compliant with its environment. Behavior refers to the decision-making, underlying rationales and cognitive biases of management (as function) and managers (as individuals) in a production plant. Here, attitude towards risk, time preferences, degree of commitment and cohesiveness play an important role [4]. When it comes to the described environment, decision-making regarding uncertainty in practice as well as established incentive, steering and performance measurement systems influencing the social practices are to be investigated. Activities on the strategic level comprise the strategy development and formulation process, here referred to as strategizing, in order to adjust structures and behavior, to implement measures and to conduct detailed studies and projects afterwards. Including the management aspects significantly influences the speed of action and the culture of decision making and addresses obstacles O1, O2 and O3.

Management dimensions. As defined above, the strategic plant management is the relevant system level to be considered. According to Bleicher [19], the focus of strategic considerations are strategic programs as well as the design of fundamental structures, systems of management and of the problem solving behavior of the relevant individuals. However, this management dimension should not be considered independently since manifold interdependencies take place [19]. Bleicher also argues that the task of strategic management is to influence the alignment of activities, which are established by the normative management and which focus on general targets, principles, norms and guidelines. The operational management focuses on the implementation of conceptual specifications of the normative and strategic level by means of operations according to capabilities and resources [19]. However, unexpected events can occur as obstacles within operations, which require changing future expectations (visions of the normative level) and strategies (programs of the strategic level) [19]. Ac-

cordingly, the normative and the operational plant management level has to be considered in an integrative manner within strategizing VoC. However, the potential to influence might be limited since important aspects are largely given by corporate directives (e.g., role and functions of the plant within the manufacturing network and supply chain) and can just be “translated or completed” by local plant management. Furthermore, behavior aspects of the normative level (e.g., plant-specific characteristics of corporate culture) can be indirectly influenced in the long-term. The implementation on the operational level might require adaptations to local (cultural and legal) conditions (e.g., social practices, concerns and reservations due to events in the past, formal and informal leadership, statutory participation of employees) [20]. These could incorporate plant-specific restrictions if plant management cannot directly and fully influence them. Therefore, an approach should integrate management dimensions beyond the strategic level as a generic framework in order to enable adaptation to plant-specific conditions and restrictions within strategizing. Thereby, it focuses on obstacles O3, O4 and O5.

3.4 Contextual requirements

The contextual requirements address areas beyond the plant- or project-specific system boundaries, which should be investigated due to their relevance as input for strategizing VoC or due to the impact of VoC on them. They incorporate relevant relations to the hierarchical superior (supersystem) and subordinate systems (subsystem), which affect setting management priorities. Hence, the contextual prerequisites, the organizational and strategic embeddedness of the plant into the manufacturing network and the company as a whole and inter-organizational implications are to be regarded [21].

Consistent strategic alignment. The above summarized obstacles [4] highlight the complexity of the underlying problem. The obstacles O1 and O2 reveal existing and dynamic changing target conflicts for managers. The obstacles O3 and O4 worsen and cause further target conflicts due to various existing interfaces and interdependencies between different target dimensions, management aspects and interests of stakeholders across several organizational and hierarchical company levels [4]. These kind of target conflicts often exist in management aspects of networked systems [19] and involve cross-hierarchical practices [5]. An approach should make these target conflicts transparent to decision makers, probe the causes of them and provide options to balance them. Consistent strategic alignment should address the obstacles O3, O2 and O1.

Coherent strategic alignment. This requirement takes into account the subordinate production-related system level as well as the interfaces towards corporate management and network management. The subordinate levels include crucial elements in regard to cost structure (e.g., labor, material and machinery) and comprise technical and/or technological potentials or limitations. The superior levels set the rules and assignments for the plant management. Lastly, it is within each plant management’s target scope to identify and sustain its strategic value within the company’s manufacturing network (e.g., within performance measurement, which might focus on benchmarks of the plant in relation to internal and external competitors). Thus, it is necessary to closely look at the temporal preferences of the organization and individuals (i.e., incentive systems) regarding realizing benefits. The requirement focuses on obstacles O1, O2 and O3.

3.5 Approach-oriented requirements

Many theoretically founded management approaches are too complex or too generic to be directly applied in practice. Besides, various approaches are lacking clear guidance on how to be applied in practice. Kerr et al. point out seven key principles for developing industrially relevant strategic technology management toolkits [22]: Since strategic problem solving is a social process, it should be developed under participation and social interaction of individuals, i.e. **human-centric**. The mode of this interaction and participation shall be **workshop-based** since it offers the opportunity to merge individual knowledge into collective knowledge which is crucial in face of the complexity of strategic problems. The process shall be **neutrally-facilitated** by an individual external to the system. The process shall remain **lightly processed**, i.e. flexible. It includes alternating steps of divergence and convergence as well as plenary and small group sessions. Different tools shall be integrated. Results shall be in a **modular** form. The tools should be **scalable** and applicable at different levels within the organization. It should be **visualized** both in the application and in the output. These should also serve as guiding principles for an applicable approach for strategizing VoC. In order to get solid results within a limited timeframe, existing approaches might need to be adapted.

4 Conclusion and Outlook

The target of volume-oriented changeability (VoC), synchronizing of capacities and costs with demand fluctuation, should ensure the plant's profitability and competitiveness. However, obstacles arise within the strategizing. Practitioners' on the plant level require methodical and conceptual support to realign their strategy regarding structure, activities and behavior in a socio-technical perspective. Within this paper requirements are presented in order to provide scientific researchers a guideline for developing an academically sound and practice-oriented approach that support plant managers in strategizing VoC. The requirements also function as criteria to evaluate existing scholarly approaches regarding their appropriateness for the given problem context.

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