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Increasing Resilience in Procurement in the Context of the Internet of Production

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Abstract

Recent developments have demonstrated the challenges and impacts of disruptions in supply chains. Current disruptions especially affected procurement and have indicated a lack of resilience. Resilience aims at being prepared, decreasing the impact, and enabling fast reactions and adaption in case of disruptions. The systematic design of resilience in procurement is significantly influenced by proactive and strategic actions before disruptions occur. Thus, the procurement strategy plays a major role when increasing resilience. The procurement strategy is influenced by various factors. Thus, a data-based approach for its systematic design is required. Based on the vision of the Internet of Production (IoP), this paper presents a data-based approach for designing procurement strategies. The IoP is a framework that enables cross-domain collaboration by providing semantically adequate and contextual data from production, development, and usage in real-time at an appropriate granularity. The paper aims at analyzing the state of the art regarding the design of procurement strategy in uncertain environments and the identification of success-critical purchased articles. Based on this, an approach is developed that is structured along the action research cycle and uses CRISP-DM to further detail the different steps. Through the use of these frameworks, both practical applicability and objective evaluation are ensured. The proposed approach thus allows the systematic evaluation of purchased articles regarding supply risks and lies the foundation for the adaption of the procurement strategy. The resulting approach is the foundation for future practical application of different use cases. As one central use case for the presented approach, the paper introduces the textile industry and its supply chains.

Keywords

Resilience; Procurement Strategy; Disruptions; Supply Risks; Textile Supply Chain

1. Introduction

Companies operate in an increasingly volatile and uncertain environment and face different kinds of disruptions. Hard-to-predict disruptions like the Covid-19 pandemic come hand-in-hand with numerous uncertainties and impact multiple areas of the supply chain. Disruptions can impact the procurement side through difficulties in sourcing input products, while on the sales side, companies are for example confronted with major changes (decline or increase) in their sales volumes. Besides effects on the internal production processes can include employee outages or production downtime. [1] The effects of the Covid-19 pandemic illustrate the lack of preparation of companies for crises and the resulting disturbances. Moreover, disruptions are expected to occur more frequently in the future. For example, a disruption lasting at least one month is expected to occur on average every 3.7 years [2]. Additionally, several factors lead to an increase in complexity in the supply chains of companies. Shorter product lifecycles and the demand for customized products result in an increasing number of products and parts to be coordinated. [3] Complex product

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structures and increasing interconnectivity between value-adding partners lead to increasingly complex procurement structures. [4] This development contributes to a higher vulnerability to disruptions of companies and their supply chains.

To ensure competitiveness, companies must therefore prepare for disruptions. One way of dealing with uncertainty and disruption is represented by the concept of resilience, which has received increasing attention in research in recent years [5] Resilience aims at designing companies in such a way that they are affected as little as possible in the event of a disruption and quickly return to their original state [6]. The level of resilience is significantly influenced by actions initiated before the disruption. A lack of preparation to reduce the impact and possible damage can lead to uncoordinated, delayed, or even ineffective responses in the case of disruptions [7]. Thus, the systematic design of resilience is required [8].

Although disruptions can occur at different points in supply chains, they are particularly critical when they occur on the procurement side [9]. Minimizing and monitoring procurement-side disruptions is critical for companies to anticipate, adapt and respond to sudden changes, recover, and gain experience to manage subsequent disruptions more effectively [10]. In particular, the procurement strategy influences the competitiveness and continued existence of companies after disruptions [11]. In this context, the procurement strategy must be adjusted at an early stage since a short-term change is often hardly possible. Different items and raw materials must be procured for each product manufactured. Since each of these items has different characteristics, procurement strategies must be adjusted accordingly. [12,13] In doing so, various factors have to be taken into account.

For the systematic design of a resilient procurement strategy in terms of resilience transparency about the procurement situation is required. By linking and analyzing different data sources, the framework of the Internet of Production (IoP) enables data-based support for the design of the procurement strategy. As part of the research project Cluster of Excellence “Internet of Production”, the presented project, therefore, aims at answering the question of how the procurement strategy can be evaluated and designed based on internal and external data to ensure high logistics performance in an uncertain environment.

This paper demonstrates how resilience in procurement can be increased in the context of the IoP. It thus aims at summarizing the state of the art regarding the design of the procurement strategy with regards to disruptions and the identification of success-critical purchased articles. Furthermore, it seeks to develop a data-based approach for designing the procurement strategy. For future practical application of the approach, a use case of the textile industry and challenges in the procurement within textile supply chains are presented.

The remainder of this paper is organized as follows. Section 2 defines the terms resilience and procurement and introduces the concept of the IoP. Section 3 summarizes current approaches for designing procurement strategies and identifying critical purchased articles. Section 4 introduces the data-based approach for the design of the procurement strategy in the IoP and section 5 presents the use case of the textile industry.

2. Design of the Procurement Strategy in the IoP

In this chapter, the vision of the project is presented. In doing so, the terms resilience and procurement are first defined. The introduction of the overall goal of the IoP is the foundation for the vision of the data-based design of the procurement strategy.

2.1 Procurement and Resilience

KAMALAHMADI & PARAST define **supply chain resilience** as “the adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations” [5].

From the **supply perspective**, resilience describes the ability of the buying firm to develop effective practices in anticipating, adapting, responding, recovering, and learning from any disruptive event using resource management. Resilience is considered a dynamic set of conditions that enables the organization to better cope with unpredictable disruptions (both reactive and proactive) and is achieved through ongoing resource configuration and management practices designed to recover knowledge from past experiences so that risks and vulnerabilities can be identified and managed. This also involves collaboration with internal and external partners to improve visibility across a complex network. [10]

Overall, **procurement** focuses on the acquisition of goods required to carry out, maintain and control the company's activities, considering quality, quantity, delivery time, and affordable prices. To align internal supply requirements with the outside (market-) conditions, companies require procurement strategies. [12] While strategic procurement activities are concerned with supply planning, supplier selection and contracting, operational activities include material ordering, order processing and payment. In addition to ensuring a secure and timely supply, procurement also aims to achieve good costs and contribute to innovation and the improvement of a company's strategic position. Procurement activities have three main objectives: ensuring safe, timely, and sufficient supplies at adequate quality with the lowest possible cost. Further objectives are to facilitate innovation from and with suppliers and to secure competitive advantages for the company by ensuring privileged access to sources of supply. [14,13]

Procurement strategies are purchasing plans, made to facilitate the achievement of superordinate objectives. The setting of a procurement strategy includes the determination of the number of suppliers on the one hand and on the other hand the definition of a supplier selection strategy, the number of purchases, and the sales/purchase relationship with suppliers. During the definition of such strategies, companies must identify the characteristics of each procurement item. [12]

For each manufactured product, the procurement of various items and raw materials is necessary. The choice of the right procurement strategy for different items depends on the characteristics of the items. [12] As product complexity increases, so does the complexity of the production process, and with it the requirements for collaboration between production planning and resource procurement. Particularly in cases where a company manufactures several different products, this collaboration can no longer be based purely on experience. [15] A company's procurement department employees are often responsible for purchasing a wide range of materials, making it difficult for them to develop specific industry knowledge which is relevant for future purchases. Depending on the size of the company, transparency within the procurement process may be lost, with different company departments ordering from the same supplier on different terms and purchasing power not being utilized due to small order quantities. [13] When it comes to decisions made during the procurement process, supply risks have a significant impact. [14] Due to the complex procurement structures, it is therefore important to identify articles that pose high supply risks and have a high impact on the company’s resilience when designing the procurement strategy. To determine which critical material poses the greatest risk of disruption, the concept of criticality must first be defined. There is no universally recognized definition of criticality because any essential material required by a manufacturer can be considered critical to that operation. However, in the context of raw material criticality, a material is considered critical when the risks of supply disruptions and their impact on the economy are higher compared to most other raw materials. [16]

2.2 The Vision of the IoP

The vision of the IoP is to increase productivity and agility across different engineering domains along the whole product lifecycle by enabling cross-domain data access. This data access allows a new level of cross-domain collaboration. [17] As a basis for this, so-called Digital Shadows are developed that link heterogeneous data sources and detailed production engineering models to provide decision support. A Digital Shadow contains “sufficiently aggregated, multi-perspective and persistent data sets, which are generated by the conscious selection, cleaning, semantic integration and analysis and serve for reporting, diagnosis, prediction, and recommendation" [17]. The framework of the IoP is structured along with the three different phases of the product lifecycle (the development cycle, the production cycle, and the user cycle) and consists of three hierarchical layers (see Figure 1).

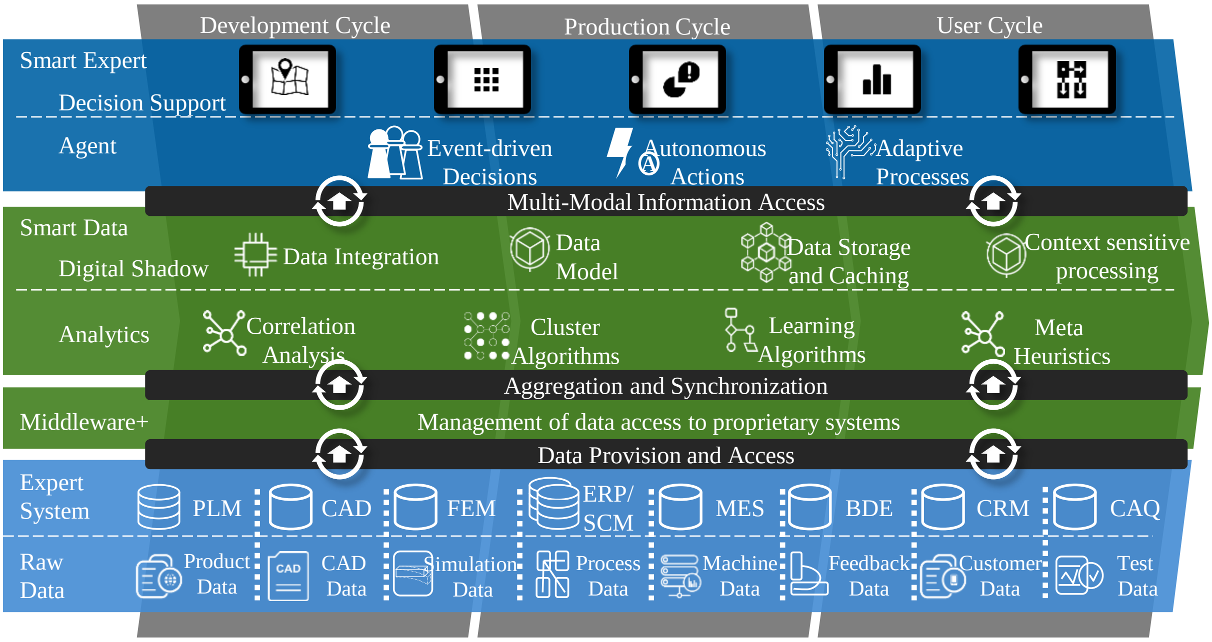

Figure 1: Infrastructure of the Internet of Production [18]

Analysis and decision support are based on raw data derived from various business application systems such as ERP systems. To generate smart data with a higher information content the raw data is processed with the help of algorithms and business analytics. With the use of assistance systems, that enable fast and well-founded decision making, the gathered information can then be utilized by the decision-maker. Various assistance systems in the different cycles are developed within the research project Cluster of Excellence "Internet of Production". [18]

2.3 Data-based Design of the Procurement Strategy in the IoP

The content of this paper is part of the production cycle. Within the IoP, production management aims to increase the quality and speed of decision-making in a volatile and uncertain environment. [17] The overall goal is the development of a so-called "Global Production Cockpit" which links different developed applications and assistance systems with one another. In this way, the combination of different data can increase the knowledge gained and improve future decision-making. For this to be successful, the user-specific applicability of the data must be ensured through user-oriented processing. Additionally, the user shall be able to access the processed data through several different applications. [19]

The presented project contributes to the overall vision of increasing decision quality in production management. It focuses on the processes at the intersection of different network partners and the improvement of the design of the procurement network to secure material supply in a turbulent environment. As ensuring material availability is a major prerequisite of successful production, it plays an important part in creating the "Global Production Cockpit". The overall goal of the project is to improve the systematic design of the procurement strategy. It aims at increasing the transparency regarding the current procurement situation of a company as a basis for further risk analysis and adaptation. Moreover, the project focuses on providing risk analysis with a focus on supply risks. An application is developed that enables the identification of success-critical purchased parts and provides recommendations for the adaption of the procurement strategy. This application uses both internal and external data (s. Figure 2).

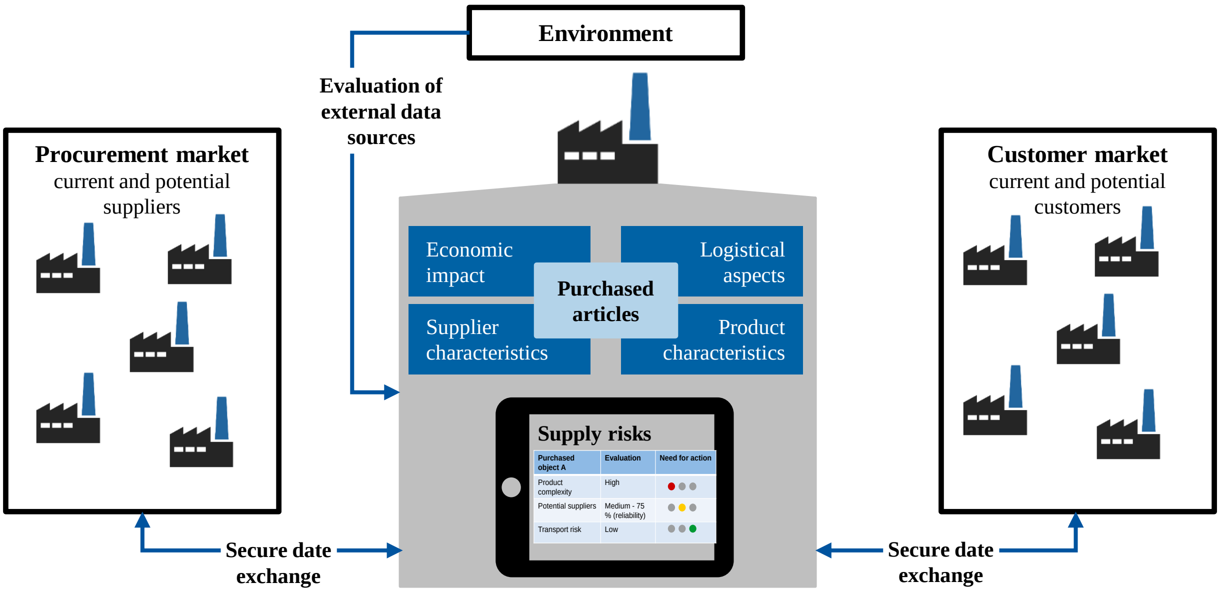

Figure 2: Application framework and considered influencing domains

3. State of the Art

The analysis of state of the art focuses on approaches to develop procurement strategies as well as approaches to identify critical purchased articles. Special attention is paid to dimensions and criteria that allow the characterization of purchased articles regarding supply risks.

3.1 Approaches for Developing Procurement Strategies

Portfolio methods are often used to develop procurement strategies. Through evaluating company-external and company-internal factors products or suppliers are categorized in a 2x2-matrix and standard strategies can be derived. Based on this, concrete strategically suitable actions are then assigned and developed. [20] The first comprehensive portfolio approach to purchasing and supply management was introduced by KRALJIC. It classifies products based on supply risk/complexity and importance/profit impact in non-critical, leveraged, bottleneck, and strategic goods and provides recommendations for the procurement strategy. The external dimension (supply risk/complexity) addresses factors related to suppliers and the procurement market, namely availability, number of suppliers, competitive demand, make-or-buy opportunities as well as inventory risks and substitution opportunities while the internal dimension relates to the importance and profit impact of a particular product. The internal dimension is represented by purchase volume, percentage of total purchase cost, and impact on product quality/business. Each dimension must be evaluated based on several variables, with an overall score ("low" and "high") being determined. [21]

JAIPURIA ET AL. describe a quantitative approach for the advancement of Kraljic's procurement matrix, which particularly considers the procurement costs, to reduce the controllable cost components. Considering Kraljic's procurement portfolio model, spend analysis and market analysis are applied to identify the strategic issues based on the cost structure and market conditions. [14]

To overcome the qualitative and thus subjective nature of the Kraljic Portfolio Matrix (KPM), MONTGOMERY ET AL. develop an objective, quantitative decision analysis approach for positioning products and services within the KPM. The strategic purchasing attributes of the KPM are quantified using individual attribute value functions. A multi-attribute value function is then used to quantify and rank products and services within the KPM based on the two strategic purchasing objectives. [22]

DIXIT develops an integrated framework composed of item type, buyer-supplier relationship type, pricing type, and six types of procurement risk (delay in receipt of items, change in currency rate, disruption in communication, funding problem, failure to realize technology, and requirements and failure to contact enough suppliers) to select the best combination as the item procurement strategy. Throughout the methodology, the Kraljic matrix is used to categorize items being procured for a project. Given that the described framework focuses only on EPC (Engineering-Procurement-Construction) projects, future extensions of this study could analyze and compare procurement risks from multiple sectors. [23]

Portfolio approaches support the design of procurement strategies. However, there are several limitations. These limitations include the condensation to only two dimensions and a lack of objectivity in the classification within the evaluation dimensions. The quality of the strategy derived from the purchasing matrix is thus strongly related to the know-how of the purchaser. Also, due to the two-dimensionality of the method, important decision criteria are neglected. [20,24] Moreover, it is criticized that the supplier side and the buyer-supplier relationship are disregarded. [13,24]

3.2 Approaches to Identify Critical Purchased Articles

Research related to criticality assessments mostly focuses on supply chain disruptions caused by raw materials, such as non-energy minerals, metals, or biotic materials. [25] These approaches can serve as input for the identification of critical purchased articles and are thus summarized in the following. Raw material criticality assessment is used to identify the likelihood of supply disruptions of the material and the vulnerability of a system (e.g., an economy, a technology, or a company) to that disruption. In a literature review by SCHRIJVERS ET AL. [25], it was found that criticality assessments diverge in terms of the system under study, the expected risk, the objective of the study, and material selection, leading to different decisions regarding indicator selection, the level of aggregation required, and the subsequent choice of aggregation method and the need for a threshold. Data availability and data quality were identified as key factors during the assessment of raw material criticality. [25]

HELBIG ET AL. [26] review methods for evaluating raw material criticality, including assessments of vulnerability to supply shortages. These raw material vulnerability assessments use a variety of indicators representing the economic importance of that raw material, its importance to a strategic objective, or the impact of supply disruptions. Eighteen vulnerability indicators have been identified, of which a set of six are commonly used (substitutability, value of products affected, future demand-to-supply ratio, strategic importance, value of utilized material, and spread of utilization). The created overview on vulnerability aims to provide a basis for the selection of vulnerability indicators, corresponding thresholds, and weightings in future raw material criticality assessments. [26]

LAPKO ET AL. [27] examine how manufacturing companies in different sectors and supply chains assess the criticality of materials and what strategies they pursue to mitigate this criticality. The assessment of criticality is based on the materials identified by the European Commission as being critical due to their high economic importance and high supply constraints (e.g. antimony, beryllium, cobalt). It was found that the criticality factors and mitigation strategies used in companies are not very extensive compared to those established in the literature and that companies are not inclined to trace the supply risk factors back through multiple levels of suppliers to their source. The results also indicate the existence of interdependencies between companies within and between supply chains, which should be included in the assessment of material criticality. [27]

Defining critical materials (CM) as any raw materials whose risks of supply shortages and impact on the economy are higher compared to most other raw materials (e.g. Neodymium, Germanium, Gallium), the research by GARDNER ET AL. [16] focuses on improving the resilience of manufacturers. The paper proposes a framework enabling a manufacturer to effectively and systematically identify, assess, and mitigate CM risks. To identify CM, a list of keywords is developed against which input data is compared. The scenario planning capability aims to provide the manufacturer with insights into how changes in current circumstances may cause significant shifts in risk, which in turn may affect the available mitigation options or what is ultimately considered the most effective or desirable mitigation strategy. The major limitation of the proposed tool is its dependence on the high quality of both internal and external data. Internal data is provided to the user in conjunction with a "Tool User Guide"; external data must be updated through a knowledgeable source. [16]

Griffin et al. [28] develop a framework for evaluating material criticality on the enterprise level. This work aims to quantify the impact of supply chain disruptions on companies by developing a risk monitoring methodology using metrics and organizational structures embedded within a company. To do so, three categories of risk are initially defined: profitability, product concept viability, and production. The first category is designed to capture threats to the financial sustainability of firms manufacturing products that rely on a particular critical material. The second category concerns, in part, the ability of a product to still meet performance requirements when an initially specified critical material is affected by a supply disruption and, in part, the market potential of a product that depends on a particular critical material. The third category is intended to capture threats to the production and distribution of products that rely on a specific critical material. Using internal company-specific data, a criticality risk assessment and monitoring matrix was developed. The matrix includes the three risk categories, mentioned above, as well as four key business functions, including finance, procurement, marketing, and production. [28]

Figure 3 summarizes the examined approaches and classifies them in terms of different criteria.

	Industry independent approach	**Data-based evaluation of**		**Classification of**		**Recommended strategy design**
		Procurement strategy	**Supply risk**	**Raw material criticality**	**Purchased articles**	
Kraljic (1983)	●	○	◑	○	●	●
Jaipuria et al. (2016)	○	◑	◑	◑	○	●
Montgomery et al. (2018)	●	●	○	○	●	○
Dixit (2020)	○	○	●	○	●	●
Helbig et al. (2016)	◑	○	○	●	○	○
Lapko et al. (2016)	◑	○	◑	●	◑	●
Gardner et al. (2018)	◑	○	●	●	◑	○
Griffin et al. (2019)	●	○	●	●	◑	○

Figure 3: Classification of the examined approaches

Approaches for designing the procurement strategy are often based on a qualitative evaluation and do not allow a data-based evaluation of the procurement strategy or the supply risk. However, as the portfolio approaches focus on the derivation of standard strategies, they support the design of the procurement strategies by providing recommendations for strategy design. Current research on criticality assessments generally focuses on the supply of raw materials such as metals or other resources and rarely considers the supply of components or finished products. As the assessment of criticality often requires an overview of various risks and criticality factors, data-based approaches are rather common. The extent to which the identified indicators are applicable for the assessment of component and product criticality remains to be examined and will be part of the presented project. To increase the resilience in procurement the evaluation of the purchased articles regarding supply risks and recommendations for designing the procurement strategy are required. The analysis of the state of the art demonstrates, that a data-based approach for such an evaluation is needed to ensure an objective evaluation. However, current approaches that focus on supply risks of purchased articles are lacking.

4. Approach for Data-based Design of Procurement Strategies in the IoP

Based on the identified research need, an approach is developed in the following that enables a data-based evaluation of purchased articles with regards to the procurement strategy. Important requirements for such an approach are its practical applicability, fast implementation in companies and the assurance of an objective evaluation.

To ensure practical applicability, the proposed approach is based on the action research cycle. Action research is characterized by a highly practical approach that focuses on "research in action, rather than research about action" [29]. It thus aims at incorporating a participative and active collaboration between the researcher and the target group. [29] Due to its iterative approach for practical problem solutions, it offers a good framework for the presented research. The presented work will focus on integrating different use cases from the industry to achieve application-oriented results. In doing so, the results can be developed with close linkage to the challenges of the industry partners. Action research thus provides a well-fitting framework to meet the requirement of practical applicability.

Action research is structured along a problem-solving cycle that covers diagnosing, planning action, taking action, and evaluating action. This cycle is repeated several times to continuously improve the results (see Figure 4). [30]

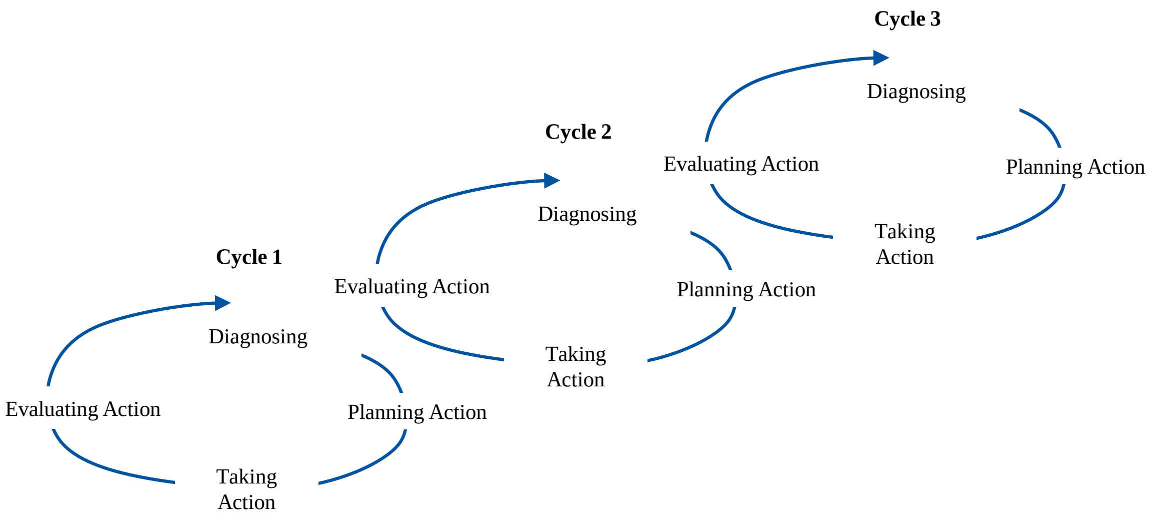

Figure 4: Spiral of action research cycles [30]

The proposed approach for a data-based design of procurement strategies in the IoP covers three action research cycles. Within the **first cycle**, the aim is to establish an application that characterizes purchased articles in the context of supply risks. In doing so, transparency regarding the procurement situation and supply risks is created to validate the dimension for characterizing purchased articles. The research in the **second cycle** focuses on implementing a calculation logic that enables the identification of success-critical purchased parts. The basis for this is the analysis of the interactions between different factors. Within the **third cycle**, the application is adapted to ensure general applicability across different industries and companies. Through this iterative approach, results can be reached and implemented fast. That allows a continuous validation of results through industry partners and additionally increases the practical applicability.

To ensure an objective evaluation, different data sources are analyzed to identify success-critical purchased articles and design the procurement strategy. As the project focuses on analyzing different data sources to enable a data-based design of the procurement strategy, the problem-solving cycle is further detailed according to the CRISP-DM (Cross Industry Standard Process for Data Mining) framework for data mining projects. CRISP-DM is a reference model which contains six phases: business understanding, data understanding, data preparation, modelling, evaluation, and deployment. [31] The use of the data mining framework supports the consideration of the large number of influencing factors required by the complexity in strategic procurement.

In the first step, the different phases of CRISP-DM are detailed for the first action research cycle (see Figure 5).

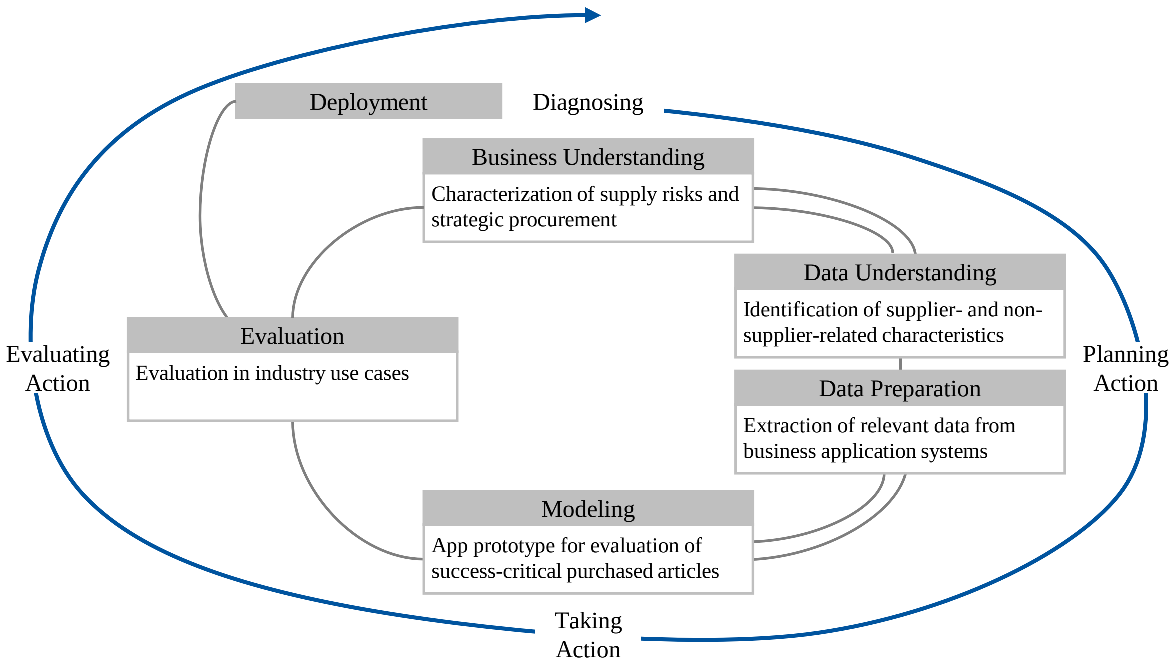

Figure 5: Combination of action research and CRISP-DM for the data-based design of the procurement strategy

Business understanding in the context of the data-based design of the procurement strategy focuses on understanding risks in the context of procurement. In doing so, a characterization of supply risks is developed based on a literature survey that structures different dimensions of supply risks and the corresponding negative impacts on companies. Moreover, the characteristics of strategic procurement and its influencing factors are identified. In the context of data understanding, an overview of potential data sources from both inside and outside the company is created. While internal data sources largely involve the business application systems used, external data sources comprise data from the procurement and customer market as well as the environment of the supply chain. To identify specific data sources that allow the characterization of purchased articles a four-step approach following SCHMITT ET AL. and WILDE & DUST is used [32,33]. Based on the gained business understanding general characteristics of purchased articles can be divided into non-supplier related and supplier-related characteristics. These are further detailed into relevant aspects and relevant data or indicators. Based on the relevant data and indicators the required data sources can be identified. These results will be validated using company use cases from different industries. In cooperation with the use case partners, the required data will be extracted from their business application systems and modelled within an app prototype.

In distinction to the analyzed work, the developed approach presents a systematic procedure that allows the development of an application for a data-based design of procurement strategies with regard to supply risks. Other than existing approaches for the evaluation of criticality, this approach focuses on purchased articles rather than raw material. Through an increase in transparency, the proactive design of resilience is supported. This generic approach can then be adapted and detailed for different use cases. It especially focuses on the systematic identification and integration of different data sources and thus ensures an objective evaluation. This approach will be used in future work to implement a prototype as part of the "Global Production Cockpit".

5. Use Case Textile Industry

To validate the developed approach and implement the application with industry partners, different industries will be analyzed. One use case will focus on the textile industry. Thus, characteristics of the textile supply chains and resulting challenges are briefly introduced in the following.

Textiles are used in a high variation of fields, from medical applications (e. g. stents), technical applications (e. g. protective clothing) to building materials (e. g. insulation) and clothing (apparel) [39]. In 2019, nearly 108 million tons of fibers were produced [40]. Raw materials that are sourced include cotton (23,6 %), wool (1 %), cellulose (6,5 %) and crude oil/chemicals (63,4 %) for man-made fibers [41]. Relevant intermediate products in textile supply chains include yarn, textile fabrics (e.g., weft, knitted, braided), finishing products (e.g., chemicals for the functionalization) and (semi-) finished and confectioned composites. The textile industry is particularly dependent on the worldwide networking and globalization of value chains [34]. This is due on the one hand to the high number of production steps and the associated specialization of individual companies, and on the other hand to the still high proportion of manual production work in textile production [37,35,36]. Due to cost pressure, a large part of the "Cut Make Trim" (CMT) activities is therefore located in Asia [38]. Raw materials, on the other hand, are sourced almost worldwide. Cotton production, for example, is particularly strong in India, Egypt, and the USA. Textile machinery, contrarily, is largely designed and manufactured in Europe (especially Germany and Italy) and Asia (Korea and Japan) [39]. All in all, the result is a heterogeneous, closely ramified, and interwoven network that is required in order to produce textiles on a competitive level. The demands on the value chain also vary greatly with the wide variety of products.

The example of a plain T-shirt is a good way to demonstrate the complexity of the supply chain (representative example): Raw material extraction (cotton) takes place in India, for example. Processing into yarn then could take place in Turkey. The yarns are then shipped to Taiwan to produce a textile fabric by knitting. The fabric could then be dyed in China and sent on to Bangladesh for confectioning. There, the items get packed and enter the retail market, for example in the USA. Thus, a simple T-shirt in the store has travelled about 35,000 km before reaching its customer.

Due to the high number of product movements, the supply chain is particularly susceptible to disruptions. In the recent past, for example, accidents (e. g. Ever Given – Suez Canal), Covid-19 outbreaks in ports and thus closures or container shortages [42], piracy [43] or accidents in production facilities in Asia (e. g. Rana Plaza – Savar [44]) have caused a stir worldwide.

Apart from globally distributed and highly complex networks and the above-mentioned crises that hit almost every industry, the textile supply chain faces a number of specific obstacles, which complicate the planning procedure for the textile production. For man-made fibers, the link to the oil price is important to keep in mind, when buying raw material. With a high volatile oil price, the costs for fiber production can increase or decrease significantly [45]. Price fluctuations are also experienced with other raw materials, such as cotton, and represent a challenge in planning [46,47].

In addition to the price fluctuations for raw materials, certain freight conditions must be provided for textiles. This applies both to raw materials (e.g., plastic pellets), which must be free of any impurities in order to be further processed (solution: special containers), and to textile semi-finished products or end products, which must be shipped dry and free of dirt. As rework often cannot be carried out, quality defects in products often lead to far-reaching consequences [48].

Due to its complexity and characteristics textile supply chains serve as a good example for detailing the presented approach.

6. Outlook and Conclusion

In volatile environments, companies must prepare for disruptions and increase their resilience. Especially in the context of procurement, the design of the procurement strategy has a major impact on a company's resilience. The procurement strategy and resilience in procurement are influenced by various factors. Therefore, a data-based approach that considers different risks aspects is needed to design procurement strategies. This paper first presents an overview of the state of the art regarding the design of procurement strategies and the identification of success-critical purchased articles. The results show that data-based approaches that allow an objective evaluation of purchased articles regarding supply risks are currently lacking. This paper thus proposes an approach for the data-based design of procurement strategies within the context of the IoP which aims at improving the systematic design of the procurement strategy. In doing so, increasing transparency regarding the current procurement situation serves as a prerequisite for risk analysis and strategy adaption. As a major contribution, the goal of the project is to develop an application to identify success-critical purchased articles. The presented approach is structured along the action research cycle and is further detailed using the CRISP-DM approach. Through this, special attention is paid to the systematic identification of various data sources which support the objective evaluation. Moreover, the textile industry as a potential use case is presented. Further research is required to implement the presented approach in collaboration with industry partners. Future work will focus on detailing the relevant article characteristics and linking them to relevant risk factors. The results will be implemented within an app prototype that serves as a decision support tool for designing the procurement strategy. In doing so, special attention will be paid to the presented use case of the textile industry.

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