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Deriving Collaboration Cases in Production Networks Considering Smart Services

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Abstract

The ongoing individualization of products forces companies to focus more on flexibility and adaptability. To achieve this, cooperating companies need to intensify their cooperation into collaboration. New types of collaboration are enabled by a wave of digitalization reducing organizational efforts and risks of collaboration. Especially smart services can be a medium to incentivize more interaction. This paper contributes a method to connect the loose ends from the study of collaboration on a strategic level to the digitalization trend on an operational level, representing all key aspects of a collaboration like relevant stakeholders, case of application and system interrelation.

Keywords: Production Network; Collaboration; Digitalization; Smart Services

1. Introduction

Production networks need to be increasingly flexible and adaptable to meet customer needs and therefore gain a competitive advantage. On the other hand production networks are historically grown and inefficient [1]. This affects production networks of on company as well as production networks consisting of multiple companies. Together with the increasing customisation logically the revenues shrink. Therefore, the efficiency of production networks gain importance [2]. One method to increase the efficiency of production networks is collaboration [3]. To implement a collaboration with a focus on production a holistic framework was already presented by Stamer et al [4]. The core idea of the framework was the use of smart services as a medium to incentivize interaction. Here, the importance of the right incentive was deducted from the state of the art and can also be easily argued by the definition of collaboration as negotiated cooperation [5]. This means for a successful collaboration in the end we need an agreement all stakeholders have a high incentive to fulfil.

Although the mentioned holistic framework by Stamer et al [4] is consistent, the derivation of the collaboration case in the context of production is still vague. For example, how to consider the role of stakeholders is not explained. The goal of this paper is to fill this gap by elaborating a more precise method to develop a collaboration case.

Before this task is carried out, different models in the context of collaboration are discussed in the state of the art (2.1). As already stated all stakeholders of influence need to have a high incentive to fulfil a collaboration agreement and, thus, need to be considered. The state of the art about stakeholder analysis is given dedicatedly in the second part (2.2). After a short discussion and goal refinement the approach to derivate the collaboration cases is presented (3) considering the state of the art. The paper finishes with a summary and conclusion.

2. State of the Art

Although the relevance of collaboration in global production networks is recognized in both business [6] and

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research [7], the implementation looks different. Only few companies collaborate successfully. Holistic methods for the implementation and gradual design of collaboration in the context of production shall support industrial companies and show the way to success, at least partly [8]. For example, the necessary steps from a collaboration vision to a factually and individually assessed list of collaboration scenarios can be part of such a way. As stated in the introduction they should also take into account the influence of stakeholder carefully.

The following section deals with related work as well as influential frameworks for stakeholder analyzation and classification.

2.1. Related Work in Context of Collaboration

In the context of collaboration the following work will be presented: The Collaborative Supply Chain Framework (CSCF) by Simatupang & Sridharan (2005) [9], the Design for Supply Chain Collaboration (DfC) [10] (based on the CSCF), and the conceptual model for collaboration in value networks by Min & Roath et al (2005) [11] and the three-phase model by Fawcett & Magnan et al (2008) [12]. Finally, there will also be a more detailed statement to the work of Stamer et al. [4] compared to the introduction.

The Collaborative Supply Chain Framework (CSCF) is based on the assumption that the exchange of information and the equalization of incentives between the participants in a global production network is a central basis for collaboration [13]. Together with the Collaborative Performance System (CPS), decision synchronization and integrated supply chain processes, they form the five elements of the CSCF. The overall performance of the production network is influenced by the decision-making competencies of its members. Independent decisions can only achieve local optima and cannot maximize the overall performance of the network [10]. Therefore, incentive exchange motivates a common decision-making process that is crucial for the success of the collaboration. It refers to the process of sharing the costs, risks and benefits of collaboration between members of the global production network [13]. Advantageous behavior for the overall performance should thus be rewarded and disadvantageous behavior of the members should be punished. In contrast to the CSCF, the Design for Supply Chain Collaboration (DfC) also takes into account the reciprocity of the relationships and the key interaction of these elements [10]. In a four-step cyclical process, first the strategic goals of the collaboration are defined, followed by the specification of the five elements and the architecture structure [10]. The architecture is then implemented. Through continuous monitoring, the final step is to identify dysfunctions in order to update the strategic goals and restart the process. However, Ho & Kumar et al. [8] criticize this model for the lack of implementation tools and therefore for the absence of practical support.

Min & Roath et al [11] present a conceptual model is presented which describes the necessary characteristics of collaboration under consideration of certain conditions. This should lead to advantages such as increased efficiency, effectiveness, profitability and a deepening of relationships in the global production network. Similar to the model of Simatupang & Sridharan [9], the exchange of information as well as a joint planning and problem-solving process in addition to the use of the available skills and resources are of central importance. However, Ho & Kumar et al. [8] criticize the model for failing to consider the continuous improvement necessary for successful collaboration (as can be found in the DfC).

The three-phase model of Fawcett & Magnan et al. [12] divides the transformation process to implement collaboration in production networks into three steps. The first step is to create a willingness to collaborate and to generate a deeper understanding of the production network. The obstacles to collaboration can then be overcome in the second phase of the model. In the final, third phase, a continuous improvement process is initiated, which permanently develops the companies' collaboration capabilities. The three-phase model thus represents a good roadmap for the implementation and continuation of collaboration in value networks but does not describe a procedure for overcoming the obstacles [8].

The Framework by Stamer et al. [4] provides an approach for developing a collaborative relationship from modeling a collaboration strategy to an implementation with smart services. The paper identifies Smart Services as the potential to overcome the existing resistance to implementing collaboration in global production networks. The use of Smart Services can reduce, for instance, a lack of focus, irrational behavior, or investment risks [4]. To substantiate this hypothesis a framework is presented, which starts on a strategic level with the definition of a collaboration strategy and develops further in a top-down procedure via various modelling and concretization steps to the implementation and realization of the service. The provided framework divides the development of a Smart Service into three phases. In the first phase (Strategy) a collaboration strategy is defined based on the production strategy. In the second phase (Deriving Collaboration Cases and Smart Services) the collaboration case is developed and in the third phase (Smart Service Design) the Smart Service for this collaboration is created in negotiation with all parties involved.

The different steps of the presented framework are a good starting point for the elaboration of collaboration scenarios but need to be further detailed which is also a conclusion in the work itself.

2.2. Stakeholder Analysis

The industry structure analysis (Five Forces) according to Porter [14] serves to determine the attractiveness of an industrial sector. It cannot be easily applied to the analysis of stakeholders, but it offers an interesting basis for evaluating of and classifying a market structure. For this purpose, the five components of the industry structure ("Five Forces") are analysed and evaluated: the bargaining power of suppliers, the bargaining power of customers, the threat of new competitors, the threat of substitute products and the intensity of competition in the industry.

Mainardes et al. [15] provides a model of stakeholder classification and a model that clarifies the relationship between the organization and relevant stakeholders. The model divides the stakeholders into six stakeholder types (regulator, controller, partner, passive, dependent and non-stakeholder). The relationship among the stakeholders is examined with regard to relevance, mutual influence and participation. It provides an approach that classifies the stakeholders according to their importance, which allows prioritization when considering them. The model thus offers an interesting approach, which can, however, be regarded as an extraneous basis due to the lack of reference to production and industry.

Henry C. Co & Frank Barro [16] provide an approach for the analysis of stakeholder management strategies in supply chain collaboration. Based on a factor analysis, two groups of stakeholder strategies were identified: aggressive strategies and cooperative strategies. For these two types of stakeholder management strategies, models have been developed that help companies to collaborate with their stakeholders. Depending on trust, urgency, and the awareness that the collaboration benefits everyone, the aggressiveness and degree of cooperation can be adjusted. The approach provides important insights for the analysis of stakeholder management strategies in supply chain collaboration, but the selection of relevant stakeholders and their analysis is not the focus of this work.

2.3. Interim Conclusion and Deduction

In summary, some approaches to collaboration in the global production network already exist, but without a dedicated focus on production and without consideration of the relevant stakeholders. So, deficits can be found in the detailing. The available scientific work does not offer a holistic method for the implementation and gradual design of collaboration in the value network. In particular, a detailed elaboration of the necessary steps from a collaboration vision to an evaluated list of collaboration scenarios is missing. Although the paper by Stamer et al. [4] indicates these steps, a more detailed elaboration is needed. Additionally, the influence and role of stakeholders could be examined more. Consequently, this work is a contribution to shed light on how to implement collaboration in more detail. This is done by providing insight on the elaboration of a collaboration case following up the work of Stamer et al. [4]. This work also looks at stakeholder analysis to investigate the influence of third parties on the collaboration case.

3. Deriving Collaboration Cases

The following approach is a contribution to filling the gap shown in 2.3. To better understand the overall context, the approach can be allocated to phase 2 of the framework presented by Stamer et al. [4]. It assumes the existence of a production strategy and collaboration strategy. The collaboration strategy can be simplified as the difference between the desired and the actual state of the production factors price, flexibility, quality, delivery and service [4]. It provides the basis for determining the relevant value streams at the location level in order to detail the relevant production and logistics processes in the following steps.

As the approach is allocated to phase 2 it further shall enable the configuration of smart services in phase 3 by providing a clear collaboration case. When speaking of the term collaboration case it is useful to have a clear definition in before. The collaboration case shall be defined as the model, which represents all key aspects of a planned collaboration. One key aspect can be the situation to be improved. Other key aspects can be the available time and resources or influencing stakeholders. The type and amount of aspects depend on the collaboration case itself.

3.1. Identification of the Collaborative Situation

The elaboration, specification, and modelling of the collaboration case covers the specific situation to improve in the value stream. Therefore, the affected value stream in a plant should be modelled. At the plant level, detailed production and logistics processes should be examined as far as they have a critical influence on the interaction and data flow. The idea is to include only as much as necessary, but as little as possible. This principle is decisive for later possible optimization and simulation steps. For the modelling and investigation of the focused value stream, the following approach can be used:

In accordance with the collaboration strategy, the selected value stream is examined for deficits and potential for improvement. Depending on the circumstances, methods are used that are established and originate from the already existing toolbox of integrated production systems. Examples are Value

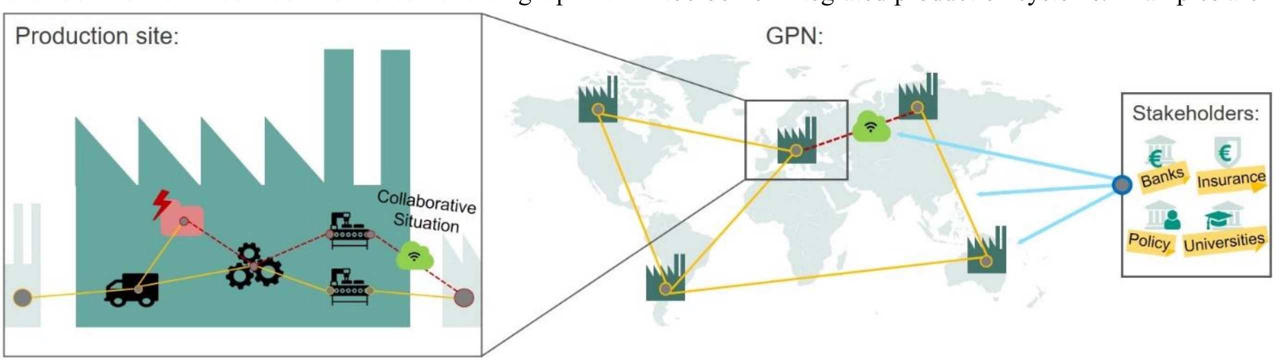

Fig.1. Schematic Model for the Collaborative Situation under Consideration of the Influence of External Stakeholders.

Stream Mapping, Ishikawa diagrams, SIPOC and bottleneck analyses [17]. Starting from the localized deficit or potential, the processes and information flows towards the customer and supplier are then recorded. For each subsequent node step, the influence factor on the deficit in the previous node is estimated. The modelling ends when a system boundary, in this case the plant boundary, is encountered. By linking the influencing factors, the overall influence of individual customers and suppliers can be demonstrated. Next, only active chains with high influence are selected (e.g. with an ABC analysis). The critical system section is identified with these chains of high influence and is described as a collaborative situation. The collaborative situation finally gives an abstract idea of the possible improvement of collaboration.

3.2. Analysis of Relevant Stakeholders

In the following step, the question must be answered whether the collaborative situation has so far failed due to a lack of incentive or whether the idea of collaboration simply did not exist so far. Next, third parties must be considered. As the value stream of a global production network continues to take place in and between different plants change through collaboration has effects on the whole network. Consequently, a network model is required considering all stakeholders up to the network level, even if they are not to become part of a later collaboration. Since the collaborative situation has not been clearly defined until now, an analysis of these stakeholders would have been out of hand. Now they can be included in the model if they have a significant influence on the known collaborative situation. Figure 1 summarizes these thoughts schematically.

The detailed analysis of the relevant stakeholders starts with the identification of all actors that can influence the collaboration. These actors may include selected customers or suppliers, but also politicians, insurance companies and universities. Competitors and potential imitators in the target market must also be considered in the stakeholder analysis. This first step serves to generate an overview; no evaluation of the actors is yet taking place. For a systematic search we will divide the actors into five stakeholder categories. The analysis and categorisation of the business environment and stakeholder is based on the findings of Porter's 5 Forces and the PESTEL analysis. Starting from the identified collaborative situation, we analyse the *internal stakeholders*. These include involved internal company actors. These could be managers or employees of the company. An early involvement of the internal stakeholders is essential, as they are directly influenced by the collaboration and can also influence the later negotiation.

At the next level, we consider the *primary stakeholders*. They have a direct impact on the planned collaboration and are therefore also highly relevant. They can include suppliers and customers of the company involved in the collaboration. Their demands on the collaboration will later have a strong impact on the negotiation of the collaboration scenario. Afterwards the analysis of the *secondary stakeholders* is of great importance. These can include various institutions and groups of people who might have an indirect interest in the outcome of the collaboration. Often this step is missing because actors usually only take on peripheral roles in the collaboration process or are only periodically involved. However, involvement at this early stage can very well decide on the success or failure of a collaboration vision. Secondary stakeholders can include, for example, insurance companies, banks, politicians, end customers or universities.

Fourthly, the *oppositional stakeholders* must be analysed. A complete recording of these can decide on the outcome of the collaboration, as they can possibly have a negative influence. These include primarily competitors. Indirectly or directly, they could take advantage of the costly infrastructure and organizational processes built up for the collaboration.

Finally, to complete the overall picture, it is important to consider the *"outside" stakeholders*. At first glance, they do not have any influence on the collaboration, but they could have an indirect interest. They can be summarized as society or environment.

In the following framework you can see an exemplary classification of stakeholders according to the scheme just described (see Figure 2). The first step of the stakeholder analysis ends with the identification and classification of all potentially relevant stakeholders. In the next step, the actors

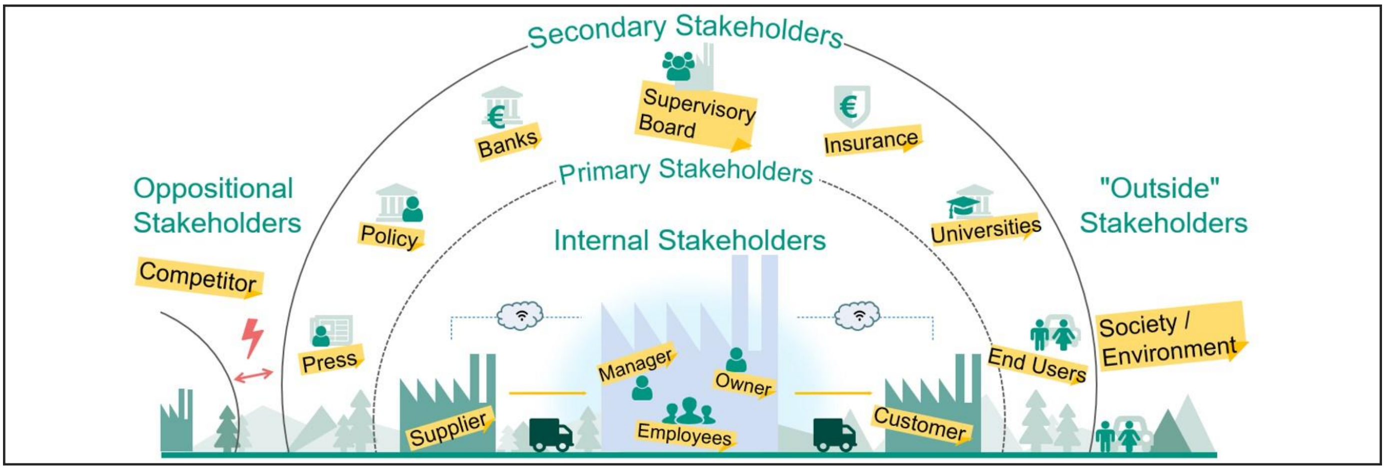

Fig. 2. Visualization of an Exemplary Classification of Stakeholders

can be narrowed down to the stakeholders relevant for the collaboration. By adding the evaluated stakeholders to the network model, the influences of the individual parties can be visualized. The exemplary influence of stakeholders on production sites, transport routes and the collaboration itself was visualized in Figure 1. Based on the collaboration vision and the identified value stream, the highly relevant stakeholders can now be identified. The network model puts the stakeholders in relation to each other and illustrates their influence on the collaboration. This step allows decisions and responses of the individual stakeholders to be anticipated later on. To reduce the complexity of the network model, irrelevant stakeholders that have no influence on the collaboration can be removed. The newly acquired information allows the early involvement of critical stakeholders in the design of a collaboration. This can bring a decisive advantage in the implementation of the collaboration [4]. In addition to the critical stakeholders who can cause a collaboration to fail, there are also supporting stakeholders. These can make a decisive contribution to the implementation of the collaboration (e.g. open-minded employees (internal) or collaboration platform providers (external)).

For this reason, in the following step of the stakeholder analysis we divide the actors into collaboration supporters and collaboration saboteurs. Due to the fact that some stakeholders cannot be clearly assigned to one or the other group, there is no clear line between them. The classification can rather be seen as a kind of scale with different gradations. In the framework shown (see Figure 3), this scale has been extended with an additional axis that illustrates the power and influence that stakeholders have on collaboration. The resulting two-dimensional matrix is a common presentation style in stakeholder analysis [18] and can be found in various versions in a variety of literature. In this last step of the stakeholder analysis, the pre-sorted, relevant stakeholders can now be sorted by power and their intentions. The evaluation by power helps to focus on the most relevant stakeholders again and to include their influence in the planning of the collaboration at an early stage. The complete and narrowed down network model in combination with the elaborated collaboration vision are not yet sufficient for the negotiation phase (phase 3). Specifically, an evaluated list of different "configuration options" of the collaboration scenarios would be useful. The factual and individual evaluation of the decision options is a basic requirement for the later negotiation regarding the

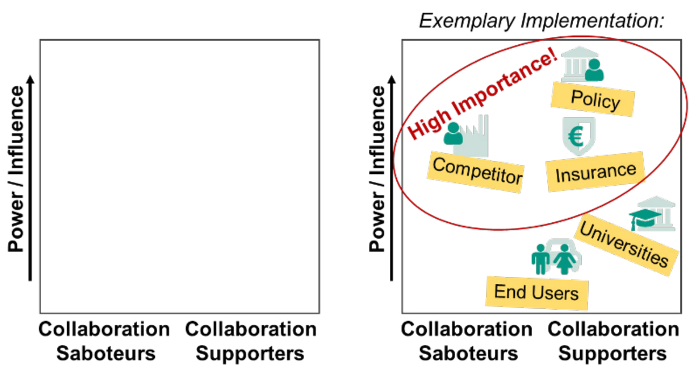

Fig. 3. Framework for Evaluating the Intention and Power of Stakeholders

collaboration. It shall enable practitioners to base their decisions and negotiations on the results of the method. In other words, it pushes the approach from being purely descriptive to being prescriptive. In order to obtain this evaluated list, various topics must be addressed based on the collaboration vision. These were derived by backward induction and close the gap to the third phase.

3.3. The Modular System to Support Decision Making

First, the possibilities for decision making have to be identified and evaluated according to factual and individual criteria. This means the theoretic decision space must be known. In order to evaluate the resulting decision options, their effects on the network and plant must be known. Therefore, one topic area is the determination of the causal relationship in the form of a causal model. The last component that is still missing is the data describing the as-is situation, which is necessary to evaluate the possible decisions. With these three components, *decision space, causal relationship* and *as-is data* the decision options can be *evaluated*, which is the fourth and last component.

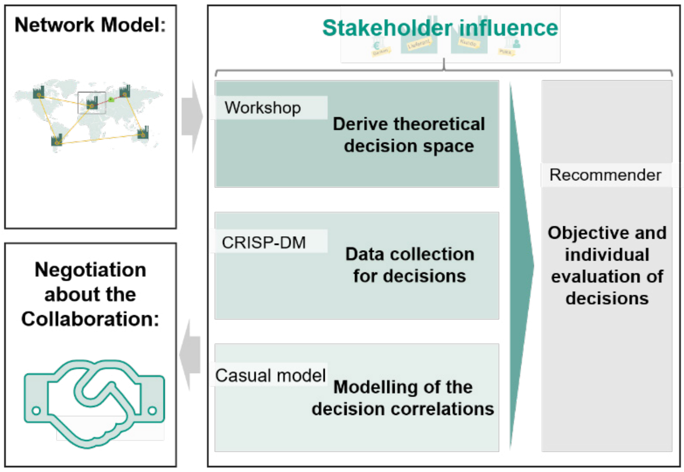

Fig. 4. Modular System to Support Decision Making

The Modular System in Figure 4 was developed to systematically work through the topics just described. It gives a good overview of the necessary steps up to the negotiation of the collaboration partners. The four components have to be addressed to obtain an evaluated list of collaboration scenarios. The first three areas do not have a strict sequence logic, as this is defined depending on the problem and the use case. They can be seen as a kind of checklist with steps that are necessary to evaluate the decision possibilities. The individual topic areas of the toolbox are also provided with an exemplary method that can help in fulfilling the task. The *theoretical decision space* can be worked out in a workshop, for instance. Methods such as CRISP-DM can be used for *data collection* [17] and a causal model can be recommended for modelling the *decision correlations*. Each of these topics can be strongly influenced by one stakeholder. Their influence must therefore be considered in each step of the toolbox. After successful completion of the first 3 steps, it is now finally possible to *evaluate the collaboration scenarios*. This can be done with the help of a recommender-like system. This system creates a prioritized list of the possible collaboration solutions that serve as a basis for the negotiation. The design of this list depends on the problem definition, the collaboration vision and the use case partners. Exemplary records of this list could be concretely elaborated interfaces, such as an automatic ordering process or a defined price function as a basis for the following negotiation. At this point, during the development of the method the focus laid on strategic decisions regarding collaboration. However, it could be used theoretically for an operational collaboration decision stream as well. A strategic decision stream would mean that parameters of a collaboration would be near constant for a relevant time, e.g. the content is a collaboration decision leading to the implementation of a new infrastructure or service product. A more operational decision stream would mean that collaboration parameters and content could change more often, e.g. when deciding to exchange demand and capacity data or planning together on a daily basis.

Anyway, with the presented approach the methods are given to connect the loose ends of the collaboration strategy (phase 1) to the negotiation phase (phase 3).

4. Summary and Outlook

To meet customer needs of individual products and be profitable at the same time production networks need to become more efficient. Collaboration can be a method to gain the needed efficiency. An important step to implement collaboration is a well set out collaboration case in the form of a model. This models needs to consider relevant stakeholders and needs to limit the scope of collaboration as discussed in the state of the art. It should finally lead to the different decision possibilities. Consequently, a general approach was given to derivate collaboration cases. In this approach a network and a plant model was used to focus the scope of interest. The plant model describes the extract from the value stream of interest in detail by following cause relationships from the point of improvement to the plant boundaries. The network model focusses on the identification of stakeholders by further following the value stream in the network. In order to evolve from being only descriptive and enable practitioners decision process in collaboration, four components were deducted which guide from the network and plant model to an evaluated and prioritised list of possible collaboration solutions. The four components are

- the theoretic decision space
- the causal relationship,
- the as-is data
- The evaluation (Recommender System)

The personal list of possible and ranked decisions resulting from the evaluation is the prerequisite for a following identification of possible agreements and real negotiations.

A critical view on this work reveals that the given approach is not perfect. There are still open questions on how to execute the steps in practice although examples were given. Therefore, further work needs to be done to make it executable. This is especially true for the four components: How can a workshop be designed to derive the theoretic decision space? How much effort needs to be carried out to get a suitable decision space? How is it evaluated? And so on.

Besides these questions regarding the approach itself, next steps can also address the elaboration of the negotiation support system which is mentioned as phase 3 in [4]. It should be designed to help the practitioner to understand and find the best agreement about collaboration. This could be done by analysing different negotiation equilibria, their robustness, and consequences. For this purpose, the result of this paper, the decision options list, can be used.

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