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CONSIDERATIONS REGARDING SUPPLY CHAIN COLLABORATION. THE CASE OF RENEWABLE ENERGY RESOURCES PROJECTS, IN ISOLATED REGIME.

- PhD Thesis Summary -

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CONTENT

PHD THESIS CONTENT

1. SUMMARY OF PHD THESIS

The unprecedented evolution of new technologies and the stunning speed in diversification of product variants offer consumers a much wider number of possibilities of choice, causing reorienting loyal customers at any time. In this situation, the chain links from any logistics activity are confronted with increasingly complex situations in the supply chain. Logistics of any business it's getting harder to keep up the step pace with daily speed and evolution in such way the collaboration between the links of the logistics chain has become a topic of current debate.

The purpose of the research is to identify viable solutions for collaborative issues influenced by the emergence of new technologies, by configuring the general objective of research and identifying integrated formalisms into a collaborative framework model to ensure the synchronization of the logistic flow with special materials in isolated collaborative conditions, for renewable energy projects (RES).

The expansiveness of cutting-edge technologies, the demands of the current market and the sudden changes in consumer preferences have led to the development of ever more complex dependencies of collaboration between the logistics chain links. Regardless of the challenges posed by market changes, consumer buying behavior and the emergence of cutting-edge technologies, chain links from any logistics chain must ensure a continuous flow of supply to manage a much larger order run. In this sense, building a collaborative alliance in the logistics chain involves certain rules and methods to control the variations imposed by the challenges mentioned above. The present research has made essential contributions to determining a formalism, which contains generally valid techniques, to achieve harmonious collaborations. The case of renewable energy projects express it best both the challenges posed by new technologies as well as those of the market and consumer behavior. This was the argument for research delimitation, by focusing on RES projects.

The study elaborated in this thesis highlighted the conception, the adaptation and the integration of a collaboration formalism between the logistic chain links within a RES project, with difficult weather conditions. The identification of trust "drivers" and knowledge "drivers" and their insertion through a decision-making method and a dimensioning method led to the conceptualization of the collaboration formalism framework ("$CV^{AHP\text{-}DBR}$") adapted to the RES project, in isolated regime. The application of the collaboration formalism identified the optimal technical decision and balanced the logistic flow by sizing a safety buffer between two links to complete the RES project. "$CV^{AHP\text{-}DBR}$" model has detected the technological variant of composite material, indicated to isolated regime so that the supply with the special materials does not suffer interruptions, regardless of the nature of orders, which can be isolated. Collaboration between logistic chain links based on algorithms and operating rules solves the bottlenecks caused by new technologies in renewable energy projects.

2. OVERVIEW OF PHD THESIS

The emergence of collaborative bottlenecks caused by desynchronization of logistics flow with raw materials as well as the use of more and more raw materials with special properties, needed for cutting-edge technologies in the RES field have determined the current research theme.

The research **aims to identify viable solutions for collaborative issues influenced by the emergence of new technologies**. The pressing issue up to date in the RES field, debated in interest environments involves the emergence and use of more and more raw materials with special properties, needed for cutting-edge technologies in the production of special components in the wind industry. The frequent desynchronizations produced in the raw material logistics flow have created bottlenecks that have delayed the implementation of RES projects, especially those in difficult weather conditions.

According to these considerations, the general objective of the research is to identify formalisms integrated into a collaborative framework model, which ensures synchronization of the logistic flow with special materials in isolated cooperation conditions, for RES projects.

In this doctoral thesis, the specific objectives established have led to the configuration of the research in 6 chapters. Thus, each specific objective was reached through a dedicated chapter, which ends with intermediate conclusions and original contributions of the author.

The structure of the doctoral thesis is presented below:

Chapter 1, called *„Introduction"*, presents the actuality of the thesis theme, justifying the purpose of research, respectively the objectives which must be met to achieve it.

Chapter 2, designated *„Supply Chain Management Conceptual Aspects",* is structured in two parts. In the first part the author reveals the conceptual aspects of supply chain management that favored the development of collaborative relationships between the logistics chain links. [1][2][3] The relationships complexity between chain links in the supply chain, respectively collaborations between primary vendors, intermediary suppliers, third-party service providers and customers requires the integration of formalism to solve the bottlenecks between them in managing the supply. In second part the research is delimited. Through this delimitation it expresses the need for formal collaboration, which resolve the constraints of cutting-edge technologies specific to RES projects. Due to these constraints, the logistics chain links are pushed to find different formalisms by which to develop long-term collaboration relationships with specialized suppliers.

Chapter 3, entitled *„Supply Chain Collaboration Models "* aims to achieve the specific objective of identifying an innovative collaboration formalism between the supply chain links. In the structuring and scientific argumentation of the proposed solution have been identified representative collaboration models from supply chain, respectively: The general model of an alliance [Popa, 2009] [4], Collaborative performance system model [Simatupang, 2004] [7], Collaborative potential and collaborative intensity model [Bititci și Mokadem, 2010] [9], which have been submitted to a critical analysis. Although the collaboration models identified present dynamic strategies capable of delivering performance, some critical limitations have been highlighted as a result of the critical analysis, which does not provide solutions to all the issues of collaboration between the actors in the logistics chain. The critical analysis of the three representative collaboration models has led to the creation of a broad framework for resolving the limitations (CLRL). CLRL was a transition to conceiving the original framework of collaboration formalism between supply chain links, entitled Collaboration between Supply Chain Links ($CV^{AHP-DBR}$) through Analytic Hierarchy Process (AHP) [8] and Drum-Buffer-Rope (DBR) [5] [6]. The collaboration formalism "$CV^{AHP-DBR}$" combines a decision-making method of analysis with a dimensioning method, being adaptable to a RES project with extreme weather conditions and difficult landforms.

Chapter 4, named *„The Conceptualisation of Decizional and Dimensioning "$CV^{AHP-DBR}$" Model for Supply Chain Collaboration",* aims the concrete adaptation of the collaboration formalism between the logistics chain links, which integrates a decisional algorithm and a buffer dimensioninig philosophy within a RES project, in isolated regime. The "$CV^{AHP-DBR}$" model created involves the combination of trust "drivers" and knowledge "drivers" so that the collaboration relationship between the chain links to be balanced. Through the configuration of the "$CV^{AHP-DBR}$" collaboration formalism, the technological alternatives of an isolated RES project were evaluated, in which safety stocks for two special materials were placed. In the model development phase two directions have been identified. The first direction, respectively, trust "drivers" was concretized based on the Analytic Hierarchy Process (AHP). Through AHP method basic technical criteria have been identified, for a high-tech technical field that contributes to the fulfillment of the decisional goal. The second direction, respectively, knowledge "drivers" was designed by Theory of Constraints (TOC) metod through Drum-Buffer-Rope (DBR) and "Thinking Process" (TP), in which a steady stream of supply has been achieved, and collaborative bottlenecks have been identified, providing feasible solutions.

Chapter 5, called *„Validation of the "$CV^{AHP-DBR}$" Model for Supply Chain Collaboration in RES Projects Type",* it is achieved the validation of the "$CV^{AHP-DBR}$", within a real scenario for an experimental project, concerning the assembling of wind turbine blades in an isolated location (difficult access by road, Seuşa village, Alba-Iulia county), with difficult weather conditions. This scenario implied the harmonization of the specialists teams and finding quality suppliers for the procurement of composite materials. According to the information obtained from the topographic and wind tests, the specialists teams provided information about the technical criteria of the optimal composite material for the wind blade structure, which were integrated into the decision tree of the AHP method. After obtaining the technological variant composed of two special materials it was necessary to supply them. In this case, using the DBR method, was assured a synchronized flow for the required composite materials. The model has also been validated within a company with a department specialized in the design and execution of composite materials. Through collaborative formalism, orders for Current Customers have been streamlined, providing immediate availability of the cutting-edge technologies of composite materials also for Isolated Customers without any interruptions in the supply flow.

Chapter 6, named *„Conclusions, Personal contributions and Future work",* presents the conclusions, personal contributions and development directions applied of the collaboration formalism "$CV^{AHP-DBR}$".

3. CONCLUSIONS

Collaborations in the supply chain are among the factors that ensure the success of supply activities, favoring the growth of organizational performance and the fulfillment of strategic plans.

Unannounced changes in customer orders change the dynamics of supply flow and amplify desynchronizations between logistics chain links, confronting them with various conflicting situations in terms of service quality and supply gaps. Frequent desynchronizations along the supply chain also have repercussions in relationships attitudes between supply links. Also, the resulting desynchronization attracts more uncertainties and unexpected risks, which create bottlenecks and make it difficult for logistics activities to acquire raw materials. Specifically, there is a relational fragility between the actors in the logistics chain, which causes instability of the supply flow, influencing the delivery time of the orders.

The emergence of collaboration models and their advantages have influenced logistics chain links to initiate and develop strategic alliances to solve bottlenecks between them in the supply chain. To solve bottlenecks between links through collaboration involves a structured process, which consists in the ability of joint partners to work together, gaining mutual benefits.

The collaboration models studied in the thesis present dynamic strategies capable to deliver performance, but following a critical analysis, some limitations have been highlighted, which do not provide a reliable solution to all the problems of collaboration among the actors in the supply chain. After, identifying the limitations it is confirmed the need for collaboration between supply links to achieve a high level of motivation and confidence in sharing important information. Following the critical analysis, the framework model "$CV^{AHP-DBR}$" has been set up, in which trust factors and knowledge factors have been integrated into two special "drivers". Trust "drivers" and knowledge "drivers" represent two consonant constructs that by their homogeneity facilitate the sharing of optimal information between chain links and contribute to the exchange of knowledge in achieving the common benefit.

In the present PhD thesis, has been exemplified the integration of "drivers" in the "$CV^{AHP-DBR}$" model, the way in which the AHP method and the DBR philosophy have contributed to achieve the collaboration between the logistic chain, by taking the ideal technical decisions and by synchronizing the chain links along the supply chain, to obtain a constant flow of raw materials. Through AHP method, important technical criteria have been taken into account, in order to weight as best multi-criteria decisions of a high-tech technical field. Through DBR method was made a dimensioning formalism so that the flow of material does not suffer interruptions, regardless of whether occasional commands occur over the current ones.

"$CV^{AHP-DBR}$" model optimizes the collaboration relationship so that through trust "drivers" and knowledge "drivers" are offered certainty to chain links to share viable information in a timely manner to supply safety buffers at the right time. A collaboration agreement based on trust supports knowledge sharing by establishing a know-how sharing routine between the chain links involved, offering feasible solutions to obtain the benefit of collaboration. The collaboration formalism "$CV^{AHP-DBR}$" based on the two "drivers" identifies optimal supply frequency with special materials and facilitates the creation of active knowledge by weighting the key factors in making the right decisions.

In conjunction with the issues described above, the implementation of RES projects is a topic of great relevance that requires particular attention due to the frequency of bottlenecks between the chain links in the supply chain. In this situation, through collaboration are solved the complex interactions between the wind turbine producers and the suppliers of raw materials respectively are provided reliable solutions in orders forecasting, thus avoiding disruptions in logistics flows with raw materials. Interactions between wind turbine producers and raw material suppliers are increasingly complex due to the expansion and diversity of new composite materials technologies. By adopting rules and norms based on an algorithmic formalization, presented in the framework model "$CV^{AHP-DBR}$", a profitable collaboration is achieved, where quality raw materials are guaranteed, in order to obtain the technological variants necessary for RES projects, in isolated regime. A partnership between wind turbine producers and materials suppliers is indispensable, as the research has highlighted the need to continually access high quality raw materials to technically innovate the wind turbine blade dimensions, especially in special installation situations with complex meteorological conditions.

Within the RES project in isolated regime, the collaboration bottlenecks between the logistics chain are based on the rigidity of the relational techniques in taking important decisions. Solving these bottlenecks between the chain links were achieved by applying the "$CV^{AHP-DBR}$" model, which facilitated the harmonization of the chain links in taking the ideal technical decisions and guaranteed the supply of special materials at the optimum time. More precisely, the "$CV^{AHP-DBR}$" model identified the ideal technological variant and ***synchronized through safety buffers both the flow of the composite materials used in the RES project in isolated regime and the flow required for Current Customers' orders without it being affected.***

The use of decisional formalism and dimensioning formalism from the "$CV^{AHP-DBR}$" model have contributed sharing optimal knowledge between chain links, ensuring the visibility of the inventory level along the supply chain for composite materials, corresponding to the technical specifications of the parts required in the RES project in isolated regime. "$CV^{AHP-DBR}$" offers adaptive solutions to harmoniously solve the cooperation problems of both parties involved in the RES project.

The doctoral thesis presents a large theoretical contribution with practical applicability, in which is systematically analysed the current literature in the field. The thesis provides adaptive solutions for a RES project, in isolated regime. The "$CV^{AHP-DBR}$" model provided a synchronized run of composite materials, to satisfy customer demands also in some isolated collaborative situations. The search for logistical connections through the collaboration framework model has provided practical solutions to control supply chain fluctuations and reduce inventory costs.

4. AUTHOR'S PERSONAL CONTRIBUTIONS

The contributions made outline a set of theoretical and conceptual fundamentals that ensure the importance of implementing a collaboration formalism in the case of isolated RES projects.

Starting from the stated objectives of the thesis, it is presented a selection of the most important contributions from the wide range of contributions made by the author in the paper:

- The main original theoretical contributions are:

- Identify collaborative factors that strengthen the collaboration process between logistic chain links, trust factors, knowledge factors, and relational facilitators.
- Identification of Model I limitations, which led to the need to configure the decisional formalism.
- Identification of Model II limitations, which led to the need to configure the dimensioning formalism.
- Identification of Model III limitations, which led to the necessity of configuring communication formalism, eliminating constraints and enhancing the trust.
- Integration of trust "drivers" and knowledge "drivers" into the broad framework for resolving the limitations.
- Configuration the original collaborative formalism "$CV^{AHP-DBR}$", which combines a decision-making method of analysis with a dimensioning method.
- Analysis and synthesis of TOCTP stages, for RES projects, in isolated mode.

- The main theoretical contributions with applicability in practice are:

- Adapting the application of the DBR philosophy to dimensioning safety buffers useful in supply chain collaboration.
- Adaptation of the Tb and Sb formulas within the DBR philosophy.
- Identifying constraints and conceptualizing of the TOCTP trees in the RES project.
- Integration of the two formalisms in the first stage elaboration of the original model "$CV^{AHP-DBR}$".
- Configuration and adaptation of a logistic chain particularized for RES projects, in isolated regime.
- Validation of the "$CV^{AHP-DBR}$" model through decisional formalism, identifying the optimal technological variant for the structure of the wind blades needed for a turbine plant with a power less than 1 MW.
- Conceptualization and configurating the AHP decision tree by identifying the criteria and subcriteria in the wind blade assembly project for a wind turbine in an isolated regime.
- Validation of the "$CV^{AHP-DBR}$" model through the DBR dimensioning formalism, placing strategic buffers of composite materials necessary for the wind blade structure.
- Validation of the "$CV^{AHP-DBR}$" model inside the company McarbonParts by identifying the technical combination of composite material and obtaining an

optimal composite material optimal frequency with the three suppliers involved.

- Comparative analysis between the two combinations of composite material, respectively Kevlar-Glass fiber and Kevlar-Carbon.
- Dimensioning buffer for glass fiber, carbon fiber and Kevlar materials for Isolated Clients.

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