



ANALYZING NEW WAYS TO ADAPT THE TRIPLE-A SUPPLY CHAIN MODEL AND ITS EXTENSIONS IN AGRI-FOOD SUPPLY CHAINS

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ABSTRACT. Background: With the emergence of supply chain management as a key strategic function in the agri-food sector, a lot of research has been conducted to find ways to improve the performance and sustainability of agri-food supply chains. The Triple-A Supply Chain concept, which refers to the agility, adaptability, and alignment of the supply chains, has been a field of study for various researchers aiming at shaping meaningful and sustainable competitive advantages for businesses and organizations in various sectors. Over the years, alternative, complementary, or upgraded versions of this approach have been proposed, such as the “New AAA Supply Chain”, which describes the renewed Triple-A Supply Chain model based on Super-Agility, Architectural Adaptability, and Ecosystem Alignment, and the “Triple A & R” framework, which refers to Agility for Robustness, Adaptability, and Resilience, and Re-Alignment.

Methods: This paper presents the results of a selective study of the bibliography considering the Triple-A Supply Chain model, the “New AAA Supply Chain” model and the “Triple A & R” framework. These frameworks are analyzed and compared with each other considering their principles, and their implementation in the agri-food sector is researched. The scope of this study is to analyze the potential of the application and suitability of these frameworks in agri-food supply chains, having considered the particularities of the sector.

Results: Examining the models concerning the evolution of the Triple-A Supply Chain paradigm, it is evident that they differ from each other, as they approach supply chain management from different viewpoints.

Conclusions: The potential of application of various models originating from the Triple-A Supply Chain paradigm was examined in the case of the agri-food sector considering product nature, sustainability, and investment cost as the factors affecting it. These frameworks could partially find application in the agri-food sector, as some of their guidelines promote the increase of the agri-food supply chain effectiveness.

Keywords: agri-food supply chain, agility, adaptability, alignment, sustainability

INTRODUCTION

In the era of globalization, supply chain systems are highly involved in material flow procedures worldwide [Manning, 2018]. The interconnection of supply chains across the world shapes a new kind of supply chain network, enhancing the need of applying new supply chain management practices. Supply chains have been affected by the recent economic, environmental and social crisis, having altered the supply chain management approaches, which are currently focused on the adoption of sustainable practices as a means to form resilient supply chain systems. Especially in the case of agri-food supply chains, which are

complicated systems consisting of different internal and external stakeholders, there is a high need for the application of up-to-date supply chain management systems that take into consideration the particularities of the products involved and the different circumstances of each region [Tsai et al., 2021]. There are global attempts to overcome these barriers and move towards a sustainable world, such as the Sustainable Development Goals (SDGs) 2030 Agenda, which includes 17 ambitious objectives with 169 targets on all dimensions of sustainable development [UN General Assembly, 2015]. The agri-food supply chains are highly engaged in the achievement of the SDGs, as FAO has published a strategic framework to promote the principles established by the United Nations in the agri-food sector [FAO, 2016].

Sustainability has been considered a pillar of the current proposed frameworks of supply chain management. In terms of sustainable supply chain management, there have been efforts of shaping models to include specific targets of the supply chains in order to achieve higher performance in a sustainable means. The Triple-A Supply Chain concept [Lee, 2004] which refers to the agility, adaptability, and alignment of the supply chains has been a field of study for various researchers aiming at shaping sustainable competitive advantages for businesses and organizations in various sectors. An updated version of this framework, the “New AAA Supply Chain”, which describes the renewed Triple-A Supply Chain model based on Super-Agility, Architectural Adaptability and Ecosystem Alignment has been recently presented by Lee himself as a modification and evolution of the original Triple-A Supply Chain model in order for supply chains to gain a competitive advantage focusing on the new aspect of the Triple-A supply chain framework principles [Lee, 2021]. The “Triple A & R” framework, which refers to Agility for Robustness, Adaptability, and Resilience, and Re-Alignment, has also been proposed as an updated alternative based on the original Triple-A Supply Chain model approaching sustainable supply chain management and managing uncertainties [Cohen & Kouvelis, 2021].

The scope of this study is to analyze the potential of the application and suitability of these frameworks in agri-food supply chains, having considered the particularities of the sector.

SUPPLY CHAIN PARADIGMS

This paper presents the results of a selective study of the bibliography considering the Triple-A Supply Chain model, the “New AAA Supply Chain” model and the “Triple A & R” framework. These frameworks are analyzed and compared with each other considering their principles, and their implementation in the agri-food sector is researched.

The Triple-A Supply Chain model

The Triple-A Supply Chain model indicates that supply chains should be agile, adaptable, and

aligned in order to achieve a competitive advantage and high efficiency [Lee, 2004]. This means that supply chains should respond to short- and long-term changes occurring through all stages, providing all stakeholders with a competitive advantage related to the supply chain performance [Alfalla-Luque et al., 2018; Leończuk, 2021]. This model is also proposed as a means of achieving at the same time higher performance for both supply chain systems and all stakeholders in both developed and developing countries [A. Attia, 2015; Kontopanou et al., 2021].

The first pillar of the Triple-A Supply Chain model is agility. Agility refers to the ability of the supply chain to rapidly adapt to short-term changes that occur considering market demand and manage any external upheavals [Lee, 2004]. The ability to adapt the volume and range to meet the demands under short-term changes is also a dimension of agility [Marin-Garcia et al., 2018]. Agility is proposed as a means to manage the complexity and uncertainties of supply chains [A. M. Attia, 2016] such as in the case of the recent COVID-19 pandemic that tested the supply chains systems’ agility [Jindal et al., 2021]. For example, in the case of meat supply chains, it is shown that agility is essential for firms to survive sudden changes in the market and still retain a competitive advantage [Hobbs, 2021].

Adaptability is the second component of the Triple-A Supply Chain model. Adaptability refers to the ability of supply chains to respond in long-term changes, driven by market trends, economic changes, customer habits, and internal changes caused by the updating of production processes and technological equipment [A. M. Attia, 2016; Marin-Garcia et al., 2018]. Proper forecasting and monitoring of trends in the supply chain can reinforce risk management and become the source of a sustainable competitive advantage.

The Triple-A Supply Chain model indicates that supply chains should also be aligned. Alignment involves the promotion of common interests between the stakeholders involved in a supply chain, minimizing the differences between the individual targets and setting common goals for all of them which are related

to the total productivity and effectiveness of the supply chain. This indicates a holistic approach to supply chain management in which all stakeholders are treated with respect to their goals, but also as a part of an interdependent supply chain system [Gölgeci & Kuivalainen, 2020].

All three pillars of the Triple-A Supply Chain management are treated as components of one system, even though each of them has been investigated separately [Engelseth, 2016; Geyi et al., 2020]. Achievement of competitive advantage and performance targets of the supply chains depends to all three dimensions, as it is shown that all should be achieved [Marin-Garcia et al., 2018]. The connection of this model to the sustainability of supply chains is also a matter of discussion between scholars [Erhun et al., 2021]. Even if achieving agility, adaptability, and alignment of a supply chain could reinforce the achievement of higher performance and competitive advantage, the SDGs are not necessarily achieved [Gligor et al., 2020].

The research on the application of the Triple-A supply chain framework in supply chain networks has been expanded recently, focusing on different aspects of supply chain systems and producing various results. Implementing the Triple-A paradigm in the sectors of automotive components, electronics, and machinery as a means of enhancing the competitive advantage gives mixed results [Alfalla-Luque et al., 2018]. When considering the Triple-A concept in its core ingredients, it is observed that agility has a slightly positive impact on the total competitive advantage, in contrast to adaptability and alignment, which seem to enhance the competitive advantage of supply chains. In the case of the textile industry, the application of the main principles of the Triple-A paradigm positively affects the overall performance of the supply chain [A. M. Attia, 2016]. In the case of the agri-food sector, agility, adaptability, and alignment are proposed as a means of forming more sustainable agri-food supply chain networks [Erhun et al., 2021].

The “New AAA Supply Chain” model

In 2021 Lee presented the “New AAA Supply Chain” model, aiming to replace agility,

adaptability, and alignment terms with more contemporary ones, aiming to focus on recent supply chains as formed by the global changes that have taken place [Lee, 2021]. In order to enrich the existing Triple-A Supply Chain paradigm, he proposed Super-Agility, Architectural Adaptability, and Ecosystem Alignment as the new pillars of an effective and resilient supply chain system.

Super-Agility refers to the response to the short-term changes in the digitalization era, where information can be rapidly spread and easily accessed. As a result, the upcoming changes are rapid, and the response of supply chains to them should be accelerated. New technologies implemented in the supply chain sector, such as Internet of Things (IoT), Big Data, and sensor technologies, are used as a means for stakeholders to predict changes and gives them information in order to facilitate decision making and achieve competitive advantage [W. Ali et al., 2022]. Despite the advantage given by technological development during the recent COVID-19 pandemic, there are cases where firms revealed lack of responding to the new conditions [Patrucco & Kähkönen, 2021].

Architectural adaptation refers to an extended term of the response to long-term changes which includes more dimensions, focusing more on the production and supply management. The adoption of new technologies, the forecasting of demand, and the design of supply chains according to the market needs also drive architectural adaptability. Continuous changes in the rules of commerce and the nature of products, especially in the case of the agri-food sector, lead to the shape of a different structure of the supply chain in order to ensure long-term adaptability.

The original alignment term included the relation of interests between stakeholders that constitute the supply chain. In this renewed model, ecosystem alignment encloses all internal and external stakeholders, such as nongovernmental organizations (NGOs), governments and communities which are involved in the supply chain from environmental and social aspect. By including external stakeholders in the equation, Lee aims to

improve information sharing between the different parties in order to facilitate decision-making in the supply chains in a way that promotes the total productivity of the supply chain as a common goal for the groups involved by being approached from different aspects.

The “New AAA Supply Chain” model is recently presented, and the literature on this subject is limited. Especially in the case of the agri-food supply chains, the different impact of the new version of the Triple-A Supply Chain paradigm is slightly explored. However, there have been some attempts to improve the original Triple-A model by setting new components, such as the “Triple A&R” paradigm [Cohen & Kouvelis, 2021] that is analyzed in the following section.

The “Triple A&R” model

The “Triple A&R” model has been proposed as an alternative approach to the Triple-A Supply Chain model by adapting its main pillars to contemporary supply chain systems. According to this proposal, Agility for Robustness, Adaptability, Resilience and Re-Alignment are the three characteristics that determine a functioning and effective supply chain system.

Robustness refers to the ability of a supply chain network to respond to internal and external pressures or failures without losing its original structure [Monostori, 2021]. A robust supply chain system is planned to be resistant to sudden changes, such as pandemics and extreme weather conditions [Gölgeci & Kuivalainen, 2020]. A robust system is based on the creation of a stock of products and the acquisition of backup suppliers in order to be functional during disruptions [Cohen & Kouvelis, 2021]. In the case of the agri-food supply chains, supplier selection is a very important issue, as the nature of the products involved gives stakeholders limited choices [Verdecho et al., 2021]. In this case, robust optimization systems have started to be applied in order to reduce risk, manage uncertainties, and facilitate the decision-making processes [Banasik et al., 2019]. Robust strategies are mostly applied in a preventive way; thus agile strategies are referred to the actions taken during and after a crisis. Agility for

Robustness encompasses all the actions planned to smoothly survive and recover from sudden changes in the supply chain environment [Chowdhury & Quaddus, 2017].

Resilience is a holistic term that refers to the ability of an organization, supply chain, or system to respond to disruptions and uncertainties. The ability to recognize, avoid, and adjust to disturbances and changes characterizes a resilient organization. Resilience focuses not only on the tolerance on a supply chain system to shocks but also on the ways it can recover and adopt innovative practices in order to resist to similar interruptions [Coopmans et al., 2021; Ramdan et al., 2021]. Gligor et al. [2019] extensively analyzed agility and resilience and came up with six major traits for each of them that are partially overlapping. Aslam et al. [2020] claim that supply chain ambidexterity leads to supply chain resilience and suggest that supply chain agility plays a mediating role in the relationship between ambidexterity and resilience. Adaptability is related to resilience, as they both refer to the adoption of strategic planning in order to be prepared to withstand and recover from unexpected events and, at the objectives of same time maintain the supply chains [Lohmer et al., 2020]. Resilience has been a field of study for the agri-food sector, especially after the COVID-19 crisis, when agri-food supply chains were particularly stressed due to the limitations of transportations worldwide [W. Ali et al., 2022; Coopmans et al., 2021; Hobbs, 2021; Rejeb et al., 2020]. Especially in the case of cold and perishable products, the formulation of a resilient strategy is very important to survive the sudden changes and decrease their impact on total performance [I. Ali et al., 2018]. Most agri-food systems were afflicted by this crisis, showing that resource management is also important to achieve resilient and adaptable agri-food supply chain systems.

Re-alignment promotes the enhancement of coordination between stakeholders in a different way. In recent months, alternative supply chain contracting designs have been implemented by various sectors and government bodies. After-sales service supply networks in a variety of industries have embraced the Performance Based Logistics model, in which suppliers’ profit is based on supply chain performance. This

framework suggests that the alignment of profits leads to alignment of interests, and thus to the increase of the supply chain efficiency. In the case of agrifood supply chains alignment is mostly as a way to set common goals, mostly focusing mainly on achieving higher sustainable performance of the agri-food supply chain system [Chen et al., 2017].

AN ANALYSIS OF SUPPLY CHAIN MODELS IN THE CASE OF AGRIFOOD SUPPLY CHAINS

The contemporary agri-food supply chain systems

Agricultural products are vital for human life. Food availability is an emerging problem that has arisen, as food production should increase by 70% by 2050 to cover the world's food demand [Alexandratos & Bruinsma, 2012]. For this reason, the agri-food supply chain management practices followed in the agri-food domain are very important in order to ensure product availability worldwide.

The agri-food supply chains present many particularities compared to other supply chain systems. Products involved in agri-food supply chain procedures are characterized by various properties referring to their safety and quality [Jouzani & Govindan, 2020]. The seasonality and perishability of agricultural products indicates that the stages of production,

transportation, processing distribution, and retailing operate under a strictly controlled environment to ensure product integrity [Esteso et al., 2021]. Managing uncertainties that occur in the agri-food sector is challenging [Feyissa & Sharma, 2016]. The production of agri-food products depends on environmental conditions and the demand is modified depending on the economic and social circumstances.

Modern agri-food supply chain systems consist of different stakeholders, from various fields and regions, linked to each other “from farm to fork”. As a result, there is a need for cooperation between all parties in order to achieve a competitive advantage through the agri-food supply chain [Moreno-Miranda & Dries, 2022]. In the case of agri-food supply chains, sustainable performance is positively linked to total efficiency [Pearce et al., 2018]. For this reason, the models and frameworks proposed as appropriate for agri-food supply chain systems take into account the sustainability factor.

Results and discussion

Examining the models concerning the evolution of the Triple-A Supply Chain paradigm, we observe that they differ from each other, as they approach supply chain management from different viewpoints. In Table 1 there is a categorization of the principles proposed by each of the proposed frameworks.

Table 1. The evolution of the Triple-A Supply Chain model

Models	Triple-A Supply Chain [Lee, 2004]	“New AAA Supply Chain” [Lee, 2021]	“Triple A&R” [Cohen & Kouvelis, 2021]
Principles	Agility	Super-Agility	Agility for Robustness
	Adaptability	Architectural Adaptability	Adaptability for Resilience
	Alignment	Ecosystem Alignment	Re-Alignment

Source: own work.

The two new proposed frameworks have retained the basis of the original Triple-A Supply Chain model and explore new ways to implement the Triple-A paradigm in supply chain management. To analyze the potential of

these new frameworks to be adopted by agri-food supply chain systems, the assessment of critical factors is necessary.

The preservation of food safety and quality is one of the primary objectives in the formation

of a framework for an agri-food supply chain system. In many cases products are characterized by a short shelf life, such as in the case of fresh fish, meat, and vegetables. Most food products demand specific environmental conditions while transported and stored. The right temperature and humidity should be ensured through all stages [Dora et al., 2021]. As a result, decisions should be made by taking into account the products' nature.

The aspect of sustainability is strongly related to the performance of agri-food supply chain systems. Most recently, the practices followed by stakeholders have started to be modified in order to achieve the environmental, economic, and social targets set in the agri-food supply chains. Some of the most emerging goals for the agri-food supply chains are food waste, energy, and gas emission reduction [Jouzani & Govindan, 2020; Matzembacher et al., 2021; Samotyja, 2021]. Contemporary agri-food supply chain management frameworks must include sustainability as a factor affecting the total outcome of agri-food supply chain systems.

In examining the adoption of a new agri-food supply chain management model, the investment cost is a matter of discussion. Especially in the case of small-scale firms, a big investment negatively affects the short-term profit and discourages them [Cupertino et al., 2020]. Even for firms that have already invested in new technologies, the adoption of a new framework is easier when it is proposed as a smooth transition towards more efficient agri-food supply chain systems. Therefore, the cost of investment for the implementation of the new framework is also important in the decision-making process.

Considering the nature of product, sustainability and investment cost as three of the main axes affecting the adoption of these frameworks, the level of the potential application is analyzed.

The "New AAA Supply Chain" model promotes Super-Agility, Architectural Adaptability, and Ecosystem Alignment. Super-agility is necessary for the agri-food supply chains due to the quick shifts on the product demand, depending on consumer needs and

availability of products. The quick response is necessary due to the short shelf life of the product. To achieve an accurate forecasting of demand information sharing, using technologies such as blockchain, through all stages, has proved to be helpful [Lohmer et al., 2020] but not easily adopted by medium and small-scale firms. Another strategy proposed to achieve Super-Agility is delayed differentiation, which demands the creation of a stock before the demand evolves [Mak & Max Shen, 2021]. In the case of perishable agri-food products this strategy cannot easily be applied. Architectural adaptability as proposed in the "New AAA Supply Chain" model includes the product quality factor in the equation, in contrast to the original framework. The quality and innovation have been taken into account in the long-term strategic planning of the agri-food supply chain, which is very important for food products. Long-term planning in the agri-food supply chain sector meets difficulties due to the existing uncertainties. As a result, the adoption of such a model can lead to the framework of more successful long-term strategic planning, facilitating uncertainty management, and thus increasing the efficiency of the agri-food supply chain. Ecosystem alignment refers to the involvement of both internal and external stakeholders' interests in a holistic framework for agri-food supply chains. This requires cooperation and coordination between all parties involved in the agri-food supply chain management, not only "from farm to fork" but even beyond the consumption stage to those actions which will lead to a closed-looped agri-food supply chain system that strengthens its sustainable performance. Taking into account the relationship of the agri-food supply chains with external stakeholders, such as the government, the achievement of the SDGs considering the agri-food supply chains could be enhanced in the form of a holistic strategic plan. The application of an advanced AAA supply chain model in the agri-food sector can enrich agri-food supply chains with new capabilities, especially in the post-pandemic world [Patrucco & Kähkönen, 2021].

The "Triple A&R" framework promotes Agility for Robustness, Adaptability and Resilience and Re-Alignment as its basic pillars. For robust agri-food supply chain systems a stock of products is necessary. In the case of the

agri-food supply chain systems something like this is not possible due to the nature of the products as it can lead to food waste, affecting its sustainable performance. On the other hand, agri-food supply chains could use robust optimization systems in order to strongly resist sudden changes that occur. Resilience is strongly linked to the survival of the agri-food supply chains through the changes, as it includes an integrated plan to predict changes, facing difficulties and recover. Re-Alignment as proposed in this framework focuses on the economic motives in order to align interests between stakeholders. Re-Alignment should be expanded and include not only the economic, but also the sustainable coordination between the stakeholders. If the goals of all stakeholders are aligned and achieved in common efforts the agri-food supply chain systems have greater chances to a long-term survival, evolution and profitability. The adoption of the “Triple A&R” framework could promote the form of resilient agri-food supply chains, proposing a solution to problems caused by sudden disruptions. The form of a resilient agri-food supply chain system can have a strong impact on the sustainable performance of agri-food supply chains.

CONCLUSIVE REMARKS

Thousands of research conducted in order to find ways to improve the performance and sustainability of agri-food supply chains. The shape of various frameworks towards more effective supply chains reinforces the improvement of the agri-food supply chain performance. The Triple-A Supply Chain model, as proposed by Lee in 2004 is promoted as an effective way to endorse agri-food supply chain management. After the recent COVID-19 pandemic, the need for more evolved frameworks led to the proposal of the “New AAA Supply Chain” model by Lee and “Triple A&R” framework from Cohen and Kouvelis [2021]. These frameworks aim to adapt the original model to new circumstances by proposing more holistic approaches to each of its three components. The agri-food supply chain systems have their own discrete characteristics compared

to other supply chains. The potential of application of these models was examined considering product nature, sustainability, and investment cost as the factors affecting it. These new frameworks could find application in the agri-food sector, as some of their guidelines promote increased agri-food supply chain effectiveness. There is still room for improvement in the ways in which these frameworks. However, the shape of a framework adapted to the particularities of the sector could lead to the shape of more sustainable and efficient supply chain networks. This research focused on the exploration of these two frameworks as an update of the original Triple-A Supply Chain system. The exploration of suitable supply chain management models for the agri-food supply chains is ongoing research aiming to shape a holistic framework for sustainable agri-food supply chain management.

ACKNOWLEDGEMENTS

The authors acknowledge support of this work by the project “SMART AGRICULTURE AND CIRCULAR BIO-ECONOMY – SmartBIC.” (MIS MIS5047106) which is implemented under the Action “Reinforcement of the Research and Innovation Infrastructure”, funded by the Operational Programme “Competitiveness, Entrepreneurship and Innovation” (NSRF 2014-2020) and co-financed by Greece and the European Union (European Regional Development Fund).

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