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LA LOGISTIQUE ET LE SUPPLY CHAIN MANAGEMENT A LA CROISEE DES CHEMINS

PRO-ACTION RESEARCH FOR PERFORMANCE IMPROVEMENT OF SUPPLY CHAINS: FROM A SOCIAL IMPROVEMENT CASE TO A GENERALIZED FRAMEWORK

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Abstract

This paper aims to address how interactive research (via the adaptation of the PrOACT view of thought) can support the improvement of social improvement supply chains, via the case study of Bienestarina in Colombia. To do that, an interactive research case study is developed and proposed. First, the main issues of social improvement logistics are presented. Then, the proposed methodology is defined from the four theories and methodologies: the PrOACT way of though, the group decision theory, the social systems theory and the Supply Chain Processes Management methodology. After that, the case study is presented, then, as results, the main characteristics of the Bienestarina supply chain will be presented and analysed, to identify the main information disruptions. After that, two proposed improvement solutions are analyzed and compared, identifying the levers and limits of their respective deployment, to understand on which bases the final implementation choice has been made and which trade-offs were needed.

Keywords: Supply Chain Traceability; Social Improvement; Digitalization; Performance; Food assistance programs

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INTRODUCTION

The performance of a supply chain is crucial for its daily execution, but also for its technical, economic, and social continuity. This is the case of not only commercial supply chains, but also those of humanitarian nature. Indeed, although goals and objectives are not the same (Holguin-Veras et al., 2012), the efficiency and efficacity of humanitarian supply chains results on reaching those goals, which are mainly the decrease of suffering and diseases. In humanitarian supply chains, different categories can be established (Gonzalez-Feliu et al., 2019), related to the type of crisis they deal with: long-term crises, exceptional crises, recurrent crises, or social improvement needs. Indeed, social improvement systems are those issued to bring inclusive growth and welfare to populations in difficulties (Maldonado and Moyá, 2013; Thomas and Hedrick-Wong, 2019), via economic and financial support, nutritional improvement or resource/logistics help, among others (Gonzalez-Feliu et al., 2018). In this last category, less studied, we find many schemes having important lacks that affect performance. This is the case of food assistance programs (Rueda-Velasco et al., 2021), which are often seen as governmental humanitarian projects aiming to support the fight against malnutrition via the supply of complementary food products to sensible populations. However, those programs have little knowledge of supply chain management, relying mainly on service providers without a central, integrated monitoring of the supply operations by the program's promotion institution. Indeed, few studies can be found (either in scientific or practice literature) about the assessment of food assistance programs efficiency on a supply chain management perspective, mainly in those countries having a high number of families facing malnutrition (Information Resources Management Association, 2021).

To improve those programs' supply chains, digitalization can play an important role (Rueda-Velasco et al., 2019). Indeed, recent works showed that the main problems those supply chains face are related to the lack of information tracking, traceability and synchronization/integration, issues that can be improved by digitalization and ICT tools (Betancur Betancur, 2013; Cruz Castelblanco, 2019; Knoops, 2019; Rueda-Velasco et al., 2019, 2021), since main dysfunctions are related to the lack of tracking and exchanging information concerning the efficiency of the whole supply chain process and its components (Gonzalez-Feliu et al., 2018). In any case, the adoption of digital technologies and traceability is not always easy, and although traceability is

a popular subject in food supply chains, it is not the case in distribution systems related to food assistance programs (Rueda-Velasco et al., 2021). For those reasons, the analysis and implementation of traceability tools in those types of supply chains require a good comprehension of the context of application, and a contextual or interactive planning approach (Ackoff, 1994, 2001). Thus, research needs to be re-defined and adapted to catch the reality of the context, and results obtained need at their time to be compared to that reality and more precisely the main objective the involved stakeholders fixed with respect to the research. A pure "observational research" approach seems having their limits, and action research needs to include the main issues of interactive planning to lead to applicable decision-making issues.

For those reasons, this paper aims to propose a methodology to carry out action research from the PrOACT way of thought (Raifa et al., 2001) and the interactive planning issues of Ackoff (2001) adapting it to a social improvement supply chain case, that of the Bienestarina production and distribution in Colombia. First, the main issues of social improvement logistics are presented. Then, the proposed methodology is defined from the four theories and methodologies: the PrOACT way of though, the group decision theory, the social systems theory and the Supply Chain Processes Management methodology. After that, the case study is presented, then, as results, the main characteristics of the Bienestarina supply chain will be presented and analysed, to identify the main information disruptions. After that, two proposed improvement solutions are analyzed and compared, identifying the levers and limits of their respective deployment, to understand on which bases the final implementation choice has been made and which trade-offs were needed.

AN OVERVIEW ON SOCIAL IMPROVEMENT LOGISTICS

As seen above, the aim of food assistance programs is to fight hunger and malnutrition. It can then be considered as a case of social improvement logistics (Orwell and Dawes, 1993), a sub-set (often under-studied) of humanitarian logistics (Gonzalez-Feliu et al., 2019). In humanitarian support organizations and actions, we find three main types of logistics problems: (1) supply chain issues related to long-term crises (which can be planned in advance), (2) humanitarian logistics relief facing exceptional crises, those that are difficult to anticipate (such as terrorist acts or the recent sanitary crisis of COVID-19, among others), (3) humanitarian logistics facing recurrent crisis, similar to that above but in cases where the causes and impacts of a future crises, although not forecasteable precisely, can be anticipated from previous events, and (4) social improvement logistics, related to distributing products to support everyday needs of poor and sensible populations and improve their social status.

Element	Long-Term Crises	Exceptional Emergencies	Recurrent Emergencies	Social Improvement
Frequency	Permanent	Punctual Exceptional	Punctual recurrent	Permanent
Anticipation andprevision	Robust characterization	Very difficult,high incertitude	From historical eventsand time series	Robust characterization
Priorities of theintervention	Give a major change	Saving lifes	Saving lifes, assisting population	Give continuous improvement
Horizon of theintervention	Very long term	Very short term	Short term	Long term
Planning needs	Long term change	Post crisis reconstruction	Post crisis reconstruction, anticipation	Continuous improvement
Basic references	Van Wassenhove(2006)	Holguin-Veras et al. (2012)	Vargas-Florez (2017)	Gonzalez-Feliu et al.(2018)

Table 1: Main types of crises regarding supply chains (adapted from Gonzalez-Feliu et al., 2019)

Although humanitarian logistics (both for disasters or post-disaster) is nowadays a popular research subject (Kovács and Spens, 2009; Apte, 2010; Chandes and Paché, 2010; Holguín-Veras et al., 2016), we find a lower scientific interest for social improvement logistics. Indeed, we find a first statement on the importance of logistics in supporting the social welfare, or social improvement, made by Orwell and Dawes (2007), after what we observe only three works related explicitly to the logistics of social improvement: Stock (1990) is the fist, to the best of our knowledge, that states the poor contribution of logistics research to evidence its contribution to social welfare; Adivar et al. (2010) focus on the notion of value chain for social improvement and welfare; finally, Maldonado and Moya (2013) show the importance of combining social improvement policies with reverse logistics in developing and improving food banks actions and logistics schemes. Finally, recent works focusing on the distribution processes of food assistance programs address some questions of social improvement logistics but without an explicit definition of this notion (Clark and Hobbs, 2015; Cruz Castelblanco, 2019; Knoops, 2019; Rueda-Velasco et al., 2019; Peters et al., 2021).

The first categorizations of social improvement logistics are found in Gonzalez-Feliu et al. (2018, 2019), in a comparison to other humanitarian logistics visions. Social improvement logistics aim to deploy logistics systems to bring vulnerable populations with the goods and services they need for improving their daily life conditions. With respect to other categories of humanitarian logistics, most issues can be planned, since they are acting with daily life improvement, but are of particular importance since the consequences of those logistics systems' efficiency have a direct impact on populations' growth (Anand et al., 2013). According to Gonzalez-Feliu et al. (2018), there are 5 sub-categories of social improvement initiatives:

1. Primary economic improvements (mainly by subsidies and income transfer actions to beneficiaries).
2. Cost reduction to improve nutrition and welfaire (mainly by subsidies to retailers and distribution companies).
3. Food access initiatives (by bringing beneficiaries, hospitals, nurseries and schools foods).
4. Education and monitoring initiatives (by promoting good habits and/or monitoring the risk of families and sensible groups of the population regarding malnutrition).
5. Promotion and development of self-production.

In this research, we deal with food access initiatives, and more precisely with nutrition improvement programs. Making such foods arriving to destination (i.e. beneficiaries) need the deployment of supply chains that are not commercial and cannot be monitored on the basis of classical SCM KPIs, and remain, in many countries, not always integrated (Gonzalez-Feliu et al., 2018). Main works in this field (i.e. the distribution processes and supply chains of food assistance programs and food access initiatives) remain mainly related to supply chain or transport optimization (Cruz Calstelblanco, 2019; Peters et al., 2021; Rueda-Velasco et al., 2021), ICT/ITS design-development (Rueda-Velasco et al., 2019) or supply chain design (Clark and Hobbs, 2015). In all cases, the problems addressed are a lack of efficiency of supply chains and to solve them, top-down, engineering approaches are used (as on many operations research and management science applications), with the conviction that current systems are inefficient by organizational gaps that can be solved via optimization. But as showed by Ackoff (1994), those methods are a way to deal with problems but not the only one to solve them. Indeed, all those methods result into what Ackoff (1994) call "problem resolution", i.e. the use of known methods and techniques, in a quasi-replicational viewpoint, to deal with a problem, sometimes adapting the problem to the existing models and methods and not the opposite. However, there

are other two ways to deal with a problem (that for sure start by resolution, but complete it): problem solution (i.e. the definition of unexisting methods to make the problem disappear, at least currently) and problem dissolution (i.e. the identification of variables and issues that can be change in a way that the problem has none reason to exist anymore, making it disappearing permanently, or in Ackoff's words, dissolving it). To extend and evolve problem resolution techniques leading then to more long-term consequences on the capability to make the problem disappear, it is important to address problems in a more interactive way. To do that: to main, complementary visions can be addressed: that of Raiffa (2007) related to finding the roots of a problem and defining various solutions to finally make tradeoffs and consensus, and that of Ackoff (1977) aiming to start by a first modeling and problem solving approach which is compared to the decision needs and the problem's reality and modified iteratively until a satisficing solution (for the decision makers) is found. Both approaches are complementary and have similarities. For those reasons, this paper aims to apply an interactive planning and research approach based on both frameworks to deal with a real problem of food access supply chains: that of the Bienestarina distribution processes in Colombia.

THEORETICAL AND METHODOLOGICAL FRAMEWORK

Since the main problem addressed in this research is of applicative nature, it is important to examine it on an applicative way, and the "observation" viewpoint or the "theoretical optimization" one both remain little adapted to the field of application: that of food assistance programs. Indeed, the aim of such programs is to provide vulnerable population with dietary complements to improve their daily nutrition conditions. This research is aimed at improving such programs and supporting institutions and NGOs on the deployment of social improvement logistics policies. For that reason, action-research seem the most adapted category of research methods that can be used. More precisely, theory of practice in social systems (Ackoff, 1988) is followed here. Indeed, supply chains, as well as organizations and societies, among others, can be seen as social systems. Social systems can be defined as "open systems that (1) have purposes of their own, (2) at least some of whose essential parts have purposes of their own, and (3) are parts of larger (containing) systems that have purposes of their own" (Ackoff, 1994). The author states also that systems where people play an essential role cannot be completely understood, and then managed, if viewed in other ways than as social systems. Seeing the considered field as a social system raises also the questions of how identifying the problems to be solved in order to correspond to the organization's aims, that of the method and models

proposed to deal with the problem and that of how addressing eventual changes the research will identify as necessary for improvement (Ackoff, 1988), among others.

To address all three of them, four frameworks are called here, which are:

- The PrOACT way of thought (Keeney, 1999; Raiffa et al., 2002), since it allows to address a problem in an interactive way, relating it directly to practice. The PrOACT methodology identifies 5 stages: 1) Defining Problems; 2) Setting Objectives; 3) Generating Alternatives; 4) Assessing Consequences; 5) Making Tradeoffs.
- The Optimization cycle (Ackoff, 1977; Gonzalez-Feliu, 2019), which sees the problem solving as a cyclical procedure that starts from the observation of a reality, the definition of a decision problem, the modelling of the problem, the resolution of that problem (by proposing solving methods), and the validation of the solution with respect to the model, the problem and the reality represented. If one of the three validations is unsatisfactory, the cycle in re-iterated until all three validation conditions are verified.
- The Group Decision Analysis Theory (Keeney, 2013), which defines the decision processes on a group and their relationships to individual decisions. That theory is completed by the decision distance issues of Gonzalez-Feliu et al. (2013), mainly those guiding and orienting consensus searching.
- The Supply Chain Business Process Management Components (Lambert, 2008), which can be divided into physical and technical (the physical, financial, work and information flow structures of a supply chain, the company's organizational structure, which are of different types, the optimization/organization methods), and human and behavioural (the structures of culture and attitude, rewards and risks, and power and leadership, plus the management methods).

Those four frameworks have been mixed to propose a pro-action research method. The conceptual and methodological framework proposed here can be summarized in the following schema (Figure 1):

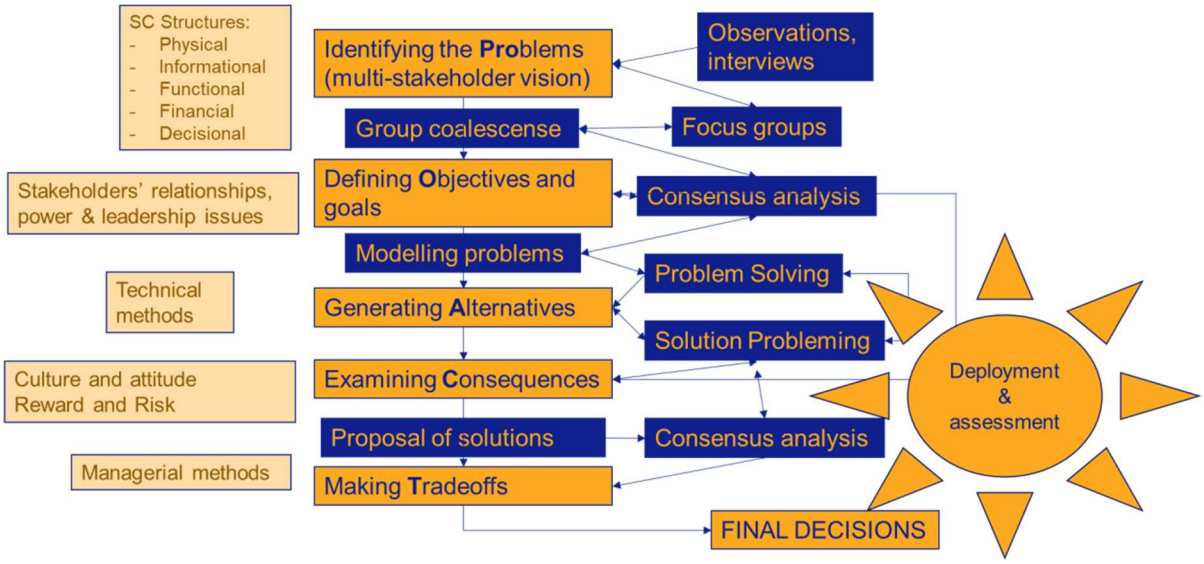

Figure 1: The theoretical-methodological framework proposed here

The methodology proposed here is that of case study research (Eisenhardt, 1989). In other words, we will start by presenting the case of Bienestarina supply chain in Colombia (managed and organized by a centralized stakeholder&r), then we tried to identify the main traceability issues and generalize it mainly for transferability issues.

To do this, we propose the following methodological frameworks organized as follows:

- Characterization of the Bienestarina supply chain.
- Identification of the main problems and dysfunctions due to lack of traceability.
- Definition of traceability needs.
- Proposal of two solutions: a combined and an integrated traceability alternatives.
- Suitability assessment and deployment issues.

The Bienestarina supply chain characterization will be made via an adapted framework issued from Cooper et al. (1997) but extended to social improvement supply chains. It will combine a supply chain process modelling, an analysis of social improvement management components and an assessment of the resulting network structure, in the sense of Lambert (2001).

Figure 2: Framework to characterize the supply chain in social improvement systems and identify the main lacks (authors' elaboration, adapted from Cooper et al., 1997)

As a second step, we propose the description of the main logistics problems regarding the product traceability. This is done as a conclusion of the interviews' analysis and the application the AFNOR (2014) framework, to identify which dysfunctions in the four base activities (plan, program, execute and control) are observed at each stage of the supply chain integration level. As a third step, there is an analysis about the needs of the stakeholders involved in the Bienestarina Supply Chain, also on the basis of the interviews results. Finally, the fourth and fifth step consist on the comparison of two tools: an integrated one, issued from Rueda-Velasco et al., 2019), and the combination of a commercial traceability tool for B2B commercial logistics and the implementation of an ad hoc traceability solution for final deliveries (Monsalve Salamanca, 2019). Those two tools are assessed and compared using a framework that combines risk assessment, adoption issues and functional ICT assessment. Finally, a discussion about the proposal is presented, as well as the main generalization issues.

The data needed to build the case study and prepare the research work has been collected in different steps, on a logic of action-research (and in the context of an applied research program funded by Colciencias, the Colombian Agency of Research). First, an exchange with the department of malnutrition fighting at the Colombian Institute of Familiar Wellness has been carried out, with different interviews, to set the problem and develop the action-research plan. Then, a 24 month research period has led to the observation of the Bienestarina Supply Chain, various exchanges with the different stakeholders involved, a set of quantitative surveys, an analysis of the current traceability tools, the identification of current problems and the proposal of solutions to improve the current lacks, some of which have been implemented and followed.

FIRST RESULTS

Case study presentation

Bienestarina is a public program launched in 1976 led by the Colombian Institute of Family Welfare (ICBF) that manages direct transfers of food to the vulnerable population to fight malnutrition, especially in children and teenagers. With an annual budget of 40 USD million, the ICBF and the Colombian government projected 22 thousand tons/ year to produce and deliver to reach around six million of beneficiaries annually (DNP, 2015).

The physical supply chain structure includes public and private actors. Among these actors is the public entity in charge of leading the program, a private logistics service provider who manage food assistance's production and distribution, about 15 private companies work as raw materials suppliers, beneficiaries (individuals, associations, public institutions like hospitals, schools, etc.) and volunteers.

The design of the structure of the distribution system is fundamental to guarantee access in a context of national demand to a geographically dispersed population as shown in Figure 3 (b)

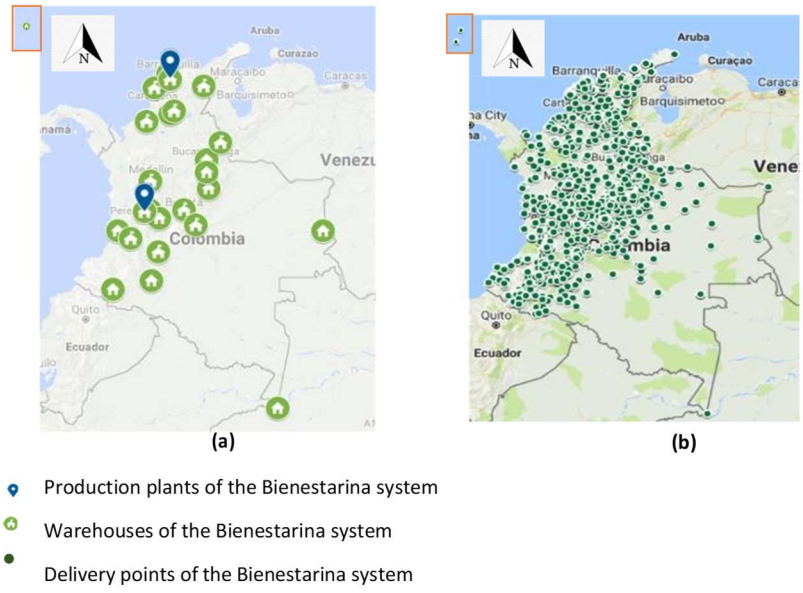

Figure 3. Facilities Location in the Bienestarina distribution system. (a) Factories and warehouses location; (b)Delivery Point location.

Analysis of the system

The distribution system has been configured with two production plants that send the food supplement freight to 25 warehouses (Figure 3 (a)). From there, the product is distributed to around 5000 delivery points at the national level. The production plants can also fulfill the role of distribution centers and could send the product directly to the delivery points. As can be seen, the structure of the system covers a large part of the national territory because of the maintenance and financing of the program for over 40 years. Figure 4 shows a Bienestarina supply chain scheme with its main longitudinal structure (stakeholders) and both physical and information flows.

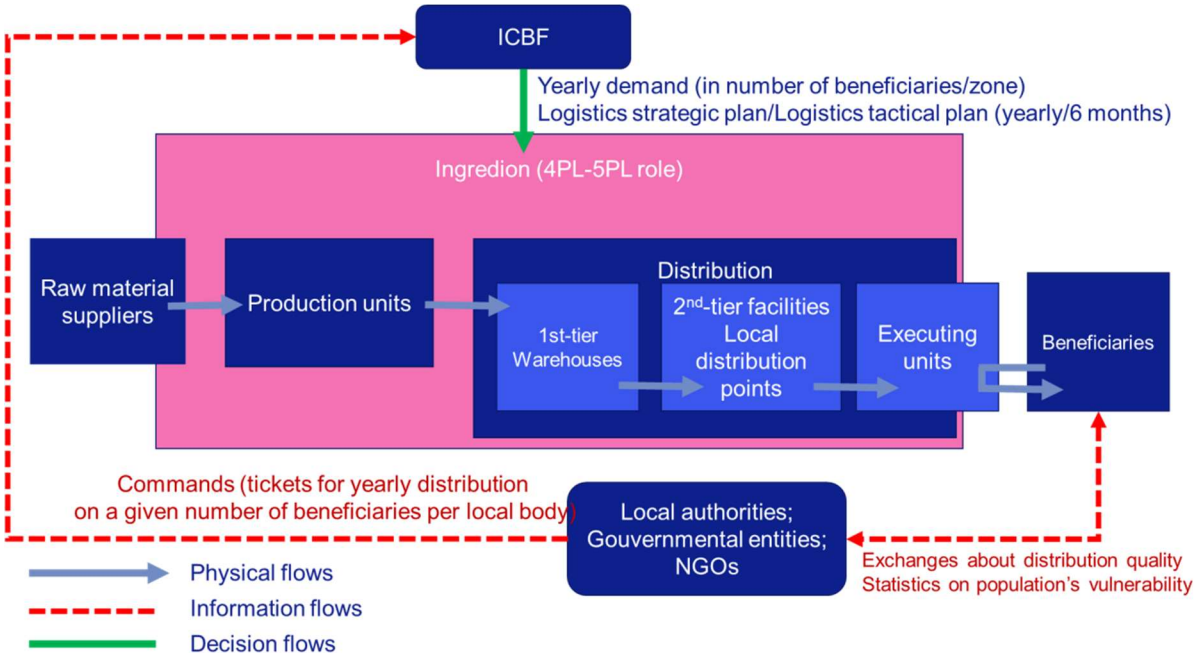

Figure 4. Bienestarina supply chain scheme.

The PrOACT interactive analysis led to the following main issues.

- Agreed Identified Problems: There is a high difficulty to track a part of the information (mainly at the final echelons of the supply chains, i.e. between the executing units and the beneficiaries), which results on high product losses. Moreover, processes seem integrated in the majority of the supply chain (i.e. until executing units) by the current contractual issues with Ingredion, but that integration is cut at the last echelon. Finally, all stakeholders agree that cost is not a major issue, and product losses and families not accessing to products are more important questions to address.

- Objectives: the main objectives that have been defined are the need of improving service rates (to feed better populations) and that of a higher information transparency.
- Alternatives: various alternatives have been analyzed and compared. Supply chain optimization seems little relevant at inbound level, and production, as the supply chain is entirely planned in advance, does not need further optimization. Optimisaiton is very difficult at distribution level, mainly in the last echelon, made of volunteers. This lase echelon is critical and the main alternatives seen as improving it are related to process integration and information transparency. For that reason, traceability seems the most suitable issue in terms of cost and acceptability. Two traceability tools have been analyzed and proposed: the first is an integrated solution and the second the combination of two non-integrated tools, the existing one (that does not cover the last echelon) and a second one to cover it.
- Consequences: after examining the two solutions, the integrated one seems to present high risks (continuity, culture mainly). The non-integrated solution (2 tools) presents decoupling points but is more accepted than the first one.
- Tradeoffs: it seems that an information system is currently available until local points. A second solution (social network-based) seems easily accepted by volunteers. For that reason, the second traceability approach (2 combined tools, with a decoupling point at executing units) has been accepted by ICBF.

The results allowed to identify a set of dysfunctions, which main causes are:

- Registered Beneficiaries' accuracy.
- Disintegration between supply chain processes and lack of integral information traceability.
- Lack of coordination between social scope and the scope of supply chain informational, functional, and physical structures.
- One single supply chain structure for heterogeneous population groups (e.g. rural, urban, or ethnical) and heterogeneous territory features (urban concentred and rural dispersed population)
- Public contracts for 4PL-5PL operators do not cover the full program scope.
- Disfunctions related to the different ways of consumption.
- Lack of last mile tracking.

- Lack of primary data about efficiency of the Bienestarina program in fighting malnutrition.
- Loss of product because of improper storage or packaging
- High levels of unclaimed product.
- Important levels of distributed product for improper use.

Those causes highlight the importance of having robust traceability and transparency of information, and the main disjointing point of the information low continuity seems to be the link between regional distributors and executing units (i.e. the volunteers that finally bring Bienestarina to beneficiaries). Those units are composed of volunteers and the current tracking tools stop at the regional point level, the last part of the supply chain relying only on paper-based registers, most of them being difficult to verify its accuracy. For that reason, an analysis of traceability solutions to improve the continuity and transparency of that information have been assessed.

Two main solutions are proposed. The comparison of such solutions shows some important concerns. In technical terms, the information applications must be synchronized to an address where the server is located; it could be an issue for the update process of all devices. The server as a central entity may have defaults; all devices must be pointing to a specific URL or address, if it is changed, it is necessary to update each application by tracking. The system proposed may allow after few testes to be an example to implement similar systems on a different first need products that are distributed to vulnerable populations.

In consequence, it is important to a comprehensive development logistics for this case, the implementation of ICT strategies, methods and techniques of various kinds, according to each region's nature of the Colombian territory to bring Bienestarina just in time and make compliance with the fundamental rights of the vulnerable population. More in depth studies of supply chain operators and logistics information technology allows to strengthen the Bienestarina logistics system and to get more sustainability efficient results.

A recent interview with J.P. Cruz, program director at ICBF and former researcher in the Bienestarina improvement team revealed that the acceptability of the chosen system was high, and the qualitative appreciation of both volunteers and beneficiaries has strongly increased. Due to recent events of sanitary importance, a quantitative evaluation of the improvements is not still available but the improvement of the Bienestarina distribution system can be highlighted by the fact the supply chain was used to support logistics operations of sanitary importance

during the COVID-19 crises, showing that some of the deficiencies have been reduced and the system increased its robustness.

Other evidence on the improvements of the system can be read in a recent work trying to propose an automatized system to register the last-echelon issues (and then to replace the current system), proposed by Marquez-Diaz and Perilla-Benitez (2020). Authors base their work on the observation that the main issue nowadays arise on the fact volunteers and operators have orthograph and grammar difficulties, having a difficulty to standardize information, but no explicit mention to freight losses or service quality difficulties as stated before the proposed pro-action research approach is made in their work. It is clear that improvements on the system are still needed but one of the major limitations of the system seems to be reduced by an interactive research approach aiming to understand the causes of the problem and then trying to solve/dissolve it. Moreover, the proposed solution seems having been easily implemented and accepted, and even if it can obviously be still improved it has its positive effects.

However, traceability issues are not the only ones to be considered. The human factor, the regional disparities and the lack of accessibility of some regions (which need specific transport modes, such as barges or helicopters since roads are sometimes absent) need to be taken into account in the proposal of efficiency management tools. The case study shows the complexity of the problem, the strengths of action-research and the central place of traceability issues that go beyond the only technical issues to consider also social and human factors. All those elements play an important role in assessing the efficiency and ensuring a good functioning of food assistance programs based on the distribution of dietary complements.

CONCLUSION

This paper proposed an interactive, proactive methodology allowed to exchange with stakeholders and identify the real problems to solve, and was applied to solve an information and integration problem at ICBF, Colombia, for the Bienestarina distribution food improvement program. After examining, in a PrOACT way, the problem, traceability was identified as the most suitable issue to address to improve the Bienestarina supply chain in a cost-speed-acceptability equilibrium. A first traceability solution, which was more integrated and allowed a better improvement, had little acceptance, for both cost issues and the lack of integration culture in the Bienestarina supply chain (mainly at the last echelon, made of non-logistics volunteers). Also functionality and education issues constituted a limit for implementing this solution. Exchanging with ICBF and SC stakeholders allowed to implement a more suitable

solution, that integrates the information system of the logistics provider (Ingredion) of the supply chain (from producers to executing units) with a social network information system able to be used by volunteers. This solution is working since 2017 and the SC efficiency and sustainability increased highly, although a quantitative evaluation would reinforce the already observed qualitative feelings and is being planned for a moment the sanitary conditions would be more stable. Finally, further works will try to generalize the proposed framework to problem-solving and decision support in other SC fields.

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