The appropriateness of action research to achieve increased supply chain sustainability – a case study

Anita Romsdal*

**Department of Production and Quality Engineering, Norwegian University of Science and Technology, Trondheim, Norway (anita.romsdal@sintef.no)*

Abstract: Companies in a supply chain are dependent on the performance of their supply chain partners. Any efforts to improve sustainability must therefore incorporate a supply chain perspective and build on collaboration. The paper argues that action research is appropriate for this purpose due to its ability to create joint meaning construction, build trust and commitment, incorporate multiple research methods and disciplines, and close the gap between industry and academia. The paper uses a case study from the Norwegian grocery industry to look at how an action research strategy has resulted in the development of a concept for increased supply chain sustainability. The concept is based on the application of real-time, demand-driven planning and control principles to assist supply chains in integrating all three pillars of sustainability (economic, environmental and social) at an operational level.

Keywords: action research, sustainability, supply chain management, grocery industry

1. Introduction

The most commonly sited definition of sustainability is that of the Brundtland Commission (World Commission on Environment and Development, 1987, p. 8): "development that meets the needs of the present without compromising the ability of future generations to meet their needs." Since 1987, sustainability has grown in importance and been progressively incorporated into governmental policy and corporate strategy (de Brito, Carbone, & Blanquart, 2008). However, the broad, macro-economic, societal definitions of sustainability can be difficult for organisations to apply (Carter & Rogers, 2008), and there is a need to operationalise sustainability in terms of the implications and impacts it has on traditional assumptions and practices in the field of operations management (OM) (Linton, Klassen, & Jayaraman, 2007). Today, sustainability is often associated with the "triple bottom line", referring to the inclusion of social and environmental responsibilities in addition to the traditional economic focus. Although this can be difficult enough to implement for a single company, a further complication is the fact that organisations are no longer acting alone but rather form part of one or more supply chains (Kaplinsky, 2000; Lambert, Cooper, & Pagh, 1998). These supply chains consist of several organisations acting together, with each organisation dependent on the performance of supply chain partners. Thus, any effort aimed at improving sustainability must necessarily incorporate a supply chain perspective.

This paper discusses supply chain sustainability within the frames of a research and development (R&D) project in the Norwegian grocery sector called *Smart flow of goods*. Indicative of the growing interest in sustainability, the project is an industry – academia collaboration focusing on how a change in the planning and control of supply chains can improve economic and environmental performance. One of the objectives of the project is therefore to develop new supply chain control models that will support sustainability. A key characteristic of these models is that they are based on intelligent, demand-driven control principles, enabled by the sharing of real-time information and the application of modern technology.

The main purpose of the paper is to demonstrate how action research in this particular collaborative R&D project has the potential to increase sustainability for the industrial actors and supply chains involved. The argument of the paper is that an action research strategy is a suitable means to achieving increased economic and environmental performance. Also, in order to contribute to a more holistic understanding of supply chain sustainability, the paper will offer some reflections on the role of social aspects, given the particular cultural context of the case example.

The following chapter will outline some current issues and developments within the topics that form the background for the paper and the *Smart flow of goods* concept. Next, the methodology of the paper is described, before the *Smart flow of goods* project and its action research strategy is presented. The discussion chapter reflects on the action research strategy and its contributions to sustainability and some of the preliminary findings from the project, before the paper concludes with some reflections on the broader contributions of the work.

2. Background

2.1. Trends in R&D

Over the years it has been claimed that there has been little guidance from academia to the fields of OM, logistics and supply chain management (SCM), and that academia in general has been following rather than leading business practice (Chopra, Lovejoy, & Yano, 2004; Lambert, et al., 1998; Sachan & Datta, 2005; Westbrook, 1995). However, recent calls for more non-positivist methods based on closer industry – academia collaboration might be indicative of a beginning shift towards a closing of this gap between theory and practice (see e.g. Arlbjørn & Halldorsson, 2002; Johannessen, 2005; Näslund, 2002; Sachan & Datta, 2005). It can be argued that action research is an appropriate research strategy for supply chain sustainability projects due to its characteristics of action, research and participation, the dual objectives of improvement and knowledge generation, and its ability to incorporate multiple disciplines and research methods, thus meeting the calls for less fragmented, more multi-disciplinary research efforts.

Over the past decade or so, a lot of research has been performed within the frames of sustainability. However, the majority of these efforts have been fragmented and mainly focussed on one or two of the pillars of sustainable development, with the majority looking at environmental factors (Carter & Rogers, 2008; Linton, et al., 2007; Seuring & Müller, 2008b). A recent literature review by Seuring and Müller (2008b) found a clear deficit in literature on the social aspects of sustainability. One can only speculate as to why social issues have not been addressed more to date. Within the Norwegian context, one contributing factor might be the extensive legislation already in place to regulate the most critical social issues, thus leaving researchers and practitioners to focus more attention on the environmental and traditional economic aspects.

2.2. Supply chain management and sustainability

The domain of SCM focuses on the need for coordinating and integrating the operations of several companies involved in supplying a market with products and services. Further, sustainable SCM has been defined by Seuring and Müller (2008b) as: "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e. economic, environmental and social, into account…" The wider range of issues involved in sustainable SCM compared to traditional SCM implies that a focal company needs to take a larger part of its supply chain into consideration than what is needed for traditional economic reasons, indicating that a more cooperative approach to sustainable SCM seems to be required (Seuring & Müller, 2008a). It has also been suggested that while meeting the economic criteria is still considered the most critical order winner, the fulfilment of environmental and societal criteria is increasingly becoming an order qualifier in the competitive environment (Seuring & Müller, 2008b).

When environmental problems related to logistics, SCM and OM have been discussed, many have called for technical solutions like cleaner engines or alternative fuels to reduce greenhouse gas (GHG) emissions (Rodrigue, Slack, & Comtois, 2001). However, it is unlikely that the required GHG emission reductions will be achieved from technical developments alone (Nereng, Semini, Romsdal, & Brekke, 2009). Thus, to achieve broader environmental and sustainability effects, a combination of technical and organisational measures seems to be in order.

In 2008, the British Standards Institute (BSI, 2008) introduced the PAS 2050 methodology; a specification of assessment of GHG of goods and services. The methodology is based on the view that not only the direct burning of fossil fuels but also the consumption of goods and services give rise to GHG emissions – referred to as indirect or "embodied" emissions (BSI, 2008; Minx, Wiedmann, Barrett, & Suh, 2008). This is particularly relevant in supply chains of perishable products such as food, where an overwhelming proportion of GHG emissions arise in the primary production stage and much less in distribution and packaging (Nereng, et al., 2009). This implies that any assessment of GHG emissions for a product provided to the customer should include emissions at all the stages of the supply chain. The embodied emissions perspective thus highlights the importance of efficient logistics and operations in the food supply chain in order to speed up the product's journey through the supply chain to increase the likelihood of the product fulfilling its function, i.e. being consumed before its use-by date.

2.3. Supply chain planning and control

In order to meet some of the challenges facing today's complex supply chains, new concepts for supply chain planning and control are emerging. Manufacturing planning and control (MPC) tasks in a supply chain involve determining what, who, when and how to act in order to meet customer demands with the exact supply in a coordinated chain (Jonsson & Lindau, 2002; Vollmann, Berry, Whybark, & Jacobs, 2005). Since supply chain actors affect each other, they cannot be managed in isolation (Shi & Gregory, 1998). Today, most of the planning and control systems used in supply chain operations are based on traditions of make-to-stock (MTS) and material requirements planning (MRP) where forecasts and expectations of future demand are the main inputs. The consequences are that a number of supply chain operations are decoupled from actual end customer demand, and that inventories are used as a buffer against uncertainty and fluctuating demand.

The needs for increased supply chain integration and collaboration has resulted in the development of several collaborative models for orchestrating supply chain and network activities, such as vendor managed inventory (VMI), collaborative planning, forecasting and replenishment (CPFR), and automated replenishment programs (ARP). The aim of such models is to achieve seamless inter-organisational interfaces by specifying control principles and models for the flow of materials and information, where network operations are tied and adjusted to customer demand and more make-to-order (MTO) strategies.

2.4. Information and supply chain transparency

In their 2008 literature review on sustainability, Carter and Rogers (2008) identified transparency as one of the supporting facets of supply chain sustainability. Increased transparency is in part being driven by the rapid speed of communication and improvements in software, and can be improved through vertical coordination across supply chains, as well as horizontal coordination across networks (Carter & Rogers, 2008). Access to real-time demand and event information in supply chains is a critical element in the implementation of the demand-driven control concepts described above. Advances in technology within areas such as RFID, sensor technology and electronic product code information services (EPCIS) will enable access to more real-time information than the existing technology solutions, supporting a shift in the planning and control concepts towards purer demand- and pull-driven supply chains.

2.5. Summary

To sum up, this chapter has identified a number of factors that affect R&D within the topic of sustainable supply chains. Action research was identified as a candidate for ensuring close industry – academia collaboration. It was also found that supply chain collaboration is essential to achieving sustainable supply chains and that future supply chain cooperation and integration should be built on real-time, demand-driven planning and control principles. Further, emerging technology such as RFID and EPCIS were identified as enablers of increased transparency and new control concepts in supply chains.

3. Methodology

This paper uses an ongoing R&D project, *Smart flow of goods,* as a case example of how an action research strategy can contribute to supply chain sustainability in an industry – academia collaboration. The author has been involved in nearly all phases of the project, from writing of the initial project proposal, planning and execution of project activities, and reflection on findings. Data has been gathered through personal participation, observation, discussions with industrial and academic participants, project reports and presentations, secondary documentation about the companies and the industry, other ongoing R&D projects, and relevant literature on the involved topics. The following chapter will describe the research strategy and methodology of the *Smart flow of goods* project in more detail.

The arguments of the paper build on literature in SCM, OM and logistics. The approach to action research builds mainly on the perspectives of Coughlan and Coghlan (2008) in terms of the application to the industrial context and Greenwood and Levin (2007) with regards to action research as a strategy for social change.

4. Collaborative R&D; the case of the *Smart flow of goods* project

4.1. Project background

The project *Smart flow of goods* was initiated in 2006 by nine major players in the Norwegian grocery industry; three food manufacturers, two manufacturers of packaging material, two wholesaler – retailer dyads, and two logistics solution providers. The three-year project (2007 – 2009) is being carried out in close collaboration between industrial and academic partners, with financing coming from the industrial participants and the Research Council of Norway.

The background for the project was three-fold; there was a need for track and trace solutions in the food sector, a wish to increase the competitiveness of actors through responsive and efficient logistics solutions in the supply chain, and a need for development and testing of intelligent and automated logistics solutions enabled by RFID and EPCIS technology.

4.2. The fresh food supply chain

Food supply chains are complex and form large networks, and the grocery industry's solution to its logistics challenges has tended to set a standard for other industries. The logistics structure is often centrally coordinated, enabling use of cross-docking and terminal facilities in distributing goods to retailers in parallel with direct shipments from manufacturers.

The Norwegian grocery market is dominated by a handful of large actors within each stage of the supply chain and there is a near full consolidation into four chains of wholesaler – retailer dyads which in total control 98 % the market. Control concepts in the industry are dominated by traditional push and forecasting based control. Information on consumer demand is in many cases not accessible due to lack of, or infrequent, information sharing, and those who have access to information do not necessarily utilise it for control purposes. Some other typical challenges and problems associated with the current operations and control of Norwegian food supply chains include:

- A high number of stock points or buffers along the supply chain

- Large amounts of waste/scrapping due to long lead times and temperature sensitive products
- Forecasting and planning in each node based on forecasted demand from subsequent node
- Forecasting based on historic sales and extensive manual parameter setting in forecasting software
- Limited information sharing and use of available information for operations planning and control

Since fresh food is highly perishable, efficient production planning and SCM is crucial. The amount of food waste generated along the supply chain and in consumers' households today is substantial, and a recent British study found that 61 % of household food waste is avoidable and could have been eaten if it had been managed better (Ventour, 2008). Even though cause-effect chains are complex and further mapping of these are required, it is reasonable to claim that a substantial share of this waste can be attributed to long lead times and resulting short shelf life of perishable food products. Thus, MPC systems in food supply chains should support cross-company processes in a manner that avoids increasing demand amplifications, stock levels, and lead and response times.

4.3. Organisation and working method

Focus and activities in the *Smart flow of goods* project were determined in cooperation between practitioners and researchers based on the specific challenges facing the participating organisations and their supply chains. The project provides a detailed study of real-life situations in the Norwegian grocery industry, capturing a number of different supply chains for a variety of food products and packaging materials. A typical supply chain involved in the project is depicted in Figure 1.

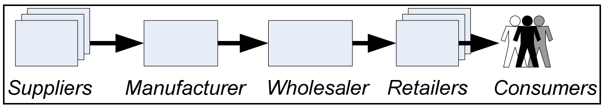

Figure 1: Typical food supply chain

The project is organised to support cooperation between the academic and industrial participants, as well as across disciplines. A project steering committee consisting of representatives from all industrial and academic participants has been responsible for providing direction to the project, setting goals and objectives, approving plans and deliverables, providing access to the respective organisations and manning project groups to work on the individual activities and tasks. A number of project groups consisting of industry and academic participants have been responsible for carrying out activities, collaboratively developing and testing new solutions, reflecting on findings, writing reports and academic papers, giving presentations, etc. This joint preparation of project materials has been a central element of the project – where the action research strategy has added the opportunity for participants to continuously reflect on and in action (see Schön, 1991) to increase practical and theoretical knowledge creation.

Four R&D partners have been involved in the project since the start, all contributing with expertise and experience from different disciplines; logistics and operations management (SINTEF Technology and Society), ICT (SINTEF ICT), RFID technology and application (RFID Innovation Center), and sustainable innovation and development (Ostfold Research). The R&D partners have participated in all project groups and activities according to the expertise required in each case.

New solutions in the project were developed using the *control model methodology* (Alfnes, 2005). A control model is a description of the material and information flows in a supply chain documenting the material and information flows between the various supply chain actors, as well as processes, transportation modes, and the detailed principles and rules used to control material flows. Initially, an AS IS control model describing the starting point for each supply chain was developed. The main purpose of this AS IS model was to make all involved actors aware of and agree on the structures and policies that were currently used to control the supply chain. Information was collected through workshops, meetings, interviews, observation, written documentation, databases, etc. The supply chain actors were responsible for providing the information requested by researchers, who then systematised the information into an illustrated, structured AS IS document that all the involved participants agreed on.

After an analysis of the AS IS control model and a mapping of improvement opportunities, several TO BE control models were developed introducing new aspects such as RFID and collaboration through real-time information sharing. The TO BE models specified how the individual supply chains should be controlled in the future. The future models were developed in a creative collaborative process consisting of workshops, meetings, discussions, etc. among key supply chain actors and the involved researchers. The solution development process drew heavily upon existing theoretical knowledge and concepts, best practice principles, researchers' experience and decision-makers' detailed knowledge of the supply chains. Finally, an implementation plan for the TO BE control model will be developed, mapping out the requirements and prerequisites for achieving increased collaboration and improved operations in a supply chain.

4.4. The Smart flow of goods concept

The core idea of the project is to investigate how the use of RFID and EPCIS technology integrated into packaging can increase supply chain sustainability. The concept builds on development and testing of the following key elements:

- New concepts for the flow of food products through the supply chain using RFID and EPCIS integrated in the packaging material
- "Intelligent packaging" and returnable transport items (RTI) based on RFID and EPCIS as standard for data capture and information exchange in the supply chain
- New ICT architecture and systems that support SCM and eTraceability
- Control models for demand-driven supply chains based on real-time and transparent information and streamlined business processes
- New business and supply chain collaboration models

Figure 2 illustrates the desired effects of the project and the means used to achieve them in order to contribute towards the three pillars of sustainability.

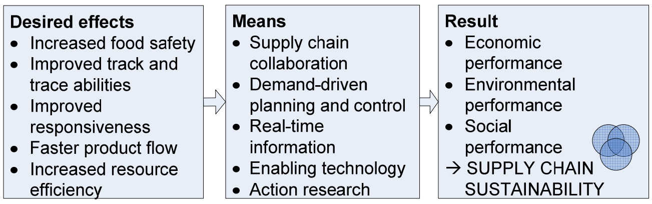

Figure 2: Desired effects, means and result of the *Smart flow of goods* project.

Based on literature, experience and discussions within the project, a number of expected positive effects on supply chain performance from the implementation of the concept have been identified. Sharing of real-time information and more pull-driven MPC principles are expected to lead to better forecasts and reduced demand variability (the Bullwhip effect), improved manufacturing and inventory control, better capacity utilisation and reduced inventory levels. Other effects include better planning of transport and distribution, reduced response time and total lead time to demand satisfaction, fewer stock-outs, earlier warning of potential supply problems, and more responsive supply chain actors. Expected environmental effects are mainly related to the reduction in product loss/wastage due to improved planning and control in manufacturing and distribution, thus reducing energy, GHG and embodied GHG emissions, and increasing re-use of packaging resources.

5. Discussion

5.1. Action research for sustainability

The origins and basic ideas of action research can be traced back to the psychologist Kurt Lewin, who has been attributed with the coining of the term "action research". However, action research is not so much a methodology as a collection of approaches that aim to: *"…contribute both to the practical concerns of people in an immediate problematic situation and to the goals of science by joint collaboration within a mutually acceptable ethical framework"* (Rapoport, 1970, in Middel, Coghlan, Coughlan, Brennan, & McNichols, 2006). The three crucial elements of action research are thus *action*, *research* and *participation*. Research projects aim to contribute both to the specific organisation and academia, and are in essence change processes in which one seeks to develop a holistic understanding of a complex dynamic system (Coughlan & Coghlan, 2008). Another key characteristic is that action researchers are actively involved in the change initiative in the organisation and thereby directly contribute to the results of the project. An action research project can therefore be said to have two parallel objectives: an improvement objective to solve a specific problem and a research objective to contribute to the generation of new knowledge.

An important characteristic of action research is that it is situational and thus does not generate universal knowledge, and that theory generated through action research therefore is very hard to replicate or test. Theory emerges incrementally during the project – based on the theoretical understanding that grows through the reflection on the planning, implementation and evaluation phases of the action research cycle(s) (Coughlan & Coghlan, 2008). Generalisation from qualitative studies like action research and case studies takes place towards theory and not towards samples and universes (Yin, 2003). Thus the value of the findings will lie in the ability to achieve "extreme relevance" and practical applicability, leaving the question of generalisation up to the practitioners' evaluation of whether or not the findings apply to their particular situation.

Based on experiences from the *Smart flow of goods* project, the following section discusses how some of the central characteristics of action research can contribute to increased supply chain sustainability.

Joint meaning construction; action research facilitates joint meaning construction and problem definition. By spending considerable amounts of time talking to and interacting with each other, both the researchers and the organisations' members were better able to understand the situations they were facing and develop appropriate solutions.

Building trust and commitment; an environment of trust and commitment is essential in any collaborative project. Since action research is built on participation and close interaction between practitioners and researchers it can build trust and commitment not only within a project but amongst the supply chain partners as well, having a mitigating effect on some of the disturbing effects for instance power issues potentially have on supply chain collaboration efforts.

Multiple methods and disciplines; action research is not synonymous with a purely qualitative methodology. Instead, it is a research strategy that combines qualitative and quantitative methods in analysis and problem solving where appropriate depending on the issues at hand. In addition, action research is not restricted to any particular scientific field and can easily incorporate theories, perspectives and tools from other research disciplines, thus supporting the multi-disciplinarity required within sustainability.

Gap between industry and academia; the dual project objectives of improvement and knowledge generation contribute to closing the gap between industry and academia. The action research approach can ensure the relevance and applicability of solutions for increased sustainability and knowledge generated in an R&D project.

Action research for social change; action research can be understood as a set of collaborative ways of conducting research that promotes democratic change through its basis of democratic inclusion (Greenwood & Levin, 2007). This facilitates the combining of technical and organisational measures that were identified in chapter 2 as necessary to build sustainability.

5.2. Limitations of action research

Despite the advantages of action research described above, there are also some challenges associated with its use, particularly within a supply chain context. In general, action research puts fairly high requirements on the involved researchers in terms of skills in addition to the typical skills required of any researcher (e.g. diagnosis, intervention, learning in action, social skills, and dealing with uncertainty). Therefore, action research teams should always involve experienced action researchers to ensure knowledge transfer to lesser experienced researchers. Other challenges are related to the need for spending an extended period of time within the context under study – which in supply chain terms will involve researchers closely interacting with a number of companies. This puts resource constraints on projects in terms of time, cost and personnel. In addition, gaining access to companies is frequently an issue in any action research project and might be particularly difficult in supply chain projects where success of the project depends on obtaining the commitment of and gaining access to a number of companies simultaneously. Also, the fact that action research does not generate universal knowledge might limit the usefulness and transferability of results to other settings. However, inherit in the action research strategy is the understanding that the judgement of the applicability of knowledge generated in one context to another context is left up to the practitioners' assessment.

5.3. Preliminary findings on sustainability

The basic idea of the *Smart flow of goods* project was to combine technical and organisational measures to enable increased supply chain sustainability. Although the project is still ongoing, some preliminary assumptions with regards to the project's contributions to the topic of sustainability can be made.

In terms of the economic aspects, both the academic and industrial partners agree that the control models for real-time demand-driven supply chain planning and control developed in the project are likely to impact positively on operational and logistical efficiency, thus improving economic performance, see section 4.4.

With regards to environmental aspects, the project has built on the embodied emissions perspective, focusing on the reduction of waste at all stages of the supply chain. By focusing on time compression enabled by information sharing and collaboration the *Smart flow of goods* concept aims to help food products fulfil their function such that resources spent upstream have not been wasted (Nereng, et al., 2009). Although perhaps motivated primarily by economic reasons, the logistical and operational effects of the collaborative and integrated approach to supply chain planning and control developed in the project is likely to also have significant impacts on the collective environmental performance of the supply chain. Thus, the *Smart flow of goods* concept and its embedded emissions perspective enables a more holistic picture of environmental sustainability and clearly links the importance of operational and logistical efficiency to the environmental side of sustainability.

Although the social perspective has not been a main focus in the project, some contributions towards the social dimension can also be inferred. The action research strategy, a working method which originated from the social sciences, is considered to be particularly appropriate for creating and/or supporting social change. The project has established a collaborative environment, which has enabled the development of new collaborative processes and collaboration models. Hopefully the industrial actors will be able to build on this in their long-term relationships, thus supporting their future efforts towards sustainability. The fact that the project was conducted in Norway must also be taken into consideration when discussion the project's perhaps somewhat lacking focus on social aspects. Norway has a long tradition of strong socio-democratic influence which has impacted on the culture and the business environment. There is extensive legislation in place regarding health, safety and environment (HSE), working conditions, pollution, gender equality, etc., and there has long been a fairly cooperative relationship between trade unions and employers' associations. These facts are likely to have reduced the need for explicit focus on social aspects in sustainability projects. However, for companies which outsource e.g. manufacturing to other countries and cultural contexts, social issues will be highly relevant and critical aspects that must be incorporated into any sustainability efforts.

Technology has by some authors been suggested as a fourth pillar of sustainability. Investigation of the potential of RFID technology was the main trigger for the *Smart flow of goods* project. RFID has been found to provide a good starting point for successful information sharing by improving data quality and capturing data at multiple points in the supply chain, making it possible to share more relevant information. However, preliminary findings also indicate that the project's most important contributions towards sustainability not necessarily stem from the application of the technology itself, but rather from the increased ability and willingness to share information with supply chain partners. POS data and inventory information can currently be shared without RFID. However, the focus on RFID seems to have motivated the supply chain partners to work on supply chain transparency and information sharing – thus enabling improved supply chain planning and control.

There is still a need for more business cases demonstrating the effects of the use of RFID and EPCIS in a supply chain setting. To date, the effects are still not well documented through actual case studies and there is a risk of exaggeration of positive consequences by interest organisations and RFID solution suppliers. The full potential of the control models and concepts developed in the *Smart flow of goods* project remains to be demonstrated in full-scale implementations. The value of the project as a business case will therefore increase as the actors start implementing aspects of the new control models. More research is also needed in studying the detailed operationalisation and implementation within supply chains, which would again contribute to a better understanding of how the three pillars of sustainability can be integrated to support supply chain efforts.

6. Conclusion

This paper's main contribution has been towards R&D practice and the use of action research in collaborative projects. The paper has shown how the project through its action research strategy has had contributions towards all three pillars of sustainability.

In terms of SCM, the project's research strategy has demonstrated how action research has the ability to broaden the perspective of traditional SCM where much of the focus for case studies has been on dyads or limited part of the supply chain. The sustainability perspective, combined with the industry – academia collaborative strategy, has shown that it is indeed possible to consider larger parts of supply chains in R&D projects.

In addition, some preliminary results from the *Smart flow of goods* project have shown how action research has enabled the development of new solutions that can contribute towards increased sustainability in the food supply chain. Many of the existing tools and methods for sustainability tend to focus on long term, strategic planning and to some extent tactical issues. However, the control model perspective of the *Smart flow of goods* concept shows how supply chains can integrate sustainability on an operational level.

The reporting on action research projects in literature is still rare and one can only speculate as to whether this is because the approach is in fact not being applied in R&D, or because existing action research is not being published in the academic community. This paper has shown how action research can be applied in a supply chain sustainability project, and hopefully we will see more such examples in the future which will contribute to establishing action research as a more recognised and applied tradition in supply chain sustainability and SCM in general.

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