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## Physical Internet inspired Atomic Modeling for Supply Chain Risk Management

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**Abstract:** *At a time when instability is the norm, as the global health situation confirms, managers have to deal with increasingly complex situations. Managers expect to have decision support tools that allow them to manage this instability in order to suffer as little as possible. Simulation is one of the main tools to meet this demand. This paper presents the work in progress for the development of a modular supply chain simulation model inspired by the Physical Internet (PI). Its modules are developed from the processes defined in the Supply Chain Operations Reference (SCOR) tool. This simulation model will generate the inputs to apply Physics Of Decision (POD) approach, an innovative approach to risk management that draws on analogies with physical forces. This approach is dedicated to steering the performance trajectory of systems evolving in an unstable environment.*

**Conference Topics:** *Business models for open & interconnected logistics, modularization and PI Modelling and Simulation.*

**Keywords:** *supply chain management, risk management, SCOR, system modeling and physical internet.*

### 1 Introduction

The observation that instability is the norm made in Benaben et al. (2021) makes sense today in view of the global health situation. Supply chains are not exempt from this instability, the global competitive environment in which they operate makes them even more sensitive and vulnerable to this instability. As a result, supply chains are more sensitive to risk than ever before, due to factors such as globalization of procurement, production and sales, increased complexity and competitiveness (Aqlan and Lam, 2015). In order to maintain their performance and profitability, supply chains have to be able to respond quickly to events driven by this instability and therefore be resilient to these events (Aqlan and Lam, 2015). However, this requires from managers a thorough understanding of the supply chain, its environment, the risks impacting it and how to manage them. Supply chain managers therefore need tools that allow them to access this information, in order to identify the causes and assess the impacts of this instability on supply chain activities (Cope et al., 2007). Among the many tools and methods developed to help managers dealing with instability, the solution studied in this paper is simulation. Indeed, simulation allows to support decision making and risk management through a better understanding of the processes of the modeled system (Neu et al., 2002). However, due to their its network structure, connecting independent entities that do not always have the same

objectives at the same time, supply chains are complex systems. Their modeling requires efficient simulation tools, time and energy. Often, much of this effort for one model cannot be reused when creating another model. Therefore, this is where the use of standard reference models like SCOR becomes important. By providing standard processes that can be adapted to any type of supply chain, SCOR should build simulation models more efficiently and quickly.

This article aims to present the first developments of an "atomic" simulation model based on SCOR and inspired by the concepts of the Physical Internet. This simulation model will be used to generate the data needed to feed the POD approach, a physics-based approach dedicated to risk management and decision support. The fundamentals of the POD approach will be presented and illustrated by a case study of a fictitious aeronautical supply chain impacted by the Covid-19 crisis.

This article is structured as follows: section 2 offers a quick overview of existing work on supply chain risk management and the utility of simulation in this area. Section 3 presents the POD approach. Section 4 describes the application of this approach through the study of a fictitious aeronautical supply chain. Section 5 presents the first work done on a modular simulation model of a supply chain. Section 6 proposes an extension of this atomic vision to help address some of the challenges of the Physical Internet. Finally, section 7 concludes with a roadmap to turn that atomic modelling workable.

## 2 Background: Supply Chain Risk Management

Over the past few decades, researchers have focused on Supply Chain Risk Management (SCRM) and provided numerous contributions in this field. Indeed, SCRM is an essential part of supply chain management. It is primordial to control this process in order to guarantee an efficient operation of supply chains. According to Blackhurst and Wu (2009), the SCRM process includes the following actions: risk identification and modeling, risk analysis, risk assessment and impact measurement, risk monitoring and control, and learning. Ho et al. (2015) divide this process into four steps:

- Risk Identification: determines the potential risks that may impact the system by studying the system and its environment,
- Risk Assessment: estimates the probability of occurrence and the impact of the risk in order to estimate its significance,
- Risk Mitigation: identifies the actions and strategies to be implemented to limit the impact of risks,
- Risk Monitoring: monitors the evolution of the status of identified and treated risks.

This process described in Ho et al. (2015) is consistent with and similar to the "traditional" risk management processes that exist in the literature. Therefore, all existing risk management methods can be applied in the case of supply chain risk management, especially the simulation. As mentioned in Aqlan and Lam (2015), simulation is an effective and ideal tool for visualizing supply chain risks. Simulation allows to take into consideration the stochastic factors present in the behavior of supply chains and the risk uncertainties. Simulation is used in many critical areas of engineering because it allows issues to be addressed before they arise and become problematic (Müller and Pfahl, 2008). It allows to build models that support decision making and risk reduction by providing a better comprehension of the processes and the modeled system (Neu et al., 2002). These simulation models serve as virtual laboratories where it is possible to test different scenarios, modeling the risks and corrective actions tested before their implementation in the real system. The evaluation of these scenarios allows to measure the impact of the modeled risks on the system, allowing to compare their criticality and to prioritize

them. Moreover, risk modeling is used to identify the best mitigation strategies and to monitor risk evolution. Among the existing simulation methods, the most used in the study of the supply chain risks are: discrete-event simulation, agent-based simulation, system dynamics, Monte Carlo simulation and Petri nets (Aqlan and Lam, 2015).

### 3 Physics of Decision Approach

This article presents the Physics of Decision (POD) risk management approach, introduced in Benaben et al. 2021. This approach is founded on analogies with physics in order to help supply chain managers deal with instability and to support them in their decisions. Several pieces of information are essential for making decisions in an unstable environment, such as an understanding of the system being managed and its environment, the potential consequences generated by instability and change, and how to select the best possible alternatives (Benaben et al., 2021).

In order to provide managers with all this information in a single tool, the POD approach defines two modeling spaces: description and performance spaces. The **description space** allows to describe the studied supply chain and its environment, by positioning the supply chain in the framework of its attributes. Figure 1 illustrates this description space whose dimensions are its attributes. The value of the attributes varies over time, according to the risks impacting the supply chain and the decisions made by managers. The control space (blue parallelepiped) allows to consider these changes, by defining freedom constraints on each attribute. This subspace is therefore in constant evolution. In this subspace, the studied supply chain can move freely. In certain areas of this description space, modeled by the context characteristics (orange shape), the system is more sensitive to the following potentials:

- Charges: represent the mandatory costs for the proper functioning of the system (e.g. salaries, energy expenses, etc.),
- Environment: includes all the potentials generated by the system's environment (e.g. new taxes related to the Brexit, etc.),
- Innovations: represent all the actions and measures put in place to enhance the system (e.g. purchase of new equipment, etc.),
- Interactions: correspond to the potentials created by the interactions between the various partners (e.g. customer demand, lead times, etc.).

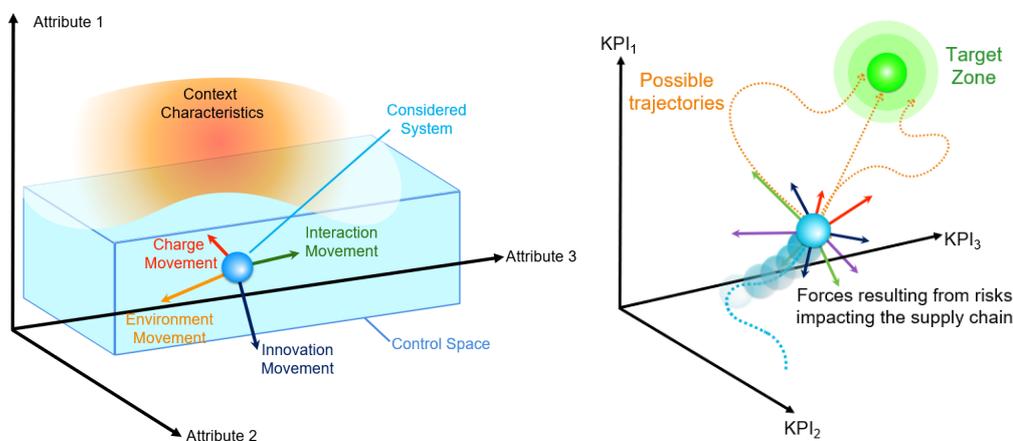


Figure 1: Description (left) and Performance (right) spaces (adapted from Cerabona et al., 2020)

The **performance space** (illustrated in Figure 1) depicts the evolution of the supply chain performance. It allows to position the supply chain in relation to its current performance. The interest of this space is to monitor the evolution of the performance over time by obtaining the performance trajectory (Benaben et al., 2021). The supply chain performance evolves following the occurrence of disruptions, whose impact on the performance is designed by forces (color vectors). Schematically, this impact can be observed by comparing the performance trajectories of the perturbed system with the inertial trajectory. It reflects the initial performance of the supply chain subjected to no perturbations and serves as the basis for this study. In this approach, this framework supports managers in their decisions (Cerabona et al., 2020), in particular in the choice of the best possible alternatives (the possible trajectories described in Figure 1) to join the target zone at the lowest “costs” (for instance money, time, etc.). The target zone is an area of this space representing the performance to be achieved in order to be in line with the performance objectives set. In Figure 1, the target zone is represented by a green sphere but it could be a surface, a subspace, etc.

## 4 Application to Supply Chain Risk Management

### 4.1 Studied Supply Chain

Let's consider a fictitious aeronautical supply chain (called Air-POD) to illustrate this approach. This supply chain is strongly inspired by one of the supply chains of a famous European aircraft manufacturer. For this example, only the last phase of manufacturing an aircraft is considered, i.e. the assembly of the constitution assemblies. Figure 2 describes the organization of this supply chain network, composed of eight partners. A and B are the two assembly sites. B also supplies some fuselage sections to A. C, D, E, F and G are the suppliers of A and B, they supply respectively the vertical stabilizer, the cockpit, the horizontal stabilizer, the wings and the engines. H is the customer of A and B. The use-case presents a very simplified version of an aeronautical supply chain (for example, only one customer is considered in this model because the processes allowing to customize an aircraft are not considered currently), but includes a large potential of evolution and complexification. The associated model and processes have been developed on the Anylogic© simulation software.

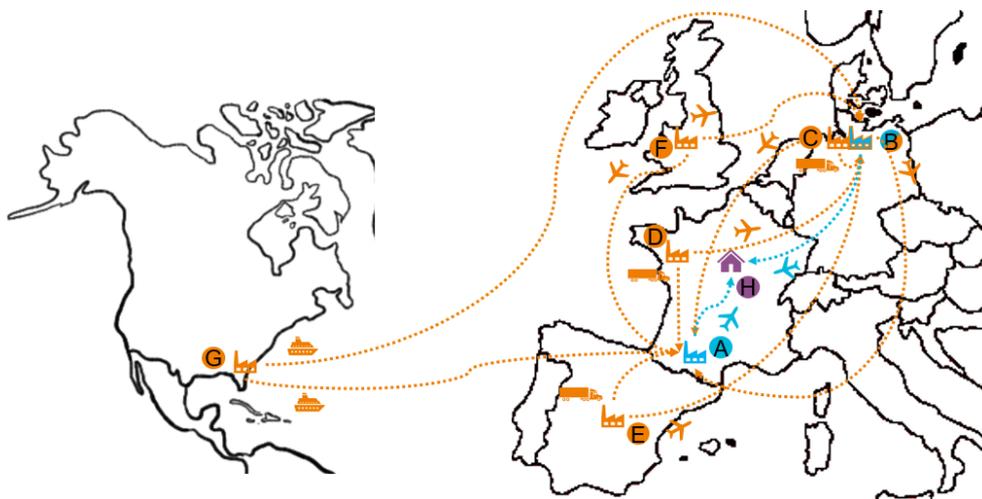


Figure 2: Air-POD network<sup>1</sup>

<sup>1</sup> The maps used in this figure are taken from the websites: <https://www.pinterest.fr/pin/497295983852497660/> for the European map and <https://www.waouo.com/carte-du-monde-vierge/> for the map of the Americas.

## 4.2 Experiments and Results

In this application example, the experiments carried out focus on the study of the impact of predefined risks on the performance of this supply chain. In order to facilitate the visualization of the results, the description and performance spaces will be limited to three dimensions. The description space will be built from the following attributes: the sales price of the airplanes, the monthly production and the number of employees assigned to the assembly of the airplanes on the two production sites (A and B). The performance space will have the following dimensions: the number of planes sold, average cycle time and capital asset. The description space and the inertial performance trajectory of Air-POD supply chain are illustrated in Figure 3.

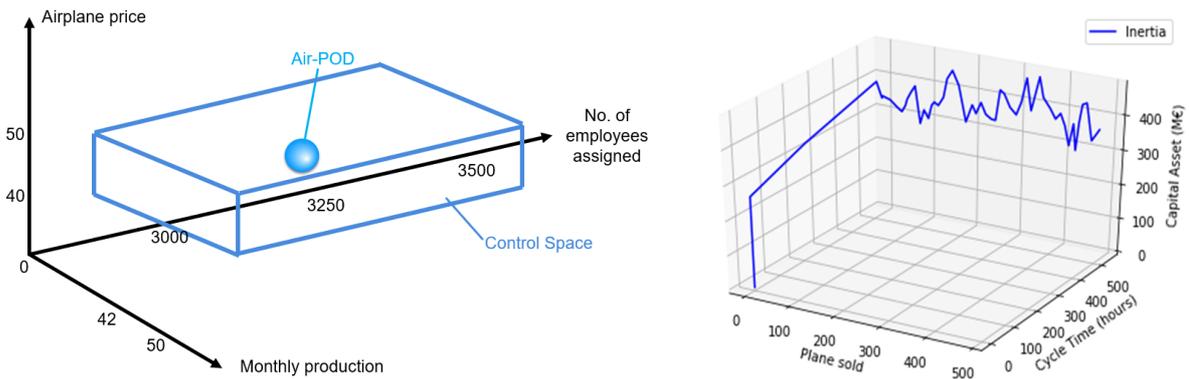


Figure 3: Air-POD description (left) and performance space (right)

Two disruption scenarios (DS) are studied, these two scenarios are used to evaluate the impact of the Covid-19 crisis on the performance of this supply chain. The results associated with the studied scenarios focus mainly on the visualization of the Air-POD performance trajectories and the study of the deviations they generate (these results are correlated with the realism of the model). DS1 is relative to a demand that is brutally divided by two. Logically, the number of aircraft sold has decreased. This disruption reduces the downtime costs by 27%, the average cycle time is reduced by about 13%. This reduction in cycle time is normal, in this scenario the available resources are not correlated to demand. DS2 represents a decrease of 10% in the number of employees available due to Covid-19 (e.g. due to illness, childcare, etc.). For this scenario, all of these lost human resources are not replaced. The performances are identical over the first six months simulated. This disruption slightly increases the average cycle time by seven hours and the average capital asset by about 2%. The differences in the number of aircraft sold can be explained by all the stochastic factors present in this model. The performance trajectories of the perturbed system are shown in Figure 4.

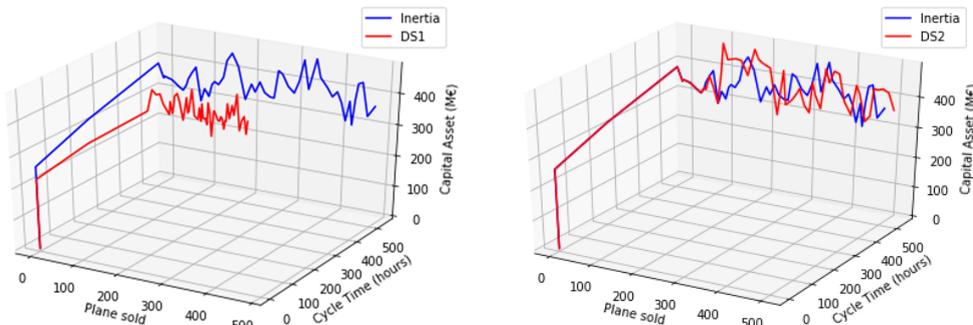


Figure 4: Inertial trajectory versus disruption scenarios trajectories

## 5 Atomic Supply Chain Model based on SCOR

The POD approach, presented in the section 3, makes it possible to monitor the evolution of performance following the realization of risks, especially by measuring their impacts. However, in its current state, this approach does not allow decision-makers to measure and understand the micro-consequences created by these macro disturbances impacting the studied supply chain, its actors and processes. The study of these micro-consequences is a key component to effectively analyze a system as complex as a supply chain network. One way to solve this problem and bring this information to managers is to create a simulation model of the elementary processes, atoms, of a supply chain. To determine these atoms, the model relies on SCOR, in order to benefit from its many advantages, such as: standard descriptions of supply chain processes, a framework of relationships between these standard processes and standard performance indicators (Stefanovic et al., 2009). Moreover, building on SCOR also allows us to develop a model widely studied and recognized in research and industry (Long, 2014).

### 5.1 SCOR – A hierarchical process model

The SCOR model provides a cross-functional framework with standard process elements and performances indicators to assess and improve supply chain management and performance (Long, 2014). With an inter-process and hierarchical views (Huang et al., 2005), SCOR describes, measures and evaluates the configurations of any type of supply chain. The SCOR model is composed of processes organized into four hierarchical levels. Figure 5 illustrates this process decomposition. At level 1, SCOR describes the overall supply chain operations at the macro level through six macro processes, defining the scope and content of the supply chain model. These six macro-processes are: *Source*, *Make*, *Deliver*, *Return*, *Plan* and *Enable* (Council, 2017). The *Source* process contains all the actions allowing the supply of components necessary for the production of goods or services in order to meet customer demand. The *Make* process contains the activities that transform raw materials or products into finished products (Long, 2014). The *Deliver* process contains all the activities of transport and distribution of finished products or services responding to the customer demand (Persson et al., 2012). The *Return* process defines the actions to manage the flow of flawed products (Huang et al., 2005). The *Plan* process coordinates the four previous processes to meet business objectives and customer expectations. The *Enable* process supports the other processes with supply chain management techniques (Council, 2017). At level 2, in order to model any type of supply chain, these macro processes are divided into three process categories based on the business-products of the supply chain studied: make to stock (MTS), make to order (MTO) and engineer to order (ETO). At level 3, each of these process categories is broken down into generic process elements representing and describing one step or action of each of these process categories. Thus, this inter-process breakdown by process brick allows, once assembled according to a predefined scheme, to realize all the macro-processes defined previously. Level 4 is the level of implementation, each process element is detailed according to the tasks specific to each organization. This level deals with practices and activities beyond the scope of SCOR (Long, 2014), it is therefore not considered in our study.

### 5.2 Positioning of atoms in the SCOR framework

This hierarchical decomposition of the processes performed in SCOR defines the level from which the elementary processes, the atoms, will be built. As illustrated in Figure 5, the atoms will be built from the processes defined in SCOR level 2. For this first version, this model will essentially consist of six atoms, modeling the *Source*, *Make* and *Deliver* processes in the case of MTS and MTO business. In order to ensure the main function associated with them, each

atom must perform a sequence of predefined and configurable actions. These actions, called atom process, will be modeled from the process elements defined in SCOR level 3 (as illustrated in Figure 5).

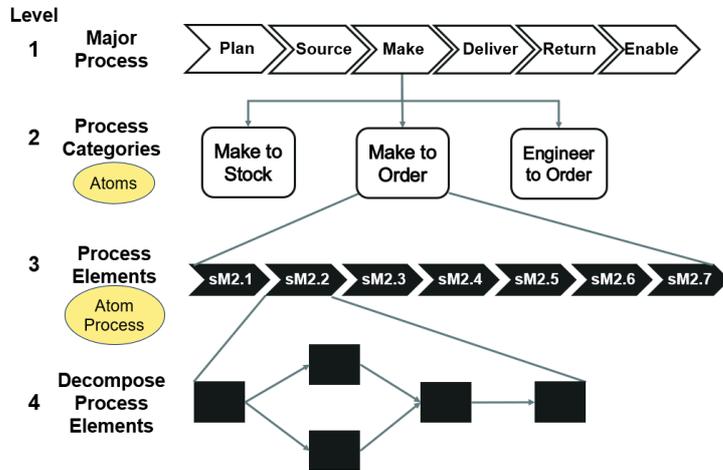


Figure 5: SCOR hierarchical process structuring and Positioning of atoms in the framework

### 5.3 Links between atoms, simulation model and POD approach

One of the strong expectations of this model is to offer reconfigurable modules that can be adapted to any type of supply chain, in order to reduce the effort required to develop new models. To achieve this, each atom will be modeled so as to be as parameterizable as possible. As stated in the introduction, this model is developed in order to generate the data necessary for the application of the POD approach. Thus, this parameterizable character of the atoms, will also make it possible to cover a broad zone of the possible of the description space which will be associated to it. In particular, by adapting the values of the parameters of the model to the variations of values of the attributes following the realization of disturbances or the decisions taken by the managers. The description spaces at the atomic scale will be subsets of the description space describing the supply chain studied in its entirety. Each atom will be associated with a performance space and its own key performance indicators. In order to keep the root cause analysis of the performance proposed in SCOR thanks to the hierarchical decomposition of the metrics, aggregation functions will be defined and will allow to calculate the global performance of the supply chain from the metrics assessed by the atomic models. In SCOR, these global indicators are called performance attributes and defined as the strategic performance characteristics on which to align supply chain performance (Council, 2017). Figure 6 illustrates the links between atoms, simulation models and the POD approach.

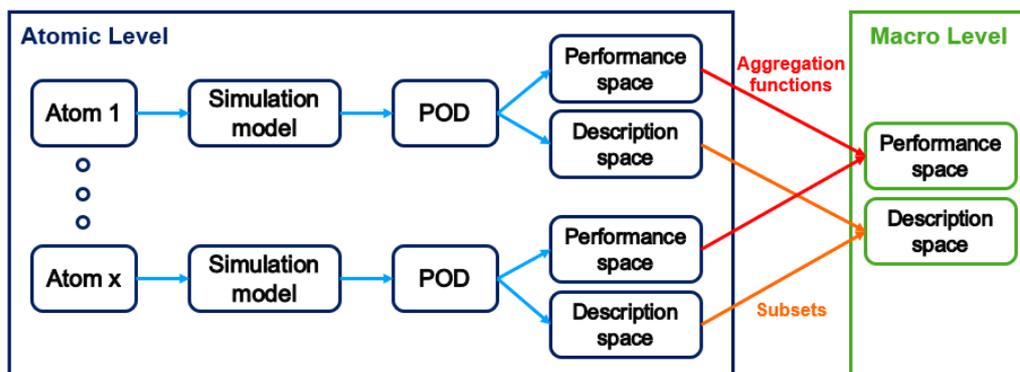


Figure 6: Links between atoms, simulation models and POD approach

## 6 Physical Internet

### 6.1 Research areas on the Physical Internet

The Physical Internet (PI) was introduced to address the Global Logistics Sustainability Grand Challenge (Montreuil et al., 2012a). In Montreuil et al. (2012a), PI is defined as “an open global logistics system founded on physical, digital and operational interconnectivity through encapsulation interfaces and protocols”. PI aims to develop a universal logistic network interconnecting all logistic services through the encapsulation of goods in smart modular containers. Thus, PI completely reshapes the current logistic network models, which are fragmented and most often dedicated to a specific company or market (Montreuil et al., 2012b). As mentioned in Pan et al. (2017), the current contributions on the Physical Internet can be divided into four axes: *conceptual research*, *assessment research*, *solutions design research* and *validation research*. *Conceptual research* focuses primarily on describing and expanding the fundamental concepts on which the PI is based (Pan et al., 2017). *Assessment research* focuses on the rigorous dimensioning of opportunities for improving the economic, environmental, and societal efficiency and sustainability induced by the PI, through experiments based on optimization and/or simulation modeling (Pan et al., 2017). *Solution design research* questions what is blocking the industry from committing to and implementing such a process and network. To address these shortcomings, it focuses on designing methodologies and technologies that enable the exploitation of the PI in the management of logistics flows across the globe. Solution design research is articulated around two main axes: designing the PI key components (for instance smart modular  $\pi$ -containers) and building methodologies and models to address key planning and operational decisions driven by the PI in logistic networks (Pan et al., 2017). *Validation research* aims to conduct studies to understand and determine the efforts needed to embed the PI in the industry and define the roadmap for implementing this approach (Pan et al., 2017).

### 6.2 Towards $\pi$ -atoms

This atomic approach is inspired by some concepts developed in the PI approach. In the same way that the PI divides the logistics network into interconnected, adaptable and smart nodes, called  $\pi$ -nodes (Montreuil et al., 2010), the idea is to divide the supply chain processes into interconnected, adaptable and smart sub-processes, called atoms. Thus, this atomic vision of the supply chain operationalizes the multi-level PI architecture from the network level down to the enterprise level, as illustrated in Figure 7. The entire supply chain network will be reconstructed by linking the atoms together (Figure 7). The bonds between the atoms will therefore be a major issue in the realization and functionality of this model. Indeed, a lot of work on the connectivity between the atoms will have to be done. This work will be inspired by the way PI manages the interconnectivity developed between all the actors of the network.

Moreover, the goal of this approach is to contribute to the *assessment research* and *solution design research* axes, by creating  $\pi$ -atoms. These  $\pi$ -atoms would allow to evaluate the impact generated by a PI transformation on the performance of a supply chain, and thus determine the forces generated. But also, to be able to compare the robustness and resilience of a classical logistical network versus a network using PI principles in front of certain disturbances. The  $\pi$ -atoms will be created at first by modifying the actions of the delivery atoms. In particular by replacing some of the current actions by actions respecting PI protocols, for example by using  $\pi$ -containers for the transport of goods, by modifying the shipping routes so that the products transit from  $\pi$ -node to  $\pi$ -node, etc. These new atoms will be called  $\pi$ -Deliver, as in Figure 7. In

a second step,  $\pi$ -atoms will be created from the protocols and processes defined in the literature, in order to develop atoms allowing to manage  $\pi$ -nodes,  $\pi$ -hubs, etc.

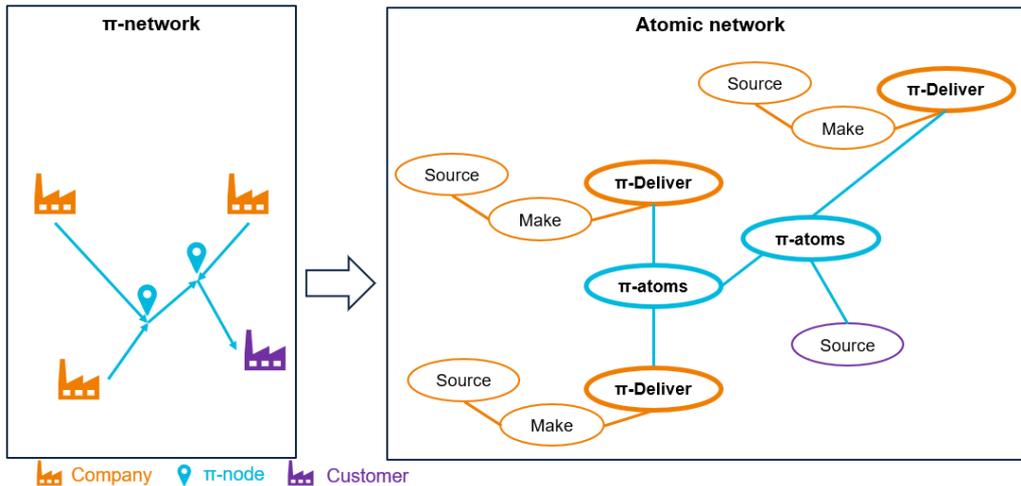


Figure 7: Link between Physical Internet and atomic modeling vision

## 7 Conclusion and Perspectives

All the works presented in this article depict some preliminary applications of that physics-based approach to supply chain risk management and future works in progress, such as that “atomic” modeling of supply chains. The following points and perspectives define the roadmap for making this approach workable:

- Develop and design the atomic model equivalent to the supply chain presented in section 4. The aim is to use the "classical" model in order to validate the "atomic" vision, by comparing the results (the performance trajectories) of these two models subjected to the same type of disturbances.
- Carry out simulation campaigns on the modeled risks, in particular by conducting sensitivity analyses on the parameters (supply chain attributes) impacted by these risks. The data collected will allow us to analyze the sensitivity of the studied supply chain to these risks and thus determine the resulting forces.
- Check and study if the atomic perturbations are independent and if it is possible to sum the resulting forces in order to support the managers' decisions by determining the possible optimal performance trajectories allowing to reach the fixed objectives at lower costs.
- All of the material generated during the simulation campaigns will be used to train neural networks, which will replace the atomic models. They will thus offer more freedom in predicting and studying the sensitivity of a supply chain to many different risks. These neural networks will avoid the need to find a mathematical equation for each force.

## References

- Aqlan F., S.S. Lam (2015): Supply chain risk modelling and mitigation, International Journal of Production Research, v53, no18, 5640–5656. <https://doi.org/10.1080/00207543.2015.1047975>.
- Benaben F., L. Faugere, B. Montreuil, M. Lauras, N. Moradkhani, T. Cerabona, J. Gou, W. Mu (2021): Instability is the norm! A physics-based theory to navigate among risks and opportunities, Enterprise Information Systems, 1-28. <https://doi.org/10.1080/17517575.2021.1878391>.

- Blackhurst, J., T. Wu (2009): *Managing Supply Chain Risk and Vulnerability: Tools and Methods for Supply Chain Decision Makers*, 12, London, Springer.
- Cerabona T., M. Lauras, L. Faugère, J.P. Gitto, B. Montreuil, F. Benaben (2020): A Physics-Based Approach for Managing Supply Chain Risks and Opportunities Within Its Performance Framework, In: Camarinha-Matos, L.M. et al. (eds.) *Boosting Collaborative Networks 4.0*, 418-427, Springer International Publishing, Cham. [https://doi.org/10.1007/978-3-030-62412-5\\_34](https://doi.org/10.1007/978-3-030-62412-5_34).
- Cope D., M. Fayez, M. Mollaghasemi, A. Kaylani (2007): Supply chain simulation modeling made easy: An innovative approach, 2007 Winter Simulation Conference, 1887-1896, IEEE, Washington, DC, USA. <https://doi.org/10.1109/WSC.2007.4419816>.
- Council S.-C. (2017): *Supply-Chain Operations Reference-Model, Scor Version 12.0*, Supply-Chain Council.
- Ho W, T. Zheng, H. Yildiz, S. Talluri (2015): Supply chain risk management: a literature review. *International Journal of Production Research*, v53, no16, 5031-5069. <https://doi.org/10.1080/00207543.2015.1030467>.
- Huang S.H., S.K. Sheoran, H. Keskar (2005): Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model. *Computers & Industrial Engineering*, v48, no 2, 377-394. <https://doi.org/10.1016/j.cie.2005.01.001>.
- Long Q. (2014): Distributed supply chain network modelling and simulation: integration of agent-based distributed simulation and improved SCOR model, *International Journal of Production Research*, v52, no23, 6899-6917. <https://doi.org/10.1080/00207543.2014.910623>.
- Montreuil B., R.D. Meller, E. Ballot (2010): Towards a Physical Internet: the Impact on Logistics Facilities and Material Handling Systems Design and Innovation, 11th IMHRC Proceedings, Milwaukee, U.S.A, 40, [https://digitalcommons.georgiasouthern.edu/pmhr\\_2010/40](https://digitalcommons.georgiasouthern.edu/pmhr_2010/40)
- Montreuil, B., R.D. Meller, E. Ballot (2012a): Physical Internet Foundations, IFAC Proceedings, v45, no6, 26-30. <https://doi.org/10.3182/20120523-3-RO-2023.00444>.
- Montreuil B., E. Ballot, F. Fontane (2012b): An Open Logistics Interconnection model for the Physical Internet, IFAC Proceedings, v45, no6, 327-332. <https://doi.org/10.3182/20120523-3-RO-2023.00385>.
- Müller M., D. Pfahl (2008): *Simulation Methods, Guide to advanced empirical software engineering*, edited by F. Shull, J. Singer, and D.IK. Sjøberg, 117-150, London, Springer
- Neu H., T. Hanne, J. Münch, S. Nickel, A. Wirsen (2002): Simulation-Based Risk Reduction for Planning Inspections, *Product Focused Software Process Improvement*, v2559, 78-93.
- Pan S., E. Ballot, G.Q. Huang, B. Montreuil (2017): Physical Internet and interconnected logistics services: research and applications, *International Journal of Production Research*, v55, no9, 2603-2609. <https://doi.org/10.1080/00207543.2017.1302620>.
- Persson F., C. Bartoll, A. Ganovic, M. Lidberg, M. Nilsson, J. Wibaeus, F. Winge (2012): Supply Chain Dynamics in the SCOR Model - A Simulation Modeling Approach, 2012 Winter Simulation Conference Proceedings, 1-12, IEEE, Berlin, Germany.
- Stefanovic, D., N. Stefanovic, B. Radenkovic (2009): Supply Network Modelling and Simulation Methodology, *Simulation Modelling Practice and Theory*, v17, no4, 743-766.