# Research on collaborative processes in non-hierarchical manufacturing networks

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**Abstract.** Collaborative networks research has increased over the last years due to the advantages experienced by the enterprises that establish collaboration. In this paper, a set of relevant collaborative processes are identified in the literature and analysed considering their specific application in non-hierarchical manufacturing networks (NHN). Besides, collaboration within networked partners is enhanced through designing a roadmap to deal with the migration path towards collaborative processes establishment. Currently, the research aim is focused on modelling the network and the collaborative processes, established within the partners, through a mathematical model that identifies the collaboration objects. In this context, experts will be able to promote the establishment of collaboration, analyse the processes performed within a network and consider their redesign/design towards collaboration. The model would identify the objects of collaboration, in order to be analysed and thus serve as a tool to improve the enterprises' performance and, consequently, the network performance.

**Keywords:** collaborative processes, non-hierarchical networks, collaborative networks, SMEs

## 1 Introduction

The interest increase on collaborative processes establishment, within partners of the same network, has resulted in an increment on the emergence of the number of network topologies [1,2]. Amongst all the network topologies this research is focused on collaborative non-hierarchical manufacturing networks (NHN) [3]. Unlike hierarchical networks (HN), based on centralised approaches of decision making in which one partner possesses all the power, NHN are characterised by the establishment of collaborative processes with decentralised decision making models (DDM). The establishment of collaborative DDM in NHN implies that all the network partners are autonomous; all decisional independent units are collaboratively involved in the management of the network processes and integrated with different degrees of collaboration. Involved partners equally enjoy power sharing and status, and no individual partner leads the network [4].

For enterprises whose nature does not imply a hierarchy in the network structure, conforming decentralised and collaborative structures, that is NHN, provide important benefits [5]. These benefits are led to improve the network competitiveness, innovation, partners' adaptability, customers' satisfaction and inefficient processes elimination [6]. DDM, in which the NHN are based on, improves each network node commitment as regards to the overall goal of the network while improving communication, collaboration and flows among nodes. Furthermore, NHN, as equally considers all network partners, helps SMEs to position in the global market [7]. NHN are characterised by long term partnerships with close collaboration. Accordingly, collaborative DDM changes the way how processes are executed in a network, implying an evolution towards collaboration, in which the exchanges of information are to be done in an interoperable way and the business processes are jointly performed. Thus, this paper particularly focuses on collaborative NHN.

### 1.1 Motivation and Research Question Formulation: Collaborative processes in non-hierarchical networks (NHN).

Research in collaborative non-hierarchical manufacturing networks is motivated, on the one hand, by the call funded by the European Commission, "FP7-NMP-2008-SMALL-2" (Activity code *NMP-2008-3.3-1: Supply chain integration and real-time decision making in non-hierarchical manufacturing networks*) [8]. On the other hand, the Intelligent Manufacturing Systems initiative (iNet-IMS) has encouraged to (i) analyse the needs that arise from relationships between SMEs belonging to NHN, (ii) analyse the technology innovation trends to support DDM, (iii) analyse standards for information exchange to support collaborative processes and (iv) define a framework for collaboration in NHN [7]. Moreover, the growing interest of enterprises on establishing collaboration has led to study the establishment of collaborative processes. Therefore, the development of a Collaborative Framework (proposing models, guidelines and tools) to handle with the barriers SMEs can encounter when establish collaborative processes, is considered the research line followed by the thesis. Taking into account the above said, the research questions are hereafter raised:

(i) Identify, through the literature review, relevant collaborative processes that networked SMEs perform [6].
(ii) Analyse the collaborative processes treatment in order to determine how the approaches provided in the literature deal with the NHN characteristics and therefore can be applied to support the establishment of collaborative processes within NHN partners [3,6].
(iii) Recognise the non-covered processes, as regards the solutions that do not treat the collaborative process in specific contexts of collaborative and decentralised NHN [3, 9].
(iv) Provide solutions in the NHN context to fill the literature gaps of non-covered collaborative processes. In order to fill these gaps, research on new approaches to model collaboration is to be considered from the NHN perspective [10, 11].
(v) Build a Collaborative Framework containing a set of models (M), guidelines (G) and tools (T) to support SMEs on their participation in collaborative processes within decentralised NHN structures. The Collaborative Framework consists of a

set of building blocks characterised by the type of collaborative process and the type of solutions (M, G and T) to cope with the process [6].

(vi) Develop a roadmap to support SMEs on the migration path from non-collaborative NHN towards collaborative NHN [12].

(vii) Model the collaborative network, NHN, and the objects identified to deal with the collaboration and formally conceptualise the collaborative processes performed. The formal model will serve researchers as a tool to analyse the degree of collaboration set up within groups of networked partners.

Once identified the research questions, the paper is devoted to identify the relationship between the research developed within the paper and the *Collective Awareness Systems* (section 2). Besides, the literature review results as regards collaborative processes are shown (section 3). The research contribution and innovation is proposed (section 4) and research results are discussed (section 5). Finally, conclusions and future research lines are identified (section 6).

## 3 Literature review: collaborative processes

The literature review carried out collects the diverse knowledge on the research arena of collaborative processes, both in HN and NHN contexts. The works analysed so far (1981-2012) reveal the existence of an extensive literature concerning collaborative processes. The literature review was carried out considering the most relevant processes to establish collaboration; the processes were reviewed considering the solution's approaches used to deal with them: models, guidelines and tools.

Afterwards, an analysis was completed in order to identify into which extent the treatment given in the literature was appropriate to be applied from the NHN perspective; that is the extent into which the approaches to support collaborative processes can be employed in decentralised and collaborative networks. Three classification criterion are used: (i) ***NHN*** when most of the contributions to deal with the collaborative processes are designed from the NHN perspective (ii) ***HN → NHN*** when most of the contributions are designed form the HN perspective but can be adapted to the collaborative and decentralised features that characterise the NHN and (iii) ***HN*** when most of the contributions in the literature are designed for HN.

The processes identified are classified according to the three decision making levels, strategic, tactical and operational and according to the solutions degree of application (NHN, HN→NHN and HN) (table 1).

Conforming to the classification criteria, the existence of some processes that are not specifically treated form the NHN perspective are identified.

The main conclusion deduced from the literature review is led to consider that there are a set of processes that still do not have a complete treatment in the literature due to the approaches to support the collaborative processes are not provided form the NHN perspective. These processes are identified considering those belonging to the group of ***HN*** and ***HN→NHN*** (see table 1).

**Table 1.** Collaborative Processes and Degree of Application [3, 6].

| Collaborative Processes | STRATEGIC | | TACTICAL | | OPERATIONAL | |
|---|---|---|---|---|---|---|
| | (1) Network Design | **HN→NHN** | (1) Forecast Demand | **NHN** | (1) Scheduling | **HN→NHN** |
| | (2) Decision System Design | **NHN** | (2) Operational Planning | **HN→NHN** | (2) OPP | **NHN** |
| | (3) Partners Selection | **HN→NHN** | (3) Replenishment | **HN→NHN** | (3) Lotsizing Negotiation | **HN** |
| | (4) Strategy Alignment | **HN** | (4) Performance Management | **NHN** | (4) Inventory Management. | **HN→NHN** |
| | (5) Partners Coordination and Integration | **HN→NHN** | (5) Knowledge Management. | **HN→NHN** | (5) Information Exchange Management | **NHN** |
| | (6) Product Design | **HN→NHN** | (6) Uncertainty Management. | **HN** | (6) Process Connection | **HN→NHN** |
| | (7) PMS Design | **NHN** | (7) Negotiation Contracts among partners | **HN→NHN** | (7) Interoperability | **NHN** |
| | (8) Coordination Mechanisms Design | **HN→NHN** | (8) Share costs/profits | **HN** | | |
| | | | (9) Coordination Mechanisms Management | **HN→NHN** | | |

## 4 Research contribution and innovation in collaborative non-hierarchical manufacturing networks

According to the literature reviewed, a set of non-covered processes are identified as regards the collaborative NHN perspective. Therefore, the main aim is to design solutions to fill the gaps in those processes whose degrees of application are classified as ***HN*** and ***HN→NHN***. The processes classified with the **HN** degree of application are the *strategy alignment*, *uncertainty management*, *share costs/profits* and *lotsizing negotiation*. An example is considered with a solution proposal for the *share costs/profits* process. The methodology, *Share Profits in Non-Hierarchical Networks* (SP-NHN), is designed to ensure equitable sharing among networked partners to foster collaborative and trust behaviours and deal with the gap of collaboratively *share costs/profits* [10]. The research also considers the processes classified in **HN→NHN**, in order to adapt the solutions provided in the literature and procure suitable solutions from the NHN perspective. An example can be found with the *operational planning* process, considered a complex activity in collaborative NHN due to the agreements and standardised processes demanded. In the light of this, a solution is adapted, from the literature considering the novel *Supply Chain Agent-based modelling Methodology that supports a Collaborative Planning Approach* (SCAMM-CPA), in order to handle with the problems associated when the *operational planning* is performed in NHN under a collaborative perspective [11].

Taking into account the literature reviewed and admitting that many factors and conditions may cause threats, specifically in SMEs, when establishing collaborative processes [3, 9] in decentralised NHN; a roadmap, to support the new SMEs challenges, is provided. The importance on collaboration within the networks under study encourages the development a roadmap to deal with the evolution from non-collaborative scenarios towards the establishment of collaborative processes among the SMEs decided to participate in decentralised and collaborative NHN. The

roadmap, *NHNmap*, consists of a set of ten phases structured into four main areas (i) collaboration establishment, (ii) performance evaluation, (iii) solutions' proposal to overcome possible barriers appearing when collaborative processes are established, and (iv) information and technology systems to efficiently manage the decentralised decision making models that characterise the NHN [12].

An additional research contribution is identified with the modelling of collaborative networked processes, as well as modelling the NHN. This research line is the early stages of development.

The modelling research line is motivated due to, currently, the models proposed in the literature are based on individually model specific collaborative processes, such as interoperability, collaborative product development or knowledge management, amongst others. Therefore, a gap is found to provide a general only model that could be valid for all the identified collaborative processes. Thus, regardless the process to be modelled an only model could be used through identifying different objects that take part in each of the collaborative process. In the light of this, a new research line is proposed to design a collaborative model and identify the objects participating in the establishment of collaborative partnerships. The model is to be generally designed in order to be used by the vast majority of the collaborative processes previously defined in the literature reviewed [6]. The model is to be developed to support researchers on the formal conceptualisation of the collaborative processes, giving them an insight of (i) how to analyse the processes and measure the collaboration (ii) how to design a collaborative process, if this does not already exist or (iii) how to redesign a process, if this has not been already executed from a collaborative perspective, in order to globally improve the network performance and individually improve the enterprises' performance. An example can be encountered in [4], that models the network, the relations established within the networked partners, and the links between them to determine where the partners' transactions lead. A model is proposed to allow researchers to identify the power degree of each networked partner and therefore determine the power distribution. Once the network, the partners and the partners' relations are modelled, *Markov Chains* are used to compute the power distribution. Modelling the power and therefore the relationships of the network nodes allows to better consider the networked partners' relationships and obtain more sustainable and balanced networks.

## 5 Discussion of results and critical view

Taking into account the results obtained from the literature reviewed, it is evidenced that a high percentage of the approaches developed in the collaboration research field are mostly designed from the HN perspective, so do not have a full application on collaborative processes established by SMEs belonging to NHN. The lower complexity on HN treatment makes them more studied. Contrarily, research in collaborative NHN environments is less widespread due to researchers have to deal with companies that could be part of several production networks at the same time; what motivates the study of these networks. In the light of this, the research focuses on the creation and management of non-hierarchical manufacturing networks and the

proposal of supporting approaches for SMEs to establish collaborative processes in networks characterised by DDM, in order to simultaneously deal with both the enterprises' objectives the and the global objective defined for the network.

Considering the outcomes from the literature review and the results based on the iNet-IMS initiative, relevant collaborative processes and barriers associated to SMEs, when participating in NHN, are identified. A Collaborative Framework is built as a set of solutions classified into models, guidelines and tools to cope with the SMEs requirements when participating in collaborative NHN. The research developed provides, researchers and practitioners, an approach to handle with the changes needed to be performed by the SMEs in order to efficiently achieve the desired future state of establishing collaborative processes in NHN, and, therefore, get the benefits derived from the collaboration.

Furthermore, the design of a collaborative model allows to (i) model the network and the collaborative processes, (ii) quantitatively analyse the collaborative relationships, (iii) determine how the network system is, AS-IS and (iv) propose a collection of tools and guidelines to cope with collaborative barriers so as to improve the establishment of collaborative processes within the involved parts of the NHN. A quantitative analysis on the established collaborative processes is needed to identify the most relevant processes performed and those that are lagging behind but indeed are important to be performed. The quantification will determine how the system is and how important is to make improvements throughout the network.

Dealing with the NHN and the barriers associated with the collaborative processes establishment is a laborious task due to the added difficulty to individually consider each of the companies with its objectives, strategies and particularities. Moreover the existence of conflicting objectives appearing, due to companies belong to more than one network, are to be taken into account. This research work is a step forward in the study of real networks consisting of autonomous SMEs and deals with the next generation of manufacturing enterprises embedded in global environments characterised by multi-lateral collaborations.

## 6 Conclusions and further work

Research in NHN has been launched only few years ago therefore there is a long way of work to cover in the future. This research is focused on identifying those processes that can be collaboratively established within a NHN and modelling the NHN in order have a current view on the processes performed in a NHN, with the main aim to improve the partners collaboration through solutions procurement. The Collaborative Framework for NHN will give researchers a tool to, once identified the barriers when collaborative processes are established, overcome the appearing weakness through the application of models, guidelines and tools provided.

The high interest on the topic under research and the wide variety on the approaches to deal with collaboration, leads the research contributions to: (i) summarise the existing knowledge regarding the establishment of collaborative processes within networks, specifically in NHN; (ii) provide a roadmap to overcome the possible barriers appearing when SMEs decide to participate in collaborative

NHN and (iii) design a formal model defining the collaboration objects to allow researchers to specifically model the collaborative processes and the network.

Future research lines are led to provide solutions amongst all the processes that are not treated form the NHN perspective; for processes with **HN** degree of application solutions will be designed; for processes with **HN→NHN** degrees of application existent solutions in HN would be adapted to be applied in NHN contexts. The results obtained so far reveal the need of providing a collaborative framework to cope with those processes that are treated in the literature without considering NHN features. The work developed so far has provided a set of solutions to overcome the collaborative processes form the NHN perspective [10, 11, 12]. This research begins a series of solution proposals to build a Collaborative Framework for NHN, designing new models, guidelines and tools to support the establishment of collaborative processes in the networks under study. Future work is led to complete table 1 and achieve, for all the processes, **NHN** degrees of application.

The standardisation of the collaborative processes established within the networked SMEs is to be done in order to consider the information exchange systems in an interoperable way and the negotiation mechanisms to regulate the collaboration within the network.

Considering the aforementioned, future work is led to (i) identify or design models guidelines and tools to deal with collaborative processes in NHN contexts, (ii) consolidate collaborative processes across a network through Information Systems and Technologies (SI / IT), (iii) promote collaboration through the implementation of the roadmap, (iv) validate the proposed Collaborative Framework through its application to various industrial pilots and (v) design a formal model for collaboration and implement it in real networks.

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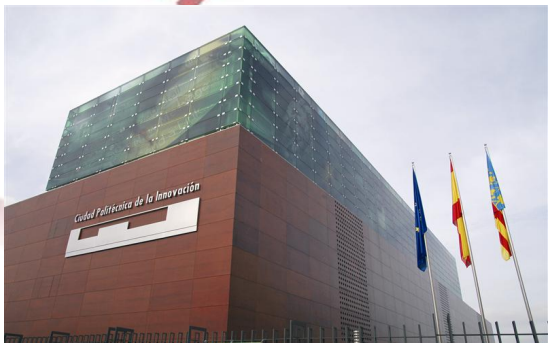


# OUTLINE

- Introduction
- Motivation and Research Question Formulation: Collaborative processes in non-hierarchical networks (NHN).
- Literature review: collaborative processes
- Research contribution and innovation in collaborative non-hierarchical manufacturing networks
- Discussion of results and critical view
- Conclusions and further work

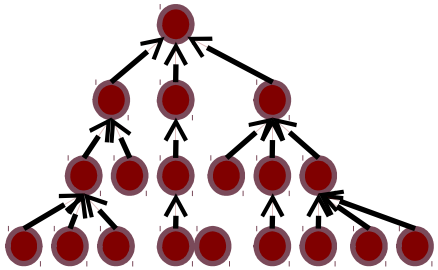
# Introduction
## HN vs. NHN

Hierarchical refers to the power of hierarchy in decision making

***Hierarchical Networks (HN)***

Centralised decision making models

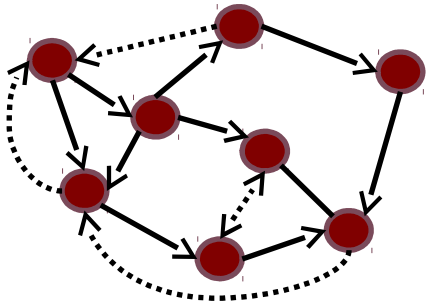
- One partner possesses all the power

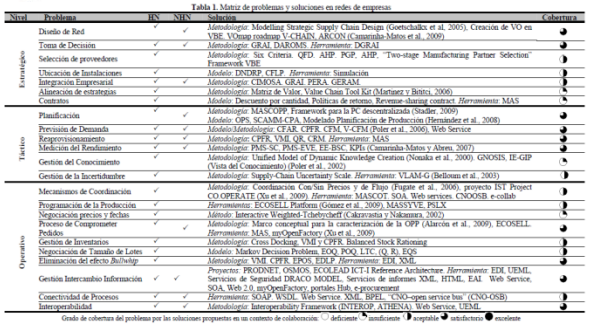


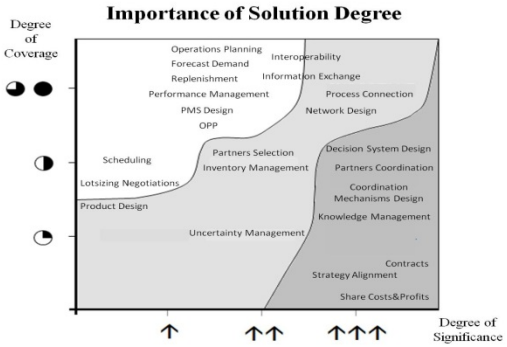
***Non-Hierarchical Networks (NHN)***

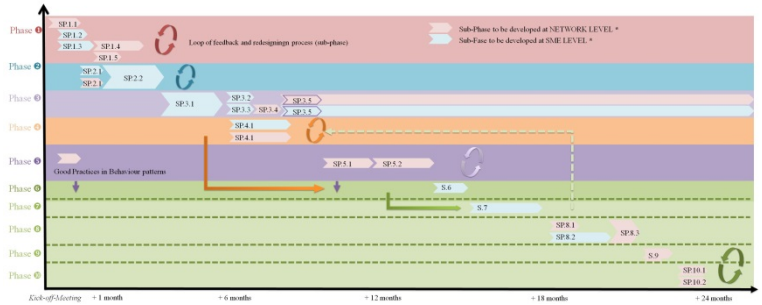
Decentralised decision making

- All the network partners are autonomous
- All decisional independent units are collaboratively involved in the management of the network processes
- Integrated with different degrees of collaboration
- Involved partners equally enjoy power sharing and status, no individual partner leads the network
- Improves communication, collaboration and flows among nodes






*Problems&Solutions Identification in Collaborative Networks*
*(Andrés and Poler, 2011)*

*Non-covered Problems Relevant to Study In Collaborative NHN*
*(Andrés and Poler, 2012)*

*Roadmap for NHN*
*(Andres and Poler, 2013)*

- *SMEs needs*
- *NHN Requierements*

# NHN research evolution

iNet·IMS

*FP7-NMP-2008-SMALL-2 Activity code NMP-2008-3.3-1: Supply chain integration and real-time decision making in non-hierarchical manufacturing networks*

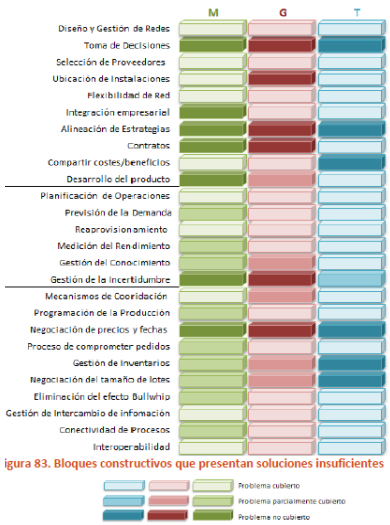
SEVENTH FRAMEWORK PROGRAMME

NET-CHALLENGE

Sustainable Mass Customization mass customization for Sustainability

iNet·IMS
Intelligent Non-Hierarchical Manufacturing Networks

*Building Blocks of the Collaborative Framework for NHN*
*(Andrés and Poler, 2012)*



igura 83. Bloques constructivos que presentan soluciones insuficientes

*Provide a Solutions in Collaborative NHN*

***Model the collaborative NHN***

*Tool to analyse the degree of collaboration of the networked partners*

*Tool to analyse the degree of alignment of strategies*

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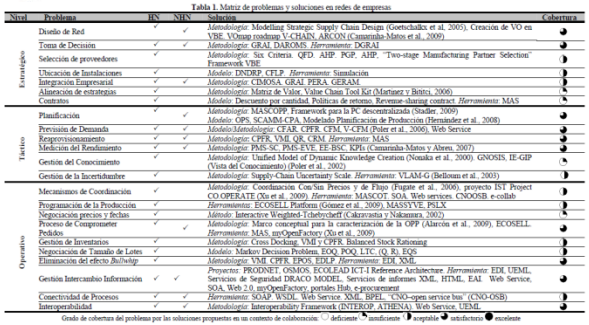
Tabla 1. Matriz de problemas y soluciones en redes de empresas

| Nivel | Problema | HN | NHN | Solución | Cobertura |
|---|---|---|---|---|---|
| Estratégico | Diseño de Red | ✓ | ✓ | *Metodología:* Modelling Strategic Supply Chain Design (Goetschalkx et al, 2005). Creación de VO en VBE. VOmap roadmap V-CHAIN, ARCON (Camarinha-Matos et al., 2009) | ◕ |
| | Toma de Decisión | ✓ | ✓ | *Metodología:* GRAI, DAROMS. *Herramienta:* DGRAI | ◕ |
| | Selección de proveedores | ✓ | | *Metodología:* Six Criteria. QFD. AHP. PGP. AHP. "Two-stage Manufacturing Partner Selection" Framework VBE | ◑ |
| | Ubicación de Instalaciones | ✓ | | *Modelo:* DNDRP. CFLP. *Herramienta:* Simulación | ◑ |
| | Integración Empresarial | ✓ | ✓ | *Metodología:* CIMOSA. GRAI. PERA. GERAM. | ◕ |
| | Alineación de estrategias | ✓ | | *Metodología:* Matriz de Valor. Value Chain Tool Kit (Martinez y Bititci, 2006) | ◔ |
| | Contratos | ✓ | | *Modelo:* Descuento por cantidad. Políticas de retorno. Revenue-sharing contract. *Herramienta:* MAS | ◔ |
| Táctico | Planificación | ✓ | ✓ | *Metodología:* MASCOPP. Framework para la PC descentralizada (Stadler, 2009) | ◕ |
| | Previsión de Demanda | ✓ | ✓ | *Modelo:* OPS. SCAMM-CPA. Modelado Planificación de Producción (Hernández et al., 2008) | ◕ |
| | Reaprovisionamiento | ✓ | ✓ | *Modelo/Metodología:* CFAR. CPFR. CFM. V-CFM (Poler et al., 2006). Web Service | ◕ |
| | Medición del Rendimiento | ✓ | ✓ | *Metodología:* CPFR. VMI. QR. CRM. *Herramienta:* MAS | ◕ |
| | Gestión del Conocimiento | ✓ | | *Metodología:* PMS-SC. PMS-EVE. EE-BSC. KPIs (Camarinha-Matos y Abreu, 2007) | ◕ |
| | Gestión de la Incertidumbre | ✓ | | *Metodología:* Unified Model of Dynamic Knowledge Creation (Nonaka et al., 2000). GNOSIS. IE-GIP (Vista del Conocimiento) (Poler et al., 2002) | ◔ |
| Operativo | Mecanismos de Coordinación | ✓ | | *Metodología:* Supply-Chain Uncertainty Scale. *Herramienta:* VLAM-G (Belloum et al., 2003) | ◑ |
| | Programación de la Producción | ✓ | | *Metodología:* Coordinación Con/Sin Precios y de Flujo (Fugate et al., 2006). proyecto IST Project CO-OPERATE (Xu et al., 2009). *Herramienta:* MASCOT. SOA. Web services. CNOOSB. e-collab | ◑ |
| | Negociación precios y fechas | ✓ | | *Herramienta:* ECOSELL Platform (Gomez et al., 2009). MASSYVE. PELX | ◑ |
| | Proceso de Comprometer Pedidos | ✓ | ✓ | *Método:* Interactive Weighted-Tchebycheff (Cakravastia y Nakamura, 2002) | ◔ |
| | Gestión de Inventarios | ✓ | | *Metodología:* Marco conceptual para la caracterización de la OPP (Alarcón et al., 2009). ECOSELL. *Herramienta:* MAS. myOpenFactory (Xu et al., 2009) | ◕ |
| | Negociación de Tamaño de Lotes | ✓ | | *Metodología:* Cross Docking. VMI y CPFR. Balanced Stock Rationing | ◑ |
| | Eliminación del efecto *Bullwhip* | ✓ | | *Modelo:* Markov Decision Problem. EOQ. POQ. LTC. (Q, R). EQS | ◑ |
| | Gestión Intercambio Información | ✓ | ✓ | *Metodología:* VMI. CPFR. EPOS. EDLP. *Herramienta:* EDI. XML | ◕ |
| | Conectividad de Procesos | ✓ | ✓ | *Proyectos:* PRODNET. OSMOS. ECOLEAD ICT-I Reference Architecture. *Herramienta:* EDI. UEML. Servicios de Seguridad DRACO MODEL. Servicios de informes XML. HTML. EAI. Web Service. SOA. Web 2.0. myOpenFactory. portales Hub. e-procurement | ◕ |
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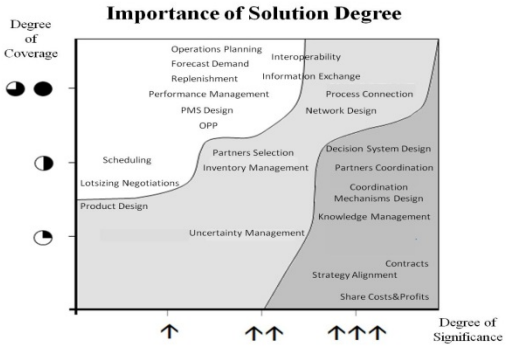
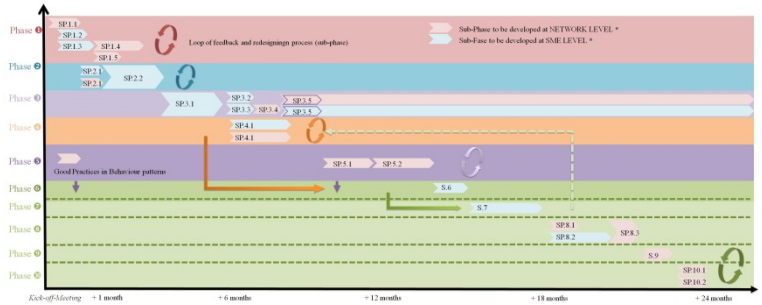
| | | ✓ | ✓ | *Metodología:* Interoperability Framework (INTEROP. ATHENA). Web Service. UEML | ◕ |

Grado de cobertura del problema por las soluciones propuestas en un contexto de colaboración. ○ deficiente ◔ suficiente ◑ aceptable ◕ satisfactorio ● excelente

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- *SMEs needs*
- *NHN Requierements*

# NHN research evolution

iNet·IMS

*Building Blocks of the Collaborative Framework for NHN (Andrés and Poler, 2012)*

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***Model** the **collaborative NHN***

*Tool to analyse the degree of collaboration [illegible] networked partners*

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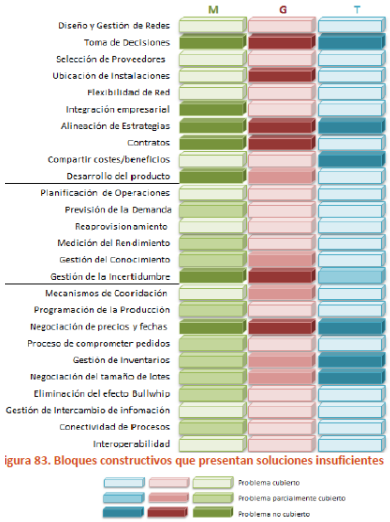

igura 83. Bloques constructivos que presentan soluciones insuficientes

Sustainable Mass Customization
mass customization for Sustainability

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# Motivation and Research Question Formulation

- **Motivation**
  - Call funded by the European Commission, “FP7-NMP-2008-SMALL-2” (Activity code ***NMP-2008-3.3-1: Supply chain integration and real-time decision making in non-hierarchical manufacturing networks***)
  - Intelligent Manufacturing Systems initiative (**iNet-IMS**) has encouraged to
    - analyse the needs that arise from relationships between SMEs belonging to NHN
    - analyse the technology innovation trends to support DDM
    - analyse standards for information exchange to support collaborative processes and
    - define a framework for collaboration in NHN
  - the growing interest of enterprises on establishing collaboration

# Motivation and Research Question Formulation

- **Research Questions**

1. **Identify relevant collaborative processes**

   Are the collaborative processes treated from the NHN characteristics?

   Recognise non-covered processes (solutions not provided for NHN topology)

3. **Provide solutions in the NHN context** to fill the literature gaps. Research on new approaches to model collaboration form the NHN.

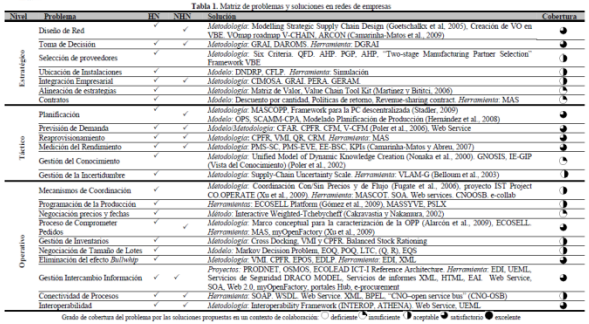
   Collaborative Framework  models, guidelines and tools to support SMEs on their participation in collaborative processes in NHN

   Roadmap to support SMEs on the migration path towards collaborative NHNs

5. **Model** the **collaborative NHN**

   Tool to analyse the degree of collaboration of the networked partners

   Tool to analyse the degree of alignment of strategies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|---|---|---|---|---|---|
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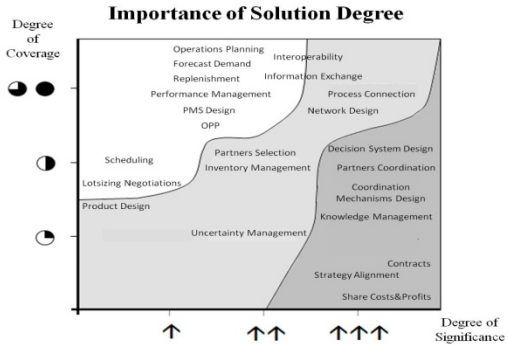


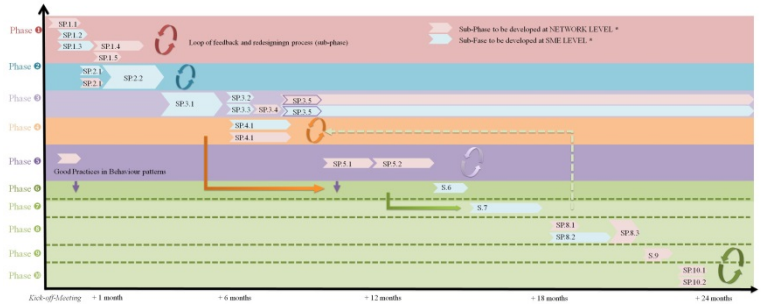


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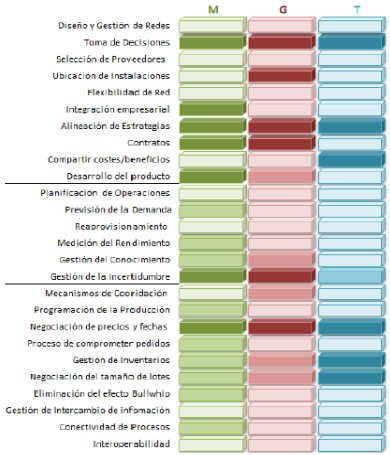

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# Literature review: collaborative processes

- The literature review was carried out considering the most relevant processes to establish collaboration (both in HN and NHN contexts)
- Processes Analysis:
  - **Solution's approaches** to deal with them: **models, guidelines and tools**.
  - Identify into which **extent** the **solutions** are appropriate to be **applied from the NHN perspective**.
- Processes classification

| | |
|---|---|
| ***NHN*** | *when most of the contributions to deal with the collaborative processes are designed from the NHN perspective* |
| ***HN  NHN*** | *when most of the contributions are designed form the HN perspective but can be adapted to the collaborative and decentralised features that characterise the NHN* |
| ***HN*** | *when most of the contributions in the literature are designed for HN* |

# Literature review: collaborative processes

**DECISION MAKING LEVEL**

| Collaborative Processes | STRATEGIC | | TACTICAL | | OPERATIONAL | |
|---|---|---|---|---|---|---|
| | (1) Network Design | HN→NHN | (1) Forecast Demand | NHN | (1) Scheduling | HN→NHN |
| | (2) Decision System Design | NHN | (2) Operational Planning | HN→NHN | (2) OPP | NHN |
| | (3) Partners Selection | HN→N | | | (3) Lotsizing Negotiation | HN |
| | (4) Strategy Alignment | HN | (4) Performance Management | NHN | (4) Inventory Management | HN→NHN |
| | (5) Partners Coordination and Integration | HN→NHN | (5) Knowledge Management. | HN→NHN | (5) Information Exchange Management | NHN |
| | (6) Product Design | HN→NHN | (6) Uncertainty Management | HN | (6) Process Connection | HN→NHN |
| | (7) PMS Design | NHN | (7) Negotiation Contracts among partners | HN→NHN | (7) Interoperability | NHN |
| | (8) Coordination Mechanisms Design | HN→NHN | (8) Share costs/profits | HN | | |
| | | | (9) Coordination Mechanisms Management | HN→NHN | | |

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| Collaborative Processes | STRATEGIC | | TACTICAL | | OPERATIONAL | |
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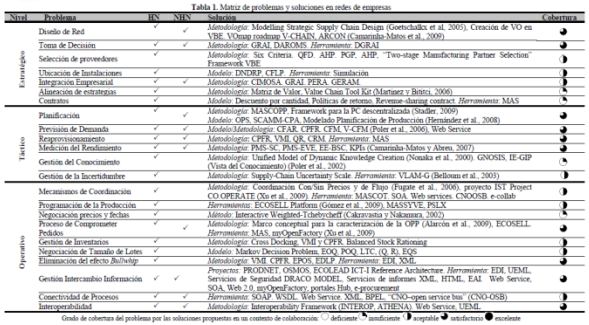
| | | | (9) Coordination | HN→NHN | | |

**SOLUTIONS DEGREE OF APPLICATION**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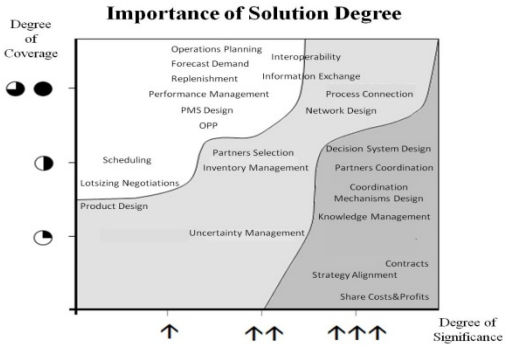


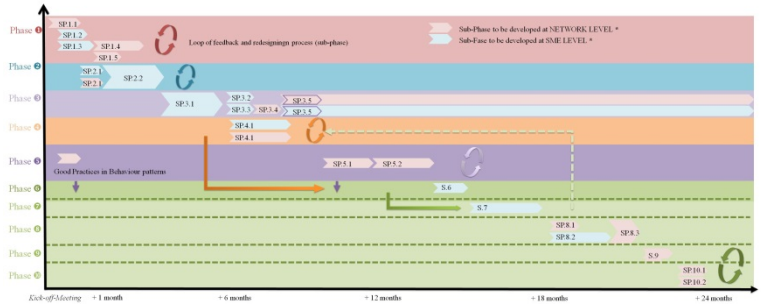


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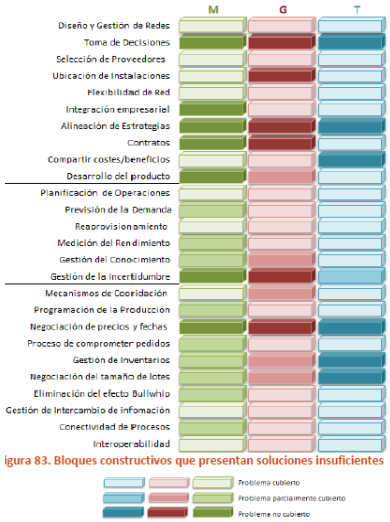

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# Research contribution and innovation in NHN

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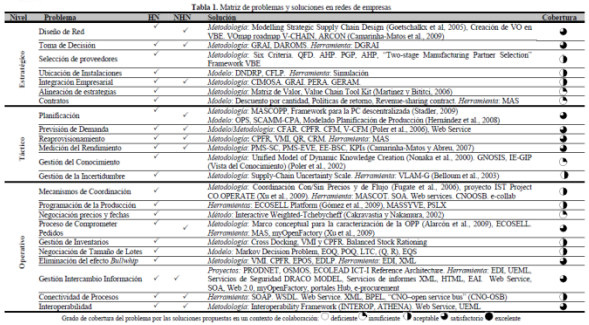
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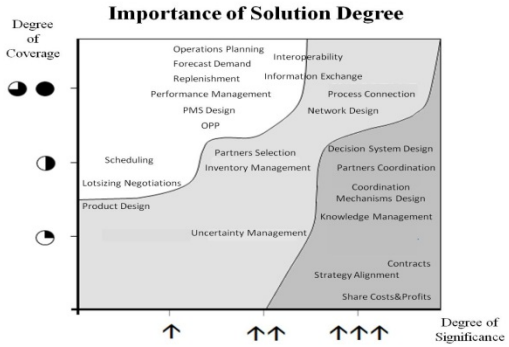


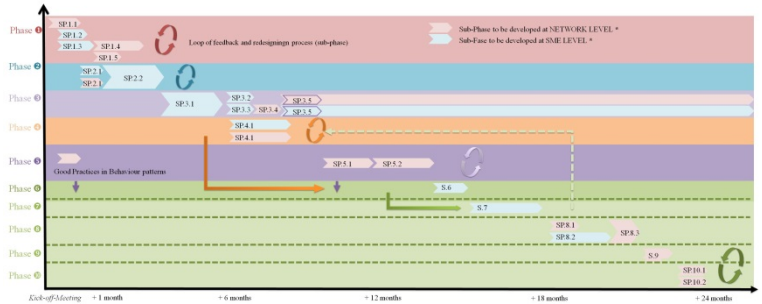


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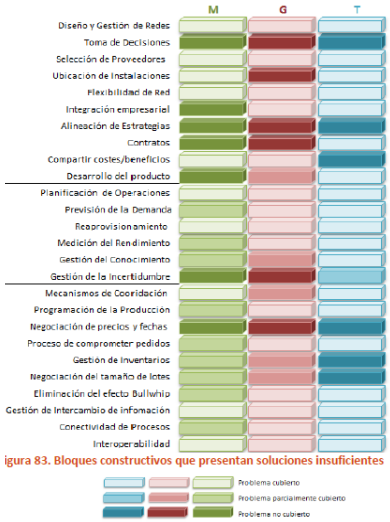

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# Research contribution and innovation in NHN

- ***Share Profits in Non-Hierarchical Networks* (SP-NHN)**
  - equitable sharing among networked partners to foster collaborative and trust behaviours and deal with the gap of collaboratively *share costs/profits*

*Andres, B., Poler, R.: A Methodology to Share Profits and Costs in Non-Hierarchical Networks. In: Prado-Prado, J.C. and García-Arca, J. (Eds.). Annals of Industrial Engineering. Springer –Verlag London. (In press) (2014)*

❶ - *NHN level- Economic Activity Definition*

❷ - *NHN level -Objective Description*

❸ - *SME level -Sub-objectives Description*

❹ - *SME level -Business Processes Specification*

❺ - *NHN level -Information Collection*

❻ - *NHN level -Final Participation Percentage*

❼ - *NHN level -Share costs and benefits*

a

# Research contribution and innovation in NHN

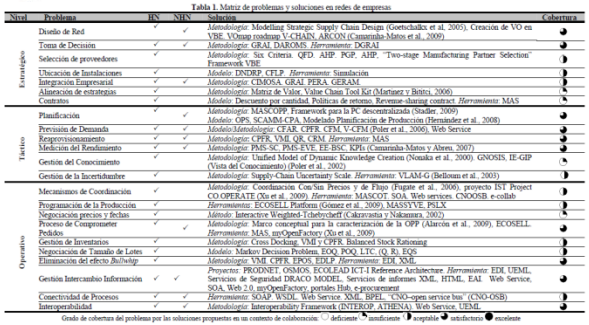
| | STRATEGIC | TACTICAL | OPERATIONAL |
|---|---|---|---|
| Collaborative Processes | (1) Network Design **HN→NHN** | (1) Forecast Demand **NHN** | (1) Scheduling **HN→NHN** |
| | (2) Decision System Design **NHN** | (2) Operational Planning **HN→NHN** | (2) OPP **NHN** |
| | (3) Partners Selection **HN→NHN** | (3) Replenishment **HN→NHN** | (3) Lotsizing Negotiation **HN** |
| | (4) Strategy Alignment **HN** | (4) Performance Management **NHN** | (4) Inventory Management **HN→NHN** |
| | (5) Partners Coordination and Integration **HN→NHN** | (5) Knowledge Management. **HN→NHN** | (5) Information Exchange Management **NHN** |
| | (6) Product Design **HN→NHN** | (6) Uncertainty Management **HN** | (6) Process Connection **HN→NHN** |
| | (7) PMS Design **NHN** | (7) Negotiation Contracts among partners **HN→NHN** | (7) Interoperability **NHN** |
| | (8) Coordination Mechanisms Design **HN→NHN** | (8) Share costs/profits **HN** | |
| | | (9) Coordination Mechanisms Management **HN→NHN** | |

# Research contribution and innovation in NHN

- ***Adapting : Supply Chain Agent-based modelling Methodology that supports a Collaborative Planning Approach* (SCAMM-CPA)**
  - *operational planning* process, considered a complex activity in collaborative NHN due to the agreements and standardised processes demanded
  - in order to handle with the problems associated when the *operational planning* is performed in NHN under a collaborative perspective

*Andres, B., Poler, R., Herández J.E. An operational planning solution for SME's in collaborative and non-hierarchical networks. In Hernández, J.E., Liu, S., Delibaašić, B., Zaraté, P., Dargam, F., Ribeiro, R. (Eds.) Decision Support Systems II - Recent Developments Applied to DSS Network Environments. LNBIP. vol. 164, 2013, pp 46-56. Springer-Verlag Berlin Heidelberg. (2013)*

| | |
|---|---|
| ❶ Physical Layer | Consider any kind of network configuration. |
| ❷ Data Layer | Define the main data structure. |
| ❸ Information Layer | Collects, manage and structure all the necessary information to support collaborative processes. |
| ❹ Ontology REA-based Layer | Support standards communication processes. |
| ❺ Agent Communication Layer | Implementation of the mechanism for the decentralised decision-making. |
| ❻ Behaviour Layer | Collect the basic structure of the network. |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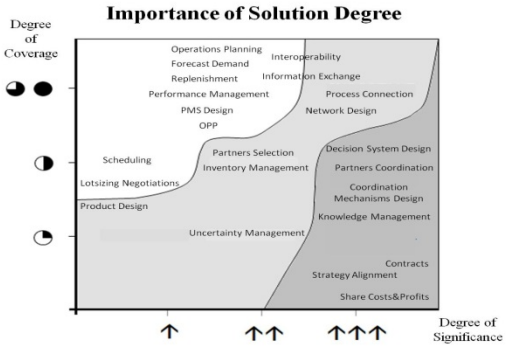


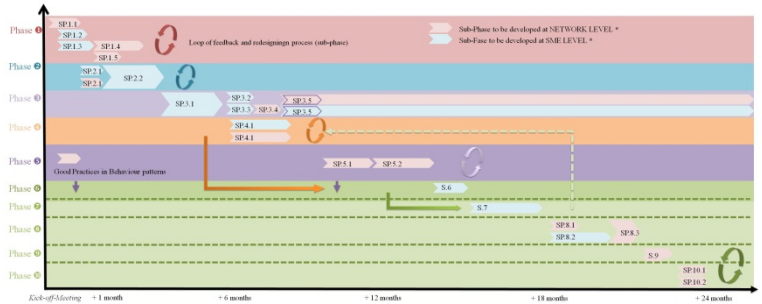


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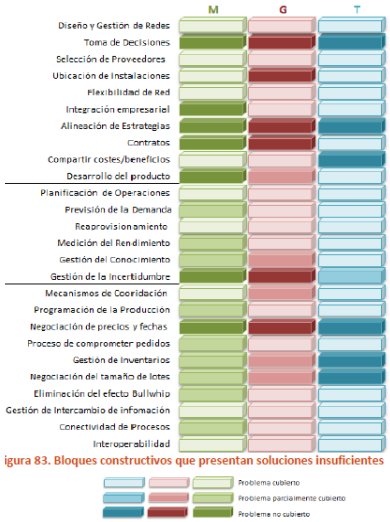

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# Research contribution and innovation in NHN

- ***NHNmap***

**To deal with SMEs needs when belonging to decentralised and collaborative NHN**

- to deal with the evolution from non-collaborative scenarios towards the establishment of collaborative processes among the SMEs decided to participate in decentralised and collaborative NHN
- ten phases structured into four main areas (i) collaboration establishment, (ii) performance evaluation, (iii) solutions' proposal to overcome possible barriers appearing when collaborative processes are established, and (iv) information and technology systems to efficiently manage the decentralised decision making models that characterise the NHN

*Andres, B., Poler, R.: A Roadmap Focused on SMEs Decided to Participate in Collaborative Non-Hierarchical Networks. In: Camarinha-Matos, L.M., Xu, L., Afsarmanesh, H. (Eds.) Collaborative Networks in the Internet of Services. 13th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2012. IFIP AICT. Volume 380 pp. 397–407. Springer Heidelberg Dordrecht London NewYork (2012)*

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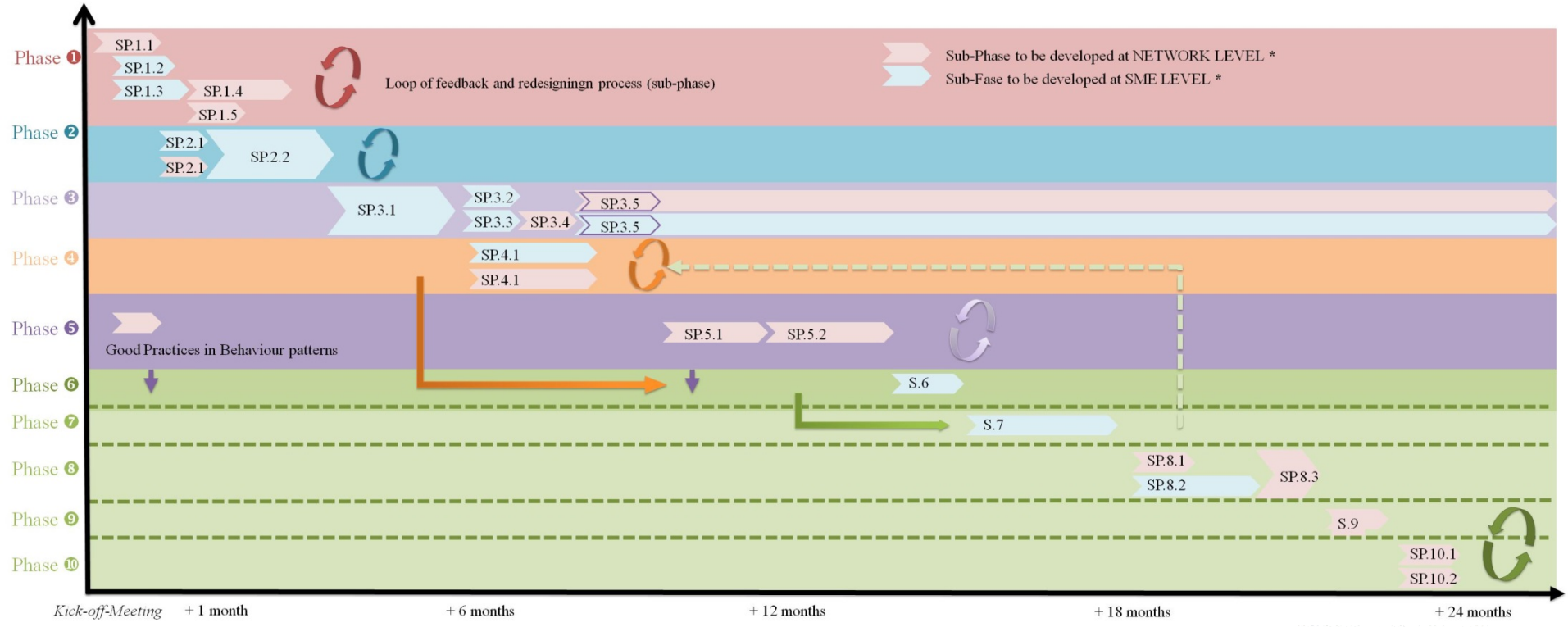

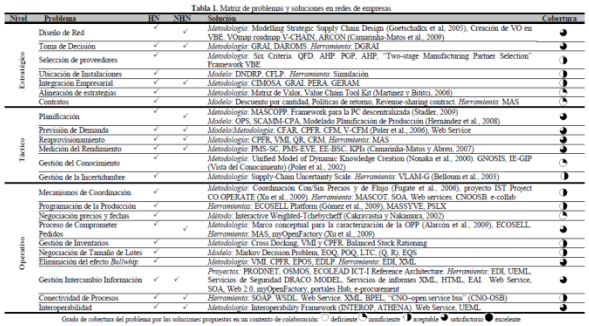
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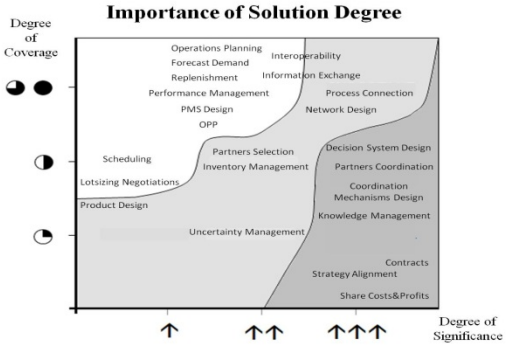


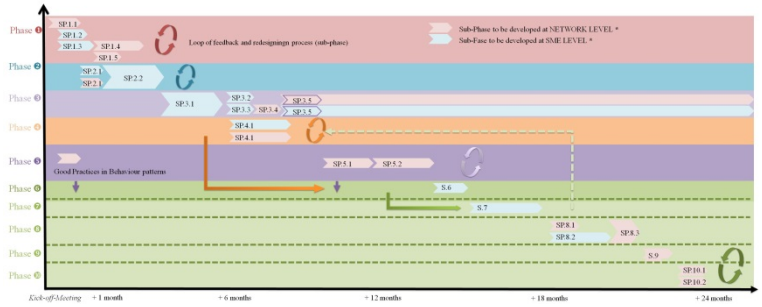


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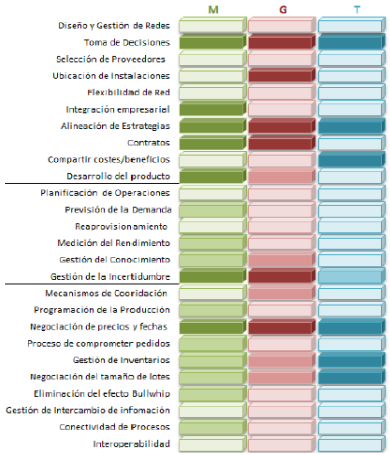

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# Research contribution and innovation in NHN

- ***Modelling Collaborative Networks (NHN)***
  - provide a general only model that could be valid for all the identified collaborative processes
  - identifying different objects that take part in each of the collaborative process
  - to be developed to support researchers on the formal conceptualisation of the collaborative processes, giving them an insight of
  - how to analyse the processes and measure the collaboration
  - how to design a collaborative process, if this does not already exist or
  - how to redesign a process, if this has not been already executed from a collaborative perspective, in order to globally improve the network performance and individually improve the enterprises' performance

# Research contribution and innovation in NHN

- ***Modelling Collaborative Networks (NHN)***
  - **Method to Quantify the Power Distribution in Collaborative Non-hierarchical Networks**
  - identify the power degree of each networked partner and therefore determine the power distribution. Once the network, the partners and the partners' relations are modelled, *Markov Chains* are used to compute the power distribution. Modelling the power and therefore the relationships of the network nodes allows to better consider the networked partners' relationships and obtain more sustainable and balanced networks.

*Andres, B., Poler, R.: Method to Quantify the Power Distribution in Collaborative Non-hierarchical Networks. In: Camarinha-Matos, L.M. and Scherer R.J. (Eds.). Collaborative Systems for Reindustrialisation. 14th IFIP WG 5.5 Working Conference on Virtual Enterprises, PRO-VE 2013. vol 408, pp. 660-669. Springer Heidelberg NewYork Dordrecht London (2013)*

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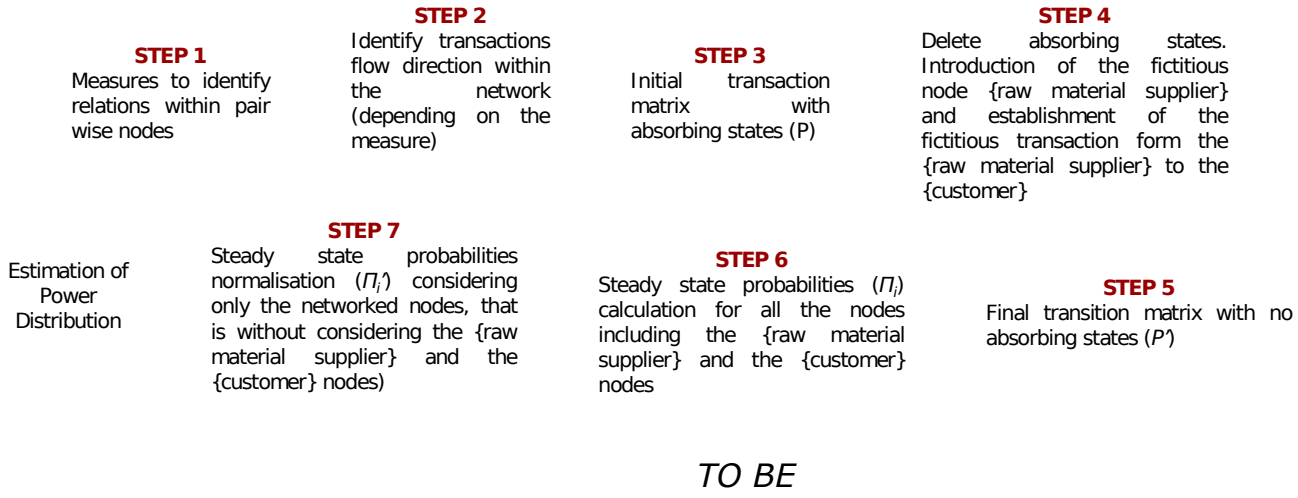
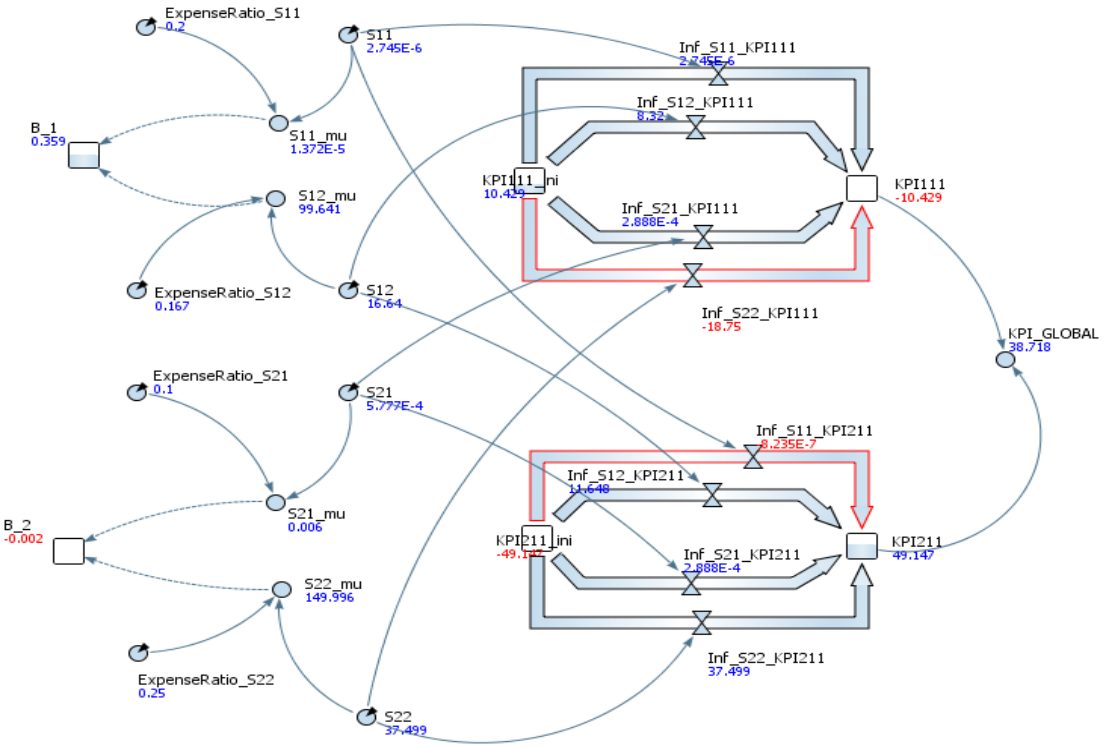


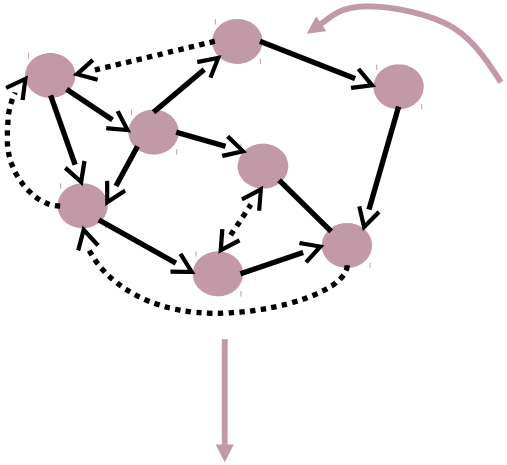
# Research contribution and innovation in NHN

- ***Modelling Collaborative Networks (NHN)***
  - **Identifying the strategies to be activated for optimising the performance in collaborative networks**
  - a model, based on system dynamics, is provided in order to support enterprises in the decision making of determining what are the strategies to activate in order achieve the optimal performance within the network.



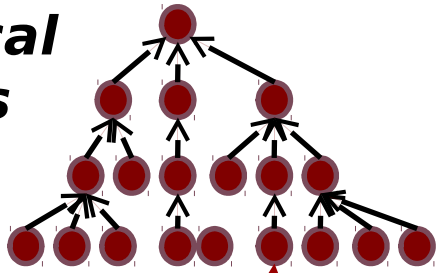
# Discussion of results and critical view

***Non-Hierarchical Networks***



**Approaches developed in the collaboration reearch field**

***Hierarchical Networks***



Lower complexity on HN treatment makes them more studied

Deal with companies that could be part of several production networks at the same time

Research focuses on the creation and management of non-hierarchical manufacturing networks and the proposal of supporting approaches for SMEs to establish collaborative processes in networks characterised by DDM, in order to simultaneously deal with both the enterprises' objectives the and the global objective defined for the network.

# Discussion of results and critical view

Dealing with the NHN and the **barriers associated** with the collaborative processes establishment is a laborious task due to the added difficulty to in**dividually consider each of the companies with its objectives, strategies and particularities**. Moreover the existence of **conflicting objectives** appearing, due to companies belong to **more than one network**, are to be taken into account.

This research work is a step forward in the study of real networks consisting of autonomous SMEs and deals with the next generation of manufacturing enterprises embedded in global environments characterised by multi-lateral collaborations.

# **Conclusions** and Future Research Lines

*long way of work to cover in the future RESEARCH IN COLLABORATIVE NH*

*2009*

This research is focused on identifying those **processes** that can be collaboratively established within a **NHN** and **modelling the NHN** in order have a **current view** on the processes performed in a NHN, with the main aim to **improve the partners collaboration** through solutions procurement.
Overcome the appearing **weakness** through the **application of models, guidelines and tools** provided

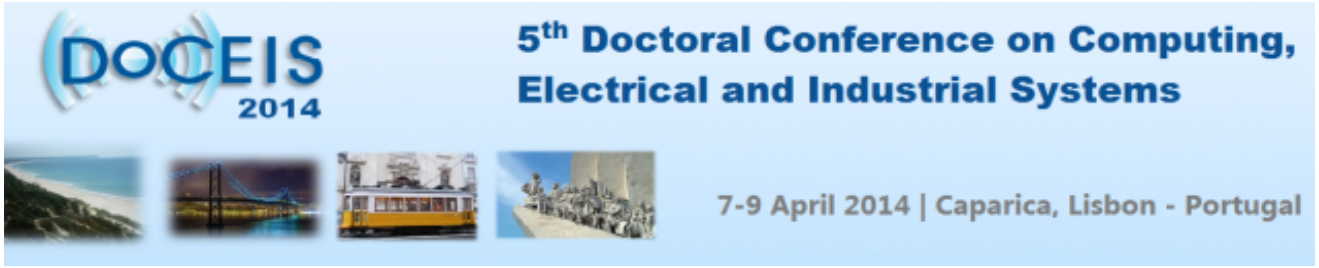
- **Research Contributions to**
  - Summarise the existing knowledge regarding the establishment of collaborative processes within networks, specifically in NHN
  - Provide a roadmap to overcome the possible barriers appearing when SMEs decide to participate in collaborative NHN and
  - Design a formal model defining the collaboration objects to allow researchers to specifically model the STRATEGIES ALIGNMENT PROCESS.

# Conclusions and **Future Research Lines**

- **ROADMAP  NHNmap**
  - Promote collaboration through the **implementation** of the **roadmap NHNmap**
  - Validate the proposed Collaborative Framework through its application to various industrial pilots and

- **STRATEGIES ALIGNMENT PROCESS**
  - **Provide a solution** in order to deal with the **strategies alignment process.** Design a **formal model to be implemented in** real networks.
  - **Maximizing the KPI GLOBAL of the network**
  - **Decide what strategies activate but also decide in which time unit activate them.**
  - **Validate the formal model**

# Research on collaborative processes in non-hierarchical manufacturing networks

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