

INTERUNIVERSITY PH.D. PROGRAM BETWEEN
POLITECNICO DI BARI AND UNIVERSITÀ DEGLI STUDI DI BARI ALDO MORO
IN INDUSTRY 4.0

Sustainable and Green Supply Chain of the Aeronautical Sector

Resiliency models and indicators for supply chains

PhD candidate

Ciro Cierro

Cycle

XXXVII

Tutors

Prof.ssa Nunzia Carbonara

Prof.ssa Mariagrazia Dotoli

Description of the research program

The fourth industrial revolution, known as Industry 4.0, is increasingly being adopted in production, distribution and marketing chains around the world. The digital revolution is reshaping the way people live and work and has a substantial influence on the manufacturing industry. It is based on the creation of smart factories, smart products and smart services integrated into an Internet of Things (IoT) and services.

In the panorama of large international manufacturing companies, the aeronautical industry has peculiarities in the field of procurement that substantially differentiate it from all other types of industries. Its supply chain is particularly complex as the perimeter of supply covers a very wide variety of industrial types. The digitalization process is slowly starting to introduce new and more efficient supply chain management methods, but this process requires long adaptation times by OEMs and all related industries. To date, the aeronautical supply chain is managed with traditional methods and measured with “analog” type parameterizations. Therefore, the implementation of innovative assessment processes and the development of suppliers, which push towards a digitalization of the supply chain, are fundamental for the solution of this problem, which is to all intents and purposes a problem of “Big Data Computing” and which requires a strong synthesis of the supply chain and digitization of its management.

At the same time, the progress of European and world regulations in the field of “green” processes is further complicating the world of aeronautical production, forcing companies to make a particularly fast ecological transition with respect to the speed of adaptation of the aeronautical sector; therefore, the supply chain must be properly addressed and guided in the application of these new regulations. The big players in the aerospace sector are looking for ways to combine the profit objective, necessary for economic sustainability, with the respect for the environment, setting themselves the goal not only to obtain an economic gain, but also to respect the environment in a long-term perspective. Therefore, several large companies are reorganizing their business processes from a “green” perspective by requiring their suppliers to have the same eco-sustainability standards that they themselves impose. In this respect, the aeronautical industry was the first to equip itself with advanced management systems for production and its subcontracting, through the use of highly integrated management systems in the factory. However, this condition was not reached by all levels of supply in the sector, often made up of a multitude of small and medium-sized enterprises highly specialized in the product but not very digitized. The current fleet of suppliers of Leonardo Company, the main Italian aeronautical industry, is managed with methodologies that require the use of a few digital tools and through evaluation processes that are not always effective.

The proposed research presents an approach based on Industry 4.0 to address a key aspect within the factories of the aeronautical sector, namely that of supply chain management in a 4.0 perspective. This issue will be addressed through some fundamental aspects, namely the analysis and evaluation of suppliers with innovative methodologies, the introduction of logistics 4.0 concepts from a “world class manufacturing” perspective and the introduction of “green” manufacturing, especially in compliance with the new REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) regulations.

The research therefore aims to optimize the supply chain in both qualitative and environmental terms. In details, it aims to implement the following innovative macro aspects within the aeronautics industry:

- Evaluation of the supply chain with digital and interconnected tools;
- Use of artificial intelligence methodologies for supply chain management;
- Introduction of a new management system for warehouse activities and optimized transport routes, intra-logistics and automatic handling of loads;
- Implementation of methodologies to support the transition towards green processes;
- Creation of a simulation model of the entire supply chain of a product in the sector.

The final objective will be to apply the methodologies studied / implemented at one or more pilot suppliers of the Leonardo Company. The result will therefore be the issuance of new logistics procedures and supplier performance measurement through reports and digital tools.

Schedule of the research activities

First academic year (planned)

	Description	Period	Activity abroad
Systematic Literature Review (State-of-the-Art)	Study of existing supply chains and their characterization in terms of sustainability performance; Study of the regulations for the transition towards green processes.	Nov. 2021 – Apr. 2022	NO
Initial assessment	Initial assessment of suppliers and assessment of the supply chain of the aeronautical sector (wrt macro-themes of Resilience, Sustainability, Supply Chain Management, Circular Economy, Digital Transformation).	May 2022 – Oct. 2022	NO

Second academic year (planned)

	Description	Period	Activity abroad
Sustainability and performance metrics	Development of metrics for measuring sustainability and improving supplier performance parameters.	Nov. 2022 – Apr. 2023	NO
Logistics 4.0 solutions	Definition of solutions oriented to the use of logistics 4.0 methodologies and technologies in the aeronautical supply chain.	May 2023 – Oct. 2023	NO
Green solutions	Definition of solutions to support the implementation of the ecological transition towards green processes.	May 2023 – Oct. 2023	NO

Third academic year (planned)

	Description	Period	Activity abroad
Case studies	Practical application to the aerospace sector, with one or more case studies for suppliers of the Leonardo Company.	Nov. 2023 – Apr. 2024	YES (Tbd)
Models development	Development and validation of logistics management and supplier performance measurement models.	Nov. 2023 – Oct. 2024	NO
Final results and future trends	Presentation / publication of final results (reports and digital tools) and definition of future trends.	Jul. 2024 – Oct. 2024	NO

Provisional training and research activities plan

First academic year (planned)

	Description	Period	Duration	CFU
PhD courses	Smart Education for Industry 4.0	Jun. 2022	20 h	2
	Complex Networks: Big Data modelling and learning	Jun. 2022	20 h	1 of 2
	Collective intelligence of human groups	Tbd 2022	Tbd h	2
	Human-based Smart Manufacturing Systems	Tbd 2022	Tbd h	2
	Sustainability in smart manufacturing: open research questions	Tbd 2022	Tbd h	2
	Multidisciplinary Research Applications of 3D Printing	Tbd 2022	Tbd h	1 of 2
	Mixed Reality for data visualization in the Smart Factory	Tbd 2022	Tbd h	1 of 2
	Theories and methods in structural design: modeling and experimental issues	Tbd 2022	Tbd h	1,5 of 3
	Emerging technologies and methodologies for the Cyber Security	Tbd 2022	Tbd h	1 of 2
	Fundamentals of Information Theory	Tbd 2022	Tbd h	1 of 2
Master's degree courses ([LM13] INGEGNERIA GESTIONALE)	2358 - GESTIONE DELLA SUPPLY CHAIN	II semester 2021/22	60 h	6
Participation to seminars and international congresses or workshops	Seminar: "Il ruolo delle misure e della sensoristica in Industria 4.0" (Prof. Paone)	Jan. 2022	Tbd h	1,5 (Tbc)
	DMMM seminars (Tbd)	Tbd 2022	Tbd h	2
Presentation of research products at international congresses or workshops				
TOTAL OF CFU FOR TRAINING ACTIVITIES				24
Individual research activity	<ul style="list-style-type: none"> – Study of existing supply chains and their characterization in terms of sustainability performance; – Study of the regulations for the transition towards green processes; – Initial assessment of suppliers and assessment of the supply chain of the aeronautical sector (wrt macro-themes of Resilience, Sustainability, Supply Chain Management, Circular Economy, Digital Transformation). 	Nov. 2021 – Oct. 2022	750 hours (25 hours = 1 CFU)	30
Students' supervision				

Integrative didactic activities				
Preparation of manuscripts for conferences or journals				
	TOTAL OF CFU FOR RESEARCH ACTIVITIES			30
	TOTAL OF CFU FOR YEAR I			54

Second academic year (planned)

	Description	Period	Duration	CFU
PhD courses	Tbd	Tbd	Tbd	Tbd
Master's degree courses ([LM13] INGEGNERIA GESTIONALE)	2929 - ANALISI E SIMULAZIONE DEI SISTEMI	I semester 2022/23	60 h	3 of 6
	2592 - BUSINESS E SOSTENIBILITA'	I semester 2022/23	60 h	6
	2359 - GESTIONE AMBIENTALE DEI SISTEMI DI PRODUZIONE	I semester 2022/23	60 h	3 of 6
Participation to seminars and international congresses or workshops	Tbd	Tbd	Tbd	Tbd
Presentation of research products at international congresses or workshops	Tbc			Tbd
	TOTAL OF CFU FOR TRAINING ACTIVITIES			21 (12 + 9 Tbd)
Individual research activity	<ul style="list-style-type: none"> – Development of metrics for measuring sustainability and improving supplier performance parameters; – Definition of solutions oriented to the use of logistics 4.0 methodologies and technologies in the aeronautical supply chain; – Definition of solutions to support the implementation of the ecological transition towards green processes. 	Nov. 2022 – Oct. 2023	1125 hours (25 hours = 1 CFU)	45
Students' supervision				
Integrative didactic activities				

Preparation of manuscripts for conferences or journals	Tbd			
TOTAL OF CFU FOR RESEARCH ACTIVITIES				45
TOTAL OF CFU FOR YEAR II				66

Third academic year (planned)

	Description	Period	Duration	CFU
PhD courses				
Master's degree courses				
Participation to seminars and international congresses or workshops				
Presentation of research products at international congresses or workshops	Tbd			
TOTAL OF CFU FOR TRAINING ACTIVITIES				
Individual research activity	<ul style="list-style-type: none"> – Practical application to the aerospace sector, with one or more case studies for suppliers of the Leonardo Company; – Development and validation of logistics management and supplier performance measurement models; 	Nov. 2023 – Oct. 2024	1125 hours (25 hours = 1 CFU)	45
Students' supervision				
Integrative didactic activities				
Preparation of manuscripts for conferences or journals	Presentation / publication of final results (reports and digital tools) and definition of future trends.	Jul. 2023 – Oct. 2024	375 hours (25 hours = 1 CFU)	15
TOTAL OF CFU FOR RESEARCH ACTIVITIES				60
TOTAL OF CFU FOR YEAR III				60

	TOTAL OF CFU FOR THE WHOLE PHD COURSE	180
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