PHD PROFILE, II YEAR STUDENTS, A.A. 2018/2019

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- *Title of the research:* Design and assessment of decision-making process for the provision of Cyber-Physical System-based Product-Service System
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OUTLINE OF THE RESEARCH

The research project is encapsulated in the context of Industry 4.0 and is strongly connected to the theme of the service delivery. In particular, the project aims at improving the service delivery process (SDP) of products offered by manufacturing companies, in the so-called Product-Service Systems (PSS) business model. The SDP represents the sequence of actions performed by the company's employees and the customers and necessary to deliver a certain service to the customer. The idea underpinning the PSS business model is that the customers' needs can be satisfied through the joint provision of a mix of products and services. The products and services components can be mixed in different ways and, thus, be used to customize even more company offering depending on the customers' necessities. Literature refers to the different mix of products and services as:

- Product-Oriented PSS: when the customer owns the product and buy additional services when necessary (e.g. a machine and the related maintenance);
- Use-Oriented PSS: when the company owns the product and the customers pay to use it renting it or sharing it (e.g. car-renting service or car-sharing service);
- Result-Oriented PSS: when the company owns the product and the customers pay for the results of its usage (e.g. Rolls Royce's Power by the Hour program).

Dealing with such business model and creating additional value from the service provision is not trivial and requires being able to handle a great complexity in terms of economic, social and technical variables. In addition, this scenario is complicated by the current evolution that is characterizing the manufacturing sector, due to the introduction of new, smarter, technologies that requires new competencies and skills to be exploited efficiently. In particular, the introduction of the Industry 4.0 technologies in the manufacturing production processes is leading to the generation of unprecedented quantities of data that, to be exploited and to generate additional value for the companies, have to be collected in a structured manner and processed with the right approaches, algorithms and tools. As of now, companies are still mainly approaching the decision-making process and the SDP without the support of tools specifically created to manage this kind of datasets and extract information from them. For this reason, new tools and decision-making approaches are required to address this problem in the right way and exploit the maximum value from the data collection.

The objective of the research project is to improve the SDP of manufacturing companies moving towards the PSS business model through the proposal of a framework able to guide them in design and assess Decision Support Systems (DSS) to support them in the decision-making process. To do this, the project aims at using one of the

most relevant technologies of the current industrial revolution – the Cyber-Physical Systems (CPS) – as a central mean to generate and collect the data that will be used as input for the DSS to make decisions. An aspect that it is important to consider is how the introduction of a DSS influences the role that the current decision-makers – the Human-in-the-Loop (HIL) – have in the SDP. In fact, the introduction of an effective DSS could reduce the role of the HIL, forcing him/her to find new activities or roles inside the company.

According to this, the proposed framework must be able to support and guide the analysis of the companies' current SDP to understand:

- The aim of the DSS;
- The input and output of the DSS;
- The actors involved in the SPD;
- The information flow in the SDP;
- The activities composing the SDP;
- The problems in the SDP;
- Where to position the DSS;
- The effects of the DSS introduction on the SDP and the HIL.

A literature research showed how, despite the increasing interest of researchers in the themes of PSS, CPS and DSS, currently only few papers deals with the topic of the SDP improvement in the context of Industry 4.0. Moreover, no evidence has been found about joint research on the PSS, CPS and DSS themes.

For these reasons, the research project intend to answer to the following research questions:

- How to define a decision making process able to improve a CPS-based PSS delivery?
- How the introduction of a CPS-based autonomous, intelligent, cooperative and responsive decision-making process affects the service delivery in the PSS context?
- How an augmented decision-making autonomy in the CPS-based PSS service delivery process affects the role of the HIL decision maker?

Eventually, the research project and have the following three mutually exclusive outcomes:

- Sensible improvement of the company's performance in service delivery. The CPS-based decision-making process can manage both simple and complex situations in the service delivery process. This fact leads to the sensible reduction of the HIL involvement that can be reallocated to other tasks;
- Partial improvement of the company's performance. The CPS-based decision-making process reliability in decision-making is limited to simple situations in the service delivery process. In case of complex situation, the HIL is still necessary;
- The new CPS-based decision making process do not improve the company's performance, for this reason the HIL maintains his role in the service delivery process.

Collaborations with other PhD students with similar interests and visiting periods with specific focus (e.g. The University of Hong Kong for the development of the DSS research stream) will be used to improve the research on specific topics and to strengthen the results of the project.