



PhD in ARCHITETTURA, INGEGNERIA DELLE COSTRUZIONI E AMBIENTE COSTRUITO / ARCHITECTURE, BUILT ENVIRONMENT AND CONSTRUCTION ENGINEERING - 39th cycle

PNRR 117 Research Field: DIGITAL TWIN AND VIRTUAL SENSOR FOR BETTER DECISION-MAKING ON ASSET MANAGEMENT

Monthly net income of PhDscholarship (max 36 months)
€ 1275.0
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	The Digital Twin (DT) can be understood as a probabilistic, multiscale, multiphysics, integrated simulation of a system that uses state-of-the-art physical models, sensors, and history to mirror the life cycle of its corresponding twin. DT paradigm can strengthen the link and improve interconnections between the physical and digital aspects of assets. The combined use of information management tools (BIM and GIS) and Industry 4.0 technologies allow for better decision-making on assets' operation and maintenance. Moreover, this research helps in involving users in a conscious use of the asset, identifying and suggesting potentially beneficial changes to occupants' behaviour. The final goal of the project is to demonstrate the efficiency of DT solutions. This will be measured by the improvement of indoor environmental quality conditions in buildings in a cost-effective manner. The European Parliament and the Italian government have shown great interest in this area. The first mission (M1) of the National Recovery and Resilience Plan (PNRR) is 'Digitalisation, Innovation, Competitiveness, Culture and Tourism'. One of the components of this mission is 'M1C2 - Digitalisation, Innovation and Competitiveness in the Production



	System' . This research fits very well in the first PNRR mission.
Methods and techniques that will be developed and used to carry out the research	Traditionally, data is collected using a dense array of sensors in every building location monitored. However, there is a multitude of issues to be considered using such an approach, including cost, maintenance, and calibration. Moreover, certain studies have demonstrated that the wrong location of the sensors may decrease the performance of a building automation system. Consequently, data should be acquired by locating the sensors in specific positions. Also, the current approach to monitoring is based on static sensing instruments deployed at specific points, which is not scalable owing to the high initial and maintenance costs associated with such sensors. In this approach, DTs perform better if the amount of data generated is vast; however, in existing assets that characterise most of the built environment, installing a significant number of sensors is not always possible. The introduction of Artificial Intelligence (AI) techniques might help understand information from a limited set of data. Implementation of virtual sensors within the building will enable a much higher resolution of data regarding IAQ in the building with minimal capital cost or disruption to the building. Combining physical and virtual sensors will result in better interventions to tackle environmental, comfort and energy performance issues in buildings. The deployment of validated data-driven (AI/ML) techniques will also result in the creation of additional metrics derived from the on-site installed sensors and meters that otherwise are difficult to be estimated. A 6-month period of study in a private company supporting this scholarship (Maticmind S.p.A. www.miticmind.it) and a period of study abroad of 6 months are foreseen in this doctoral project.
Educational objectives	The main aim of this PhD is to train a researcher for the extensive field of Construction Engineering. The Candidate is trained to face complex questions, to



	develop in-depth analysis and reliable models (theories) of complex contexts, and to innovate rules and organisations of the construction sites. Moreover, this PhD position is aimed to work as a drive system between the university and other non-academic entities, activating a continuous knowledge transfer among the involved parties.
Job opportunities	The close cooperation with a construction company and experts in the field required to carry out the activities planned for this PhD opens up a wide range of employment opportunities as an expert in construction management. In addition, the doctorate is the first step towards a career in research, either at a university or in a private research company.
Composition of the research group	0 Full Professors 2 Associated Professors 0 Assistant Professors 2 PhD Students
Name of the research directors	Prof. Fulvio Re Cecconi

Contacts
email: fulvio.receconni@polimi.it

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	637.5 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Maticmind S.p.A. - Via R. Bracco 6, Milano - www.maticmind.it
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	To be defined
By number of months abroad	6



Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Additional support:

Budget for the research activity (only for positions supported by scholarship): total amount Euro 5197.60 per student.

In detail:

- 1st year Euro 1732.53
- 2nd year Euro 1732.53
- 3rd year Euro 1732.53

Additional information about the organization and regulations of ABC-PhD programme can be found in the Regulations for the 39th Cycle of ABC-PhD: download is available at link: <https://www.dottorato.polimi.it/corsi-di-dottorato/architettura/architettura-ingegneria-delle-costruzioni-e-ambiente-costruito>

Additional information about ABC department and ABC-PhD programme: available at link: <https://www.dabc.polimi.it/>

Desk availability: The ABC department provides non-permanent desks to be temporarily booked in common PhD rooms.

This scholarship is funded by the PNRR national programme D.M. 117. This means that the owner of the position will be obliged to submit periodical reports about her/his activity.