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Ph.D in BIG DATA MANAGEMENT

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Ph.D thesis

THE USE OF BIG DATA IN THE ITALIAN INFRASTRUCTURE SYSTEM.
DEFINITION OF A MODEL TO IMPROVE SAFETY AND QUALITY

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ABSTRACT

This work originates from personal reflections during the three-year doctoral period as well as from considerations of a professional nature that directed me to a relevant and current issue: "*the use of big data in the Italian infrastructural system. Definition of a model to improve safety and quality*".

The term "infrastructural heritage" refers to roads and, therefore, to motorways, viaducts, road overpasses, railways and road tunnels, as well as specific structures such as dams, public buildings and port and airport structures.

The issues concerning the "healthiness" of the Italian infrastructural heritage (according to the aforementioned definition) have been the subject, over time, of a continuous debate at various institutional levels and various episodes have highlighted the need for more significant maintenance interventions. However, starting from the second half of 2018, this issue has jumped overwhelmingly to public attention due to issues, unfortunately, linked to disastrous events that have generated important social (including loss of human life), environmental and economic repercussions, requesting particular attention from the Italian government.

The necessary measures should (or could) consist in monitoring the area of safety and quality of services strictly related to the national road patrimony through careful, widespread and periodic dynamic monitoring through which to assess the state of the infrastructures and to plan ordinary and / or extraordinary maintenance interventions. These interventions are not only necessary but essential to ensure an adequate level of safety for citizens as well as to ensure the continuity of traffic flows in connections with Europe, on which a significant share of Italy's economic production depends.

The study was limited to specific elements making up the heritage de quo: highways, bridges, roads and tunnels.

The proposed paper is structured in 4 chapters:

- in the first chapter, the research problem, the research questions and the methodology used were addressed;
- in the second chapter, the theoretical background and the theoretical framework have been selected and detailed;
- in the third chapter, the two case studies were presented, through the use of a qualitative methodology of the multiple case study (Yin. 1983);
- in the fourth chapter, the conclusions of the thesis work were detailed.

A first step concerned the definition of the research problem with a precise focus on the impact of public interventions in relation to the thematic area dealt with, with the primary objective of verifying the positive elasticity of the effect of these investments on infrastructures. In detail, the results of the most significant (national and international) research works published from 1993 to 2012 were analyzed, which highlighted how, among the countries considered (USA, Europe and Italy), investments for maintenance (ordinary and / or extraordinary), or the creation of new infrastructures generate a positive impact on gross domestic product

(GDP). Subsequently, a systematic literature review was carried out to understand the knowledge framework on the topic of interest. In particular, this research strategy was aimed at identifying journal papers published in high ranked journals on the topic of big data (and therefore, Artificial Intelligence, data science, data analysis, cloud, Internet of Things, machine learning) in the context of infrastructure (and therefore on highways, bridges, roads and tunnels).

The second chapter can be defined as the outcome of the methodology applied in the first chapter. From such systematic literature review, the theoretical areas most used in dealing with the topic of big data applied in the context of infrastructures have been identified and selected. This allowed to build the theoretical background (second chapter) of the thesis work:

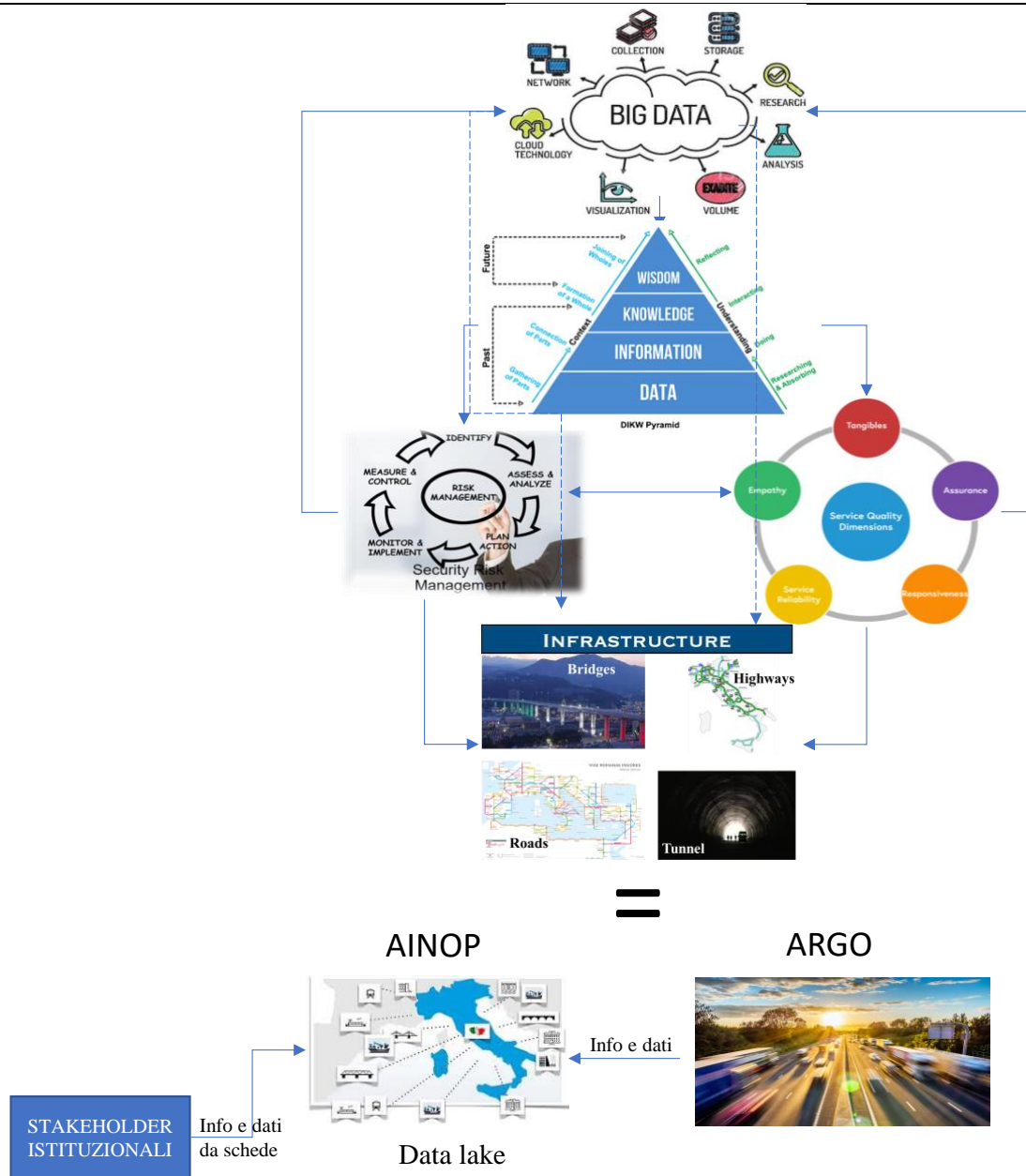
- Big data & Analytics;
- Knowledge Management;
- Risk Management;
- Service Quality.

The third chapter of the paper focused on the presentation of a multiple case study using a qualitative research strategy known as "case study research" (Yin, 1983).

Two, in particular, were the projects under study: AINOP and ARGO, both relating to the area of security in the infrastructure sector. In this regard, it is preliminarily highlighted that the interrelation that emerges between the two aforementioned cases is of significant importance.

From the construction of the theoretical background, a theoretical framework emerged (shown in the figure below) in which the relationships between the various theoretical fields were explained to measure the degree of compatibility and applicability in the projects covered by the multiple case study.

Fig. 1 – *Theoretical framework* e interrelazioni con i casi AINOP e ARGO



The theoretical framework developed in this work is unique and represents an important outcome (albeit with limitations) that can help to understand existing phenomena, and to set up future projects with a view to preventing and mitigating risks and improving the quality of related services. to the Italian infrastructural heritage.

The implications of this thesis work are both theoretical and practical. The framework allows a reading of the phenomena detectable in the context of infrastructures, also providing a greater understanding of the relationships between technologies and knowledge from which to derive advantages impacting on safety and, therefore (directly or indirectly) on the quality of the services offered. In addition, the theoretical implications of the big data issue represent an interesting prospect of expansion of this thesis work considering that:

- technology is constantly evolving, therefore the quality and speed with which massive data can be collected constitutes an acceleration of the processes; “wisdom” (as indicated in the model linked to knowledge management) is a stage which, therefore, can be matured in less time and with higher levels of security;
- the greater quantity and quality of data speeds up the decision-making process, also improving the safety and quality of the services offered in the infrastructure sector;
- the implications of technological innovation in the fields of knowledge management and of risk management and service quality also impact on decision-making processes that ensure policies more in line with environmental, economic and social sustainability.