Summary

This Doctoral Thesis sums up the carrying out of the research work and the results obtained from the safety analysis starting from the concept of 'Safety Management System' applied to Remotely Piloted Aircraft Systems (RPAS). With reference to the incoming integration of RPAS into not segregated airspaces, the future real case of specific category flight operations within the U-Space has been more precisely considered and studied.

The basic idea for the research derived from the guidelines issued by ICAO in the Annex 19 (2013) stating that every aeronautical operator shall implement a 'Safety Management System' within its own organization to be authorized to fly into the civil airspace: this indication applies to incoming RPAS operators too (ICAO Document 10019).

The Remotely Piloted Aircraft Systems are a subset of unmanned aerial systems composed of the unmanned aerial segment (the aircraft), the ground segment (a station or a remote portable radio controller) and the command and control radio link (C2) used by the human pilot to control and manage the aerial platform from ground.

The aviation authorities and, in general, the aviation community, guessing the potential high economic value of RPAS flight operations recognized that it could be adequately exploited only allowing their full integration into the civil airspaces.

Starting from these premises, a comprehensive safety analysis has been performed identifying and assessing safety hazards and possible mitigation provisions and thus implementing two risk matrices: the first one has been draft reasoning on the safety hazards related to the full integration of RPAS into uncontrolled airspaces (U-Space served); the second one has been draft reasoning on the safety hazards related to the full integration of RPAS into controlled airspaces (ATM served).

In accordance with the definition of Safety Management System (the continuous activity of identifying, assessing and mitigating risks to maintain their effects at or below an acceptable level), the content of the U-Space risk matrix has been used to layout a more advanced risk mitigation provision modelled as a rule-based 'Expert System'. The model has been focused on the implementation of the basic stage of an 'Expert System', that is its knowledge basis built as a collection of rules. The rules have been designed to be activated or not by specific precursors of previously analysed hazards and to alert the remote pilot on incoming risks in real time. In addition, they have been thought to provide him/her or the RPA flight control system (in case of fully automated RPAS flight operations) with real time decisional support about the most proper mitigation action to apply against the hazard occurring during a specific category flight mission in the not segregated airspace below 500 feet.

The above mentioned steps of the research have been used to define a proposal for a comprehensive RPAS functional architecture oriented towards mitigation of flight risks in the U-Space and to critically review the current technical solutions proposed to operatively deploy the incoming U-Space service.

The research on safety analysis on RPAS has been completed with an example of application of the STPA ('System-Theoretic Process Analysis') hazards analysis technique to show more recent methodologies beside the traditional and consolidated ones used in this research.

Finally, the impacts of the performed safety analysis on Italian RPAS regulation have been evaluated through a critical review of its state of art performed in the light of the results got from the safety analysis object of the research.

Beside the above described main topic of this work, considerations on safety and operative requirements for hybrid RPAS fed by hydrogen fuel cells have been carried out due to the necessity of enhancing remotely piloted aircraft systems endurance and range to really allow their full integration into civil non segregated airspaces.

The following points are hereinafter definitely highlighted as original added values of this work: starting from a regulation gap and, at the moment of performance of the present study, poor literature availability about, the performed study is an example of a safety analysis starting from a real case study and capable to fit with multiple RPAS in the U-space.