## Summary

The dissertation develops and validates a stage-based methodology of assessing and reducing the risk of development of tooling in automotive industry. The method answers gaps identified in literature and practice: the lack of unified definitions and a standardized, APQP/PDCA-aligned tooling-development model; the absence of tooling-specific metrics; and the limited operationality of generic risk tools such as FMEA in innovative, multi-dependency projects.

The contribution of the dissertation is the following.

First, the thesis introduces author's definitions of production tooling and the tooling-development process and proposes an integrated, stage-based model synchronized with product development (APQP/PDCA), distinguishing core tooling stages and supporting activities. Second, it establishes a measurement basis: experts selected 42 and then 8 critical metrics, with AHP-based weights confirming the dominance of Tooling Cost (TC), Tooling Lead Time (TLT) and Tooling Quality (TQ). Third, it presents a hybrid methodology of assessing and reducing the risk of development of tooling in automotive industry that structurally decomposes risk into Risk Categories (RC) and Risk Limitations (RL: cost, timing, quality), separates Input Risk ($R_I$) from Stage Risk ($R_{STG}$), and converts unified linguistic expert judgements into numbers via fuzzy logic, yielding a bounded Total Stage Risk ($R_{TSTG}$) with fixed L/M/H thresholds for gate decisions and clear ownership of mitigation. Fourth, it delivers operational artefacts (workflow, AQ templates, RC/RL matrices, thresholds, decision logic) enabling repeatable deployment.

The methodology of assessing and reducing the risk of development of tooling in automotive industry is demonstrated on a simple hand-press example and validated industrially at Autoneum Poland Sp. z o.o. on a representative project (Proj_1). Results show that Total Stage Risk ($R_{TSTG}$) supports comparable, decision-ready stage-level risk assessment; RC/RL distributions increase interpretability and guide proportionate actions; and the fixed thresholds enable transparent APQP gate decisions (go/hold/stop). The thesis discusses limitations (e.g., choice of multiplicative aggregation, expert-based threshold calibration) and outlines directions for future work (empirical threshold calibration, sensitivity analyses of membership functions, and IT integration with PLM/ERP). Overall, the approach provides a missing bridge between risk analysis and gate decisions in tooling development, improving prioritisation and aligning decisions with TC/TLT/TQ constraints.