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Hypothesis-driven Risk Management: An Approach to Enhancing Efficiency in University Research Projects

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Abstract

University research projects often address complex challenges that require systematic methodologies for efficient and transparent problem-solving. This paper proposes a combined bottom-up and top-down approach to reduce technical complexity, improve traceability, and integrate risk management into research planning. Firstly, the paper explores how complex research questions can be broken down efficiently and adapted to university research projects' settings. This leads to hypothesis-driven risk management, which reduces planning efforts and enables a review of objectives. Secondly, an adapted work package structure is developed, incorporating special features such as hypothesis, risk management, rejection, and acceptance criteria to enhance researcher involvement. Thirdly, to validate the approach, a single case study of the 3D simulation of an innovative combustion model, focusing on the challenges of emission reduction, improving the efficiency and the use of alternative fuels, to design the mobility of future sustainable, is conducted. Initial results are demonstrated by a digital risk twin. The developed procedure improves efficient risk management methodology and its integral implementation into the overall research objective. This avoids undesirable developments and enhances the quality of the research results.

Keywords
Hypothesis, work package, research question, risk management, university research projects

1. Introduction
Globalization and the resulting growing complexity of the environment can be seen as a particular risk factor at this time. This is emphasized through the increasing technological progress and worldwide networking (Schwandt 2016). This in turn, demands a different approach to the management of projects. According to the triangle of project management, it is important to adhere to budget and time to improve project success and ensure the achievement of objectives in the desired quality (Atkinson 1999, Moore and Shangraw 2011).

1.1 Problem statement
In university research projects, an adaptation to the techniques of project management, which are tailored to the university settings and the risk factors, is also important. Moore and Shangraw (2011, p.75) state that "developing project management methods that are tailored to a university setting and to risk factors specific to large-scale research projects is necessary for moving universities toward even greater success in completing research projects on time and on budget". Handling risks and uncertainty is important for university research projects. Without adapted risk management, the organization's ability to achieve objectives can be influenced negatively (Rabihah and Zurina 2017). This can harm universities' reputations or further funding. Still, in university research projects, a duality exists between taking risks and mitigating risks. On the one hand, risks must be taken to drive innovations; on the other hand, goals must still be achievable (Ernø-Kjølhede 2000). Moreover, the project manager in universities faces a duality between stemming complexity from research work and dealing with the uncertainties of research results (Ernø-Kjølhede 2000).

1.2 Objectives
Reasoning in the explored research question: How can the complexity of university research projects, according to the university settings, be controlled more efficiently by adapted risk management? This leads to the main goal of including hypothesis-driven risk management into the management strategy. The results are that including risk management in work packages (WP) enhances the awareness of risks, communication of risks, and the identification process, which leads to better control of risks and helps mitigate risks more efficiently. The following procedure investigates the research question and the belonging results.

First, the paper explores the relationship between complexity and research projects. Secondly, a conceptual method is developed to break down the hypothesis, including risk management, based on the research questions, into interim goals to improve the project control and ensure that it is on time and within budget. Thirdly, an exemplary project shows the adapted procedure. This aims to integrate the hypothesis and special features of university settings into the WPs to improve the involvement of the researcher and the management strategy in the research process.

2. Theoretical Background
This section focuses on two core areas: (1) uncertainty and risk management, and (2) the need for adaptation to university settings. It reviews common risk management knowledge, complexity, and special features that apply to university research projects.

2.1 Risk Management
Risk management is not a new discipline. It has existed for more than a thousand years (Bernstein 1996, Covello and Mumpower 1985). However, risk assessment and management based on a scientific approach is not older than 30 to 40 years based on the publications (Aven 2016). Common risk management involves planning, project definition, risk identification, analysis, response planning, monitoring, communication, and control throughout the project's life cycle (Deutsches Institut für Normung 2002, Project Management Institute 2021). Risks can be differentiated into threats (unlike events) and opportunities (desired events). Still today, often qualitative methods are being used to estimate the risks with descriptive words in terms of their likelihood and impact (van Droogenbroeck et al. 2022). Numerical methods are rarely used, but they can generate probabilistic or deterministic results. Probabilistic results support the idea of including uncertainty and risk estimates with ranges.

Many papers on handling risks are explored in construction projects and the financial sector. Mostly these sectors are chosen because of the high risks, uncertainty, and the resulting loss. University research projects do not have to increase sales, but they still want to achieve innovations, adhere to their budget, and be on time. Therefore, risk management in university settings is rarely investigated. Some related papers show the necessary to improve the risk management process for universities:

- An analysis of higher education in Tanzania focused on information security risk management practices, which led to the conclusion that higher education institution needs a standardized risk management approach to ensure data protection (Said Kombo et al. 2023).
- A conducted literature review on the topic of risk management in public universities investigated operational and strategic risks. This results in those operational risks (e.g. technological development, the satisfaction of students/stakeholders, financial, human...) having the highest impact on the achievement of the goals. Concluding operational risk management is important for university research projects. Moreover, a risk culture, a risk management policy, and a risk manager have an impact on the effectiveness of implementation (Gazoulit and Oubal 2023).
- A conducted study showed a procedure to include hypotheses in risk management to involve stakeholders and researchers better in the work process. Therefore, the lean-start-up principle and the Plan-Do-Check-Act cycle were combined. It resulted in a procedure, to optimize university research projects by including a probabilistic holistic project plan in the management strategy (Gross et al. 2024a).

Handling the complexity of universities is important to ensure the success of the project. The classification of complexity contributes to the strategic approach and is therefore considered in more detail in the next section.

2.2 Complexity in University Settings

The complexity of a university research project must be classified. Complexity can be dissembled into objects (number of parts, number of relations) and people (interests, capabilities, notions) (Flood 1990). A large-scale university research project normally involves the development of different parts, which can be eventually integrated into another system. This means many highly skilled people shall work together to achieve the overall goal and to drive the innovational potential. Many teams in university settings are foremost interdisciplinary with different cultural backgrounds. This can lead to challenges because of different approaches to the topic and communication problems. However, through the interdisciplinary approach, creativity can be enhanced by different research perspectives.

Every researcher has his subject of interest. They formulate hypotheses for their investigation. The scientific personnel then check the resulting hypothesis. Even if the hypothesis is rejected it leads to new knowledge. The hypothesis has inherent technical complexity, which can lead to unforeseen results. These uncertainty and unforeseen events increase the impact on the project. This in turn makes it more important to handle the project's complexity and ensure the project's success (Mihić et al. 2018). Moreover, just focusing on their single subject of interest, missing the targets that were promised to the funding organization, can occur. This can lead to conflicts of interest between the management and the researchers. Because of the described reasons above university research projects can be described as moderately complex to highly complex due to (1) knowledge (2) novelty, (3) highly skilled personnel, and (4) uncertainty (Haider and Haider 2012).

2.3 Development Potential

Based on these findings it shows that a standardized risk management approach is necessary to ensure the achievement of the objectives in university research projects. As mentioned, operational risk management is important to goal achievement. By including a probabilistic approach risks and uncertainties can be controlled more efficiently. The integration of stakeholders and researchers shall be improved in this paper to ensure a risk culture and improve the management procedure. By including hypothesis-driven risks technological risk management, which belongs to operational risk management, can be improved. Therefore, research questions and WPs will be used to handle the work process.

All investigated literature shows the need to develop risk management further. Therefore, a strategy will be developed that improves a shared understanding of the overall goals and reduces conflicts of interest, besides improving risk management in university settings.

3. Methodology

There are existing different methods for reducing the complexity of projects. Most methods follow these goals: (1) shorten the development cycle (2) enhance the likelihood of a successful launch (Clift and Vandenbosch 1999). In general, two procedures can be used: the top-down or the bottom-up approach in project management. The top-down method follows the approach of deduction, which means going from general to concrete. Clear hierarchies and structures exist. Bottom-up follows the inductive approach, where suggestions from lower levels can be included as well. It means this approach has a high level of employee participation and innovative solutions can be developed through input from team members. For example, the spiral model, agile approaches, and incremental delivery can be used to reduce complexity. Moreover, prototyping and extreme Project management can be used for highly complex projects (Haider and Haider 2012). This means methods for iterative and/or adaptive approaches shall be chosen due to the classified complexity (Haider and Haider 2012). Combining top-down and bottom-up methods reduces complexity and enhances feedback through short-term reviews.

3.1 Structure of the Project

The focus on the overall goals must be taken into consideration when constructing the hypothesis. Therefore, in cooperation between the application's goals and the management's goals, the vision and overall goals are stated. This ensures the engagement of both kinds of goals and reduces conflicts of interest. Based on the goals and objectives the problem and the overarching research question for the university research project are defined by the management. More than one overarching research question can be defined based on the explored issues.

Then the researchers are at the center of the work. The researchers formulate their research question according to the overarching goal setting. Based on these scientific questions WPs will be established. Every WP belongs to one hypothesis, that the researchers will investigate during the project. More research questions and hypotheses based on the overall problem definition can be included for every individual researcher. The WP includes various variables, which will be detailed in section 3.2 work package. By including a risk management procedure to the hypothesis, risks can be identified at an early stage and mitigation strategies can be conducted. The risks can be incorporated into the project plan and checked for conformity with the defined overall goals and objectives.

The procedure focuses on the involvement of research personnel to optimize goal achievement, adhere to budget, and be on time through the combination of bottom-up and top-down methodology. The developed approach can be seen in Figure 1.

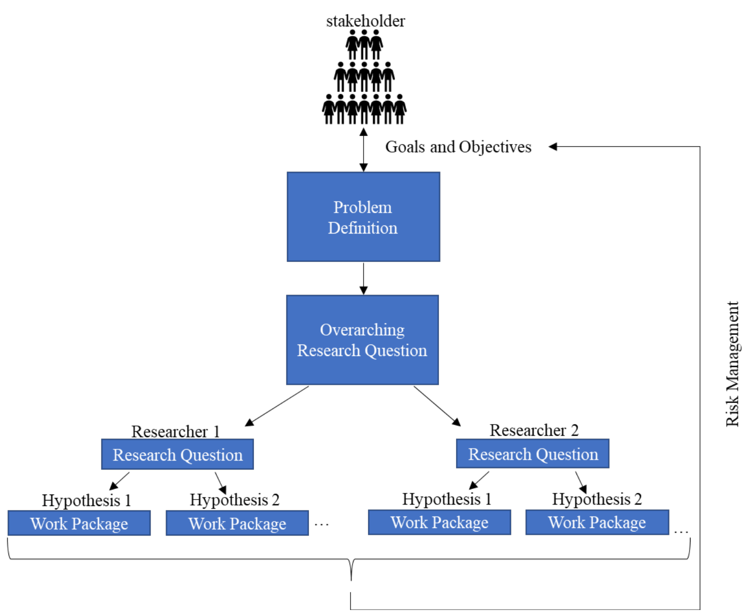

Figure 1. Schematic representation of the integration between top-down and bottom-up methodologies

3.2 Work Package

A WP is used to divide desired objectives into smaller tasks (Deckro et al. 1992). It serves as the lowest level of WBS where cost and duration can be estimated and managed (Globerson et al. 2016). There are existing different approaches to WPs. On the one hand, Li and Hall (2019) state that small defined WPs will increase the complexity and workload, which can reduce the economies of scale. On the other hand, large WPs reduce concurrent processing. Bezkorovainyi and Bezuhla (2023) state that uncertainty has a strong influence on the process parameters. This emphasizes the need for a probabilistic approach to include risks and uncertainty. Therefore, a three-point estimate is included in the WPs. There are existing different stopping criteria for further decomposition, such as organization unit, cost estimation, schedule estimation, deliverable basis, Scope of work, and risk management (Globerson et al. 2016). This paper measures the stopping criteria for university research projects based on the planned schedule and budget constraints. Therefore, the following procedure, taking the constraints of university settings into account, is developed:

For the WPs, the WBS code gets included. The responsible person as well as the start event and WP name are defined. For generating the hypothesis, the research question of the overall goal setting gets decomposed. The resulting problem definition for the conducted research is stated and the hypothesis is defined. The hypothesis shall be formulated clearly, testable, and relevant. Commonly used methods are: "If-then" or "the more" statements. The criteria for acceptance and rejection are formulated. Afterward, the goals are set up. For approving the goals and objectives criteria these are defined according to the SMART-CR method, which was introduced for university project purposes (Gross et al. 2024b).

To enrich the WP the duration is displayed with a three-point-estimation. This includes inherent uncertainties, which support estimation with ranges (van Droogenbroeck et al. 2022). Limitations and interfaces are stated to depict the dependencies. The last step includes hypothesis-related risk management with a three-point estimation. This means threats and opportunities according to the acceptance and rejection criteria are defined. The impact is shown in the probability of occurrence and impacts on cost and time. By including the three-point estimate the accuracy is improved, because three values display the reality better than one single deterministic value. The risks, which impact the time or budget are included in a digital twin, which is based on a stochastic scenario analysis.

3. 3 Project Plan
The project plan is drawn up. For inputting the project plan the research questions and the identified durations including uncertainties of the WPs are incorporated. Dependencies are linked and milestones of the WP are incorporated. A dynamic risk register is set up. The relevant risks can be linked to the probabilistic project plan. A Monte Carlo simulation is used to calculate the scenarios. For the output, the risks for the schedule (target date vs. competition date) and the budget (planned budget vs. actual costs) will be checked. Dashboards indicate if the goals are still achievable or need to be adjusted.

4. Development of hypothesis-related Risk Management
4.1 Subject of Investigation
The developed method will be shown on an example project at the University of the Bundeswehr Munich. A single case study on one research personnel and the corresponding research field will be shown in this chapter.

The research project under investigation deals with the development of a serial hybrid vehicle from the concept phase to the finished prototype. The integrated combustion engine plays a key role in the concept. The engine is not used for directly powering the vehicle but works as a generator to charge the vehicle's traction battery. This offers several advantages. For example, the engine only has to run in a limited number of quasi-stationary operating points, which can lead to an increase in efficiency and a reduction in emissions from the combustion engine. This means that the engine is operated at three fixed operating points, which are then selected to represent different vehicle scenarios (Trapp and Böhme 2022).

Goals	Description
Problem Definition	Combustion engines still power many vehicles in Germany. Due to climate change, it is becoming increasingly important to reduce both CO_2 and NO_x emissions.
overarching research question	How can an internal combustion engine with reduced CO_2 emissions be developed and at the same time the efficiency of the engine be increased?

Figure 2. Determining the research question based on the defined problem.

By operating the combustion engine at just a few operating points, it is possible to optimize these points in terms of power output and emissions. In the end, an engine is being developed for exclusive use in a serial hybrid vehicle. A main component is the use of an innovative combustion concept, the homogeneous reactivity-controlled compression ignition (hRCCI) with the fuel's ethanol and octanol. The combustion process is intended to ensure high efficiency with low pollutant emissions, as described in detail in Grundl et. al. (Grundl et al. 2023). In this combustion concept, a homogeneous fuel-air mixture is self-ignited by compression and the ignition timing can be controlled by the differences in reactivity of the two fuels. Figure 2 shows the problem description of the overall project and the resulting scientific questions. The research questions and WPs for the various project members are derived from this, as shown schematically in Figure 1. This is shown here specifically for the area of computational fluid dynamics (CFD) simulation of the described combustion concept. The specific research question and goal for the model development are shown in Figure 3.

Researcher 1	Description
General research question	How can a precise and robust 3D CFD model be developed that accurately represents the complex physical and chemical processes of hRCCI combustion, taking into account alcohol-based fuels?
goal	Creating a precise, efficient and validated simulation model for hRCCI combustion

Figure 3. Breakdown of research goals and questions into a subproject research question.

In the development of the hRCCI concept, one of the major challenges is to understand the complex interaction between the flow in the cylinder, the injection of the fuels, and the chemical reaction kinetics. A detailed investigation of the processes is essential for successful development and later optimization. For this purpose, three-dimensional (3D) CFD simulation is used as a tool for the precise modeling and analysis of thermodynamic and fluid mechanical phenomena in the combustion chamber. The model can be used to investigate the dependencies of the different processes.

The model development of the 3D CFD model for the combustion chamber and the intake and exhaust ports of the engine requires the consideration of the turbulence of the incoming air, the injection processes of ethanol and octanol, the vaporization of the injected fuels, the mixture formation of fuel and air and the reaction chemistry. Modeling the physical and chemical processes and their interactions makes high demands on the models used in terms of accuracy and numerical robustness. The impact of model complexity on computing time must also be included. Models with high accuracy often have the disadvantage that they cause long computing times and are therefore unsuitable for the development of the whole combustion process. The selection of suitable models, considering the effort involved, is an important part of the development process.

Turbulence modeling: In combustion processes, the turbulence of the flow plays a significant role in mixture formation and wall heat transfer. Various models are used in the field to calculate turbulent flows in CFD simulations. They vary in terms of their complexity, which influences the calculation time. Examples are Reynolds-averaged Navier Stokes (RANS), Large Eddy Simulation (LES), and Partially Averaged Navier-Stokes (PANS). The models are classified in terms of their accuracy and computational effort. RANS methodology is a simple and widely used methodology in the industry, which requires less computing time compared to the other models. It provides a good prediction of time-averaged turbulence for many applications. In comparison, the LES simulation, which is currently mainly used in the research field for engine applications (Merker and Teichmann 2019). The large turbulent scales are resolved directly and enable a more accurate prediction of the turbulent structures. In between, PANS is arranged as a compromise between RANS and LES. It enables a dynamic adjustment of the turbulence resolution depending on the flow conditions (Girimaji and Abdol-Hamid 2005). This allows a better resolution in the relevant areas but reduces the overall computational effort compared to an LES application.

Spray modeling: The injection model used is important to be able to accurately predict the mixture of fuel and air. The model includes important issues such as the droplet size distribution, the break-up, the interaction between the airflow and the fuel droplets, the interaction of the droplets with each other, the interaction with the walls of the combustion chamber such as the valves and the piston and the evaporation of the droplets (Stiesch 2003).

Combustion modeling: The combustion process in the hRCCI process is overly complex because the interaction between the two fuels ethanol and octanol must be considered. It must also be possible to accurately predict the auto-ignition chemistry with different mixing levels of the two fuels ethanol and octanol and different mixture reactivity (premixing ratio).

This brief overview of the most important aspects of model development is intended to illustrate the complexity of the sub-project, 3D CFD simulation for the hRCCI process. During model development, it is always crucial to consider the computational effort in terms of model accuracy. This procedure is necessary to be able to evaluate the quality of the simulation results obtained and to ensure a fast development process. The problem is illustrated once again using the example of turbulence modeling. As already described, RANS achieve good results in a wide range of applications with low computational effort, whereas LES and PANS generate results with higher accuracy at higher computational effort. For the model of the hRCCI process, this means that it must be investigated which approach offers the best trade-off between accuracy and computational effort for the specific application. Similar investigations must also be carried out in the area of spray modeling and combustion modeling and the decision for a model configuration must be made on this basis. The overarching project objective and goal setting are always considered in the decision-making process.

Model development requires a structured risk management approach that can capture the complexity of the physical processes with sufficient accuracy. Both top-down and bottom-up approaches are used for risk identification. The approaches ensure solid hypothesis generation by enabling model refinement and informed decision-making throughout the development process.

In the top-down approach, the entire hRCCI combustion process is broken down into smaller sub-problems. This reduces the complexity of the problem, and the physical and chemical processes can be analyzed. This means the overall simulation is divided into the previously described areas of turbulence modeling, spray modeling, and combustion modeling. The top-down approach enables the development of a structured understanding of the interaction of the various physical phenomena in the combustion chamber. Figure 4 shows the further decomposition of the sub-project for the development of a precise and robust 3D CFD model for hRCCI combustion. Concerning Figure 1, the lower left part of the diagram from Researcher 1 onwards is shown here with the formulation of the specific research question and derivation of the various hypotheses. The subdivision into turbulence modeling implemented in a simplified channel model, spray modeling implemented in a simplified spray chamber model, and combustion modeling implemented in a simplified homogeneous reactor model can also be found here. The hypotheses to be investigated and their associated WPs are also described.

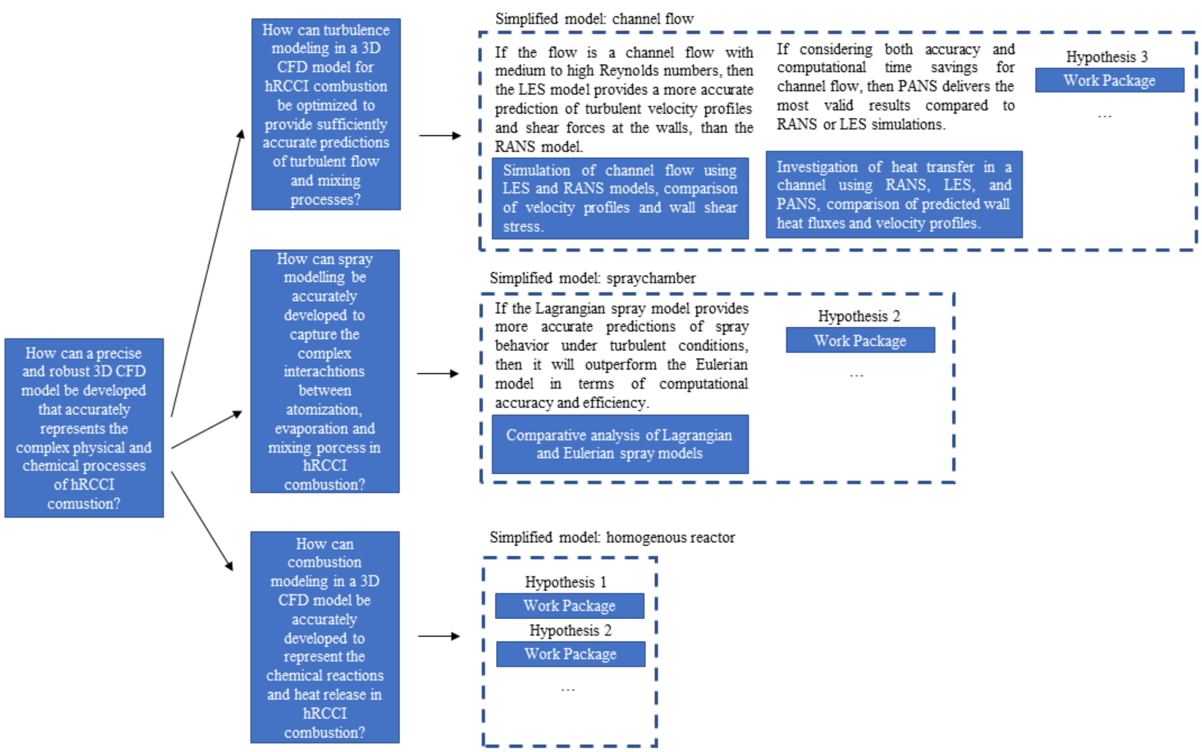

Figure 4. Visualization of the research framework for developing a precise and robust 3D-CFD model for hRCCI combustion.

5. Results and Discussion

To describe the developed procedure in more detail, it is explained using the specific example of spray modeling. Figures 4 and 5 show the simplification of the entire combustion chamber model to the three different simplified models. Hypotheses are made on how the spray modeling strategy influences the model accuracy or how the octanol spray influences the overall combustion behavior. In particular, the influence of the air-fuel mixture and the ignition delay are of crucial importance. The WPs for investigating the injection parameters are also defined for the simplified model. This offers the advantage that the flow effects in the engine caused by valve and piston movements can be ignored. Although these have a major influence on injection in the overall system, they would only unnecessarily complicate the creation and validation of a spray model. Important parameters such as spray depth, spray width, and cone angle can be better investigated without external disturbances and simplify the selection of suitable models and the adaptation of the model parameters.

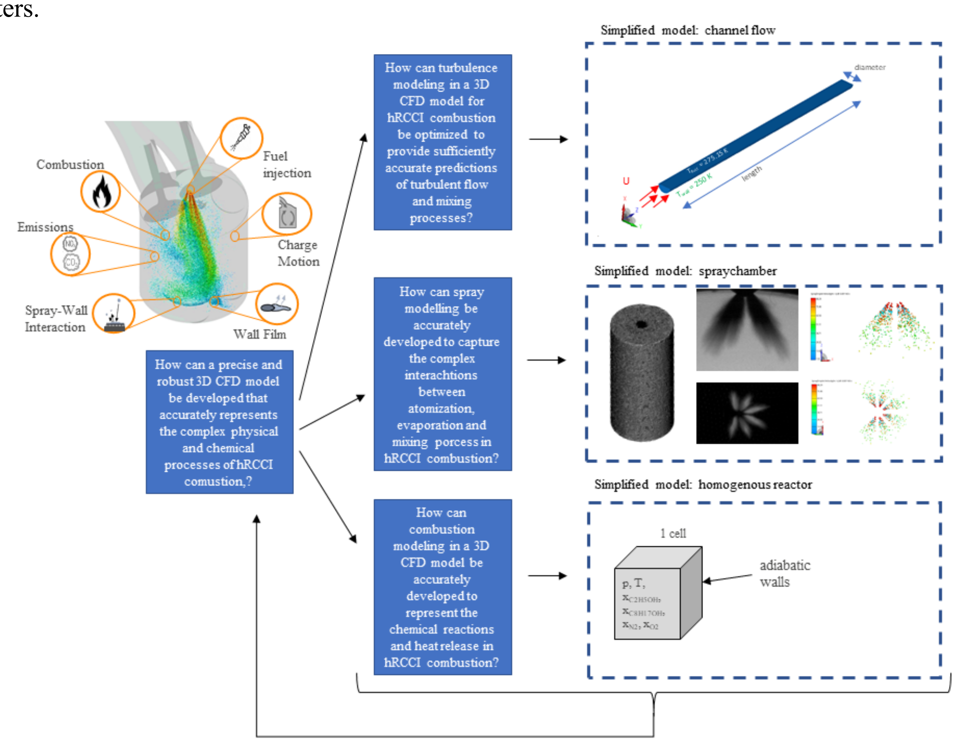

Figure 5. Method for breaking down the hRCCI process in less complex channel flow, spray chamber, and homogenous reactor model and reintegration in the cylinder model.

The top-down method focuses on the approximation of the entire system, setting hypotheses and models from the top down. Meanwhile, the bottom-up method provides detailed analyses of the individual physical phenomena, which are for example crucial for spray modeling. In the bottom-up approach, the breakup and evaporation of the octanol spray are investigated in detail to better understand its impact on injection parameters. The detailed data and insights obtained here are then used to verify and refine the hypotheses established in the top-down approach.

For example, in the top-down approach, the hypothesis can be made that the injection pressure of the octanol direct injection has a specific influence on the droplet velocity and the evaporation behavior, which leads to a different mixture formation of fuel and air. This assumption is checked in the bottom-up procedure using validated detailed spray models and the findings from this partial model are transferred to the overall simulation to improve accuracy. This combined approach iteratively improves the model, with the top-down methodology providing a clear structure and the bottom-up approach ensuring precision and validity for each model component (see Figure 5).

The integration of top-down and bottom-up methods offers considerable advantages in risk management. In the top-down approach, the entire combustion process is broken down into manageable sub-problems - turbulence, spray, and combustion - to reduce the complexity of the overall simulation. This structured approach enables the early identification pf potential risks, such as incorrect assumptions about injection or combustion behavior.

The bottom-up method completes this with detailed analyses of specific phenomena. The iterative interaction of the two methods ensures that the rough assumptions of the top-down approach can be properly validated and improved. For example, hypotheses about the effects of injection pressure on evaporation can be continuously tested, adjusted, and validated through a bottom-up analysis. This enables the partial model to be improved and transferred to the overall model. This prevents the entire combustion chamber model from being overly complex from the outset.

In addition, the combined method enables to determine the optimum balance between model accuracy and computational efficiency. The simplified top-down models can be used initially to identify dependencies and risks, while detailed bottom-up validation is performed in critical areas to ensure that computational resources are used effectively without compromising accuracy.

By continuously refining the models through this integrated approach, the risk of using incorrect or oversimplified assumptions is minimized, resulting in a more accurate, reliable, and efficient engine model for the hRCCI process.

In addition, a revised WP structure adapted to university research projects has been developed. Figure 6 shows the structure of the WP, which contains the problem definition, the associated hypothesis, the acceptance and rejection criteria of the hypothesis, a formulation of the objective, and the duration of the WP. The limitations and interfaces to other work assignments are also specified. Opportunities and threats and their influence on costs and/or time are integrated into the WP to include risk management.

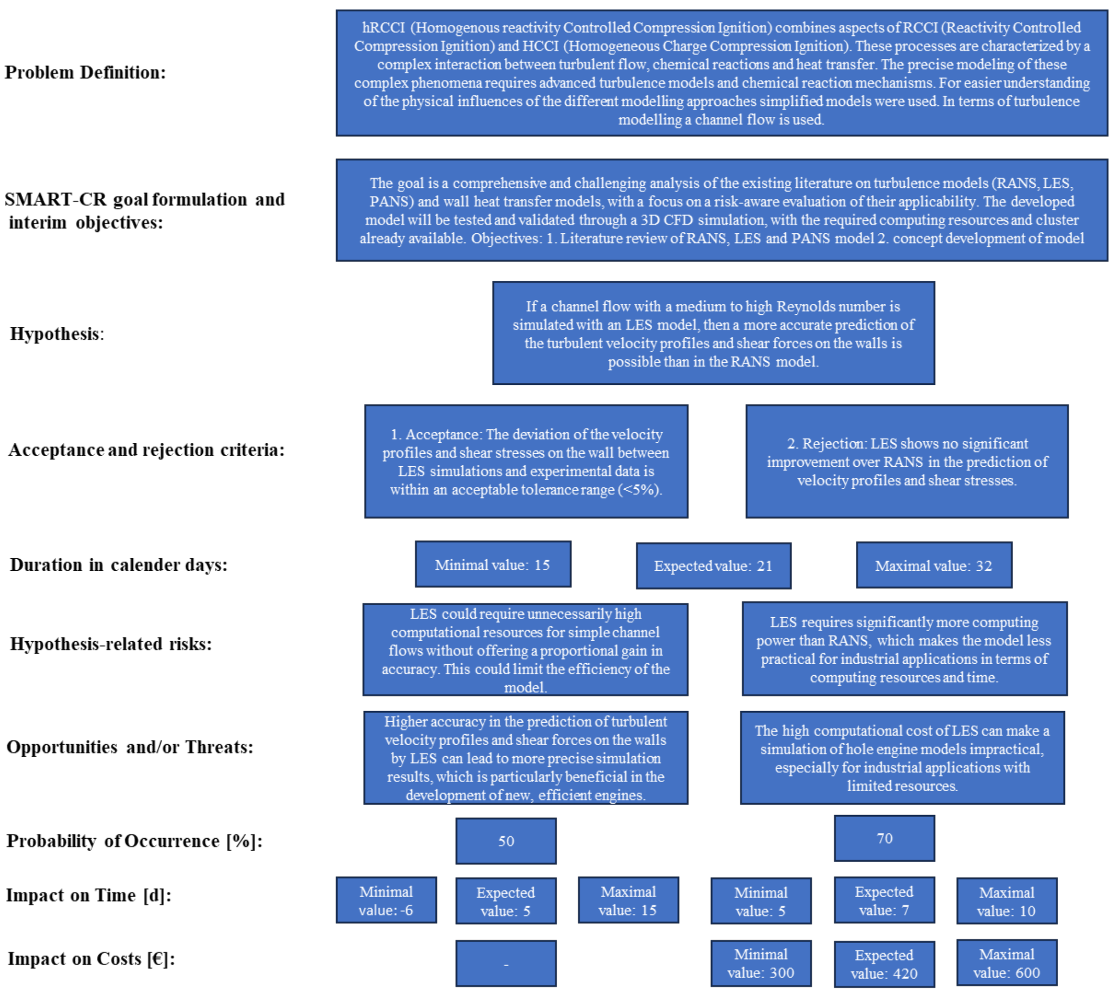

Figure 6. Excerpt WP - special features for university settings

6. Validation of the Results

6.1 Software

The used software to draw up the project plan is RIAAT (see section: 3.3 – project plan). The tool is used for these reasons: (1) free for researchers at the University of the Bundeswehr Munich (2) to create a digital risk twin by simulating different scenarios (3) already used for complex and specialized construction projects (4) multiple scenario testing (5) comprehensive risk assessment with qualitative and quantitative method (6) improves decision-making by analyzing the impact of various scenarios (RiskConsult GmbH 2024).

6.2 Results

A short title of the research question is included in the project plan. The different WPs are decomposed and linked to the research question. The identified risk register from hypothesis-related risks and other identified risks is included. Per drag and drop the risks can be linked to the project plan. Base durations, including uncertainties, are characterized in dark and light blue; however, the impact of risks is displayed in red. Milestones depict the goal of one research question. The first example of the probabilistic holistic project plan is depicted in Figure 7.

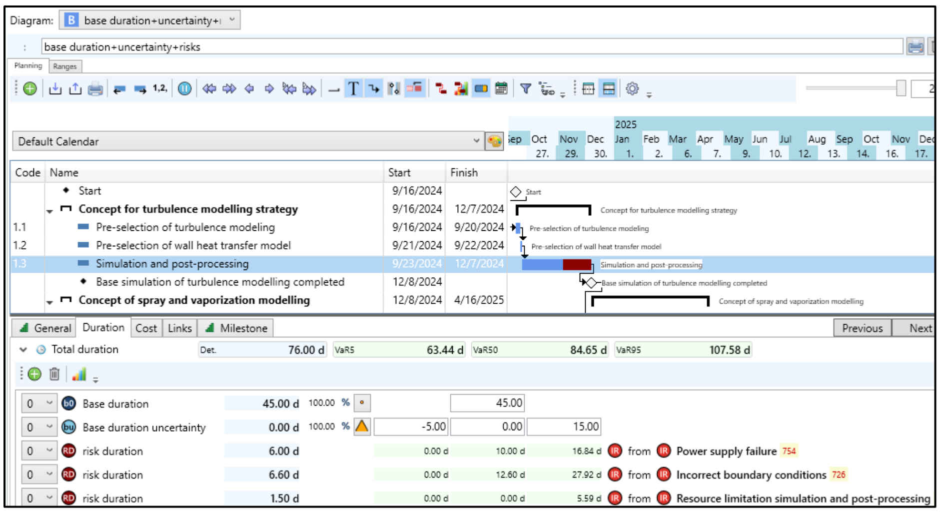

Figure 7. Probabilistic holistic project plan.

6.3 Validation

The first results of the investigated milestone (base simulation of turbulence modeling) displayed an improvement in adherence to time constraints. This means that including a three-point estimate of the base duration and the uncertainty improved the inherent uncertainty that university research projects face. By including the hypothesis-driven risks the identification process of unknown risks was improved. This in turn led to a better understanding of risks and an optimized procedure to be on time and on budget.

The top-down approach promoted the clearance in decomposing the research question made by the management into smaller WPs. This improved the control of the management and the tasks evaluation. Moreover, communication was strengthened. To avoid the rejection of researchers to the top-down strategy, the bottom-up strategy was included. This means the hypothesis was established by the researchers according to the research question. The formulation of acceptance and rejection criteria promoted the involvement of all parties of interest. Innovation thinking could be integrated through feedback loops. By checking the interim goals, the flexibility in handling the research and the management control to achieve the goals, under budget and time constraints, was improved. Moreover, this strategy led to a minimization of conflicts of interest between the management and researchers' goal setting.

7. Conclusion

The paper highlights the need to develop risk management methods that are tailored to the university settings. A duality between the management of projects and the reduction of inherent complexity is examined. The complexity of the behavior of objects and people is investigated. An example is used to illustrate how the decomposition of complex research questions can be implemented. By using the top-down and bottom-up approach, traceability and efficiency in project planning and implementation were improved. Hypothesis-related risks were already integrated in the project planning phase and processes for risk identification were applied. The procedure supports the achievement of management targets to stay on schedule and within a specific budget.

The single case study represents the application of the developed methodology to a specific research project for the development of a serial hybrid vehicle. Specifically, the development of a 3D CFD methodology for the simulation of the innovative hRCCI combustion process is considered. The integration of risk management strategies is illustrated using this complex example. The complexity of the problem is reduced to various sub-problems and risks are derived from the individual hypotheses. From this, a project plan can be derived that can consider the complexity of the problem and the risks with sufficient precision. This enables the goals for the individual scientist and the overarching project goals to be reliably achieved. The approach developed improves the quality of the research results and promotes a better understanding of the research objectives across the entire project team. This is crucial for management to understand the specific problems and the need for adaptation. In addition, the scientific personnel can gain an overview of the overarching research questions and support transparency in the project. The involvement of researchers promotes risk management and risk awareness within the team. By avoiding conflicts of interest, the project can be more successful. In the future, the validation of the developed approach will be extended from one milestone to the entire project to enrich the findings. This also includes visualizing how changes in the model complexity of the 3D CFD model, such as the switch from RANS to LES turbulence modeling, affect model accuracy and computational resources and how such changes can affect the overall project plan for the serial hybrid vehicle development.

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