SLOVENSKÁ TECHNICKÁ UNIVERZITA V BRATISLAVE
FAKULTA INFORMATIKY A INFORMAČNÝCH TECHNOLÓGIÍ

Pavle Dakić

Auto referát dizertačnej práce

Vývoj softvéru v súlade s predpismi v oblasti autonómnych vozidiel

na získanie akademického titulu *Philosophiae Doctor (PhD.)*

Študijný program:	Aplikovaná informatika
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Dissertation Thesis Abstract

Compliant Software Development in the Field of Autonomous Vehicles

to obtain the Academic Title of *Philosophiae Doctor (PhD.)*

Degree course:	Applied Informatics
Field of study:	9.2.9 Aplikovaná informatika
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Institute of Informatics, Information Systems and Software Engineering,
Faculty of Informatics and Information Technologies,
Slovak University of Technology in Bratislava.

Autor/Submitter: Mgr. Pavle Dakić
Institute of Informatics, Information Systems and Software Engineering
Faculty of Informatics and Information Technologies
Slovak University of Technology in Bratislava

Školiteľ/Supervisor: prof. Ing. Valentino Vranić, PhD.
Institute of Informatics, Information Systems and Software Engineering
Faculty of Informatics and Information Technologies
Slovak University of Technology in Bratislava

Oponenti/Reviewers: prof. Savo Tomović, Ph.D.
Univerzita Čiernej Hory (Podgorica, Čierna Hora)

Asst. Prof. Miroslav Bureš, Ph.D.
Czech Technical University in Prague (Prague, Czech Republic)

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Dekan/Dean FIIT STU Bratislava

Abstrakt

Dodržiavanie noriem, vlastníctvo prijateľnej stratégie testovania softvéru, fyzické/virtuálne testovanie a opakovane použiteľné testovacie prípady na vytvorenie bezpečného a spoľahlivého softvéru v autonómnych vozidlách. Ak použijeme existujúce riešenia, môžeme zdediť technologický dlh a nevyriešené problémy. V dôsledku toho je potrebný rozsiahlejší výskum na pochopenie logistiky, noriem, rozmanitých požiadaviek a problémov pri vývoji vhodného vývojového prostredia v automobilovom priemysle. V ideálnom prípade, ak chceme byť úspešní pri bezproblémovej reprezentácii a opätovnom použití znalostí o softvéri, musíme najprv zabezpečiť súlad s existujúcimi normami a štandardmi, ktoré sa neustále vyvíjajú. Okrem toho sa zohľadňujú požiadavky používateľov, nedbanlivosť z hľadiska otázok bezpečnosti a zákony krajiny pre pravdepodobné použitie. V dôsledku toho by sa mohli identifikovať potrebné kroky v normalizačných procesoch nariadených svetovými vládami a normalizačnými agentúrami.

Koncept, že kódovanie pomocou CI/CD, inteligentné techniky zberu údajov a softvérová inteligencia by mohli urýchliť budúci vývoj, nám umožňuje písať funkcie pokročilejším spôsobom. Bolo by prospešné navrhovať softvér kombináciou viacerých procesov a prístupov k organizácii procesu výroby softvéru, čo by umožnilo vytvárať a získavať nové znalosti. Výsledkom by bolo, že by sa celosvetovo mohla používať jednotná výrobná technika v súlade s normami a špecifikáciami.

V tejto práci navrhujeme súbor prístupov riadených dodržiavaním noriem, ktoré sa majú riešiť v automobilových softvérových systémoch, ktoré možno spoločne integrovať zahrnutím týchto prístupov:

- Prístup k architektonickému kontextu je prezentovaný pomocou novej skratky GRCopOps v oblasti CI/CD a možných budúcich aplikácií. Cieľom tohto prístupu je predstaviť zrozumiteľnú formu, ktorú môžu využívať softvéroví architekti v rámci automobilového priemyslu aj mimo neho. Za väčšiny okolností sa proces budovania súladu môže opakovať pre každú fázu vývoja, pretože prístup zachováva jednotlivé procesy. Použitie tohto prístupu umožňuje priame dodržiavanie príslušných noriem a kritérií testovania v rôznych cloudových prostrediach.

- Nový logistický prístup pre trh dodávok pre automobilový priemysel (AutoSupMkt), ktorý rieši výzvy v automobilovom priemysle načrtnutím procesov súvisiacich s dodávkami hotových výrobkov na trh. Špecifikácia tohto procesu definuje potrebné kroky vo výrobnom procese a zabezpečenie potrebných komponentov, ktoré sa dostanú do samotného závodu.

- Prístup, ktorý integruje organizačný proces pre riadenie znalostí (OPKM) a vývoj softvéru načrtnutím spôsobu, akým možno tieto procesy zaviesť. Tento proces zaviedol nový organizačný model a prístup spojením manažérskeho procesu s životným cyklom riadenia znalostí. Táto metóda zahŕňa zreteľné míľniky realizácie, pri ktorých si každý môže vymieňať informácie a získavať nové znalosti na tejto ceste.

- Prístup na integráciu početných algoritmov počas realizácie postupu parkovania vo vozidle (INAP). Základné komponenty tohto prístupu zahŕňajú strojové učenie, kontinuitu edge-to-cloud, internet vecí a rôzne aplikácie parkovania na parkoviskách. Hlavným cieľom vývoja tejto tech-

niky je lepšie pochopiť vývoj softvéru, ktorý spracúva špecifické obrazové informácie a zároveň dodržiava zákonné obmedzenia.

Abstract

Adherence to standards, ownership of an acceptable software testing strategy, physical/virtual testing, and reusable test cases to produce secure and reliable software in autonomous vehicles. We may inherit technological debt and unresolved difficulties if we use existing solutions. As a result, more extensive research is required to understand the logistics, standards, diverse requirements, and problems of developing a proper development environment in the automobile industry. Ideally, to be successful in the smooth representation and reuse of software knowledge, we must first ensure conformity with existing norms and standards, which are continually being developed. In addition, user requirements, negligence in terms of safety issues, and country laws for probable use are taken into account. As a result, necessary steps could be identified in the standardization processes imposed by world governments and standards agencies.

The concept that coding with CI/CD, intelligent data collection techniques, and software intelligence could speed up future development allows us to write functionality in a more advanced manner. It would be beneficial to design software by combining several processes and approaches to organizing the software production process, allowing the creation and acquisition of new knowledge. As a result, a consistent production technique could be used worldwide in compliance with norms and specifications.

In this thesis, we suggest a set of approaches driven by standards compliance to be addressed in automotive software systems that can be jointly integrated by including the following approaches:

- An approach to the architectural context is presented using the new acronym GRCopOps within the CI/CD area and possible future applications. The goal of this approach is to present an understandable form that can be used by software architects within the automotive industry and beyond. In most circumstances, the process of building alignment can be repeated for each development phase because the approach preserves individual processes. The use of this approach allows for straightforward compliance with the appropriate standards and testing criteria in different cloud environments.
- A new logistic approach for the automotive supply market (AutoSupMkt) that addresses challenges in the automotive industry by sketching out the processes involved in the supply of finished products to the market. The specification of this process defines the necessary steps in the production process and the provision of the necessary components that arrive at the factory itself.
- An approach that integrates organizational processes for knowledge management (OPKM) and software development by outlining how these processes can be established. This process established a new organizational model and approach by combining the managerial process with the knowledge management life cycle. This method includes distinct milestones of realization at which everyone can exchange information and gain new knowledge along this path.
- An approach for integrating numerous algorithms during the implementation of the parking procedure within the car (INAP). This approach's foundational components include machine

learning, edge-to-cloud continuum, IoT, and a variety of parking applications in parking lots. The primary purpose of developing this technique is to better understand the development of software that processes specific video information while adhering to legal constraints.

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1 Introduction

We often find ourselves in a situation where we need to store something we have written on a piece of paper. Today, there is an application for almost everything, since we use a smartphone camera to read numbers and QR codes, recognize written text, store data for further use, etc. During vehicle use, users will, in most cases, ignore mistakes, because they consider them boring and insignificant. But one of the main reasons for this concern is the possibility of serious consequences for the financial outcome or a real threat to human life. The main reason for users to continue with further use during errors and problems is the current standards that enable this to safely reach the nearest service. Malicious software can be devastating, irritating, expensive [1, 2], destructive, and deadly in various environments [3] such as smart cars, boats, satellites, space rockets, etc. Debugging is twice as hard as writing code, perhaps even harder than programming from scratch. In its first build version, all the software has problems. The main goal is to reduce and minimize the number of faults that may result in one or no errors during software distribution in the future. Detecting bugs and including a summary of steps and detection methods is critical for the developer to fix code that violates the rules.

The production of secure and reliable software requires a review of the software testing [4] strategy and a higher way of writing reusable test cases using the software knowledge of the already solved problems. Exploring the probabilities of writing software using intelligent data collection techniques with software intelligence could accelerate future software development. This combined method would reduce the number of required tests. Because having bugs that developers are trying to fix is time-consuming and extends the time until the next release. It would be useful to design software while mixing different test methodologies based on previously created tests with software reuse [5] and standards to see the impact on future development [6].

Although technologies offer many advantages, we can still decide whether or not to improve something. In most cases, new solutions are not better and can cause new unforeseen problems. Therefore, it is necessary to conduct detailed research and collect the necessary data before implementing the innovation. Mostly due to the lack of global telecommunication infrastructure and the insufficient use of 5G/6G protocols within mobile computer networks. This thesis deals with software standardization and law challenges for creating the worldwide possibility of traveling using autonomous vehicles. Later considerations of the possibility of direct use within the DevOps environment by creating concept CI/CD pipelines for software testing were made.

1.1 Thesis Statement

Establishing novel requirements implies the presence of a specific set of equipment and vehicle interior features, such as radios, air conditioning, lighting, seat heating, software functions, and so on. As a result, these solutions must substantially address the ethical and societal concerns that confront us today. Research and development are constantly searching for new software models that can help with future development. This research covers complex real-world software engineering problems and challenges for self-driving automobiles. Considering the production of new functionalities and meeting the requirements for stability per the necessary standards in this field. To achieve this, it is necessary to follow the development trends of today. This means using continuous integration and testing software with all other interconnected forms and we can create unique goods by focusing on crucial areas including standards formulation, software engineering, logistics optimization, learning process organization, and knowledge management.

The fundamental objective of this thesis is to bring together: software engineering, adherence to required standards, logistics, knowledge management, and the learning process in education from domain knowledge for direct CI/CD application within the automobile industry using the approaches presented in this thesis. The thesis statement is as follows:

> The code undergoes several identification processes to ensure consistency and adherence to the required standards. Using elements or components of the system allows segmentation and enhancements customized to the specific needs of each market and the regulatory requirements that the program must meet.

The definition of standards in a certain market implies the recognition of instructions and possibilities of implementation within the code for which a certain result is expected. The logical usage model, which includes aspects such as artificial intelligence, geolocation, control instructions, color, and signaling, differs depending on the unique scenario and the defined components of the autonomous system, which the governing body regulates.

The definition of standardization can be found within one method or system component, which represents the construction of expected information. Meeting the standardization criteria assumes that the execution of the source code can react within the legal framework of the destination country and its desired uses.

1.2 Approaches Proposed in This Thesis

This main contributions of this thesis are:

1. An approach to the architectural context is presented using the new acronym GRCopOps within the CI/CD area and possible future applications. The goal of this approach is to present an understandable form that can be used by software architects within the automotive industry

and beyond. In most circumstances, the process of building alignment can be repeated for each development phase because the approach preserves individual processes. The use of this approach allows for straightforward compliance with the appropriate standards and testing criteria in different cloud environments.

2. A new logistic approach for the automotive supply market (AutoSupMkt) that addresses challenges in the automotive industry by sketching out the processes involved in the supply of finished products to the market. The specification of this process defines the necessary steps in the production process and the provision of the necessary components that arrive at the factory itself.

3. An approach that integrates organizational processes for knowledge management (OPKM) and software development by outlining how these processes can be established. This process established a new organizational model and approach by combining the managerial process with the knowledge management life cycle. This method includes distinct milestones of realization at which everyone can exchange information and gain new knowledge along this path.

4. An approach for integrating numerous algorithms during the implementation of the parking procedure within the car (INAP). This approach's foundational components include machine learning, edge-to-cloud continuum, IoT, and a variety of parking applications in parking lots. The primary purpose of developing this technique is to better understand the development of software that processes specific video information while adhering to legal constraints.

In addition to the aforementioned approaches, research makes several analytical contributions. This includes standards, software engineering, logistics, learning process organization, knowledge management, and so on. These contributions help propel and sustain the automobile industry by promoting innovation, efficiency, and competitiveness in a constantly changing global market. All these contributions can be presented shortly as follows:

1. Standards: contributions to the automobile industry include a summary of the development and implementation of standardized protocols for manufacturing processes, safety regulations, emissions control, and automotive component exchange. Understanding these standards is essential for ensuring quality, safety, and compatibility across the many stages of vehicle production and use as a finished product.

2. Software Engineering: This includes a wide spectrum of contributions to the state-of-the-art, from understanding the evolution of embedded systems for vehicle management and diagnostics to developing compliant software with CI/CD. Software engineers in the automobile sector build, test, and optimize software solutions to improve vehicle performance, efficiency, and user experience.

3. Logistics: Contributions in this area had the objective of optimizing supply chain management by linking software engineering, distribution networks, and inventory control systems in the automotive sector. This entailed simplifying the flow of raw materials, components, and finished

cars to assure timely delivery, lower prices, and less environmental impact through efficient logistics operations.

4. Learning Process Organization: This refers to endeavors aimed at enhancing training programs, knowledge transfer, and talent development inside the automotive industry. Contributions span a variety of approaches for continuing professional development that empower employees and improve organizational capabilities in response to changing market trends and technology breakthroughs.

5. Knowledge Management: In the automotive sector, knowledge management comprises capturing, sharing, and applying domain knowledge. Where insights from many roles, departments, and stakeholders within automotive firms drive new value in software development. Contributions include the development of knowledge processes such as repositories, collaborative tools, and best practice frameworks to facilitate information exchange while encouraging innovation. All of this leads to long-term improvements in product development, production operations, and customer service.

2 Software Compliance in Autonomous Vehicles

The belief that every problem can be solved with acceptable technical solutions has been reinforced by the apparent benefits of technological developments that supposedly address these difficulties. As a result, certain organizational procedures are designed to achieve technical success, even if they occasionally raise emerging ethical quandaries. This conflict is commonly articulated through the use of checklists, processes, and assessment metrics to simplify complex ethical dilemmas into simple engineering tasks.

However, this optimism must be balanced by the understanding that many obstacles, initially portrayed as technical problems, may eventually prove ethically insurmountable. When faced with a slew of conflicts, the emphasis shifts from technological prowess to dealing with ethical issues that resist simple resolution. The automotive industry is increasingly turning to security standards to manage complex production environments [1], reduce costs, and improve quality levels. The ability to implement innovative technologies [31] is spread between several specialized IT teams and between companies located within the supplier network.

This requires a transparent plan, a classification scheme, and a structured organization. Classification is critical to system security and must be organized in a way that meets the standards of complex industrialized provision of IT services.[1]

2.1 The Government's Priorities to Achieve Technological Transition

Rapid economic progress will be achieved in many countries to achieve a technological transition and the desired trend of automation of autonomous vehicle production by achieving the fourth and fifth degrees of independent vehicle management by artificial intelligence. Testing processes are largely taking place on public road infrastructures in the world's currently most industrialized countries. There is a strengthening of competition through the creation of better conditions and support infrastructure for technology testing [4].

It is necessary to emphasize the importance of traffic efficiency and relatively simplified transport of individuals and goods with harmonized regulations that will apply to this type of vehicle in the future. Consideration of future integrations of autonomous vehicles in an everyday application is related to improving the technologies of traffic control algorithms, increasing the safety of traffic participants,

[1] This chapter is based on my published papers [25, 32, 33] to which my contribution is greater than 70%.

reducing traffic congestion through control of traffic signal time interval regulation, and increasing the level of road safety. It is necessary to connect mobility with existing infrastructure and the construction of a new infrastructure environment due to the accompanying requirements.

With the gradual development of technologies, autonomous vehicle vehicles are increasingly integrated into traffic, creating a new reality. Within this paper, different governments' priorities are considered through the necessary application of legislation that requires certain conditions that differ from case to case. Governments have different starting points on the legal framework or regulation of the necessary transport infrastructure. Based on this, a regular process can be seen to obtain a license and the ability to manage new forms of vehicles [34].

2.2 Development Responsibilities for Compliance

Because software is the foundation of today's business operations and everything we use today, it creates software bugs that may have long-term and far-reaching consequences. Therefore, the enforcement of software standards is strict, and the potential cost of infringement is also very high.

Achieving compliance along with your industry standards is in the best interests of everyone involved in software development - from regulators and auditors to executives, the legal team, HR, PR, and everybody else. However, only a team of participants can create code that conforms to software standards.

The entire organization expects your development team to announce that they are producing compatible software. It is up to you to assist them not only in the suitability of the software coding and testing standards, but also in meeting all compliance requirements. An example, which can be taken as a line, is information from a document on NATO operations, in addition to the preparation of software that, in addition to certain internal standards with world standards [35].

2.3 Summarization

Within this chapter we managed to summarize the requirement to understand current standards and technology to achieve worldwide compliance. In a competitive market where certification ensures compliance and quality preservation, it is evident how important it is to adhere to the standards of the automotive industry from the design of the product to the completion. The findings emphasized the necessity of digital standardization and reliable ICT in improving technology and ensuring future access to innovations.

We attempted to cover a wide range of perspectives to identify a repeating theme in the ethical consequences of technical progress, and as a result, we can advise against putting technology solutions ahead of human values and instead argue for policies that promote the common good. In addition, we would need to examine government objectives in technology transitions and express ethical concerns about the rapid economic progress led by automation and artificial intelligence. This must expose and address ethical issues regarding government monitoring and the maintenance of bias and injustice in AI systems, all while advocating for ethical frameworks that value fairness, transparency, and accountability. In general, the philosophy of this study highlights the importance of ethical considerations in generating technological discoveries that are compatible with human dignity and social well-being.

3 Code Analysis for Software Compliance

The sentences spoken by MIT professor Hal Abelson remained written with the formulation: "Programs must be written so that people can read them and only by chance can they be executed by machines" [36–38]. His lectures (professor Hal Abelson) [36] were designed to avoid the requirement to run code, even though they are held in an atmosphere where developers have two completely different audiences. Compilers and interpreters prioritize the simplicity and intelligibility of all syntactically correct programs over comments. The readership is broad, and while certain programs are more difficult to understand than others, we demand comments and critical thinking to comprehend them.

In recent years, there has been significant study on automated analysis and testing in numerous industries to address technical debt. Automated code analysis tools can be used to perform thorough scans of the source code. Identifying technical debt and vulnerabilities, such as code smells and security flaws. Regular penetration testing in CI/CD can imitate real-world attack situations and identify vulnerabilities in both software and hardware components such as CAN bus.

A systematic vulnerability disclosure system in the automotive sector can be implemented to encourage proactive reporting and prompt resolution of discovered roadside concerns. Comprehensive post-incident analysis can then be undertaken to delve into fundamental causes, while continual monitoring and robust patch management assure continuing protection against emerging threats [39].

Cloud-based solutions [40] require constant updating using DevOps techniques, and all this is required by networks based on the future use of the 5G/6G and modern software. All this includes the necessary implementation of continuous integration and continuous delivery/continuous deployment (CI/CD) solutions for various car manufacturers. In this chapter, we examine the processes faced by solution owners and global challenges during the development of unified CI/CD solutions and code analysis [41, 42]. CI/CD can be an adequate solution with elements created and implemented by many suppliers, such as the 5G/6G network.

A very complicated task for those who provide communication services is related to the installation of components from different vendors in the automation and configuration of the Content Security Policy (CSP). Multiple Site Scripting (XSS) prevention by inserting code to stop malicious content execution in terms of a reliable HTTPS website provides CSP as the leading standard of IT security [4]. Each identical part must perform correctly to provide an adequate process solution from start to finish. The CSP must be more efficient in terms of the challenges of a multi-CDN environment (content delivery network) [43] suppliers and thus take advantage of possible benefits. The implementation of security in life cycles is still delayed, but it is vital to stay current with current technology to reduce risks.[1]

This chapter contributes an insight into code analysis for software Compliance, providing useful information for assuring regulatory compliance and industry best practices. It investigates approaches for discovering and addressing compliance concerns via rigorous analysis, hence helping us in the development of resilient and compliant software systems using DevOps.

3.1 Estimations and Verification Techniques

Until recently, companies relied on sales data to investigate and focus on current purchasing habits. The evaluation notably covered evaluations, several promotions, expectations, development, and merchandising. At the moment, vast amounts of client information are absorbed and used for efficiency and practical improvement of their services, resulting in profit maximization, to stimulate or attract consumers by creating challenges for the retail industry.

In the face of fierce competition, new modeling approaches help marketers gain flexible and relevant customer insights, allowing them to learn about their clients' preferences and interests. They are the most important components in increasing service efficiency and customer satisfaction when purchasing. Statistical analyzers, books, and other valuable tools help developers write code. Based on this, we can identify one of the most important goals:

- The truth is that the value of any tool is determined not by the number of identified flaws but by the quantity and quality of those that can be repaired. Orientation refers to the appropriate address and detection of issues that can be corrected.
- We quote Peter Vogel [47] who said the following: "Maintaining and writing comments can be costly. Your compiler does not check your comments, so there is no appreciation for determining if the comments are correct. On the other hand, you are guaranteed that the computer does exactly what your code tells it to do. Although all these points are correct, it would be a mistake to travel to the opposite extreme and never write comments".
- Using security analysis and program testing as a pre-implementation checkpoint is inefficient as it speeds up the creation of new code. Traditional application security specialists use security technology and focus administrative tasks on hands-on testing.

Based on the above statement, we can conclude that a certain amount of time is required to think about and develop acceptable designs that will allow appropriate maintenance operations. Human error is the main cause of death in more than 1.2 million cases each year, but with the availability and progress of B2C technologies from business to consumer, these traffic outcomes should be reduced. The US Department of Transportation (DOT) points out this, estimating that the implementation of V2Xs in traffic systems will reduce the number of deaths by approximately a thousand lives a year, reducing injuries to non-fatal injuries for 2.3 million people [48].

[1] This chapter is based on my published papers [1, 3, 26, 44–46] to which my contribution is greater than 70%.

3.2 Step Identification Using SCAT

Almost every organization has a significant amount of old code, wherein comes the use of modern SCATs (Software Composition Analysis Tool). These tools employ algorithms to assess complete programs in a variety of circumstances to generate good analysis. When the study begins, 100,000 errors occur, so tens of thousands of errors can be discovered when they occur. Many digital applications are the most commonly used and the most important multiplication processes. Cryptography and signal processing are heavy computer applications in which huge sections of the chip perform circuit multiplication for efficiency and speed [49, 50].

Since the invention of integer multipliers, designers have been required to implement a variety of multiplier architectures to meet the demand for efficient and quick design. Many of these structures employ complex algorithms to reduce the number of wires, shorten the critical section of the path, and minimize the number of building components. As a result of all this, more stringent testing is necessary to ensure that the multipliers are correct. After identification, it is necessary to evaluate the communication channel associated with the problematic subspace within the program. This method will search for channels, threads (mixing matrix columns), and subspaces at the same time. Multiplier designs include two basic components: partial product creation and summation [51].

The use of non-trivial and large multipliers has gained appeal in the sector of formal verification techniques because multipliers suffer from different limitations, such as the Boolean Satisfaction Problem (SAT) [52], decision diagrams (such as BDD, BMD) and Satisfaction Module Theory (SMT). Frequently, applications in these disciplines require determining the satisfiability of formulas in more expressive logic, such as first-order logic. SAT structures can be viewed as subroutines for Boolean logic expressions [53]. Scalability and the inability to test complex concepts are also issues. The viewpoint of constraint satisfaction addresses combinatorial issues with a large number of potential solutions, but certain predefined constraints rule out the majority of these solutions. To express this precisely, we need to consider the use of two samples: graph coloring and scheduling.

Graph coloring is an example of artificial computing, but many real-world problems can also be expressed in terms of satisfiability. Reverse engineering methodologies support structurally simpler multipliers. Incomplete automation is associated with the phrase copying technique, and the need to apply a realistic approach regarding the results of the Software Composition Analysis (SCA) is related to software development companies that usually do not have sufficient resources for research. Scarcity of resources limits the correction of thousands of failures in four-week sprints [50, 52].

In the world of autonomous vehicles, the issue of completing assigned duties can be efficiently managed by implementing a variety of solutions. These tactics may involve algorithm refinement, sensor capability enhancement, the implementation of robust fail-safe mechanisms, and the integration of advanced decision-making systems. Autonomous vehicle systems can adapt and enhance their performance over time by iterating on these tactics and taking advantage of advances in artificial intelligence and sensor technologies. Furthermore, increasing collaboration among industry players, regulatory authorities, and research institutions can help to build standardized procedures and best practices, improving the administration of complex tasks in autonomous driving scenarios [54]. Some of the strategies can be presented in the following way:

1. Not all error categories have the same weight. It is necessary to recognize which classes of defects are less valuable and which are critical.
2. It is necessary to separate the activities of dealing with the "backlog of defects" from the newly emerging shortcomings that have been present in the code for some time.
3. Not all fault reports should be corrected, but they should be reviewed in each relevant category. There are criteria to delay correcting and accepting lower-priority items until later. The need for transparency with acceptance criteria is an important factor in purchasing. Loss of credibility is linked to overevangelizing the quality of results.
4. The focus of developers on solving rather than reviewing many shortcomings is related to special audit teams that give priority to identified errors.

3.3 Summarization

In the course of our study, we discovered a convincing link between philosophical principles and modern software development processes, based on our experience as software architects and business components related to development philosophy. Given that this chapter is about technology, multidisciplinary collaboration reflects the dialectical tradition among developers.

This judgment should emerge as crucial in navigating the complexities of code analysis and automation with the future use of CI/CD. The application of automation and machine learning techniques stands out as revolutionary, aligning with the philosophical problems of knowledge acquisition and comprehension discussed in this chapter. On top of that, our findings have shed light on the importance of code presentation, stressing clarity and elegance.

As an evaluation and crucial factor, we would emphasize the ease of collaboration and the preservation of code quality. This includes using current software to evaluate the accuracy of compliance checks, determining the efficacy of identifying transgressions, and calculating the overall impact on software quality. Execute tests against short software code snippets. To acquire a better understanding, we designed smaller tests that can be conducted with existing tools. This part of the examination revealed higher-level application possibilities as well as cloud storage choices.

4 Software Compliance in Autonomous Vehicle Manufacturing Based on a General Repository

The processes for standard compliance are specified within the production line, both physically and software-wise. It specifically refers to determining the requirements established by international organizations for standardization. In our instance, it is important to meet duties for the delivery of safe and stable software. Most standardization processes are defined by a team of experts who jointly plan the achievement of certain goals covering aspects inside and outside the vehicle.

This new approach, called by acronym (GRCopOps), should provide a clear road ahead for future compliant software development. More specific information is provided in the following sections, where the new organizational strategy proposed to apply the repository is discussed in greater detail through the introduction of a new notion to activate the static and dynamic components.

4.1 Achieving Compliance Using General Repository Compliance Operations

Each organization should conduct a thorough review of where it is now in its IT modernization journey, as well as where it intends to go. Companies in the automobile industry can then construct a roadmap with a timeline. Those in charge of implementation must keep strong and flexible thinking as the final aim, as well as the continuing mentality. Any modernization plan should evolve as it progresses to stay up-to-date. In the future, we want to believe that the ideal mindset for this is repository compliance operations that involve collaboration. For this reason, we propose the following new acronym that emerged during this investigation:

General **R**epository **C**ompliance Operations - **GRCopOps**

The initial conceptual characteristics of GRCopOps are as follows:

- creation of the conceptual architecture of the general repository and the way of realization of communication of the software team that relates to knowledge management life cycle (Figure 5.2).
- Connecting the client to the general repository previously defined by the automotive company.

- Conceptual scaling of resources depending on the need for testing different standards, with the possibility of dynamic creation of microservices and other artifacts for this needs.

The main idea behind this acronym is to achieve synergy and speed up the process of standardization of software within autonomous vehicles. However, utilizing it is full potential should be the correct way for the organization's strength and success, not because it is mandated by many standards organization. Although there may be a lack of confidence, this seems confusing today. However, the main idea itself symbolizes the future of software compliance and has the potential to revolutionize how technology evolves to adapt to new missions, goals, and end-user needs. Future software factory adoption, as with other comprehensive organizational improvements, should begin with an assessment.

4.1.1 Prerequisites

For our prerequisites, we looked at the use of the Windows operating system and the Linux environment as a criterion to run and test our laboratory environment. Where in the world Windows container orchestration necessitates precise parameters for a smooth deployment, such as adequate modern CPU resources for fast container operation and enough RAM to appropriately manage concurrent workloads. Storage capacity is needed to store container images and accompanying data, on a hard drive or an SSD. A well-designed network allows containers and orchestrators to communicate more easily [55].

Compatibility with containerized Linux and Windows Server versions is required, as well as Docker Engine for Windows. Depending on your requirements and workload, Kubernetes or Docker Swarm can serve as orchestrators. These requirements must be met to ensure that Windows containers run smoothly and successfully in a variety of computer environments.

According to the most recent information, the requirements for container orchestration can be classified into the following categories [56]:

1. Operating system requirements
2. Virtualized container hosts
3. Memory requirements

As a result, we must meet the following basic requirements:

1. to have a central processing unit (CPU) that supports AMD or Intel virtualization (x86/x64).
2. Virtual machines (VMs) require a host system with a minimum of one CPU and two processing cores.
3. 4 GB of memory on the host machine for container virtualization (Linux, Windows Server 2022, or Windows 10/11).

4.1.2 Architecture Design Context

This section presents the current first version of the structure, as well as the process of compliance with the standards, which includes the production of dynamic and static sections from the general repository. One of the findings of this study was the creation of a new technique and terminology to achieve compliance with standardized software and specific standards. The latest structural architecture proposal (Figures 4.1 and 4.2) includes new variable proposals that are part of the new General Repository Compliance Operations (GRCopOps) acronym method. A further option would be for the user to create a workflow-specific file within the user repository. Then the client repository would contain yml code as well as limited Python code execution capabilities.

Figures 4.1 and 4.2 contain a proposal for processing dynamic and static requests within the process itself, which could be completed within different cluster environments. Therefore, it relies on the previously created infrastructure. General Repository Compliance Operations represents a new approach and acronym with the name GRCopOps.

The initial conceptual characteristics of GRCopOps are as follows:

- design of the general repository's conceptual architecture and method of software team communication related to the knowledge management life cycle shown in Figure 4.1).
- Connecting the client to the general repository previously defined by the automotive company.
- Conceptual scaling of resources depending on the need for testing different standards, with the possibility of dynamic creation of microservices and other artifacts for this needs.

In the figures 4.1 and 4.2 mentioned is a certain series of steps that represent the direction of movement depending on the source and part of the execution.

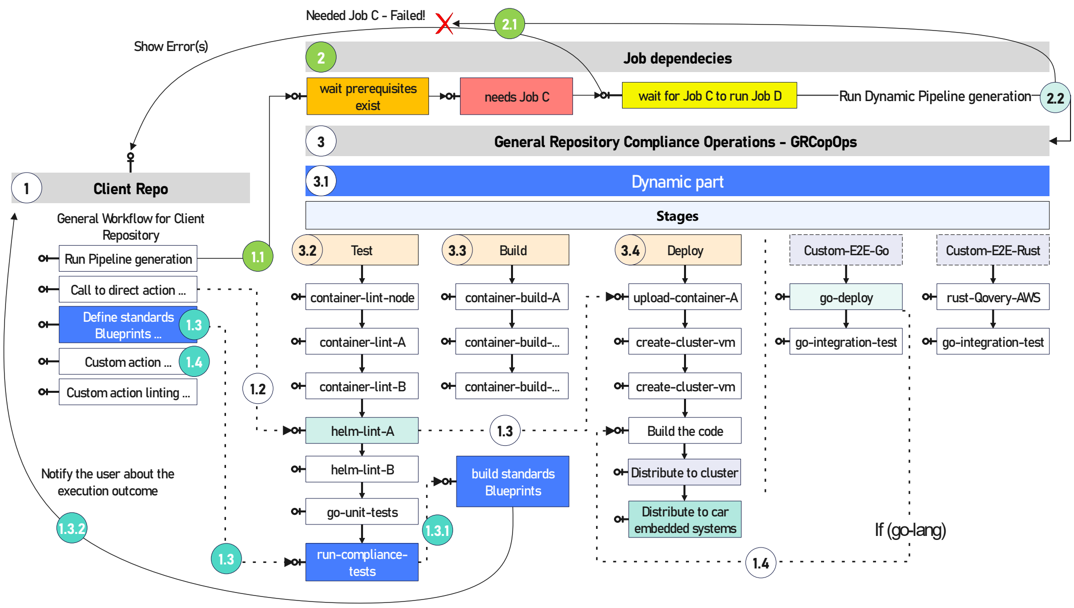

Figure 4.1: Dynamic part - General Repository Compliance Operations - GRCopOps.

The steps can generally be described and shown in the following way:

- The first step on the left is a repository that calls a specific action
- Step 1.1 implements the execution and invocation of certain prerequisites required by certain tasks
- Step 2 carries out the implementation of the tasks and what may be waiting for the next task and after that, it is implemented. Within this step, Dynamic or Static execution mode can be realized, which depends on the initiated action within the CI/CD line itself.
- Step 3 follows, in which conventional tests and tasks are implemented in three stages: test, build, deploy, or custom stages defined by the developer and the manufacturer of a specific brand of automobile.

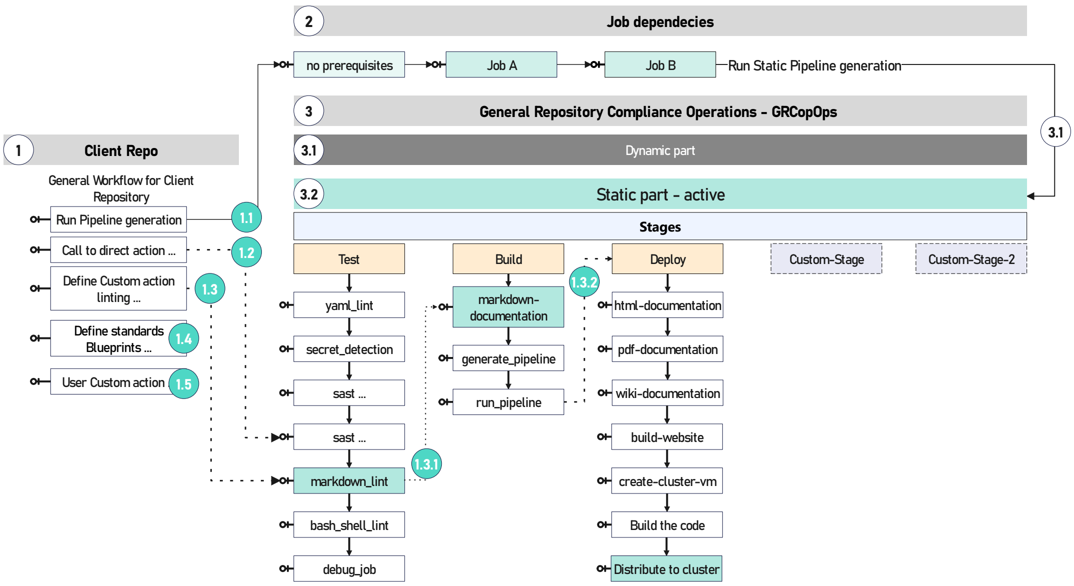

Figure 4.2: Static part - General Repository Compliance Operations - GRCopOps.

The primary goal of this phrase is to achieve synergy and speed up the process of software standardization. However, using its full capability should be the greatest way to improve the organization's strength and profitability, not because several standards organizations need it. Despite the lack of confidence, this appears perplexing today. The core concept, on the other hand, symbolizes the future of software compliance and has the potential to change how technology evolves to meet new objectives, goals, and end-user requirements. Future software factory adoption, like other major organizational upgrades, should start with an assessment.

4.2 Evaluation

For the evaluation scenario in this chapter, which covers software distribution for autonomous vehicles, we focused on user experience (UX) with CI/CD evaluation to provide a smooth and intuitive upgrade process for vehicle owners. This evaluation was realized by students from our faculty in the form of several questions and tests [41]. This evaluation ensured a seamless update process and a better understanding of the complexity of the problem and the requirements from the industry.

The first basic scenario we tested was based on an attempt to create a repository containing one standard with the help of search engines and a time frame of 60 minutes and successfully execute it. The result obtained was that only 1% of the students got half-hearted execution, while in the cases of the previously defined repository and our approach, we had approximately 50% success in application.

Feedback from surveys and forms gauged clarity and satisfaction for our approach. Error handling and accessibility were scrutinized, ensuring inclusivity and resilience in the long run. Iterative design cycles refined the interface based on feedback, enhancing usability and user trust. This comprehensive evaluation optimized the software distribution process, fostering a positive user experience. We updated the interface based on user feedback using iterative design cycles, improving usability and creating trust in our approach for future use. We thoroughly evaluated error handling and repository accessibility, emphasizing reliability in the current version.

The evaluation technique involved analyzing quantitative survey data as well as qualitative insights from user feedback forms. Conciliating differing user viewpoints and reconciling feature requests with usability criteria proved challenging at times of first GRCopOps draft. Despite these limitations, our iterative process enabled us to emphasize student-generated solutions that can effectively meet customer needs and expectations. This technique allowed us to uncover weaknesses and issues that were not as clear to us, due to prior familiarity with the subject. Based on this, we made a number of revisions and enhancements to the design of the proposed method. Another metric was measured in terms of the time it took to discover the relevant material and use it directly throughout a one-hour period.

Users initially attempted to execute a standardization process independently, but encountered difficulties, particularly in determining the essential standards within a reasonable timescale. These problems highlighted the complexities of coordinating diverse perspectives and matching feature needs with usability criteria. Nonetheless, our iterative strategy allowed us to focus on changes that users valued, optimizing software distribution and creating a great user experience.

The evaluation entailed giving the system with a sample database including thousands or even millions of elements, such as photos, written documents, or numerical data points. The system was assessed by students based on its ability to efficiently search, retrieve, and process relevant information within the time limits. Furthermore, the evaluation evaluated the system's performance under diverse levels of computational resources in CI/CD, such as different hardware configurations or network circumstances, to determine its scalability and robustness in handling large-scale data processing assignments from our students.

5 Organizational Process for Knowledge Management in Autonomous Vehicle Manufacturing

A professional architect is unlikely to start construction on a skyscraper without a blueprint. Similarly, a software architect/developer would not code an application unless they had a clear understanding of what they wanted to produce. Why is this the case? Because an application can only function if it is designed for scalability, security, and execution. Throughout human history, storytelling has been a vital instrument for social interaction and knowledge transfer. It has also been recognized to have several advantages as an instructional method, such as increasing learner involvement and making learning content more memorable, as well as boosting learner engagement.

Identifying how the process improves efficiency, quality, customer satisfaction, or other key metrics underscores its role as a pivotal asset within the organization's framework. A well-rounded narrative is not complete without highlighting success stories. Highlighting instances where the process bore fruit adds credibility and showcases the tangible impact that the process has in real-world scenarios. We seek an efficient automated solution to update production pipelines quickly and reliably. Therefore, developers may quickly explore new ideas for function engineering, model design, and hyper-parameters using an automated CI/CD framework. They can carry out the model-building process, validate code in the repository, produce deployment packages such as scripts and packages, and deploy new piping components to the phasing/production environment. In the manufacture of autonomous vehicle and any other final product, effective knowledge management (KM) is critical. The complexity of designing, manufacturing, testing, and deploying autonomous vehicle requires seamless communication between all parties involved in the manufacturing process.

5.1 Logistic Problems and New Logistic Approach

Because there is such a high demand for automotive products, they are produced all over the world. To be successful, small enterprises that control global supply chains must employ business modes that integrate telecommunications technology, software platforms, and cross-border commercial activities. Effective administration and management of vehicle supply chains are achievable thanks to technology solutions, such as contemporary information systems, which are available to organizations through cloud computing [57]. The entire process can be explained through the presented steps (1-6) within the Figure 5.1 where the displayed legend shows the entry and exit process of the movement of goods, starting from the original producer to the end customer (6.2).

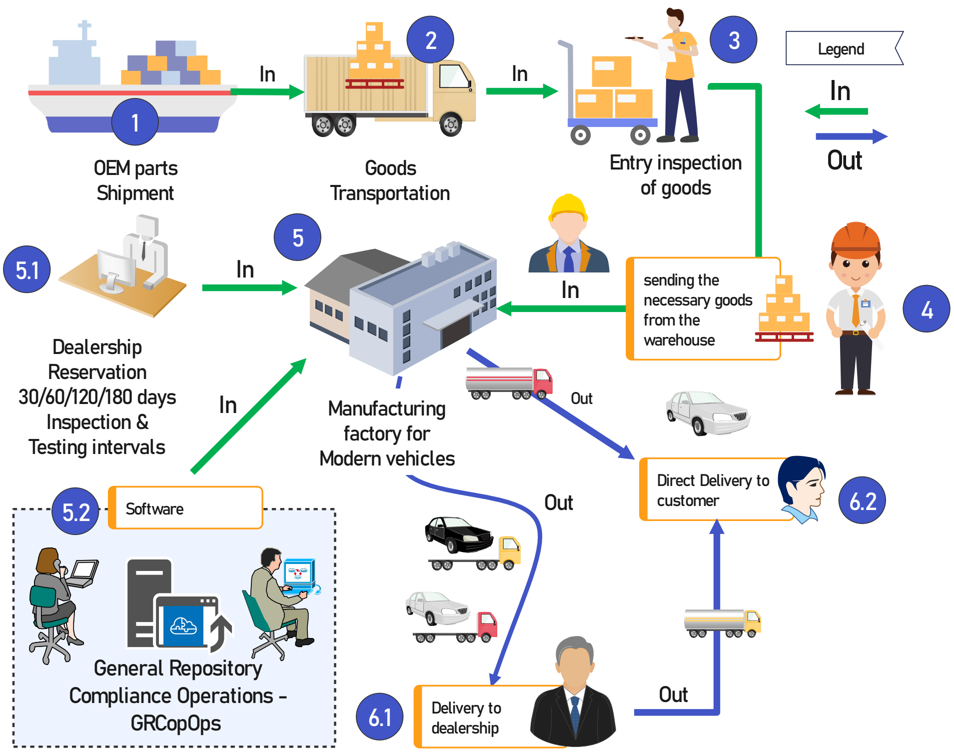

Figure 5.1: The automotive industry and the supply of final products to the automotive supply market (AutoSupMkt).

A new logistic approach to the automotive supply market (AutoSupMkt) shown in Figure 5.1 approach addresses issues in the automotive sector, drawing out the processes involved in selling finished products to the market. The process specification outlines the essential steps in the manufacturing process, as well as the provision of the necessary components as they arrive at the factory.

Profitability and efficiency are necessary for the vehicle placement market. The key provision of these preconditions is made by business management, whose role is to create an environment for the reduction of supply chain links, which will shorten the delivery time of the final products. For a good approach in the processes of business coordination [58] and the success of the step of supplying raw materials, a strategy that refers to each of the stages of production of goods and provision of services is necessary. In this way, producers will minimize barriers to business and achieve higher profits.

The basis of the existence of automotive engineering is reflected in the creation of vehicles' transportation forms on the basis of which internal and external logistics processes could be realized. By considering the economic aspect and logistics, a more efficient alignment with existing market requirements is created. Logistical problems and marketing of final products can represent success/failure for certain producers due to inadequate planning of necessary materials in production cycles. The logistics of product supply are becoming more complex due to the needs of companies on a global level and the presence of various new market requirements [59].

5.2 New Organizational Process for Knowledge Management

The new organization model OPKM approach of applying organizational process with Knowledge Management Life Cycle has the idea to be used within the production process. So, that the information can be structured into several crucial aspects that cover and apply the knowledge of all workers in the factory [25, 32, 60]. That is why efficient information and knowledge management is very important for the production of autonomous vehicles (Figure 5.2).

The new organization model of applying organizational sciences with the use of Knowledge Management Life Cycle for autonomous vehicles hardware and software production. A proposal for a process that should be implemented in six steps to minimize the impact of security breaches by enabling a clearer development cycle with more different aspects. The name of the defined method in the form of an organization model approach is OPKM (organizational process for knowledge management)

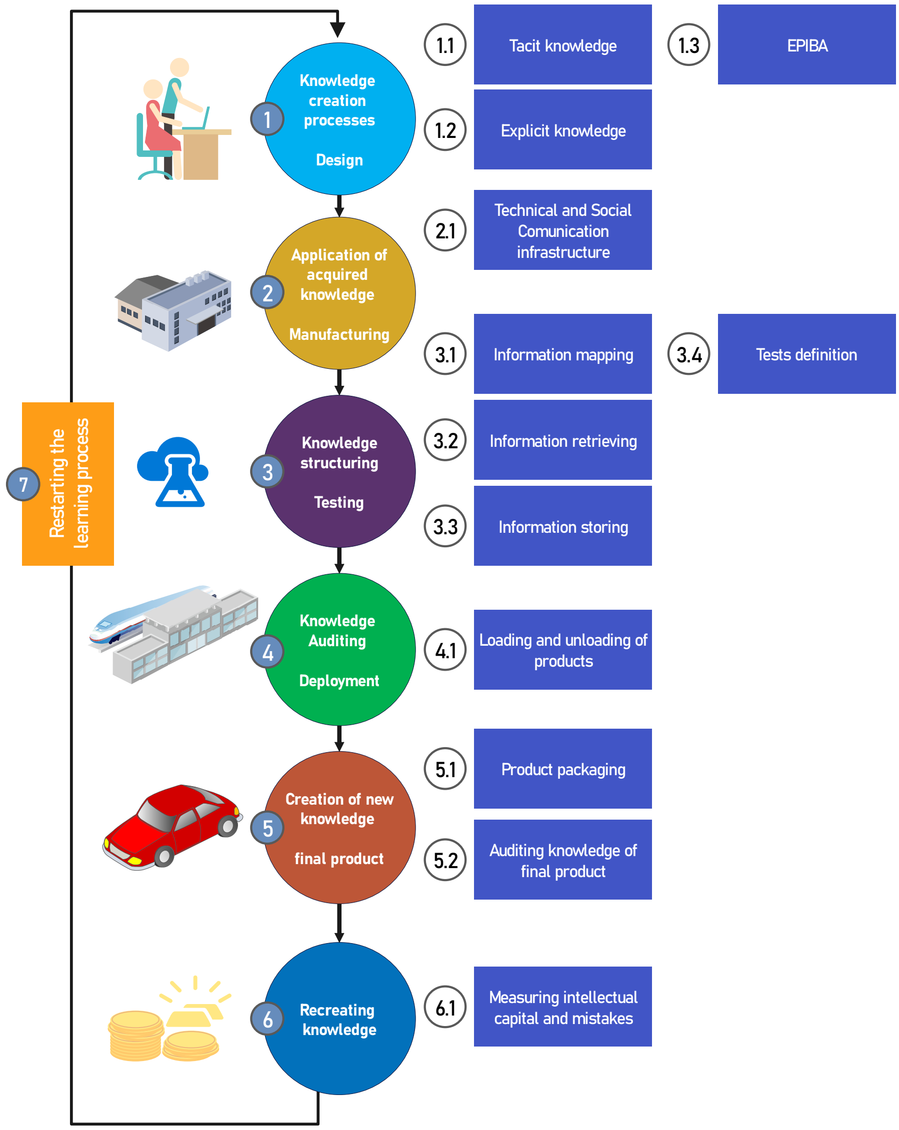

Figure 5.2: New organizational process for knowledge management – OPKM. Source: author's contribution

The process itself with the steps presented is explained further in the following:

1. Knowledge creation processes – Design: Throughout the design process, substantial data from numerous sources, such as customer requirements, regulatory standards, environmental conditions, etc., must be collected and structured systematically to develop reliable autonomous vehicles systems. This section includes and makes use of the following knowledge: explicit and tacit knowledge.
2. Application of acquired knowledge in manufacturing – Various stages: In the manufacturing process, such as assembly line operations with multiple robots working autonomously, require accurate instructions or programs delivered at precisely defined intervals as a result of efficient data flow management throughout these phases.
3. Knowledge structuring – Testing: During various scenarios, such as extreme weather conditions or unexpected events, such as system failures or accidents, rigorous testing is required. Analysis tools should be available within a complete knowledge base accessible to all key stakeholders to execute complete testing protocols and properly analyze test results using statistical methodologies.
4. Knowledge Auditing – Deployment: Following the successful completion of the development stages, the deployment of an autonomous vehicles on the roads requires compliance with regulatory standards and legal issues while maintaining the safety of passengers and other road users. The effective handling of information is critical to meeting these objectives.
5. Creation of new knowledge – Final product: During the use of the vehicle, information is collected and new knowledge is gained that can be subsequently used in the construction of a new series of vehicles. In addition, new knowledge is created and current knowledge is enriched in this manner.
6. Recreating knowledge – Education: the process of the collected knowledge is repeated, and in this way the quality of the acquired knowledge is increased.
7. Restarting the entire learning process.

5.3 Evaluation

Within the evaluation scenario, we assessed the effectiveness of methods for learning and mastering new knowledge in the context of autonomous vehicle manufacturing and integrated software production. Employees learn new skills and expertise through structured training programs, workshops, and mentoring sessions. In this case, in cooperation with students and interested colleagues, we tested their progress in use CI/CD. Their process of evaluation we monitored through quizzes, and practical application activities. Also, we have used feedback loops and continuous improvement processes to improve learning methodologies and assure mastery of new information with our approach.

We had to delve into two additional scenarios:

1. Simulation-based Learning Evaluation: In this example, employees/students/testers participate in immersive simulations that mimic real-world scenarios, allowing them to apply theoretical knowledge in practical settings. These simulations represent assembly line processes, software integration issues, and real-time decision-making scenarios. Recognizing the complexities of autonomous car manufacturing and software integration, we established simulation-based learning environments.

   This approach allows us to assess performance, decision-making efficacy, and adaptability in dynamic CI/CD situations. Metrics like completion time, error rates, and decision accuracy are quantifiable markers of learning progression. Additionally, qualitative feedback from testers and mentors sheds light on individual learning experiences and opportunities for improvement. Simulations allow us to continuously evaluate training programs, identify skill shortages, and personalize learning experiences to specific jobs in autonomous vehicle manufacturing and software production. By incorporating feedback loops and performance statistics, we ensure that employees learn the skills needed to succeed in their particular fields.

2. Cross-functional Collaboration Assessment:

   Given the interdisciplinary nature of autonomous car manufacturing and integrated software production, we see cross-functional collaboration as an essential component of learning and mastering. To assess the effectiveness of cooperation abilities, we organized multidisciplinary projects in which testers from several departments worked together to solve complex challenges. These sample projects represent real-world scenarios in which software developers, mechanical engineers, data scientists, and quality assurance professionals work together to optimize production processes. Teams use collaborative platforms and project management technologies to communicate, exchange resources, and coordinate efforts to meet project goals.

Evaluation criteria include communication effectiveness within an hour, collaboration dynamics, information sharing, and collective problem-solving ability. Observations during project execution, peer reviews with us as mentors, and post-project reflections provide useful information about individual and team performance. Feedback from cross-functional teams guides the development of mentorship sessions and collaborative learning projects. By encouraging interdisciplinary collaboration in software development, we ensure that everyone has the technical and soft skills required for seamless integration in autonomous vehicle manufacture.

6 Parking Occupancy Detection Based on Multiple Algorithms

In modern parking management systems, the convergence of IoT technology and edge-to-cloud continuity has triggered a paradigm change, resulting in creative ways to improve various parking applications within lots. Real-time occupancy status data can be easily exchanged across the edge-to-cloud continuum using IoT-enabled sensors strategically installed throughout parking facilities. This integration enables the efficient allocation of parking spaces, monitoring of parking length, and the facilitation of automated payment systems. Additionally, synergy continuity enables interaction with navigation apps, leading cars to available parking spots, and decreasing congestion. In addition, by incorporating this technology, we can improve security by continuously monitoring parking lots for suspicious activity. This holistic strategy alters parking management by increasing space use and improving user convenience, turning parking lots into intelligent, connected areas.

6.1 Tying Everything Together and Combined Approach in Parking

In this section, we were able to give a conceptual proposal for our novel technique for combining various algorithms during the implementation of the parking procedure within the car (INAP), as well as some early assumptions about the future solution shown in Figure 6.1. Based on our findings, we can propose a four-phase solution:

1. Image pre-processing
2. Motion tracking
3. Image segmentation
4. Categorization

The initial stage of implementation was to prepare the dataset utilized for training. Since we chose to integrate the PKLot and CNRPark+EXT datasets first, we needed to harmonize them such that we could import photographs from either at random. We created a csv file with the path to each image file and a label indicating whether the parking area is empty or occupied, as shown in Listing **??**. We choose to use the pandas in Python to create our labels.csv file from a pandas dataframe.

The CNRPark+EXT dataset included a.txt file containing the relevant URLs and image labels. However, each image needed a parent folder prefix. We also needed to extract the label information from each line of text and incorporate it as a separate column in our pandas dataframe. Based on the information received, we had the chance to establish our dataset and a framework for further development with physical hardware and software[61–64].

Figure 6.1 provides a simplified depiction of the algorithm, which consists of 5 phases divided into two sections, A and B, as discussed below. At each phase, there are two views of the scene: the color image (A - parking lot road) shows how we see it, while the black-and-white image (B - computer detection system or embedded system on a chip) shows how the algorithm sees it. In the color image, the car can be one of three colors: yellow if it is in motion, green if it is just parked, or green if it is already parked on stage. While in the case of a car under the letter D you can see the situation of applying the access itself inside the camera that the vehicle has.

When the item reaches the OOI threshold, we start tracking it to the end destination Figure 6.1 (steps 1-3). The scene in the computer's "eyes" appears to be a black background with a white item moving across it. When the OOI arrives at its final destination, it follows the tracks and we save its scene (steps 3 and 4). By integrating the scenes of all OOIs, we can obtain a global image and hence a clear picture of the number of vehicles parked in the parking lot (step 5). This allows us to determine the vehicle's position in relation to the parking lot as well as its proximity to other vehicles.

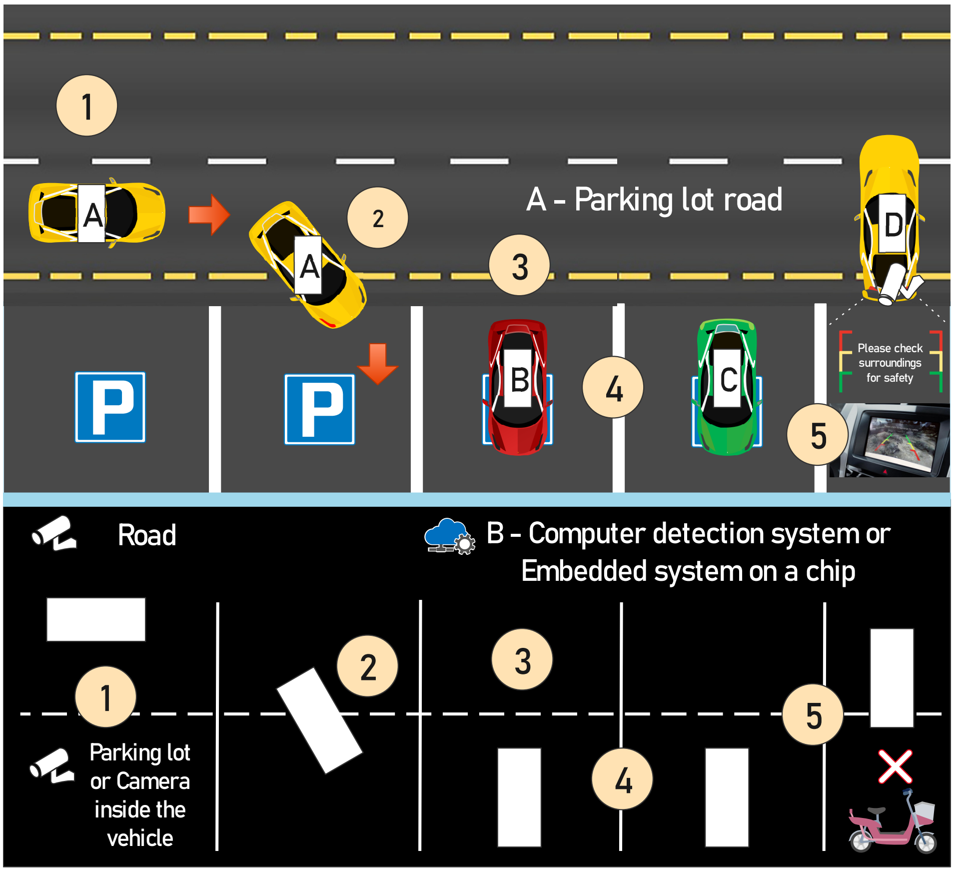

Figure 6.1: Combining various algorithms during the implementation of the parking procedure within the car (INAP).

The application can be used inside the vehicle, in a parking lot with static cameras, or in Internet of Things (IoT) devices. After detection, the information is saved in a particular scene that depicts the discovered information in the matrix coordinate system, which is utilized to save it for later processing. It is common for the vehicle entering the scene, vehicle A, to be obscured from the camera angle due to the presence of another vehicle on the scene, vehicle B. As vehicle B leaves, vehicle A becomes visible, and the newly discovered part of the vehicle, vehicle C, is not always recorded at the scene when parked.

One solution the proposed INAP approach can be presented with the use of a combination in algorithms. This can be presented with the following categories of algorithms:

1. Random Assignment and Combination of algorithms using K-Means to obtain the ground truth
2. grayscale images of parking cells
3. tracking using the Gaussian mixture model
4. speckle detection methods
5. the watershed segmentation algorithm [65]

Based on the vehicle's position, it can display the newly identified part. After that, a specific cut might be used to provide the greatest results. By combining algorithms, the best qualities of each method can be obtained based on the weather conditions and vehicle requirements encountered during parking.

6.2 Evaluation

The evaluation process was carried out using a system that included a different scene for each and every OOI (object of interest). Regardless of the objects present, each new OOI would start with an empty scene (empty background). It would be necessary to investigate objects that piqued our interest. Vehicles come in a variety of shapes and sizes, and it is not uncommon for some to hide others' views to the point that only the roof, front, or back of the car is visible. Even then, it will not look like a biker or pedestrian. This is precisely what may be used to improve the threshold for OOI.

The detection computer system depicted in Figure 6.1 (B - computer detection system) could be developed in the form of smaller microservices that are placed inside the cluster and started depending on the load and the demandingness of the operation. The software development method involves training and testing the detection model using a CI/CD pipeline [25, 26, 41, 42]. Based on these scenarios, the possibilities of combining or using only certain algorithms were tested to increase the level of detection and the success of the implementation of the parking process itself.

The fundamental premise of this system is to monitor movement in the parking lot. Motion can be defined as the difference between two (or more) pixels in the same scene. The simplest method to detect motion is to subtract the modified frame from the original. The outlines of the moving object can then be obtained simply by identifying the differences between the frames. To avoid detecting movements that we are not interested in, such as tree limb movement or light changes in the scene, we must first investigate and then set a suitable threshold that eliminates these events.

7 Discussion

To generate and advance novel ideas and solutions, we must have a clear direction for our investigation and the breadth that we want to cover. The chapters and parts that follow will present and go into detail the conclusions based on these inquiries that we have defined in the research method by using research questions. As we hoped to see, a brief analytical assessment of the understanding of the discovered findings is presented in each chapter to help the reader better understand all the intricate parts of this complex research.

Collaboration and discussion between business interests, regulatory organizations, and research institutions would be encouraged to drive innovation and improve validation standards. Future discussions will likely focus on the crucial importance of strong software validation methods in areas such as healthcare, banking, and automotive. Participants would provide ideas for incorporating research findings to improve product quality, safety, and regulatory compliance.

While discussing techniques for mitigating risks, improving efficiency, and addressing future difficulties in software validation, there should be greater emphasis on fostering collaboration to enable continuous improvement and innovation in software development processes. In general, the debate would most likely revolve around the use of research findings to improve validation methods, create collaboration, manage risks, and drive innovation in industries that rely significantly on software solutions.

As we look ahead, our research advocates a collaborative approach in which students and professionals can engage in continuous learning, adapt to technological developments, and contribute to the ongoing refinement of best practices. Monitoring serves as a vigilant musician, ensuring accurate execution, whereas deployment demonstrates excellent performance. This choreographed ballet represents the essence of agile development, in which every movement is essential, promising a captivating display of efficiency and innovation on the enormous stage of software evolution.

8 Conclusions

In conclusion, this research stands as a beacon of insight within the dynamic realm of the automotive industry. By delving into pivotal areas such as standards development, software engineering, logistics optimization, learning process organization, and knowledge management. Through actionable strategies and comprehensive analyses as main contribution, this research paves the way for enhanced efficiency, safety, and innovation. As the automotive landscape continues to evolve, the findings of this research provide invaluable guidance, empowering stakeholders to navigate challenges and seize opportunities on the journey towards continual progress and success.

During the research, we were able to contribute to the development of new approaches, such as the General Repository Compliance Operations (GRCopOps), a new logistical approach automotive supply market (AutoSupMkt), the organizational process for knowledge management (OPKM) to knowledge management, and a new approach for integrating numerous algorithms during the implementation of the car parking procedure (INAP).

Testing with standards complacency, along with other techniques to enhance software quality, is unquestionably one of the most powerful tools in the quality assurance (QA) armory. This requires effective progress management and monitoring to ensure that the method is carried out efficiently for each project phase with each version upgrade. The role of technology in the autonomous automobile assembly industry is distinct from that of the preceding categories. Understanding new concepts or technologies, standards, processes, and methodologies opens up new possibilities to develop and manage enormous volumes of software code. The outcome of creativity is linked to the direct consequence of scientific discoveries and the application of natural laws with the best profitability in mind for the future manufacturing process.

The most important component and recommendation for future research would be to focusing more on the organization of the software development process, with an emphasis on detection and image quality enhancement. This should increase visibility in a variety of environments, while anomaly detection increases safety by detecting unusual items or actions to save lives. We believe that a fascinating future awaits us, full with futuristic concepts and possibilities that are currently being developed.

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A Publications

Zoznam publikačnej činnosti/List of publishing activities
Autor: DAKIĆ, Pavle

Pedagogical Work

1. Software Modeling (MSOFT)
2. Team Projects (TP) I and II
3. Object-Oriented Programming (OOP)
4. Principles of Software Engineering (PSI)
5. Research in Intelligent Software Systems
6. Bachelor's thesis project I
7. Master's thesis project I and II

Reviewer in journals

1. Elsevier - ISA Transactions. ISSN (online): 1879-2022.
2. Elsevier - International Journal of Applied Earth Observation and Geoinformation. ISSN (online): 1872-826X.
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Editor of the proceedings

E_01 Technical Copy Editor - Proceedings of 10th Workshop on Software Quality Analysis, Monitoring, Improvement, and Applications, SQAMIA 2023. Bratislava, Slovakia.

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V3 Scientific output of publication activity in the journal

V3_01 ĆURČIĆ, Mihailo - TODOROVIĆ, Vladimir - **DAKIĆ, Pavle** - RISTIĆ, Kristijan - BOGAVAC, Milanka - ŠPILER, Marko - ROSIĆ, Milovan. Economic potential of agro-food production in the Republic of Serbia. In Economics of Agriculture. Vol. 68, no. 3 (2021), s. 687-700. ISSN 0352-3462 (2021). V databáze: WOS: 000709295300008 ; DOI: 10.5937/ekoPolj2103687C. Publication category to 2021:ADM

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V2_01 ALEKSIĆ, Marijana - **DAKIĆ, Pavle** - STUPAVSKÝ, Igor - TODOROVIĆ, Vladimir. Time and company management in cases of fake news within the automotive industry. In Economic and Social Development [Book of Proceedings] : 96th International Scientific Conference on Economic and Social Development - "Era of Global Crisis". 1. ed. Varazdin : Varazdin Development and Entrepreneurship Agency, 2023, S. 56-66. ISSN 1849-7535. Type of report: príspevok z podujatia; Report: zahraničný; Publication category to 2021:AFC

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XXX Uncategorized

01 **DAKIĆ, Pavle** - TODOROVIĆ, Vladimir - PETROVIĆ, Biljana. Investment reasons for using standard compliance in autonomous vehicles. In Economic and social development 2021 : Book of proceedings. Varaždin : Development and Entrepreneurship Agency, 2021, S. 219-228. ISSN 1849-7535. Publication category to 2021:AFC

02 **DAKIĆ, Pavle** - ŽIVKOVIĆ, Miodrag. An overview of the challenges for developing software within the field of autonomous vehicles. In ECBS 2021: Proceedings of the 7th Conference on the Engineering of Computer Based Systems. 1. vyd. New York : Association for Computing Machinery (New York), 2021, S. 1-10, art. no. 16. ISBN 978-1-4503-9057-6. V databáze: SCOPUS: 2-s2.0-85107196407 ; DOI: 10.1145/3459960.3459972. Publication category to 2021:AFC

03 TODOROVIĆ, Vladimir - **DAKIĆ, Pavle** - ALEKSIĆ, Marijana. Company management using managerial dashboards and analytical software. In Economic and social development 2021 : Book of proceedings. Varaždin : Development and Entrepreneurship Agency, 2021, S. 166-173. ISSN 1849-7535. Publication category to 2021:AFC

Statistics: publication category

V3	V3 Scientific output of publication activity in the journal	7
V2	V2 Scientific output of publication activity as part of an edited book or collection	17
XXX	Uncategorized	3
Sum		**27**

Statistics: category of feedback

1	Citations in foreign publications, registered in the Web of Science citation indexes and the SCOPUS database	39
2	Citations in domestic publications, registered in the Web of Science citation indexes and the SCOPUS database	3
3	Citations in foreign publications not registered in citation indexes Google Scholar	123
Sum		**165**